Video Engagement Effectiveness on Climate Change: An empirical investigation on university students

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Abstract. Climate change is one of the most vital issues humanity should deal with. Several natural disaster phenomena are greatly based on climate change. Awareness-raising towards its severity is a key goal in every aspect of our daily life; including education. The scope of this empirical study is to analyze university students' engagement perceptions after they watched a number of videos on this topic. Specifically, the study aims to reveal which videos are more effective based on students' demographics and their engagement perceptions towards them. Furthermore, it aims to reveal their general perceptions towards the utilization of YouTube videos in the learning process. A specific video selection procedure was conducted and an anonymous e-questionnaire was developed. Through content-based analysis, the average ratings of respondents' engagement perceptions towards 12 selected videos were calculated, providing a clear indication of the level of interest among students. These findings offer valuable insights to educators and content creators aiming to tailor their materials to diverse audiences and provide even more customized and effective video content on climate change. By identifying differences in engagement levels among different student demographics, the study provides actionable recommendations for improving the impact of online video content in climate change education.

1 Introduction

Climate crisis is considered as one of the most vital concerns of humanity as it poses a significant threat to the sustainability of life on our planet. Every single region on earth practically is affected by the severe impacts of climate change. Increasing temperatures are driving environmental destruction, wildfires, floods, rising sea levels, extreme weather conditions, polar ice melt, catastrophic storms, droughts, food and water shortages, as well as declining biodiversity are some of the consequences of climate change. Moreover, the climate crisis also impacts our health, housing, safety and work [1]. In the coming years, the number of individuals forced to relocate due to weather-related events is anticipated to increase [1]. It is more than obvious that global warming is primarily due to human activities that emit greenhouse gases, which adversely affect the atmosphere and the climate. What is alarming is that climate change takes place much more quickly than expected and it is predicted that this situation will persist unless immediate action is taken [2].

While large-scale policy reforms are crucial and up to now international frameworks and agreements to steer progress, including the Sustainable Development Goals, the UN Framework Convention on Climate Change, and the Paris Agreement have already set actions into three broad areas: reducing emissions, adapting to climate impacts, and securing financing required adjustments [1], increasing public interest and involvement in climate change issues is also essential to support eco-friendly policies and promote environmentally conscious behavior. Raising awareness and understanding of climate change can enhance participation in green practices [3].

Therefore, it is vital to find ways to inform individuals about the climate crisis and its consequences. With the decline in the reach of science content in traditional media, online communication channels have dramatically transformed the way individuals search for and comprehend scientific information such as climate change [4]. Numerous institutions and scientists are now utilizing social media platforms, such as YouTube, to communicate directly not only with their students but also with the general public [5]. Thus, social media platforms have become a rich medium for promoting science education in an interesting and engaging manner for users [6, 7]. These platforms allow for a wide reach and the ability to present complex information in an accessible and visually appealing way. By leveraging

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these tools, we can better educate the public on the urgency of the climate crisis and inspire collective action toward sustainable solutions.

2 YouTube, Climate Change and Video Engagement Effectiveness

YouTube is particularly well-suited for effective online science communication. As the world's largest video-sharing [8], among its top categories are science and technology videos. Studies show that many people use this platform to retrieve information on scientific topics [9]. Therefore, these videos are watched for a total of almost 777 million hours monthly [10]. Given its extensive reach and significant potential for disseminating scientific information, there has been a growing interest in leveraging YouTube for science outreach [11-13]. Empirical studies supporting its use for science communication are emerging, reflecting increased interest among academicians and the industry [14]. Thus, an increased interest towards video-based learning on social media, such as YouTube, can be seen as indicative of a positive shift towards more learner-centred and interactive science education [15, 16].

Regarding academia, there have already been various investigations on this topic. For instance, an empirical study on a convenience sample of 233 scientists revealed that nearly half of them used media sharing platforms such as YouTube and Flickr at least once a week [17]. Another survey of scientists from an R1 University in the USA showed that 43% of the responding scientists used YouTube for "science-related purposes" at least a few times a month [18].

Information extraction in e-learning and social media has been significantly advanced various researches [19-21]. Development of an agent-based recommendation system for e-learning platforms using machine learning, enhancing personalized learning by analyzing learner data. Additionally, topic prediction and knowledge extraction, using integrated topic modeling and deep neural networks, uncovered hidden topics and generated insights from social media datasets, particularly useful for social media information. These advancements enable more accurate information of knowledge discovery, improving decision-making and strategic planning.

