Let's Play My Way: Investigating Audience Influence in User-Generated Gaming Live-Streams

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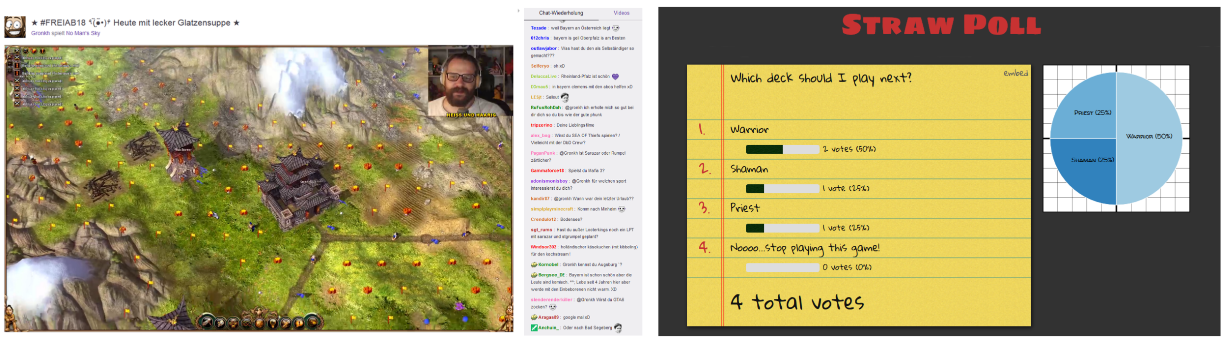

Figure 1. Left: Screenshot (taken from https://www.twitch.tv/gronkhtv) of the Twitch user interface, with the stream in the left area and the viewer chat on the right. Right: External poll application (taken from https://strawpoll.me), often used in live streams.

ABSTRACT
We investigate how the audience of gaming live-streams can influence the content. We conducted two case studies on streams in which audience influence is central and in which the audience can directly participate: First, we review an existing format of the Rocket Beans TV channel and describe how the audience can influence its course of action. With this, we illustrate current practices for integrating the audience. Second, we report the results of our investigation of a "Twitch Plays Pokémon" (TPP)-like setting in which the audience shares the control of the main character through aggregated chat messages. We explored a wider range of techniques than the original TPP offered and found that this can help the audience to organize itself in more nuanced ways. From both case studies, we synthesize results that are of relevance for streams that want to give the audience more influence.

Author Keywords
Interactive streams; co-presence; audience experience; Twitch Plays Pokémon; Rocket Beans TV; viewer participation

ACM Classification Keywords
H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

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INTRODUCTION
Twitch [37] is a streaming platform for distributing user-generated live video content. Twitch focuses mainly on gaming (which attracts a large audience [20, 48]). During such a stream, the audience can interact with the content creator (also called "broadcaster" or "streamer") through a live chat (see Figure 1, left). This provides a communication channel between content creator and audience and poses the question of how the audience can influence the creator to adapt the content which is currently streamed. In streams, where viewer numbers are large, the chat that Twitch provides as a communication channel is problematic for receiving an overview of what the audience wants [30]. Third-party tools exist that can assist the streamer, e.g. polling tools such as StrawPoll [11] (see Figure 1, right). Also, a new streaming platform, Beam.pro [2], integrates more sophisticated options directly into the platform, to make the audience integration easier.

While there are different options to facilitate audience interaction, it is currently unclear how streamers use them in gaming live-streams and whether they are sufficient. This paper addresses this question by presenting two case studies that illustrate representative examples in which audience influence is important: First, we analyze an existing Twitch live-stream format which regularly attracts more than 30,000 viewers and claims to be highly interactive. We reviewed more than 20 hours of this format for elements that involved the audience and considered how they influenced the content. Second, we investigate "Twitch Plays Pokémon", a so-called social experience on Twitch (e.g. [19]). Here, viewers simultaneously play the game's main character via chat commands, without any streamer in between. Thus, the audience alone decides how the stream proceeds. In a small-scale study, we analyzed what the audience's perception of such an experience is and whether it is beneficial to have an enhanced interface for self-organization to reach a better consensus. With case study 1, we provide an analysis of what is done (conceptually and technologically) today, if the audience is integrated. With case study 2, we illustrate novel techniques, which allow for better audience self-administration. We discuss how both studies relate and how the results can improve streams that have the goal to empower the audience with more influence.

