#TeamTrees: Investigating How YouTubers Participate in a Social Media Campaign

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YouTube is not only a platform for content creators to share videos but also a virtual venue for hosting community activities, such as social media campaigns (SMCs). SMCs for public awareness is a growing and reoccurring phenomenon on YouTube, during which content creators make videos to engage their audience and raise awareness of global challenges. However, how the unique celebrity culture on YouTube affects collective actions is an underexplored area. This work examines an SMC on YouTube, #TeamTrees, initiated by a YouTube celebrity and sought to raise people's awareness of tree-planting and climate change. The authors annotated and analyzed 992 #TeamTrees videos to explore how YouTube celebrities, professionals, and amateurs in different channel topics diagnose problems, present solutions, and motivate actions. This study also looks into whether platform identities and framing activities affect campaign reach and engagement. Results suggest that #TeamTrees reached creators who are generally not active in social issues. The participating YouTubers were likely to motivate the viewers to donate and join celebrities' and community's actions, but less involved in examining the environmental problems. Celebrities' videos dominated the campaign's influence. Amateurs' videos had a higher engagement level, although they need more support to frame campaign activities. Based on these findings, we discuss design implications for video-sharing platforms to support future SMCs.

CCS Concepts: • **Human-centered computing → Empirical studies in collaborative and social computing**.

Additional Key Words and Phrases: YouTube; social media campaign; celebrity; diagnosis; prognosis; motivation

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1 INTRODUCTION

Social media campaigns (SMCs) for public awareness promote global issues and challenges, and they are becoming prevalent and influential. As one of the largest content-sharing platforms, YouTube allows internet celebrities and ordinary netizens to share videos and participate in social media campaigns. Recent influential SMCs on YouTube include #TeamTrees for tree-planting, #IceBucketChallenge for ALS research [41, 65], #StayHome #WithMe for COVID-19 isolation [51], and other political movements [2, 60]. SMCs communicate and spread specific values in the virtual communities and call for every community member to take action. SMC hosts and participants leverage social media platforms' unique cultures to coordinate their efforts and reinforce

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or assist with the campaign goals. Despite the increasing impact of SMCs on YouTube, however, limited HCI and CSCW research exists on how the celebrity culture on video-sharing platforms affects a YouTube-based SMC and how different creators frame their collective actions. To advance the knowledge of how SMCs spread on video-sharing platforms, this study examines a recent YouTube-based fundraiser campaign called #TeamTrees. #TeamTrees was a 2019 collaborative fundraising campaign that managed to raise US$ 20 million before 2020 to plant 20 million trees[1]. Two YouTubers, MrBeast and Mark Rober, initiated this SMC on YouTube and called for all users to participate in the campaign and make a donation. The campaign asked video creators to make #TeamTrees-themed videos and, through their relationships with their fans, inspire their audiences to become #TeamTrees donors and supporters. All donations were collected through YouTube and teamtrees.org. The Arbor Day Foundation pledged to plant one tree for every dollar donated by 2022. By December 26, 2019, the SMC had successfully raised over US$ 20.7 million.

Activities in a social media campaign like #TeamTrees are shaped by the developed techno-cultural construct of the hosting social media platform [37]. Collaborative systems supporting SMCs should be observed not only as spaces of affordances but also as sites of cultural phenomena [29]. Cultures on video-sharing platforms like YouTube contrasts other networking-based platforms in that social interactions rely on the video itself rather than offline relationships [11, 32]. The celebrity culture of YouTube encourages creators to professionalize their videos in a specific area and cultivate relationships with fans to reach celebrity status [32, 33]. Although the performers don't know the fans personally, fans generate a one-sided intimacy with the performers, defined as *parasocial relationships* [31]. Content creators with more subscribers have substantial influence, but YouTubers at all celebrity levels can engage viewers through video creation. Grassroots creation for personal ideas [17, 52] and celebrification through community interaction [20] distinguish YouTube from Facebook and Twitter [61]. The increasing collaboration in SMCs requires platform designers, SMC stakeholders, and social computing scientists to understand the interplay between YouTube's unique cultural structure and the dissemination of social media campaigns.

However, beyond #TeamTrees' success, there is limited knowledge of how the spread and influence of SMCs rely on the distinctive culture of a video-sharing platform. This study aims to bridge this gap by investigating the relationships between YouTube cultural components and the #TeamTrees campaign construct. YouTubers' platform identities can be described by their level of celebrity and the topic of their channels. Snow's collective action framing [5] is used as the theoretical framework to categorize the *diagnostic*, *prognostic*, and *motivational* activities in #TeamTrees videos. We also investigate how YouTubers' identities and collective action frames affect two widely recognized factors of campaign success – *reach* and *engagement* [26, 46]. Reach is the number of times the videos have been watched, and engagement measures viewers' likelihood to interact with the video by liking and commenting. Understanding #TeamTrees on YouTube is essential for supporting SMCs and encouraging creator communities to care about social issues. A lack of this understanding reduces platforms' ability to support creators at different celebrity levels to participate in future YouTube-based SMCs. To contribute knowledge of YouTube SMCs, this work analyzes #TeamTrees and seeks to address four main research questions (Figure 1):

- RQ1: What were #TeamTrees YouTubers' platform identities?
- RQ2: How did YouTubers frame their content to participate in #TeamTrees?
- RQ3: How did YouTubers at different celebrity levels and in different channel topics frame content differently in #TeamTrees?
- RQ4: What effects do YouTubers' platform identities and collective action frames have on the reach and engagement of #TeamTrees videos?

[1]https://en.wikipedia.org/wiki/Team_Trees

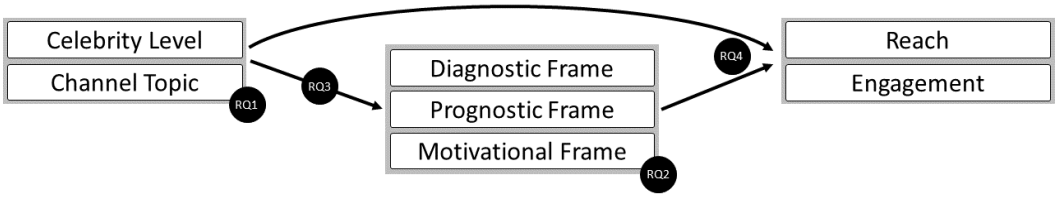


Fig. 1. Research questions of the study.

A total of 992 #TeamTrees videos were annotated and analyzed. Participating YouTubers are categorized into *celebrities*, *professionals*, and *amateurs* according to their number of subscribers. Channels are categorized as *game*, *multi-theme*, *entertainment*, *lifestyle*, and *edu&tech* based on creators' self-selected channel topics. The authors applied grounded theory methods to generate video encoding schemes for collective action frames. The number of video views, likes/dislikes, and comments were collected as video reach and engagement measurements. Findings suggest that #TeamTrees was participated by gaming, entertainment, lifestyle, and education/technology YouTubers, who were generally not active in social issues. YouTubers embedded campaign themes into their channel topics; therefore, #TeamTrees videos were mostly games, spread-the-word, tree-related creation, or explaining tree-knowledge. #TeamTrees YouTubers spent more effort on motivating actions than diagnosing problems. Celebrities' content takes a small part of all videos, but they had a dominant influence on the campaign reach. Celebrities' and professionals' videos incorporate relatively more framing activities. Amateurs' videos have higher viewer engagement, but their framing activities were at a lower level. The implications for platform design are discussed to advance the understanding of video-sharing-based SMCs.

2 BACKGROUND

Social media has opened a new horizon for social activists to run public campaigns. Studies have examined SMCs on topics such as climate change [22, 63], diseases and health [26, 34, 38, 46], social justice [3, 7, 18, 19, 24, 42, 59], and political protests [39, 40, 43, 58]. SMCs share many commonalities. The characteristics of social media shape participants' demographics and their participatory activities in SMCs [34, 39]. They seek to achieve a shared goal or value through collective actions [5, 37, 57]. This section reviews prior work on YouTube celebrity culture and the framing processes of social movements.

2.1 Celebrity Culture on Video-Sharing Platforms

YouTube is known as a place to create and circulate user-generated and personally meaningful videos [15]. Burgess pointed out two core cultural logics of YouTube – diverse participation and celebrity making – center YouTube platform ecology [11]. In contrast to platforms based on friending and networking, YouTube participation relies on the video itself rather than offline relationships [11]. Various YouTubers dedicate themselves to a specific channel topic and professionalize their content through frequent video creation [4]. YouTubers brand their channels and maintain online audiences as their fans [32]. The interaction with viewers makes them engender intimacy towards the YouTuber [12, 33]. The one-sided intimacy to the video performers generated by the "conversational give-and-take" is defined as a *parasocial relationship* [31]. In contrast to YouTube, Facebook users spread personal information among family and friends and express specific ideas [61]. On Twitter, participation features empower everyone to voice opinions and follow peer users' social activities [61]. Also, the growth of popularity is reflected by "trending topics", in which a large group of

users tweets or retweets a hashtagged subject [61]. Because of YouTube's unique culture, word-of-mouth spreading of content differs from Twitter and Facebook. During an SMC, Twitter and Facebook posts depend on users' real-life identities, and the platforms were used as amplifiers of offline activities [18, 42]. In contrast, YouTube influencers gain popularity from creating online content [55]; therefore, they may have different manners to participate in an online movement like #TeamTrees.