Furthermore, numerous studies have shown that well-designed videos enhance learning and academic performance for college students (e.g., [22-25]. The combination of oral and visual representations in videos aids them in concentrating and structuring their knowledge [26].

As a result, the importance of climate change has inspired a wide range of content on YouTube in recent years. These videos come in various forms and focus on different aspects, including encouraging behavioral change or increasing knowledge about the topic. Despite the rise of successful science communication channels, the quality of these climate change videos is not assured. Previous studies have raised concerns about the accuracy of scientific content on YouTube, suggesting that the platform may contribute to the spread of misinformation. This is particularly concerning given a study by Chen [27] that found that YouTube viewers tend to trust the content of climate change videos. To add to this, according to Allgaier [28], most of them in a sample of 200 YouTube videos on climate change presented views inconsistent with current scientific knowledge.

Regarding user engagement with YouTube videos, previous studies have traditionally focused on popularity metrics such as video views, comments, (dis)likes (e.g., [7, 29-32] and less commonly, shares [33]. For example, users participate in discussions in the comment sections beneath YouTube videos. These conversations often extend beyond mere information sharing to include argumentative deliberation, which may aid in the acquisition of knowledge [12, 13]. Some have also argued for including comment-reading and video-uploading as forms of user engagement [34]. While the vast majority of empirical studies on YouTube and science communication have primarily examined the relationship between video content videos and user engagement, some researchers have also investigated how non-content-related video characteristics, such as audience cues, correlate with variations in user engagement [5].

Based on these facts, this empirical paper aims to investigate and analyze university students' engagement perceptions after they watched several effective videos as well as reveal which of them have a higher impact based on their demographic characteristics. Engaging young people not only increases crisis awareness among younger generations [35], but also fosters a sense of social responsibility and has a beneficial long-term impact on their involvement [36-37]. Thus, the study intends to investigate the video engagement effectiveness on climate change from a different perspective, which is to investigate video's impact on their demographics and their perceptions. Moreover, taking into consideration the wide acceptance of YouTube as an effective online science communication, it also aims to show students' general perceptions towards the utilization of YouTube videos as an educational tool in the learning process.

At this point it should be mentioned that the study was conducted as part of the project "Be the Change: Innovative Higher Education for Environmental Sustainability," co-funded by the ERASMUS+ Programme of the European Union (Project number: 2022-1-SE01-KA220-HED-000087275).

3 Research Methodology

To achieve this scope a specific video selection procedure was conducted aiming at selecting twelve (12) out of the one hundred and eight three (183) videos, which were retrieved and then analyzed in previous activities of this project [38]. The selection procedure included the following criteria. Each video should have been manually coded from a researcher of the project, lasted between 5 and 16 minutes, had good audio and video (720p at least) quality, and did not include content

that promoted a product/ service and/ or misinformation. Moreover, a stratified random selection of the desired number 12 of videos was applied verifying that videos selection contained a diversity in all coding parameters. Furthermore, it was decided that the most preferred method for data collection was the development of a measurement instrument via an anonymous questionnaire. For validity and reliability issues the measurement instrument was developed based on previous empirical studies of [38-45].

The questionnaire had three Sections. Section A included the demographic characteristics questions, Section B measurement items related to students' engagement perceptions (Table 1), whereas Section C questions concerning their general perceptions towards YouTube use in the learning process. In both Sections B and C measurement items the 5-point Likert scale was applied. The data collection period lasted three months; from October to December 2023. The list of final selected videos along with their characteristics that are content type, their presenters and whether they mention consequences, causes, denial or/and solutions towards climate change are presented in Table 2.