RELATED WORK

Understanding audience interactions helps to shape performance and enrich the experience [45]. Because of space restrictions, we limit ourselves to notable examples and we focus on technology-mediated interaction, not purely social interactions, e.g., as can happen through verbal interaction or physical intervention in live theater performances [23].

TV, Theater, Dance and Sports

Even as pure consumers of TV/radio shows, the audience began to form a relationship with the persona or actor [22], a phenomenon called para-social interaction, which appears in web video as well [8]. The theory of this interaction allows one to classify different types of relationships [18]. Horton and Strauss [23] identify roles for interacting parties in TV content, e.g., studio/home audience and audience performers (e.g., volunteers from the studio audience), which can also be seen in web video. Considering these could lead to insights about which relationships could be enabled or bolstered through the addition of interactions between audience and performers. Especially the differences in how a TV performer can interact with a home audience as opposed to a studio audience are also applicable to streams where part of the audience is present during the stream and others will consume the video after the recording has been finished. Integrating the home audience has been a part of the field of social TV [6] with the goal to provide additional information [1, 10] and new communication channels [1, 60]. Ursu et al. investigated how TV storytelling can become more interactive [57] and found elements for viewer participation that are also transferred to web videos: voting in contests, content suggestions between episodes and the option to evaluate user-generated content for developing a story.

Physical co-location of audience and performance (e.g., at theater, dance or sports events) allows easy interaction, and a large variety of augmented interactions have been introduced for co-located events. Some systems allow communication among the audience or between the audience and the performers, e.g., polling systems based on mobile devices [15] that collect explicit information about the audience's opinion regarding the performance or sensing the audience [17, 58] to infer the audience's reactions. Recently, in interviews with performers, Webb et al. [59] found that the interaction with audiences is an important topic for them, which is why systems that allow interactions that shape the performance, by considering the audience itself seem beneficial, as they deliver an engaging, tailored experience [12, 46]. Providing users/viewers with more autonomy is also beneficial from a motivational theory point of view. Work such as [29] builds on the self-determination theory (SDT) [13] and has already shown that empowering users with options on how they can shape their own experience is beneficial for motivation, because of the autonomy aspect of the SDT. As our case studies also consider how the audience can influence performances, such theories are highly relevant for live-streaming as well.

Web Video

The advent of the Internet has opened up an easy-to-use return channel for communication between content creator and audience. While first approaches with similar systems have been made in the context of social TV, previous iterations of the concept had to rely on phone hotlines, text messages or custom setups [5, 24]. The Internet, however, allowed easier communications as well as ways to distribute content itself, e.g., video streaming or on-demand video [7, 51].

Research on video streaming of games has become relevant recently. Works such as [25, 35, 37] use corresponding streaming APIs to reason about, for example, viewer/channel distributions or predictions of the number of chat messages in relation to viewer numbers. The audience itself is often a relevant part in research on these platforms: Postigo describes how digital labor as a streamer on YouTube happens and discusses the importance of the community integration in this domain [38]. Cheung and Huang investigated the game *StarCraft* in the area of e-sports, and identified nine personas and what entertains spectators [9]. They found a broad range of reasons why people are interested in watching. Even though they only focused on the *StarCraft* community, it is not unreasonable that the motivations can also be valid for other categories of gaming videos, and depending on this motivation, will require a different amount of influence people can have on produced content. Smith et al. [48] conducted an analysis of gaming streaming communities, by specifically focusing on "Let's Plays" (the content creator plays a game and shares his play-through with others for entertainment purposes) and using the aforementioned personas. They also state that through social functions such as live chats, viewers have the chance to become active and that this is an incentive for them to watch a stream. Hamilton et al. focused on which kinds of communities are built around live-streams on Twitch [20] by interviewing content creators and viewers. They reported that content creators use enhanced participatory options already: viewers can play against the content creator in competitive games, they can provide answers through the chat that are used in a streamed quiz game, and polls are used to make decisions in games, or for answering unrelated questions and showing fan-art in the stream. It was also emphasized that this helped viewers to identify with the stream and to become regulars. Additionally, in terms of McLuhan's consideration of hot and cool media [34], the authors state that they see the live-streaming platform as a hybrid form, with the combination of the (cool) chat and the (hot) live video.