The celebrity culture originated in traditional media and became a significant force on YouTube. YouTubers follow up on trendy topics to build their staged authenticity [32]. Over the years, YouTube has developed a system of celebrity [11]. Studies have identified the roles of amateurs, professionals, and celebrities [54]. Amateur YouTubers upload less edited videos to archive their everyday thoughts [67] or communicate to their audience [10, 49]. Professionals have talents in particular areas, and their well-edited videos target creativity, community formation, and commercialization [11]. Celebrities are professionals with an established reputation and a large subscriber community [20, 47]. The celebrity culture encourages YouTubers to improve their video quality and become platform celebrities (referred to as "celebrification") [20, 55]. YouTube bestows awards on creators to encourage professionalization and celebrification [68]. Platform designers and campaign organizers need knowledge of how YouTube's celebrity culture shapes a social media campaign like #TeamTrees. In this work, we probe participating YouTubers' celebrity levels and channel topics as two critical aspects of the celebrity culture (RQ1). The former reflects the YouTubers' influence on the platform, and the latter suggests the area of interest around which they are building communities.

#TeamTrees shares common features with other video-sharing-based SMCs, such as celebrity participation and grassroots creation. For example, celebrities' public referral played a crucial role in #IceBucketChallenge – a challenge of pouring a bucket of ice water over the head to promote awareness of ASL disease [65]. But participants were criticized for saying little about the ASL disease [41]. #StayHome #WithMe was a YouTube movement in which creators of various skills made videos to help people deal with COVID-19 loneliness [51]. NTAC was an environmental justice movement in which activists used video-sharing to live-stream protests and express affections [2]. Proposition 8 was a movement where two political sides made self-expression videos to argue for or against same-sex marriage [60]. These video-sharing-based SMCs leveraged the richness and diversity of video media. Celebrity, professional, and amateur users connected the community to the campaign by sharing their talents or opinions. YouTubers' parasocial relationships and professional levels affect the shape and outcomes of the YouTube SMC. However, prior work did not systematically examine how YouTubers' celebrity culture affects the video creation in a YouTube SMC and how YouTubers frame their participation and affect the viewer reach and engagement. This work uses #TeamTrees as a case study to dive deeper into those questions.

2.2 Social Media Movement and Collective Action Frames

Contributors with different identities may have different ways of discussing societal or system problems, proposing solutions, and motivating actions [5]. One widely adopted theory to understand social media movements is through the concept of *collective action frames*. Snow characterized the "framing" of social movements as three core tasks: *diagnosis*, which states the social movement problem; *prognosis*, which offers a solution; and *motivation*, which provides a call for action and rationales for engaging in collective efforts [5, 57]. Prior works in HCI and CSCW that investigated SMCs on Twitter and Facebook have used collective action frameworks to examine climate change activism [35, 63], #BlackLivesMatter [59], hate groups discourse [53], Umbrella Movement [40], and science activism [24]. For example, Vu et al. applied the framing theory and found climate activists on Facebook preferred the diagnostic frame and showed ongoing global climate crises. Studies found Twitter users discussed whether climate change is real or a lie [35, 50]. While focusing on

social networking platforms, literature has not fully understood how the celebrity culture and platform identities shape a YouTube campaign. #TeamTrees provides a unique opportunity to probe collective action framing on YouTube (RQ2). We define the diagnostic framing of a video to be the environmental problems mentioned in the video. Prognostic framing is how the YouTuber plans the video's activities as their solution to help with the campaign. Motivational framings in a video are the actions the YouTubers were motivating (motivation-action) and the rationales for joining the movement (motivation-rationale). The authors applied the grounded theory method to generate frame categories for each of the three core framing tasks. We annotated and quantitatively analyzed 992 #TeamTrees videos with the derived codebook to probe how YouTubers framed and carried out campaign activities.

2.3 Campaign Participation and Influence

A rich body of research has examined the roles of participants in Twitter- and Facebook-originated SMCs. For example, the roles of the organizer, storyteller, and advocate in a Twitter social justice movement are highly tied to users' identities in real life [18]. The salience of participants' offline identities influenced the engagement in the Twitter disability march [42]. LGBT parents managed their public identity disclosure in a shift social movement to detect disapproval and identify allies [7]. Personally-identifiable participation promoted feelings of empowerment during the #ILookLIkeAnEngineer movement on Twitter [45]. Personal stories were more effective in creating positive dialogues in Facebook campaigns [46]. However, these studies did not adequately explain how YouTube's celebrity culture affects YouTubers' campaign participation. Celebrities and professionals could create influential #TeamTrees videos, but the SMC's theme might differ from their regular channel topic and thus be new to their subscriber community [56]. Amateurs can follow celebrities and upload videos, but they may not make viral videos to extend campaign influence. It is critical to examine how YouTubers with different celebrity levels and channel topics frame their campaign activities (RQ3).

Participants' identities are a key factor to the campaign influence. A study showed that social influencers generated more shareable content and greater reach than ordinary users during a Twitter health campaign [38]. Another study noted that the collective impact of peripheral users on Twitter was comparable in magnitude to that of core participants [3]. Nevertheless, in some political movements, campaign initiators faded in importance after organizations took over [58]. Studies have identified the "rich-get-richer" effects on YouTube – celebrity videos generate the most views and interactions [6, 8]. There is little knowledge on whether the reach and engagement of a video-sharing-based SMC rely more on celebrities' influence or ordinary creators' mass participation [3]. In this study, two metrics are widely used to measure #TeamTrees' influence – reach and engagement [3, 27, 38, 46]. The former is a campaign's sphere of influence, measured by how many viewers the campaign has reached. The latter reflects' viewers' preference for the campaign content and willingness to interact. To discern factors that determine campaign influence, this work investigates whether YouTubers' platform identities and framing tasks affect the reach and engagement of #TeamTrees videos (RQ4).

3 #TEAMTREES CAMPAIGN

#TeamTrees was a 2019 collaborative fundraising campaign that managed to raise US $ 20 million before 2020 to plant 20 million trees. The initiator, MrBeast, is a famous YouTubers who make viral videos of grand-scale philanthropic stunts and charitable acts on YouTube. Another initiator, Mark Rober, is a YouTuber known for his videos on popular science and do-it-yourself gadgets. On May 23, 2019, a fan of the YouTuber MrBeast posted a meme on Reddit, suggesting that MrBeast planted

20 million trees in celebration of his channel surpassing 20 million subscribers on YouTube[2]. Many comments have expressed enthusiasm in materializing the campaign because of the urgency in climate change and deforestation [9]. MrBeast and Mark Rober officially kicked off the campaign on October 25, 2019 by releasing their #TeamTrees videos simultaneously (Figure 2). The campaign's goal was to call other YouTubers to create as many videos as possible using the initiative's hashtag, #TeamTrees, to reach the campaign's main catchphrase, "Plant 20 million trees." The YouTubers attributed MrBeast's motivation to circulate fans' petitions and belief that the YouTube community's collective actions could affect changes and raise climate change awareness. #TeamTrees partnered with Arbor Day Foundation to handle all donations, for which Arbor Day pledged to plant one tree for every dollar donated.

Content creators around the world delivered #TeamTrees' success. As of December 2019, more than 8000 videos were mentioning #TeamTrees from over 400 global creators, totaling 200 million views on YouTube [9]. #TeamTrees immediately dominated headlines after the YouTube duo announced their mission, including the most trending post on Twitter and YouTube. Influential YouTubers — including Rhett&Link, Marshmello, Pewdiepie, among others, have made their videos to promote the initiative. The viral crowdfunding campaign managed to cross their proposed 20 million in 56 days, including the prolific donations of Elon Musk, Susan Wojcicki, Jack Dorsey, and many other entrepreneurs. In the end, #TeamTrees has proven to be one of the very first successful YouTube-powered campaigns that demonstrated "the organic momentum of a bottom-up campaign, but to start it by using top-down distribution" [9]. #TeamTrees is a valuable opportunity to allow CSCW practitioners to understand a YouTube SMC and capture new design opportunities to support future SMCs on video-sharing platforms.

Fig. 2. Screenshots of MrBeast's video (left two) and Mark Rober's video (right two). MrBeast shows he plants trees with a group and encourages donations. Mark Rober explains trees absorb CO2 and the global warming is caused by the increasing CO2 level.

4 #TEAMTREES DATA

This work examines #TeamTrees as a case study of YouTube SMCs. The video data set was collected using the YouTube Data API[3] on January 29, 2021. This data crawling date was a year after the campaign deadline and had left enough time for the newer videos to get views [14]. The keyword "#TeamTrees" was used to retrieve video data timestamped between 10/25/2019 00:00:00 and 12/31/2019 23:59:59 (the start and end time of #TeamTrees). We obtained channel information for each video, including the number of subscribers and channel topics. Video statistics include the publishing date, view count, like/dislike count, comment count, etc. The initial collection returned 1445 videos from 1250 unique YouTubers. A sanity check was performed on all videos to remove broken links ($N = 26$), non-English videos ($N = 308$), and videos without the "#TeamTrees" in either video title, description, or video tags ($N = 103$). We exclude non-English videos due to the differences in audience population and data tagging and categorization difficulty. After cleaning, 1008 videos constituted the data set for annotation.