Table 1. Students' engagement perceptions

Questions
The video helped me understand the topic of climate change better
The topic was well-explained in the video
The video was easy to learn from
I found the video educationally useful
The topic of the video was easy to understand
I found the video relevant to the topic of climate change
The video keeps my attention
I think that I was fully focused on the content of the video
I felt engaged to the video I just saw
I found the video enjoyable
I found the video interesting
I found the video concise
The video uses conversational language

Table 2. List of the 12 videos used

#	**Video's Title**	**Content type**	**Presenter of the video**	**Consequences/ Causes/ Denial/ Solutions towards Climate Change**
1	What Greta Thunberg does not understand about climate change | Jordan Peterson	M	Scientist, Social Influencer, Celebrity	Consequences, Solutions
2	Climate Scientist Answers Earth Questions From Twitter | Tech Support | WIRED	I	Scientist, Social Influencer	Consequences, Causes and Solutions
3	Is It Too Late To Stop Climate Change? Well, it's Complicated.	D	Social Influencer	Consequences, Causes and Solutions
4	MOTHER NATURE'S RAGE | Effects of climate change in Kenya's coast region	N	Journalist	Consequences
5	Climate Science: What You Need To Know	I	Scientist, Social Influencer	Consequences and Causes
6	What the Hockey Stick missed about climate change	I	Scientist, Social Influencer	Causes
7	Climate Change Explained Simply	I	Journalist, Social Influencer	Consequences and Causes
8	Discussing The Impact Of Climate Change: NASA's New Project | Symone	N	Scientist, Journalist	Consequences and Causes
9	Climate Change – We are the PROBLEM & the SOLUTION	AI	Social Influencer	Consequences, Causes and Solutions
10	Jordan Peterson criticizes climate	M	Scientist, Social Influencer, Celebrity	Denial

	change | Lex Fridman Podcast Clips			
11	When The World Gets 1°C Hotter | Climate Change: The Facts | BBC Earth	I	Scientist	Consequences and Causes
12	Famine propelled by conflict and climate change threatens millions in Somalia	N	Journalist, Political figure	Consequences and Causes

Note. N=news; M=misinformation; I=information; D=debate/controversy; AI=Animated Infographic

4 Results

The sample of this study consists of 349 students from four Universities (Table 3). In the rest of the section, the detailed analysis of the proposed approach is presented.

Table 3. Participated universities students' response.

University's name	%
University of Western Macedonia (Greece)	22.06%
University of Montpellier (France)	7.45%
Halmstad University (Sweden)	51.58%
UCLan Cyprus & other local universities	18.91%

4.1 Gender analysis

In the analysis of climate change videos on YouTube, a separate evaluation of viewer general perception ratings based on gender was conducted. This involved segregating the dataset into two groups: one for female viewers and another for male viewers. For each group, the average rating of the videos was calculated, providing insights into the understanding quality or engagement level of the content among different video genders (Table 4). By comparing these ratings, it was aimed to identify any potential differences in how male and female audiences responded to these videos, checking possible gender-specific preferences or perspectives regarding climate change content on the platform. This approach allowed us to gain a detailed understanding of viewers' feedback accordingly and a better connection with diverse audience segments. Overall, there were differences among genders in video perception ratings. The highest rating in the female gender was concerning a video categorized as debate/controversy whilst for males the highest rating was relevant to a video categorized as animated infographic.

Table 4. Gender distribution based on participants' responses to the questionnaire

Video Names	Female Rating	Male Rating
Climate Change Explained Simply (I)	11.11	6.07
Climate Change – We are the PROBLEM & the SOLUTION (AI)	5.92	14.01
Climate Science: What You Need To Know (I)	6.66	11.68
Climate Scientist Answers Earth Questions From Twitter | Tech Support | WIRED (I)	5.92	9.34
Discussing The Impact Of Climate Change: NASA's New Project | Symone (N)	8.88	9.81
Famine propelled by conflict and climate change threatens millions in Somalia (N)	5.92	7.94
Is It Too Late To Stop Climate Change? Well, it's Complicated. (D)	14.81	7.94
Jordan Peterson criticizes climate change | Lex Fridman Podcast Clip (M)	8.14	7.47
What Greta Thunberg does not understand about climate change | Jordan Peterson (M)	10.37	6.07
What the Hockey Stick missed about climate change (I)	2.40	9.34
When The World Gets 1°C Hotter | Climate Change: The Facts | BBC Earth (I)	7.40	4.67
| MOTHER NATURE'S RAGE | Effects of climate change in Kenya's coast region (N)	7.40	5.60

Note. N=news; M=misinformation; I=information; D=debate/controversy; AI=Animated Infographic

4.2 Fields of study analysis

With the aim to provide analysis of the climate change YouTube video data, an evaluation of average rating (5-point Likert scale) of videos based on students' field of study was conducted. To accomplish it, first respondents were classified based on their field of study (20 clusters). Then, for each cluster, the average rating of all 12 videos of each member was calculated. This approach allowed us to gain insights into how different fields of study were perceived by viewers in terms of their engagement, providing valuable information on the effectiveness and impact of climate change content across various thematic areas. Table 5 presents the highest rated video for each field of study.