How streamer-viewer communication can be improved is an ongoing and current research area. In TwitchViz [36], for example, a system is presented that allows the streamer to analyze chat messages, which should help streamers to better understand their audience for subsequent streams (as at the time, no live integration was available). Rivulet [21] is a tool for multi-stream experiences, but provides further options for the audience to better interact with the streamer (e.g. a push-to-talk option), besides just the chat. Another recent example is Helpstone [30]; here, Lessel et al. decided to focus on the game *Hearthstone* and as a case study implemented and evaluated a tool that provides new communication channels. The goal was to enable viewers to better articulate hints and feedback to the streamer, especially for large viewer numbers. They found that viewers appreciate more sophisticated interaction options (especially direct interaction on the video stream), rather than only writing into the chat, and that these options can raise the perception of influence the audience can exert.

CASE STUDY SELECTION

An audience can exert direct and indirect influence [45]. A simple example of the latter in online video is a high view count, which is desirable for every streamer. Thus, a streamer could base the decision to stream one game over another by checking variations in the view numbers. Even though [20] mentions and [30] considers direct audience influence options, this was not yet (to our knowledge) investigated in streams in which audience influence is a central component. Similar to Lessel et al. [30], we approach this topic with case studies.

In case study 1, we considered a stream with a large audience in which a pen & paper role-playing game is played and the content creators claim that the audience influence is important. In comparison to a video game, the “game engine”, “programming” and “storytelling” is represented by a human; thus, in contrast to programmed video games, the only limiting factor is the imagination of the people playing this game. By analyzing such a format we have the chance to see what is possible if the underlying content does not restrict the interaction. With this case study, our goal was to analyze the current practices in a large channel to make interactive audience options available, i.e. which approaches are possible with current technology. It is of particular interest whether the audience integration options in typical Twitch gaming streams (in which the audience influence is not central) mentioned in [20] are also found here. Even though pen & paper role-playing games are not “mainstream” for Twitch, several channels are providing such formats; thus they can still be considered as relevant.

In case study 2, we first introduce the “social experiment Twitch Plays Pokémon”, a setting in which the audience alone decides on the course of the stream, as no streamer is present in it. This provides the basis for understanding this setup, which also attracted a large number of viewers. This experiment received extensive media attention and today several “Twitch Plays” streams are available. To complement the results of case study 1, in which options that are already used today were analyzed, case study 2 had the goal to investigate how viewers perceive new options, which enable them to come to a better consensus for self-administration and enrich the experience. We created our own prototype with several influence options for the audience in the “Twitch Plays Pokémon” setting and conducted a study with it to learn how these are perceived.

Figure 2. Setup of the B.E.A.R.D.S. pen & paper session, with the “Twitter Wall” on the left. Picture taken from Episode 6, https://www.youtube.com/watch?v=crNKgbLIor0, retr. 17/04/2017

After presenting the results from the case studies, we discuss how both streaming situations are similar, and how our insights contribute to the understanding of audience influence in live-streaming. Our selection does not cover any of the Twitch “mainstream” channels (i.e., “Let’s Plays” of known games), as it appears that in these streams audience influence is often only considered as byproduct (see also [20]); thus they do not fit our goal to examine large channels with a focus on audience interaction (although analyzing such “mainstream” channels specifically is an interesting next step for future work).

CASE STUDY 1: ROCKET BEANS TV PEN & PAPER

The goal of this study was to analyze a streaming format which attracts a large number of viewers and claims to be highly interactive by giving the audience participatory options. This allows us to get a first impression of which actions are taken when the goal is to provide the viewership with more influence over what is happening during the stream.

Rocket Beans TV [47] was a German Twitch channel broadcasting 24/7 (today it broadcasts over YouTube). In 2014, they launched a pen & paper role-playing game format, in which the audience is encouraged to participate through various means. On average every two months a new episode was produced (with a much higher frequency today). The format attracts more than 30,000 viewers and is among the top formats on this channel [44]. In a pen & paper role-playing game [56] one player (the “game master”) represents the game world/narrator and can flexibly react to player actions. Players interact within this world in the form of an improvisational theater and can explore the story and the world the game master has prepared. Usually there exist rules to handle character creation and actions inside this world (e.g. fights), and dice are often used to make it more interesting by introducing randomness.