[2] https://www.reddit.com/r/PewdiepieSubmissions/comments/brzbdk/please_save_us_mrbeast/
[3]https://developers.google.com/youtube/v3

5 STUDY DESIGN

5.1 Celebrities, Professionals, and Amateurs

The celebrity culture of YouTube originates from that YouTubers improve their creative skills through consistent participation, and successful creators become YouTube celebrities [11, 32, 47]. Based on [54], this study uses celebrity, professional, and amateur to classify YouTubers' platform identities (see Table 1 for definitions). In #TeamTrees, celebrities made popular content to spike the campaign trend and raise awareness of campaign topics. The campaign was an initiative launched by YouTube celebrities making tree-themed or environment-protection videos. Many other content creators then followed and participated in the SMC. Amateur YouTubers uploaded videos to express personal opinions on the campaign and show their participation. Celebrity levels are individual YouTuber's levels of influence, which is a part of the celebrity culture on YouTube.

Two criteria based on the subscriber number are drawn from the YouTube Gold Creator Award and the merchandise line to categorize participating creators by their number of subscribers. Subscribing to a channel suggests the viewers want to stay updated about creators' latest videos, indicating more attention to the video creator. YouTube creators commonly use this number to determine the success of their content [32, 36, 64]. The Gold Creator Award is a gift given by YouTube to creators who surpass 1 million subscribers. YouTubers with more than 1 million subscribers have a significant impact and are generally considered celebrities on YouTube. The YouTube merchandise line is the number of subscribers that must be reached to qualify for YouTube monetary income and sell merchandise to make revenue. This study considers YouTubers with more than 1 million subscribers as celebrities; those with a subscriber number between merchandise line (10,000) and the Gold Creator Award line (1 million) as professionals; and those with subscriber numbers lower than the merchandise line as amateurs.

Table 1. Celebrity Levels and Definition.

Celebrity Level	Definition	Classification Criteria
Celebrity	Celebrities are professionals with an established reputation on YouTube and a large fan community.	More than 1 million subscribers
Professional	Professional YouTubers create content drawing on recognizable media forms and genres for the public and usually receive considerable monetary benefits.	Between 10,000 and 1 million subscribers
Amateur	Amateurs are beginners who upload videos for leisure purposes and use the YouTube platform for their training and to grow friendships with others.	Fewer than 10,000 subscribers

5.2 Channel Topic Categorization

Besides YouTubers' celebrity levels, channel topics are another factor that binds YouTubers' identities. Prior research found the majority of YouTubers frequently upload videos of a consistent topic [4, 11]. Three-quarters of the channels assigned the same category to at least 80% of their videos [4]. YouTubers establish and maintain their themed channel by constantly contributing videos of a consistent topic and create the stability of loyal audiences [12, 30]. YouTube channel topics are user-selected, multi-value tags obtained from the YouTube channel data API. A YouTuber can choose multiple topics from a list of tags, including "Lifestyle (sociology)", "Video game culture", "Knowledge", "Film", "Politics", etc. This work identifies the topic of a channel by first removing descriptive words in its topic tags (e.g., "Action game" is converted to "game" and "Hip hop music" is

converted to "music"). Then the resulted 20 unique tags of all channels are processed in the descending order of frequencies. When a lower frequency tag has more than 50% overlap with a higher frequency tag (50% of the channels that use the low-frequency tag also used a higher-frequency tag), the low-frequency tag is grouped with the high-frequency tag. Otherwise, a new channel topic is created. This step merges 20 tags into the six main channel topics, including *game*, *lifestyle*, *entertainment*, *edu&tech*, *society*, *sport*, and "none apply" (no tags). "Knowledge" and "Technology" are combined into edu&tech due to their content similarity. Similar to the result in [4], only around 24% of channels have two or more channel topics; therefore, we categorize them as "multi-theme" channels. The channel categorization yields eight topic categories (see Table 2 for channel topics and Table 3 for examples).

Table 2. The channel topics and their included channel topic tags.

Channel topic	# of channels	Included tags and topic definition
Game	384	"Game"
Multi-theme	221	Contains more than one main channel topics
Entertainment	129	"Entertainment", "Film", "Music", "Television program", "Performing arts"
Lifestyle	117	"Lifestyle", "Hobby", "Health", "Vehicle", "Food", "Pet", "Physical fitness", "Tourism"
Edu&Tech	62	"Knowledge", "Technology"
None apply	9	The channel does not have any tags
Society	4	"Society", "Politics"
Sport	2	"Sport", "Football"

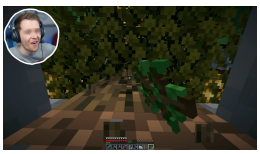
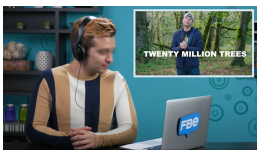
	**Game channel:** DanTDM **Channel description:** "Daily gaming videos with DanTDM :)." **#TeamTrees video:** I Planted INFINITE TREES in Minecraft Hardcore! #TeamTrees
	**Entertainment channel:** REACT **Channel description:** "Welcome to React! From our award-winning REACT series, to shows across scripted, unscripted, animation, interactive, TV series, feature films and more." **#TeamTrees video:** Generations React To MrBeast Planting 20,000,000 Trees (#TeamTrees)
	**Lifestyle channel:** I Like To Make Stuff **Channel description:** "We have lots of projects including woodworking, metalworking, electronics, 3D printing, prop making and more!" **#TeamTrees video:** Quick Farm Tour and Joining Team Trees | I Like To Make Stuff
	**Edu&Tech channel:** Linus Tech Tips **Channel description:** "We create product reviews, step-by-step computer build guides, and a variety of other tech-focused projects." **#TeamTrees video:** We Built a Tree-Planting Cannon #TeamTrees

Table 3. Example channels in the top channel topics. Figures are screenshots of their #TeamTrees videos

5.3 Encoding Collective Action Frames in #TeamTrees

Collective action frames are used as the theoretical method to understand YouTubers' participation in #TeamTrees [5, 57]. The authors applied the grounded theory approach to identify the categories

of collective actions in #TeamTrees videos [13]. This procedure consists of 3 steps: open encoding (120 videos), discriminant sampling (50 videos), and inter-rater agreement (100 videos). During the open-encoding step, the three authors watched 120 randomly selected videos individually (two authors watched 50, and one author watched 20). The authors took notes about problems mentioned in the video (diagnosis), activities presented by the YouTuber (prognosis), the actions the YouTuber was motivating (motivation-action), and the rationales for the motivations (motivation-rationale). For example, in a video that reviews tree-related laws, the author noted "restore and manage forests and mitigate climate change" for diagnosis, "the video reviews law cases that are related to natural resources or 'plants' (marijuana)" for prognosis, and "go help plant a tree" for motivation. Video activities reflect prognostic framing because YouTubers demonstrated their solution to help with the campaign or climate change (see Figure 3 for examples). The three authors then conducted affinity diagramming to summarize the notes around emerging frame categories [28]. This step generated an initial codebook. In the second step (discriminant sampling), the three authors annotated 50 videos to validate and improve the codebook. The authors decided to annotate the action and rationale of the motivation frame separately and clarified the definition of several categories. The final code is presented in Table 4. Meanwhile, a digital questionnaire was developed to annotate the data. In the third step, the three authors annotated 100 randomly selected videos to estimate inter-rater agreement. The authors selected all mentioned categories for each of the four dimensions. Fleiss's kappas with cosine similarity distance were calculated as the agreement scores. Diagnosis, prognosis, motivation-action, and motivation-rationale all reached a substantial agreement [48] between the three annotators ($k_{diagnosis} = 0.66$, $k_{prognosis} = 0.65$, $k_{motivation-action} = 0.72$, $k_{motivation-rationale} = 0.77$). After the three steps of grounded theory analysis, the three authors split the rest of the videos and used the codebook defined in Table 4 to annotate all the videos.

Table 4. The codebook of collective action frames

Diagnosis	
Climate change	The video mentions problems related to the change of climate, weather, or atmosphere
Deforestation	The video mentions problems in the decrease in forest or trees, wildfires, or wildlife extinction
Inaction	The video mentions inaction or low awareness of the government, public, or society (e.g., denial of climate change)
Other env. problems	The video mentions other sustainability problems such as human waste, lack of recycling, etc.
Prognosis	
Creation	The video shows artistic or funny creations or performances (Figure 3-a).
Spread the word	The video announces the #TeamTrees campaign by showing mission, activities, impact, or statistics (Figure 3-b).
Environmental discussion	The video shows or discusses environmental problems related to the #TeamTrees campaign (Figure 3-c).
Show donation	The video shows donating activities to the teamtrees.org website or various fundraising activities (Figure 3-d).
Plant trees	The video shows the method, activities, or process of planting real trees (Figure 3-e).
Knowledge	The video explains knowledge related to trees. It may also include the knowledge or fun facts about trees or tree-related things (e.g., arts, laws, stories) (Figure 3-f).
Gameplay	The video shows live or recorded video games that feature gaming activities (Figure 3-g).
Criticism	The video shows criticism or negative opinions on the #TeamTrees campaign (Figure 3-h).
Share videos	The video is made by sharing other's #TeamTrees videos or compiling other's #TeamTrees video clips (Figure 3-i).
Motivation (action)	
Donation	The video calls for donating to the campaign
Environmental actions	The video calls for protecting the environment and take general actions that benefit the environment
Plant trees	The video calls for planting more trees
Promote campaign	The video calls for promoting the #TeamTrees campaign by sharing or liking #TeamTrees videos
Support channel	The video calls for promoting the #TeamTrees campaign and their own channel at the same time by basing their donations or other campaign activities on the merchandise, subscribing, commenting, etc.
Motivation (rationale)	
Celebrity effect	The video mentions celebrities' involvement (e.g., mentioning MrBeast, Mark Rober, Pewdiepie, or Elon Musk).
Community effect	The video mentions the community's collaboration or actions
Tree benefits	The video mentions the rationale for planting more trees, usually by explaining the benefits of trees to the environment