Table 5. Average highest rating video based on participants fields of study

Field of study	Videos' Names	Average Rating
E-commerce and digital marketing	| MOTHER NATURE'S RAGE | Effects of climate change in Kenya's coast region (N)	3.91
Green leadership, organizational culture and sustainable innovative entrepreneurship	Climate Scientist Answers Earth Questions From Twitter | Tech Support | WIRED (I)	3.92
Management Science and Technology	Climate Science: What You Need To Know (I)	3.83
Law and political science	What the Hockey Stick missed about climate change (I)	3.68
Science	Climate Change – We are the PROBLEM & the SOLUTION (Animated Infographic)	4.12
Engineering	Famine propelled by conflict and climate change threatens millions in Somalia (N)	3.41
Sciences and techniques of physical and sports activities	Is It Too Late To Stop Climate Change? Well, it's Complicated. (D)	4.03
Artificial intelligence and data science	Is It Too Late To Stop Climate Change? Well, it's Complicated. (D)	4.03
Artificial intelligence	Is It Too Late To Stop Climate Change? Well, it's Complicated. (D)	4.03
Artificial intelligence and data handling	When The World Gets 1℃ Hotter | Climate Change: The Facts | BBC Earth (I)	3.95
Computer Engineering	Climate Scientist Answers Earth Questions From Twitter | Tech Support | WIRED (I)	3.95
Computer Science	When The World Gets 1℃ Hotter | Climate Change: The Facts | BBC Earth	3.92
Development engineer	Climate Scientist Answers Earth Questions From Twitter | Tech Support | WIRED (I)	3.92
Master of embedded and intelligent systems	Jordan Peterson criticizes climate change | Lex Fridman Podcast Clip (M)	3.56
Information Technology	What Greta Thunberg does not understand about climate change | Jordan Peterson (M)	3.87
Masters in IT	Discussing The Impact Of Climate Change: NASA's New Project | Symone (N)	3.51
Accounting and Finance	Climate Change – We are the PROBLEM & the SOLUTION (Animated Infographic)	4.12
Mechanical Engineering	| MOTHER NATURE'S RAGE | Effects of climate change in Kenya's coast region (N)	3.91
Primary Education	Climate Change – We are the PROBLEM & the SOLUTION (Animated Infographic)	4.12

Note. N=news; M=misinformation; I=information; D=debate/controversy; AI=Animated Infographic

4.3 Year of study analysis

In the subsequent phase of the analysis of the climate change YouTube video data, an evaluation to determine the average ratings based on the year of study of the students was conducted. This involved first identifying the year of study, information provided by the responded students. Then, the average rating of all 12 videos were calculated per each year of study. This approach allowed us to discern any variations in the average ratings across different years of study, providing insights into how the quality and effectiveness of climate change videos may vary with the academic progression of the students. Table 6 presents the highest rating video for each year of study. For this table we can discern that different years of study endorse different video types as shown on the table.

Table 6. Users' highest rating video per year of study

Year of Study	Highest Rated Video	Average Rating
1st	Climate Change – We are the PROBLEM & the SOLUTION (AI)	4.12
2nd	Is It Too Late To Stop Climate Change? Well, it's Complicated. (D)	4.03
3rd	When The World Gets 1℃ Hotter | Climate Change: The Facts | BBC Earth (I)	3.95
4th	Climate Change Explained Simply (I)	3.92
5th	Climate Scientist Answers Earth Questions From Twitter | Tech Support | WIRED (I)	3.92

Note. N=news; M=misinformation; I=information; D=debate/controversy; AI=Animated Infographic

4.4 Age analysis

To analyze the viewership across different age groups, we first categorized users into specific age brackets. Then, for each age group, average ratings of the videos that watched calculated. By comparing these ratings, identification of the video with the highest average rating

within each age category, indicating the most favored content among viewers of that age range evaluated (Table 7). This approach allows to understand which videos reflected the most with audiences of different ages, providing valuable insights into preferences across demographics. The results also reveal that younger students had a highest impact from the climate change videos that they watched than older ones. These results are in line with [46] previous empirical study.