Stream Content

Their pen & paper session consists of four players and a game master sitting around a table; the scenery is arranged to thematically fit the role-playing setting (see Figure 2) and in the episodes considered a post-apocalyptic and a Viking setting were used. Viewers can chat via the Twitch chat (which is not shown to the players, thus only allowing information exchange

Question	Options
What will the group encounter at the bottom of the stairs?	A zombie eating the guard Frank The guard Frank still searching for the key Another prisoner A popcorn machine
What happens in the night?	They will be wakened by scary sounds Their shelter begins to burn Someone calls one of them
What does Steven do?	He eats a leg He and a guest are drinking tea

Table 1. Examples of polls and the available answer options

between viewers), but can also post via Twitter. Tweets are shown in the studio on the "Twitter Wall", which, in contrast to the chat, allows pictures to be shared with the players. During a stream, information overlays, music and sound effects that fit the current situation are added and pre-made clips and pictures are used to visualize certain aspects.

Audience Participation

We reviewed the first six episodes (around 24 hours of video), i.e. all episodes of Season One and one of Season Two[1,2]. The review analyzed elements involving the audience, following an open coding scheme by using a thematic based analysis. We annotated direct (e.g. the community is encouraged to vote or otherwise directly addressed) and indirect (e.g. the camera shows the Twitter Wall, or elements that were formerly created by viewers are shown) social interactions, with a timestamp and a short description. This transcript was later used to derive categories which were discussed by two of the authors. We counted 209 direct and 293 indirect interactions. We clustered these into 21 categories. The number of instances per category varies (with smaller categories such as *viewers providing hints on the game rules* to large categories such as *direct acknowledgements of user contributions*). We related categories and they led to the following overall themes:

Voting

A core element in this format is voting. In Episodes 1–5, this was conducted via StrawPolls (see Figure 1, right), an external web page. Until Episode 6, usually these polls were published just before advertisements were shown. This gave the audience time to vote, without missing any story-related content in the stream (as the transition to the external page was necessary). Due to synchronization problems with the progress in the story and the need to display advertisements at specific times, this was later relaxed and polls were also used directly during the session. In Episode 6, the Twitch chat was used for voting: The question and answer options (which could be entered as commands in the chat) were displayed as a stream overlay. In general, by voting the audience could decide how scenes should proceed (see Table 1). The voting results were visualized and the most popular answers were used by the game master. In total, 24 polls were conducted and on average 9533 (SD=5338) votes were given. Not considering the first episode, in which the format was tested, and the sixth episode, in which only registered users were able to vote via the chat, the number increased to 13118 (SD=1563). Five times they used polls for which they only provided the question and viewers had the chance to tweet possible answer options. These were screened by people working with Rocket Beans TV and they generated a poll based on selected answers. Such polls are more difficult for the game master, as he needs to improvise, while for pre-defined answers, scenarios for each outcome could be derived beforehand. As this is still moderated, the audience influence remains limited. In contrast to these live polls, the community also had the chance to participate in a poll with pre-defined answers between the two seasons to decide which setting should be played next.

Direct influence on the setting and story

Viewers had the chance to send illustrations and descriptive texts of items the players found within the story. Small cards with representations of the fictive items were given to the player of the character owning the item. The viewer incentive, besides getting directly acknowledged in the stream, was that items were usually available across several episodes and thus were potentially shown multiple times. Before Episode 6, the audience was asked to send pictures and video material fitting the setting. Selected elements were shown during the episode, and even though they were not relevant for influencing the course of action, they were part of the content shown in the stream. However, the audience also had the chance to influence the story: in Episode 2, the audience was spontaneously invited to generate a name for a building in the game. This was picked up for the second season, where story elements could be generated collaboratively [26]. They could create them freely, or could provide explanations and content for aspects that were already marked by the game master. Parts of the content were approved by the game master and then used in the game. The viewers could thereby influence the imaginary world, although the decision on what would be integrated was again not audience-driven. Additionally, the audience received tasks to be carried out during the stream that were directly interwoven with the story and the world (i.e., if a task was not completed, the situation would worsen for the players): In Episode 5, the viewers were told to post photos on Twitter showing a German landmark with themselves disguised as zombies in front of it. In Episode 6, the audience represented the inhabitants of a town, and their task was to decide whether they are convinced by a speech given by the players. They were to respond via Twitter by sending "thumbs up or down".