(a) We 3D Printed Treelon! #TeamTrees

(b) Join THE WORLD'S BIGGEST COLLAB #teamtrees

(c) #TeamTrees - Google Earth Studio Cinematic

(d) How to donate to the #teamtrees movement

(e) Planting Cactus to help TeamTrees

(f) Why All Animals Need Trees #teamtrees

(g) Planting 20 million trees in Minecraft *LIVE* #TeamTrees

(h) How MrBeast Will FAIL To Plant 20,000,000 Trees

(i) I Reacted To MrBeast Planting 20,000,000 Trees

Fig. 3. Examples of videos in the 9 prognosis categories: (a) creation, (b) spread the words, (c) environmental discussion, (d) donation, (e) plant trees, (f) knowledge, (g) gameplay, (h) criticism, and (i) share videos.

5.4 Reach and Engagement

This study probes how YouTubers' platform identities and the framing of collective actions affect the reach and engagement of #TeamTrees videos. Video metrics including view count, comment count, and like count obtained from YouTube Data API are used to measure reach and engagement. Since YouTube does not provide the number of unique users who viewed or commented on the videos, using platform statistics is a common approach to measure the video's popularity and the viewers' activeness [4, 6, 8, 14]. The reach of a video is its ability to attract views and its effect on helping to spread SMC [26, 46]. The number of views measures the popularity of a video. View count is the total number of times a video has been watched as of the data collection. Other video metrics, such as the total number of comments and likes, are not used for measuring video reach because of their strong correlation with the view count [14]. Engagement metrics consider the activeness of viewers to interact with the video by liking and commenting [26, 46]. Like rate and comment rate are used to measure viewer engagement. The like rate is the net likes (likes minus dislikes) a video received per 100 views, calculated using Eq. 1. Similarly, comment rate is the number of comments a video received for every 100 views (Eq. 2). Likes and comments per hundred views reflect how engaged and interactive viewers were after watching. These measurements eliminate the effect that popular YouTubers' videos always have a higher amount of likes and comments [14, 25], to reflect how viewers engaged and interacted with the video.

$$like\_rt = \frac{likes - dislikes}{view\_count} * 100 \quad (1) \qquad cmnt\_rt = \frac{comment\_count}{view\_count} * 100 \quad (2)$$

6 DATA ANALYSIS METHODS

Based on the study design, we quantify all the videos based on the variables defined in Table 5. Each frame category is represented by one binary variable. For RQ1 and RQ2, categorical distributions are used to present the number of #TeamTrees videos made by YouTubers at different celebrity levels, from channels in different topics, and containing each frame category. RQ3 and RQ4 are addressed by multivariate analysis. For RQ3, we build ordinal logistic regression (OLR) models to predict frame categories by cel_lvl, ch_top, and the cross of the two variables. RQ4 examines how identity factors and frame factors affect video reach and engagement. Ordinary least squares regressions (OLS) are built to predict vw_ct, $like\_rt$, and $cmnt\_rt$. Independent variables are cel_lvl, ch_top, $cel\_lvl \times ch\_top$, and frame categories. The variables for diagnosis, motivation-action, and motivation-rationale are combined into three binary variables in OLS to avoid over-fitting, where 1 is a video that contains at least one frame category and otherwise 0. For logistic regressions, when significant effects being found in one factor, the Chi-squared test (contingency table) is used as the post-hoc method to examine the differences between different levels/categories. For linear regressions, views, likes, and comments do not have a normal distribution, so the nonparametric method is applied. The post-hoc method uses the pairwise Dunn's method with adjusted alpha to detect differences between factor categories. The α to determine significance is 0.05. Bonferroni corrections are applied to adjust the corresponding alphas in individual models (0.05 divided by the number of predicted categories in each frame).

Table 5. Variables in the data analysis. *Prognosis is a multi-categorical variable due to that most of the videos have only one main activity. See section 7.2 for the detail.

Concept		Variable	Description
Celebrity level		*cel_lvl*	The celebrity level of the video creator (amateur, professional, or celebrity as defined in Table 1)
Channel topic		*ch_top*	The top 5 channel topics with the most videos (Table 2)
Diagnosis	Climate change	*diag_clim*	Whether the video mentions climate change (1 for yes, 0 for no)
	Deforestation	*diag_defor*	Whether the video mentions deforestation (1 for yes, 0 for no)
	Inaction	*diag_inact*	Whether the video mentions inaction (1 for yes, 0 for no)
	Other problems	*diag_other*	Whether the video mentions other environmental problems (1 for yes, 0 for no)
Prognosis	Video activity	*prog_act**	The prognostic activities performed by the YouTubers in the video (Table 4).
Motivation (action)	Donation	*act_donate*	Whether the video calls for donation (1 for yes, 0 for no)
	Env. actions	*act_env*	Whether the video calls for environmental actions (1 for yes, 0 for no)
	Plant trees	*act_plant*	Whether the video calls for planting more trees (1 for yes, 0 for no)
	Promo. campaign	*act_promo*	Whether the video calls for promoting the campaign (1 for yes, 0 for no)
	Support channel	*act_support*	Whether YouTube depend their donations on the viewer activities (1 for yes, 0 for no)
Motivation (rationale)	Celebrity effect	*ration_cel*	Whether the YouTuber motivates participation because celebrities are participating (1 for yes, 0 for no)
	Community effect	*ration_cmty*	Whether the YouTuber motivates participation because it is a campaign of the YouTube community (1 for yes, 0 for no)
	Tree benefits	*ration_tree*	Whether the YouTuber motivates participation because of the benefits of trees (1 for yes, 0 for no)
Reach	View count	*vw_ct*	Number of views of the video
Engagement	Like rate	*like_rt*	Video's rate of receiving likes as defined in (Eq. 1)
	Comment rate	*cmnt_rt*	Video's rate of receiving comments as defined in (Eq. 2)

7 RESULTS

This section describes the results of the data analysis on the four research questions. The 1008 videos had 226,856,649 views and 579,754 comments in total. Channels of game, multi-theme, entertainment, lifestyle, and edu&tech made 992 (98.41%) #TeamTrees videos and counted for 98.98% of views and 99.06% of comments (Figure 4-right). Considering videos from society, sport,

and none-apply channels only contain a small number of videos (N = 16, 1.59%), the following analysis excludes them and focuses on the 992 videos from channels within the top five topics.

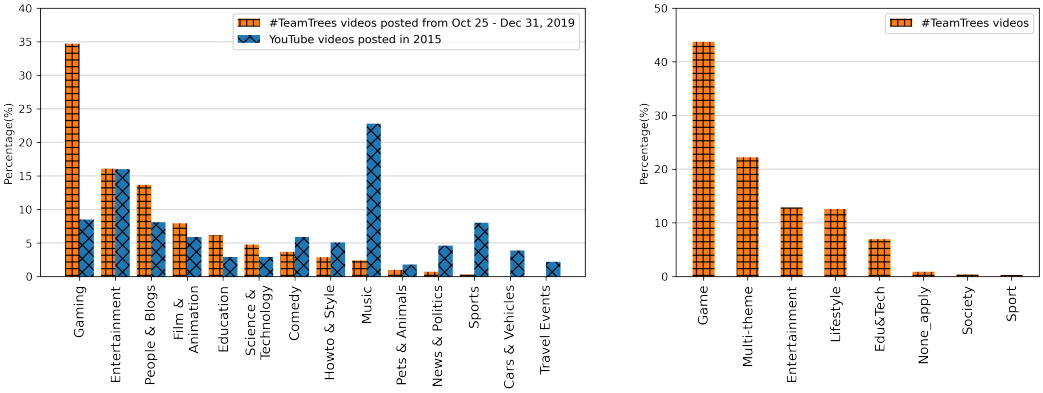


Fig. 4. Left: Comparison of category distributions between #TeamTrees videos and 2015 overall YouTube video distribution (data source: [16]). Right: Video distributions by channel topics

7.1 RQ1: Celebrity Levels and Channel Topics

RQ1 explores participating YouTubers' identities by analyzing celebrity levels and channel topics. #TeamTrees videos are also compared with overall YouTube video categories in 2015 [16] to identify trending video genres in #TeamTrees. Of the 1008 #TeamTrees videos, the majority (68.06%) were made by amateur creators (Figure 5). Compared to the video category distribution in 2015 [16], #TeamTrees has more videos in the categories of gaming, people&blogs, education, and science&technology (Figure 4-left), which is consistent with the channel topic distribution.