The technique used to evaluate the watch count of videos and determine the most watched video for each age group based on the average rating is called descriptive analytics. This involves summarizing and analyzing data to understand patterns, trends, and relationships. Specifically, we employed statistical measures such as averaging to calculate the mean rating for each video within each age group. This allows to compare the popularity of videos across different demographics and identify the most preferred content within each age category.

Table 7. Students' highest average rating per age group

Age Group	Highest Rated Video	Watched count	Average Rating
0-20	Climate Change – We are the PROBLEM & the SOLUTION (AI)	41	4.12
21-30	Is It Too Late To Stop Climate Change? Well, it's Complicated. (D)	240	4.03
31-40	When The World Gets 1°C Hotter | Climate Change: The Facts | BBC Earth (I)	48	3.95
41-50	Climate Change Explained Simply (I)	17	3.92
51-60	Climate Science: What You Need To Know (I)	3	3.83

Note. N=news; M=misinformation; I=information; D=debate/controversy; AI=Animated Infographic

4.5 General perceptions towards YouTube use in the learning process

This phase of the analysis focuses on general perceptions towards YouTube use in the learning process. Six specific 5-point Likert scale questions were formulated aimed at gauging students' attitudes and opinions regarding the integration of YouTube into their educational experience (Table 8). Each question addressed different aspects, such as the potential for enhancing the learning process, creating a more engaging environment, and increasing interest in course content. To evaluate the average rating for each question, responses from participants were collected and their ratings were aggregated for each question separately. Utilizing a descriptive statistics method, the average rating for each question was computed by summing up the ratings provided by all participants and dividing by the total number of responses. This systematic approach allowed us to quantify students' perceptions regarding the efficacy and desirability of using YouTube as a learning tool, providing valuable insights into the potential impact of incorporating YouTube videos into educational settings.

Table 8. Students' perceptions' rating of YouTube usage in the learning process

Questions	Average Rating
The Use of YouTube can enhance the learning process	4.14
I would like to have YouTube incorporated in my classes	4.14
The videos can enhance my learning/understanding of course content	4.16
The videos can create a more exciting learning environment	4.26
YouTube can make classes more interesting	4.21
The use of YouTube as a learning tool can engage me to the content of the course	4.21

5 Discussion

The findings of this study underscore the significant role that YouTube videos can play in enhancing climate change education among university students and are in line with analogous empirical studies [47-50]. By analysing students' perceived engagement with a selection of 12 climate change videos, we have identified key factors that contribute to the effectiveness of these educational tools. Younger students, like in previous studies [e.g., 50], particularly those in their early twenties, showed higher engagement with online videos compared to older students, possibly due to their familiarity with digital media. Female students also demonstrated slightly higher engagement than male students, aligning with previous research on gender differences regarding environmental concerns [51]. Moreover, students from the fields of accounting and finance, science and primary education expressed higher perceived impact of climate change videos. Finally, the fact that students expressed very positive perceptions towards social media platforms like YouTube to be included in the learning process offers a unique opportunity for university professors to reach diverse audiences globally as well as, incorporate an alternative teaching tool during the lectures and students' homework duties. On the other hand, its utilization raises concerns about the quality and credibility of the online provided content given that the misinformation videos included were also rated highly by students.

5.1 Conclusion

This practical study underscores the significant role of YouTube videos in enhancing university students' engagement and understanding of climate change. Our

findings present that educational videos on climate change can be highly effective when customized to the demographics of the target audience. The content-based analysis of the 12 selected videos provides clear insights into which types of content connected more with students, highlighting the importance of demographic considerations in educational video production. The study also shows that students' perceptions towards the use of YouTube videos in education are generally positive, suggesting that YouTube can be a powerful tool in raising awareness and promoting better behavior towards climate change. By identifying key factors that contribute to video effectiveness, this research offers insights to educators and content creators aiming to improve the impact of online educational content on climate change. Ultimately, the study emphasizes the potential of leveraging social media platforms like YouTube to complement traditional educational methods, thereby encouraging a more informed and environmentally conscious public.

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