Communication channel for the audience

Players often read tweets on the Twitter Wall, especially when they were less engaged in a game situation. They even praised the community engagement several times. The Twitter Wall is often implicitly shown when the camera position focuses on specific players, or explicitly, either because the content seemed interesting/fitting for the stage direction or because the players were discussing parts of it. Thus the wall was directly influencing the content of the stream. Images from the wall were shown and discussed, and comments, either from during or between episodes, were often read and discussed by the players. The name of the contributor was mentioned or shown in the stream, and the players also acknowledged good contributions directly. The players used suggestions by

[1] This were all existing episodes at the time of the analysis. No new audience influence concepts were introduced across both seasons.
[2] Videos are available on the Rocket Beans TV YouTube Channel https://www.youtube.com/user/ROCKETBEANSTV, retr. 17/04/2017.

the audience to alter their behavior in the game, e.g. by asking other story-relevant questions in-game or re-interpreting rules because of a viewer hint. Additionally, help from the audience was also explicitly encouraged by the game master whenever riddles were encountered by the players.

Discussion

This case study revealed different kinds of audience participation that are used in a stream that has the goal to incorporate interactive elements. We restricted ourselves to the elements that are shown directly in the stream, not social media sources around the streaming experience that were not directly involved (Facebook, Reddit, etc.). This study showed various ways to integrate the audience that exist already. Nonetheless, all the elements we found are at some point moderated, either by the game master, the players or the team behind the scenes, so they do not offer the audience direct (unfiltered) influence. Through the Twitter Wall, viewers have a direct channel in the stream, which is influencing the course of action during the stream. Through the integration of user-generated content, polls and other ways to shape the story, the audience has some kind of shared authorship. It can also be seen that single viewers' suggestions are directly incorporated (e.g. user-generated content such as images) and polls suggest what the majority of the viewers want to happen in the story, i.e., they provide influence over the content of the stream in a nearly-real-time fashion. Besides these synchronous actions during the stream, there are also elements that alter asynchronously how the content will change in the future (e.g. co-story creation).

We found means for audience influence that were also observed by Hamilton et al. [20] in streams which could be considered more "mainstream". The difference with our findings is that all options we report were integrated in one stream, while it remained unclear to what degree they were available in the channels considered by Hamilton. Elements such as the co-story creation option and directly shaping the experience that unfolds in the stream were not found in this work. One explanation is that in these channels digital games were played that do not easily allow for such adaptations. The high interest the community shows here is a hint that games/streams should offer more of these options. The large overlap of elements here and in the streams considered by Hamilton et al. hints that there are only a few common concepts for when the audience should be integrated into the streaming experience today.

We do not know yet how these options are perceived by the audience. Maybe the technological considerations are the limiting factor (i.e., concepts for more audience integration simply cannot be realized with the current setups) or the audience itself is satisfied already (i.e., making it unnecessary to develop more). The work of Lessel et al. [30] indicates that the latter is not true. As our case study only analyzed video content, we were not able to collect viewers' opinions on the different interactive elements. For future studies, we will create a similar setting in which we will also interview viewers after they have watched such a stream and ask how they experienced it. Nonetheless, this case study has contributed insights into a particular stream offering integration options for their viewers and revealed that many options are already at the streamer's disposal. In our second case study, we investigate alternatives not yet used in streams and let viewers assess the usefulness of these elements.

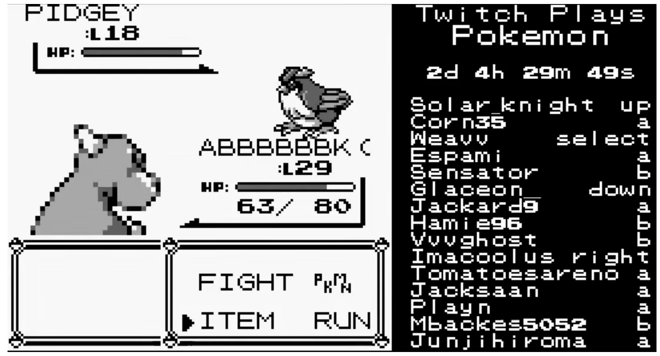

Figure 3. A TPP situation showing a fight and the viewer commands

CASE STUDY 2: TWITCH PLAYS POKEMON

We first give an overview of the "Twitch Plays" phenomenon by elaborating on its first installment. We then present a system that built upon TPP and use it to explore options that are of relevance for streams that want to empower their audience.