The 992 #TeamTrees videos come from 891 unique YouTube channels, and each channel contributes 1.11 videos on average (SD = 0.59). Celebrities' videos attract 94.00% of the total views and 86.36% of the total comments, although their videos only count for 8.47% of the total videos (Figure 5). By contrast, amateurs' videos only attract 0.14% of total views and 0.76% of total comments. With regard to channel topics, game channels make the most videos (N = 441, 44.45%). Multi-theme, entertainment, lifestyle, and edu&tech channels have 224 (22.58%), 130 (13.11%), 127 (12.80%), and 70 (7.06%) videos respectively (Figure 5). However, game channels attract only 7.67% of views and 10.92% of comments, while entertainment and edu&tech contribute 32.65% and 42.42% of video views and 26.13% and 18.66% comments. The Chi-square test suggests a significant association between cel_lvl and ch_top ($\chi^2(8) = 38.57$, $p < 0.0001$). Post-hoc shows game channels have significantly more amateur videos (74.60% $p = 0.0001$) and fewer celebrity videos (4.99%, $p = 0.0004$). While edu&tech channels have significantly more videos from celebrities (18.57%, $p < 0.0001$) and professionals (52.86%, $p = 0.0016$), but fewer from amateurs (28.57%, $p < 0.0001$).

These results indicate that #TeamTrees attracted YouTubers of game, multi-themed, entertainment, lifestyle, and education/technology channels to contribute, whose content is generally not themed in social movements or environmental activism. Celebrities' content dominated campaign popularity. Although professionals and amateurs made more videos than celebrities, their videos only contributed a small portion of campaign visibility. Channels of different topics have different celebrity-amateur ratios. Game channels had the most videos, but they were made mainly by amateurs, therefore only counted for a small proportion of views and comments. Education and

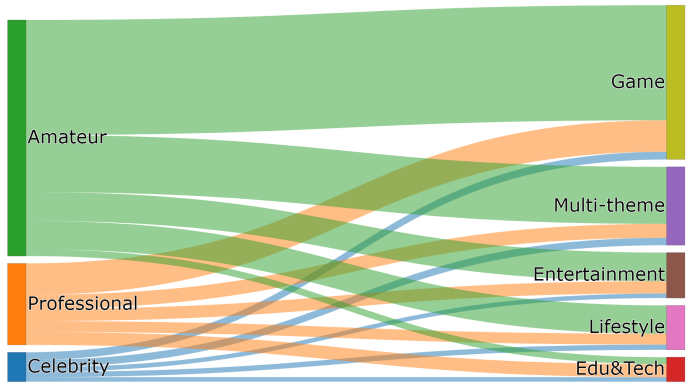


Fig. 5. The percentages of YouTubers across different celebrity levels and different channel topics

technology channels had significantly more celebrities and professionals, despite their content represents a small proportion of all #TeamTrees videos.

7.2 RQ2: Framing of the #TeamTrees Campaign

RQ2 examines the diagnostic, prognostic, and motivational framing of the #TeamTrees campaign. Figure 6 shows the percentages of videos containing each category in diagnosis, prognosis, and motivation. In diagnostic framing analysis, we notice only 23.09% ($N = 229$) of videos mention at least one problem in the video. Among the four diagnosis categories, climate change and deforestation are mentioned the most. Less than 5% of videos discuss inaction and other environmental issues. For prognosis, 30 videos (3.02%) are annotated as "none apply", and 35 videos (3.53%) contain multiple prognosis categories. Since they only take small proportions, "none apply" and "multiple" are used as their categories, and the prognosis is represented by one multi-categorical factor. Prognosis categories with more than 5% of the total videos are gameplay, spread the word, creation, and knowledge. Motivational framing includes the annotation of what actions are motivated and the rationales of the motivations. The result suggests 617 (62.19%) videos contain at least one type of action in their videos. Among them, the majority ($N = 551$, 55.54%) motivates donating to the campaign. Only around 10% of videos mention other motivation-action categories. For rationales, 566 (57.06%) videos bring up at least one of the motivation-rationales. The top two typical rationales are the celebrity effect (45.46%) and the community effect (28.12%). However, only 17.54% of videos note the benefits of trees.

The analysis of collective action frames shows that #TeamTrees were more focused on motivating the viewers – more than half of the videos encouraged actions and explained rationales for motivation. However, #TeamTrees YouTubers didn't intensively explain the environmental or the social problems the campaign targeted. #TeamTrees videos primarily motivated the viewers to donate. #TeamTrees YouTubers used celebrities' and community's participation as typical rationales rather than the benefits of the trees. Many #TeamTrees' prognostic methods were new in environmental activism. Common prognostic solutions were #TeamTrees-related gameplay, spreading the word, tree-related creations or performance, and explaining tree-related knowledge (Figure. 6). Prognosis categories such as showing donations, planting trees, and discussing environmental problems took a small part of #TeamTrees videos. These results demonstrate that YouTuber-fan relationships affected the construct of the campaign. As a part of celebrity culture, YouTubers leveraged their parasocial relationships with fans to motivate actions. The reasons to participate also relate to the

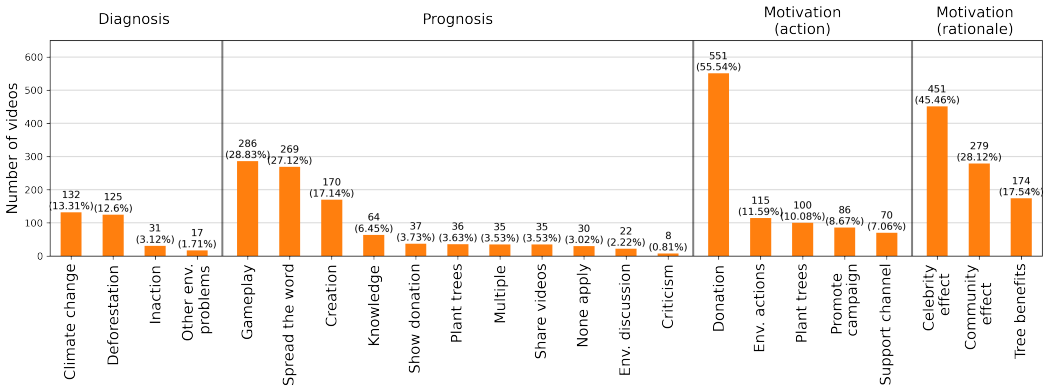


Fig. 6. The percentages of videos mentioning each category of the three collective action frames.

celebrities' and communities' collaboration. However, the #TeamTrees YouTubers didn't actively explain the problems they aimed at. The participants also did not intensively frame their prognosis around environmental activities such as tree planting or environment discussion. Instead, the participating YouTubers sought ways to merge the campaign theme into their regular gaming, creation, or knowledge channel topics. The prognostic solutions in #TeamTrees were to entertain and educate the viewers or advertise the campaign. The motivation actions and rationales also surround collecting donations, connecting to celebrities, and involving the community, instead of explaining the benefits of planting 20 million trees.

7.3 RQ3: How Celebrity Levels and Channel Topics Affect Framing

RQ3 probes how YouTubers' identities (celebrity levels and channel topics) affect collective action frames. OLR models predict frame category factors by *cel_lvl*, *ch_top*, and the cross of the two factors. OLRs are only performed on the frame categories with more than 5% of videos to avoid bias.

7.3.1 Diagnosis. This analysis probes how channel topic (*ch_top*) and celebrity level (*cel_lvl*) affect the diagnostic framing of climate change (*diag_clim*) and deforestation (*diag_defor*). The OLR models ($\alpha = 0.025$) suggest that *ch_top* and *cel_lvl* × *ch_top* have significant effects on *diag_clim* ($\chi^2(14) = 54.82$, $p < 0.0001$, $p_{ch\_top} = 0.0014$, $p_{cel\_lvl \times ch\_top} = 0.0170$). Post-hoc shows that entertainment channels have significantly more videos mentioning climate change ($p = 0.0030$, Figure 7). The test between *ch_top*×*cel_lvl* and *diag_clim* suggests that celebrities and professionals of entertainment channels ($p = 0.0004$ and $p = 0.0013$) and lifestyle amateurs ($p = 0.0005$) have a significantly higher positive association with *diag_clim*, while amateur gamers have a significant negative association ($p < 0.0001$, Figure 7). *Cel_lvl* has a significant effect on *diag_defor* ($\chi^2(14) = 38.73$, $p < 0.0004$, $p_{cel\_lvl} = 0.0133$). Post-hoc suggests that professional videos are significantly more likely to mention deforestation ($p < 0.0004$), while amateurs' videos are the opposite ($p < 0.0001$). These results suggest that celebrities and professionals of entertainment channels mentioned climate change more in their #TeamTrees videos. Professionals were likely to speak of deforestation as well. Amateurs were less likely to mention deforestation. Amateurs of different channel topics included climate change differently – lifestyle amateurs brought up this issue more while amateur gamers discussed it less.

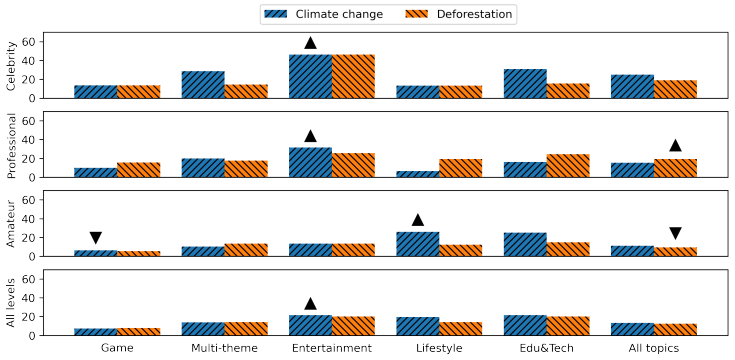


Fig. 7. The percentages of videos mentions the top two diagnosis categories across celebrity levels and channel topics. Up-pointing triangles are the significantly positive associations. Down-pointing triangles are the significant negative associations.

7.3.2 Prognosis. To investigate the effects of celebrity levels (ch_top) and channel topics (ch_top) on the prognostic framing categories ($prog\_act$), the OLR model uses cel_lvl, ch_top, and $cel\_lvl \times ch\_top$ to predict $prog\_act$. The model suggests that ch_top and $cel\_lvl \times ch\_top$ have a collective effect on $prog\_act$ ($\chi^2(140) = 696.70$, $p < 0.0001$, $p_{ch\_top} < 0.0001$, $p_{cel\_lvl \times ch\_top} = 0.0085$, Figure 8). The post-hoc analysis on ch_top suggests that game channels make significantly more gameplay videos ($p < 0.0001$). Entertainment channels have significantly more creation and spread-the-word videos ($p = 0.0015$ and 0.0009). Lifestyle and edu&tech channels make more knowledge videos ($p < 0.0001$). Further analysis on crossed ch_top and cel_lvl shows amateurs of entertainment channels have more videos of spreading the word. Lifestyle amateurs, edu&tech professionals, and multi-theme celebrities make more videos in the knowledge category. The OLR results indicate that the prognostic solutions were in correspondence with YouTubers' channel topics. For example, many gamers participated in #TeamTrees by sharing videos in which they play computer games (e.g., Table 6-a). Entertainment channels made more artistic and creative content for entertaining the viewers or spreading the campaign messages during their regular conversations with the viewers (e.g., Table 6-b&c). Knowledge videos were more likely to be made by the YouTubers of lifestyle channels and edu&tech channels in which they share knowledge with the viewers (e.g., Table 6-d).

7.3.3 Motivation. The motivational frame analysis uses OLR models to predict each of the motivational factors by celebrity levels and channel topics (cel_lvl, ch_top) and the cross of the two. Significant associations can be found in Table 7. For motivation-action, there are significant effects of celebrity levels on act_donate and act_env. $Cel\_lvl \times ch\_top$ has a significant effect on act_don. Post-hoc suggests celebrities' videos are significantly more likely to motivate the viewers to make a donation ($p < 0.0001$) and take environmental actions ($p = 0.0001$, Figure 9). Among celebrities, multi-theme channels have a higher likelihood to call to donate ($p = 0.0002$). Professionals are positively associated with motivating donations ($p < 0.0001$). Entertainment and multi-theme professionals are more likely to call to donate than other crossed categories ($p = 0.0030$ and $p < 0.0001$). In contrast to celebrities and professionals, amateurs are negatively associated with the donation (all $p < 0.0001$) and environmental actions ($p < 0.0001$). Game amateurs were significantly less likely to motivate donation ($p < 0.0001$).

Regarding rationales for motivations, the OLR models suggest that celebrity level (cel_lvl) has significant effects on celebrity effect ($ration\_cel$) and community effect ($ration\_cmty$). Ch_top significantly affects $ration\_cmty$ and the tree benefit rationale ($ration\_tree$). The crossed factor

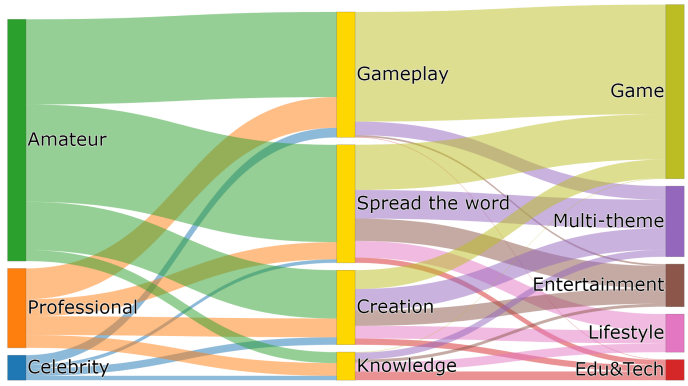


Fig. 8. Distribution of prognosis categories across celebrity levels (left) and channel topics (right). Top prognosis categories are displayed in the center with percentages on either side representing the proportion of videos from each category. Strip width is proportional to the video percentage across the two categories.

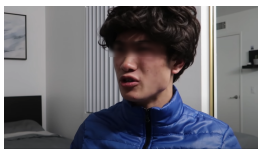
	(a) **Title:** Building a massive Minecraft tree for #TeamTrees **Content:** The YouTuber plays with several other players in Minecraft to build a tree and the hashtag in the game. **Channel topic:** Game
	(b) **Title:** Shaving My Beard For Mr. Beast! **Content:** The YouTuber talks to the viewers to introduce the #TeamTrees campaign and says he will shave his beard to promote the campaign. **Channel topic:** Entertainment
	(c) **Title:** VSCO GIRL SAVES THE PLANET!!! #TeamTrees | Petah **Content:** The YouTuber performs a comedy about himself being scolded by Petah (a character played by himself wearing a wig) when he does environmentally unfriendly behaviors. **Channel topic:** Entertainment
	(d) **Title:** I Visited The World's WIDEST Tree for #teamtrees **Content:** The YouTuber visits the Great Banyan in an Indian botanical garden and explains the knowledge of this tree. **Channel topic:** Lifestyle

Table 6. Example videos in top prognosis categories. (a) Gameplay. (b) Spread the word. (c) Creation. (d) Knowledge.

has a significant impact on *ration_tree* (Table 7). The post-hoc on the celebrity effect suggests that celebrities and professionals are more likely to motivate the viewers by celebrities' participation and the community's collective actions (all $p < 0.0001$). But amateurs are significantly less likely to use these two rationales (all $p < 0.0001$). The post-hoc on channel topics shows lifestyle and edu&tech channels are significantly more likely to mention the rationales of community effect and benefits of the trees (all $p < 0.0001$). However, game channels are the opposite (all $p < 0.0001$). The post-hoc between $cel\_lvl \times ch\_top$ and *ration_tree* further shows that celebrity of multi-theme channels ($p < 0.0001$), professionals of entertainment, lifestyle, and multi-theme channels (all

Table 7. Statistic results of the logistic regression models that predict motivation categories ($\alpha = 0.0063$). Dashes mean no significant association.

	Motivation (action)					Motivation (rationale)		
	act_donate	*act_env*	*act_plant*	*act_promo*	*act_support*	*ration_cel*	*ration_cmty*	*ration_tree*
$\chi^2(df = 14)$	109.59	33.90	-	37.87	39.89	104.42	146.50	118.23
$p(model)$	<0.0001	0.0021	-	0.0005	0.0003	<0.0001	<0.0001	<0.0001
p_{cel_lvl}	<0.0001	0.0002	-	-	-	<0.0001	<0.0001	-
p_{ch_top}	-	-	-	-	-	-	0.0045	<0.0001
$p_{cel\_lvl \times ch\_top}$	0.0017	-	-	-	-	-	-	<0.0001

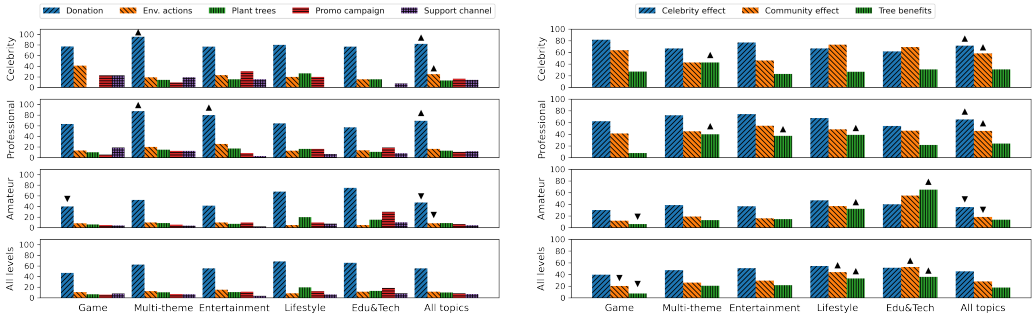
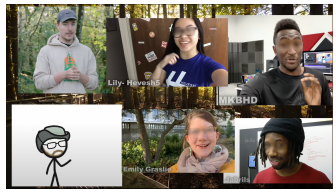


Fig. 9. The percentages of videos mention the top motivation-action (left) and motivation-rationale (right) categories across celebrity levels and channel topics. Up-pointing triangles are the significantly positive associations. Down-pointing triangles are the significant negative associations.

$p \leq 0.0019$), and amateurs of edu&tech and lifestyle channels are more likely to note the benefits of the trees (all $p \leq 0.0003$). But amateurs of game channels are significantly less likely to do the same ($p < 0.0001$).

(a) "Donate at TeamTrees.org"

(b) "Big YouTubers like Mark Rober and Mr. Beast have partnered up with the Arbor Day Foundation... "



(c) "Internet content creators from all over every genre of content were all working together to do this."

Fig. 10. Example videos in motivation frame categories. Quotes are from closed captions. (a) donation. (b) celebrity effect. (c) community effect.

In summary of motivational framing, the results indicate that #TeamTrees celebrities and professionals utilized their parasocial relationships with viewers to motivate donations more than amateurs (e.g., Figure 10-a). Celebrities also encouraged viewers to take environmental actions. The stronger parasocial relationships and community sense affected celebrities' and professionals' rationales for motivation. They tended to participate #TeamTrees because of other celebrities (e.g.,

Figure 10-b) and the community's collective actions (e.g., Figure 10-c). In contrast, amateurs were less likely to encourage viewers' donations and environmental efforts. They also didn't mention other celebrities and the community as celebrities and professionals, indicating a weaker sense of #TeamTrees as collective actions. The channel topics significantly affect how YouTubers explain their rationales for motivation. Videos of lifestyle and edu&tech channels were more likely to use community actions to motivate the viewers. They were also better at explaining the benefits of trees. However, amateurs of game channels were less likely to explain trees' benefits to the audience.

7.4 RQ4: Reach and Engagement of the #TeamTrees Videos

RQ4 investigates how YouTubers' celebrity levels, channel topics, and collective action frames affect the reach and engagement of campaign videos. OLS models were built to predict view count (vw_ct), like count ($like\_rt$), and comment rate ($cmnt\_rt$). The factors of diagnosis, motivation-action, and motivation-rationale are combined into three binary variables, where 1 is the video contains at least one frame category and otherwise 0. The prediction results and significant factors are presented in Table 8. OLS models suggest that how YouTubers frame collective actions in a video do not significantly affect reach and engagement. The video view variance comes from YouTubers' celebrity levels, channel topics, and the cross of the two factors. Post-hoc shows that the celebrities' video views are significantly higher than the professionals'; the professionals' views are significantly higher than the amateurs'. The post-hoc on ch_top shows that edu&tech videos have significantly higher average views than the other four channel topics (all $p \leq 0.0060$). In comparison, game channels have significantly lower views than entertainment and lifestyle channels (all $p = 0.0003$). This may be because edu&tech channels in #TeamTrees have more celebrities and professionals, but game channels have more amateur creators. The post-hoc on $cel\_lvl \times ch\_top$ shows that for all amateurs, videos from lifestyle and entertainment channels had significantly more views than game channels ($p = 0.0016$ and 0.0394). These results indicate the "rich-get-richer" effect exists in #TeamTrees and significantly affects the videos' reach (Figure 11-left). But for all amateurs, gamers' videos reached fewer people than videos of lifestyle and entertainment amateurs.

Table 8. Statistic results of the linear regression models that predict the reach and engagement factors ($\alpha = 0.0017$). Diagnosis, motivation-action, and motivation-rationale are converted into binary variables with 1 for containing at least one frame category and otherwise 0. Diagnosis, prognosis, or motivation frames do not significantly affect video reach and engagement.

	Reach	Engagement	
	vw_ct	$like\_rt$	$cmnt\_rt$
$F(df = 27)$	7.18	3.64	2.89
$p(model)$	<0.0001	<0.0001	<0.0001
p_{cel_lvl}	<0.0001	<0.0001	0.0002
p_{ch_top}	<0.0001	-	-
$p_{cel\_lvl \times ch\_top}$	<0.0001	-	-
$p_{diag}, p_{prog}, p_{action}, p_{ration}$	-	-	-

The OLS model[4] predicting the engagement of #TeamTrees videos suggests significant effects of cel_lvl on $like\_rt$ and cmt_rt. It is interesting to notice that amateurs have a higher like rate than professionals and celebrities and a higher comment rate than celebrities (Figure 11-middle and right). Amateurs' videos received 9.37 likes ($SD = 8.00$) and 4.44 comments ($SD = 7.84$) per 100 views on average. While celebrities' videos have 4.95 likes ($SD = 3.17$, $p < 0.0001$) and 0.37 comments ($SD = 0.28$, $p < 0.0001$) and professionals videos have 5.64 likes ($SD = 3.55$, $p < 0.0001$) and 1.52 comments ($SD = 2.88$, $p = 0.0007$) on average. This result suggests that although celebrities'

[4] 49 videos are excluded when analyzing comment rates because the YouTubers disabled commenting.

content significantly promoted the reach of #TeamTrees videos, amateurs' viewers appeared to be more engaged with their videos and were more likely to interact with the video.

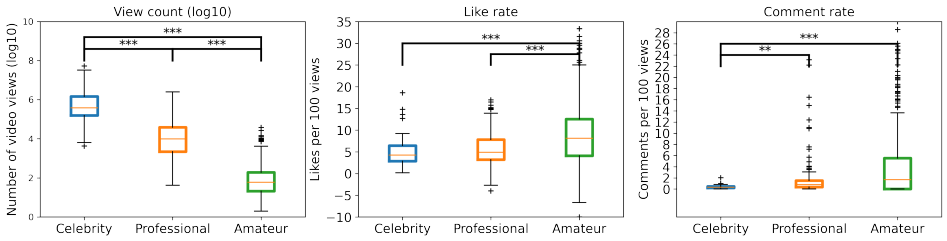


Fig. 11. The average view count, like rate, and comment rate of videos made by celebrities, professionals, and amateurs. View count is converted to log10 values. (p^* < 0.05, p^{**} < 0.01, p^{***} < 0.001)

8 DISCUSSION

The analysis of #TeamTrees data examined the platform identities of #TeamTrees participants, the framing of collective actions, and the reach and engagement of their videos. This section summarizes key findings and discusses design implications to support future SMCs on video-sharing platforms.

8.1 Identities of #TeamTrees YouTubers

Prior research suggested users' offline identities determine the manners in which Facebook, Twitter, and Instagram users involve and act in a social media movement [42]. People's offline identities shape the identities of organizers, storytellers, and advocates in a Twitter SMC, such as professionals and activists [18]. Disclosing offline identities helped LGBT movement participants establish social networks on Twitter and Facebook [7]. The disclosure of personal identities during an SMC empowers the connection within the community [45]. Besides #TeamTrees, the intensive use of video media can be seen in many other social movements such as #IceBucketChallenge [65], #StayHome #WithMe [51], NTAC movement [2], and Proposition 8 [60], which all boosted online movements through parasocial relationships. However, there is limited understanding of how the video creator communities participate in a social media campaign. The trend of YouTube SMCs calls for a deeper understanding of how video creation contrasts text-based social media in serving the SMC goals and reaching the video audience.

Our analysis shows that #TeamTrees has a different participant population from the SMCs on other social media platforms. #TeamTrees has creators of the game, multi-theme, entertainment, lifestyle, and education videos. But those people are generally not environmental activists. As a part of the celebrity culture, YouTubers establish and maintain their online identities by constantly contributing themed videos [12, 30]. Their content is generally made for entertainment or education rather than environmental protection or activism. To shape their #TeamTrees participation in line with their YouTube identities, #TeamTrees YouTubers sought ways to merge the campaign topics into their channel themes. Therefore, game YouTubers plant virtual trees in games. Entertainment YouTubers make spread-the-word videos and creative videos to draw viewers' interest. Lifestyle and edu&tech channels made videos to explain tree-related knowledge. As a result, the prognosis in #TeamTrees was considerably different from environmental movements on other platforms [35, 50, 63] – #TeamTrees featured videos of gameplay, spread-the-word, creative work, and explaining knowledge.

The celebrity culture on YouTube, Vimeo, TikTok, and other video-sharing platforms drives fans to establish parasocial relationships and calls on amateur and professional video creators to follow

celebrities' video creation activities [15]. Prior works suggested that in contrast to other social media, most YouTubers attract a group of fans and maintain their platform identity by contributing videos of a consistent topic [4, 12, 56]. The diversity of grassroots YouTubers led to various videos such as people & blogs, gaming, entertainment, and education [4]. Our findings on #TeamTrees imply that an SMC involving YouTube influencers such as MrBeast can reach these YouTube communities who are generally slack in social issues. Similarly, YouTube SMCs such as #StayHome #WithMe spread the idea of COVID support into the skill-sharing and entertainment communities. Activists and SMC organizers can utilize the YouTube platform to motivate the online communities, such as gaming, entertainment, lifestyle, and education, to participate in efforts towards a social issue. We recommend video-sharing services to consider how the campaign goal agrees with YouTubers' identities and can be integrated into common channel topics, for example, by providing stats about popular channel topics for the organizers to align the campaign activities with the video creation. For social computing research, our findings on #TeamTrees suggest researchers need to factor in that videos are richer than texts in content and are affected by creators' channel themes and platform identities. An SMC video might contain regular content of the channel theme (e.g., game or lifestyle) and the SMC topic at the same time. YouTubers can significantly alter the campaign activities and message forms (e.g., plant trees in a video game or talk about #TeamTrees and other life events simultaneously) to make them fit their video styles and be accepted by their audience.

8.2 Collective Action Frames in #TeamTrees

Prior work on the framing processes of Facebook- and Twitter-based movements suggested social media was primarily used for storytelling[19], public discourses [21, 39], undercurrent activities [40], and educating the followers [53]. In climate movements, people use text-based social media to debate the existence of global warming [35, 50] and increase climate awareness [1, 22, 44]. On YouTube, SMCs were more entertaining than critically discussing the problems [2, 51, 65].

By examining diagnostic, prognostic, and motivational framing, we find that YouTubers spent more effort motivating YouTube viewers to join the event per se than discussing the social or system problems. More than half of the videos encouraged viewers to donate and explained the rationale for actions. However, the majority (76.91%) of the videos didn't mention any problems the campaign tried to solve. The low diagnostic framing contrasts other social media that tells stories about the public issues and competes for the public discourses on the problems [19, 21, 39]. Although #TeamTrees was initiated for climate change and deforestation, YouTubers' main prognostic activities were to broadcast the campaign by entertaining content, instead of educating climate actions [1, 22, 44] or debating the existence of global warming [35, 50]. The motivational framing primarily focuses on donation. YouTube celebrities' and professionals' reasons for participation were mainly because of celebrities' involvement and the community's mobilization.

The collective action frames in #TeamTrees suggest that motivational framing is higher than diagnostic framing in #TeamTrees. This finding explains similar effects that #IceBucketChallenge participants said little about ASL [65], #StayHome #WithMe barely mentioned COVID-19 [51], and NTAC videos were more about expressing affections than discussing environment concerns [2]. YouTubers act as influencers in the community and motivate their fans to take action. However, YouTubers who are not professionals in campaign topics might find it hard to publicly explain or diagnose a social problem targeted by the SMC. The lack of professionalism might make some YouTubers reluctant to make a video to participate. Therefore, it needs future CSCW designs to facilitate diagnostic framing and video-based SMC discourse of a social problem. For example, the campaign stakeholders should consider providing resources and knowledge (such as video clips explaining climate change or deforestation) that YouTubers can embed in their videos. The platform can send notifications to YouTubers with relevant knowledge to encourage campaign participation.

Also, designers should not ignore the motivational factors reflected by #TeamTrees – platforms should highlight celebrities' and the community's involvement in SMCs. Platform designers may consider presenting an SMC's joint activities to enhance community sense and effect.

8.3 The Participation of YouTube Celebrities and Professionals

Studies found that an online video will attract new views at a rate proportional to the channel's popularity, described as the "rich-get-richer" effect [6, 8]. Prior work on SMCs showed that social influencers' content reaches more Twitter users[38]. But other studies also found that the collective impact of peripheral users on Twitter was comparable to the core participants [3]. In social movements on Twitter, initiators might fade in importance after organizations took over [58]. #TeamTrees and other YouTube SMCs such as #IceBucketChallenge and #StayHome #WithMe were promoted by YouTube influencers, therefore significantly affected by the celebrity culture of the platform. Through the analysis of #TeamTrees, this work probes how the platform celebrities' participation shape and spread a YouTube SMC. Our results show that #TeamTrees contrasts SMCs on other platforms in that celebrities' content dominated the campaign's influence. Celebrities' and professionals' videos had more framing activities than amateurs' videos.

In #TeamTrees, although celebrities made 8.47% of #TeamTrees videos, their videos attracted 94% of views and 86.36% of comments, much more than professionals' and amateurs' uploads. Videos of YouTubers at higher celebrity levels reached more viewers. Celebrities and professionals tended to use their parasocial relationships with the audience to call to donate. Celebrities also motivated viewers to take general environmental actions. Celebrities and professionals valued other celebrities' involvement and the communities' collaboration more than amateurs. Celebrities and professionals of entertainment channels explained climate change more. Professionals were also inclined to mention deforestation. These results indicate the importance of celebrities' and professionals' leadership in #TeamTrees. Involving YouTube celebrities and professionals can increase the diagnostic and motivational framing activities in the campaign. Celebrities' participation can ensure the reach of the campaign messages.

Our findings indicate that the participating creators' celebrity levels are a high-impact factor when an SMC runs through a video-sharing platform. Celebrities made premium content and have stronger parasocial relationships with more fans. The involvement of celebrity YouTubers and their willingness to contribute decide the information reach and influence sphere of a YouTube SMC. In the design of video-sharing platforms, system and service designers should suggest stakeholders consider inviting creators with a large number of subscribers. YouTube celebrities and professionals can increase awareness of the problems and the motivational framing in campaign videos. Service designs are needed to connect potential celebrities and professionals to the campaign organizers. In #TeamTrees, celebrities and professionals of education and technologies were more likely to join #TeamTrees than other communities. However, in other YouTube SMCs, real-world experts such as formal NGOs could lack visibility on YouTube due to low subscribers [2]. Therefore, future HCI and CSCW studies should examine what factors encourage video creators to connect and motivate one another to join an SMC (like the referral in the #IceBucketChallenge [41]). Our findings also imply that the number of videos may not reflect the breadth of the campaign influence in social computing. Instead, the numbers of the involved celebrities and the widely-viewed videos may be a better indicator of the actual reach of the campaign.

8.4 Supporting Amateur YouTubers

Prior work on Twitter and Facebook SMCs focused on how activists leverage the social network [18, 39, 42, 46, 62]. The celebrity culture on YouTube encourages content creators with different celebrity levels and different skills to join platform activities [11]. Amateurs leverage the platform

culture to improve video quality and grow their popularity. Studies on other YouTube SMCs have found amateurs leveraged YouTube to share their witness of protests and echo others' thoughts [60]. Through #TeamTrees, this work explains amateurs' SMC participation and contributions on a video-sharing platform.

Our findings suggest amateurs made the majority of videos in #TeamTrees. Although counted for a small number of views and comments, amateurs' videos attracted more likes and comments per 100 views, indicating more active and engaged viewer groups. YouTube amateurs have smaller subscriber circles and can interact with the audience more frequently. More regular interactions with the viewers may increase their willingness to donate. However, the amateurs need more support in framing the campaign activities. Amateurs didn't actively mention deforestation. Game amateurs who make a myriad of videos didn't actively talk about climate change. Amateurs also didn't motivate donation and environmental actions as much as professionals and celebrities. They were also less inclined to use celebrity and community effects as motivational rationales. Our finding suggests that YouTube amateurs performed fewer framing tasks, resulting from not actively diagnosing the problems and motivating viewers' actions.

Frankly, #TeamTrees and #IceBucketChallenge differ from other smaller YouTube SMCs such as NTAC [2] and Proposition 8 [60] in that they successfully attracted the attention of many celebrities. But in #TeamTrees, amateurs from entertaining channels are still the majority of video contributors, despite their minor influence on the campaign's reach. We argue that stakeholders should call on amateur creators because their viewers have a higher viewer engagement level. Amateurs of relevant channel topics, such as the lifestyle and education channels in #TeamTrees, may actively discuss the climate problem and explain tree benefits. These findings can be applied to video-sharing-based SMCs in which networking with viewers and other creators is essential (e.g., [41, 51]). In a YouTube SMC, joint actions can also help amateurs cultivate parasocial relationships with the viewers, which may benefit their channels' growth. Meanwhile, many amateur YouTubers need more help than celebrities and professionals on integrating the campaign tasks in their videos. Platform and service designers should consider providing more support to amateurs by providing background knowledge about the targeted problems, video clips of calls for action, and information about the participating celebrities and communities. Technologies and automation that evaluate the video quality and suggest improvements can be promising ways to motivate amateurs to improve their campaign videos.

9 CONCLUSION AND FUTURE WORK

SMCs are becoming prevalent and influential beyond the digital landscape. However, the manners in which creators of video-sharing platforms participate in a social media campaign remain understudied. Grounded on framing theory, this work conducted a systematic examination on #TeamTrees – an environmental movement to plant trees and protect the environment. We explored YouTubers' platform identities, core framing tasks, and video reach and engagement by addressing four research questions. This work provides a case study of how the YouTube celebrity culture shapes a YouTube-originated campaign, which provides knowledge to understand other YouTube SMCs. Findings show that movements like #TeamTrees can potentially mobilize "slack" communities that are generally not active in public issues to take action. Nevertheless, they may not intensively explain or diagnose the targeted problems. YouTube celebrities' participation determines the campaign's influence. Celebrities and professionals are better at framing the targeted social issues and campaign motivations. Amateurs' videos have higher viewer engagement. To support SMCs on video-sharing platforms, platform designers and campaign organizers should provide resources to support amateurs' video creation. We believe these insights provide a better understanding of the interconnection between platform cultures and campaign participation.

The investigation of #TeamTrees is seminal research on using videos as the primary form of campaign messages. Our data analysis experience recommends future work to pay attention to creators' platform identities when understanding the video content. Also, future analysis on video-based SMC should notice that unlike texts and images [53], a video can contain multiple diagnostic, prognostic, and motivational activities and construct different framings in the same video. Moving forward, our research will extend the present work's findings to advance knowledge about supporting social media events on video-sharing platforms. First, we are not arguing #TeamTrees will be the only model to launch and spread a video-sharing-based SMC. Instead, #TeamTrees suggests a successful way to raise a celebrity-driven, amateur-participated SMC. In the future, it is essential to understand the roles of videos in possible bottom-up SMCs and videos used in Twitter and Facebook posts. Second, it is also necessary to know how YouTubers' creation activities and video content affect public problems. The findings on collective action frames were derived from the analysis of one SMC. How platform celebrities frame public opinions must be studied in other SMC contexts [23, 66]. We will explore the community culture of video-sharing platforms in other public awareness events that target environmental, societal, and political problems. We will also examine other video dimensions, such as the credibility of YouTubers' videos and the mitigation of debunked and radical videos.

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