The "Twitch Plays" phenomenon

In February 2014 "Twitch Plays Pokémon" (TPP) launched on Twitch and the game "Pokémon Red" was streamed. In this game, the player's avatar collects creatures and fights against others in a turn-based manner. The game's goal is to win fights against specific non-player characters. The novelty in this channel was that the audience alone played the game simultaneously via chat commands that mapped to game commands (e.g. typing in "down" moves the avatar downwards; see Figure 3). Every registered user on Twitch could participate and more than 1.1 million people entered 122 million commands [39]. At the peak, 121,000 people played simultaneously. The game was finished in 16 days, despite players hindering progress ("trolls"), the "Twitch lag" [61], the (initial) decision that every command was carried out ("anarchy" mode) and difficult game areas. Beneficially for this, the "democracy" mode (only commands entered by the most players within a time-frame were carried out) was introduced [33]. The mode could be switched by the audience [27].

TPP provides a completely different experience than playing a multiplayer online game: all players share control over one character. TPP lived through more than one instance; after the first game was finished it continued successfully with other Pokémon games. And more TPP-like channels appeared with different games, e.g. Hearthstone [54], a round-based trading card game, or Dark Souls [53] a (real time) action role-playing game. But other non-gaming areas were also explored. For example, in "Twitch Installs Arch Linux" [52], the audience (successfully) installed a Linux operating system. Twitch also provided its own section for such channels [16]. These examples show that this is an emerging phenomenon falling into the purview of several research areas, such as computer-mediated communication and crowdsourcing. We crawled ten days of viewer count data in April 2016 from streams that appeared on the aforementioned TP section, to

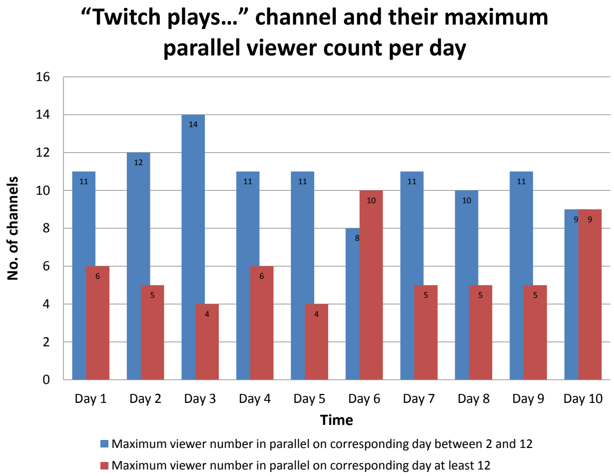

Figure 4. Maximum parallel viewer count per day for TP channels.

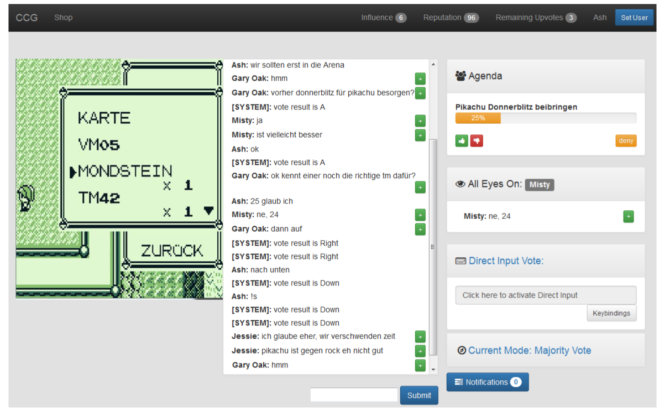

Figure 5. Screenshot of our web application.

learn how frequented these channels are. Every 20 minutes, we checked the viewer count in channels listed there. 58 channels appeared, and the massive numbers seen during the first instance of TPP were not reached by TPP itself or any other TPP-like stream. The channel with the most viewers in parallel had 7689 viewers on one day and was a notable exception. TPP had 322 viewers in parallel at the peak and apparently, there are two classes of channels (see Figure 4): a few channels that attract a larger number of viewers, and channels that have a small viewership in parallel (< 13).

For our second case study, we were interested in how such an experience is perceived, how far the audience can administrate itself and how this can be facilitated. In contrast to the first case study, in which we reviewed an existing stream, here, we analyze potential future options for live-streams. To explore these aspects, we created a system with a TPP-experience to be able to manipulate different elements: As the "democracy" mode in TPP was introduced to make progress faster [33], we were interested in exploring further modes. Work on crowd input aggregation [28, 42] has already investigated different options ("aggregators"), partially in game settings as well [32], but not yet in a setting similar to TPP. As the audience changes over time, goals may change as well, which is why the audience should also have the option to alter the aggregator used. We wanted to add further options for self-administration to learn how the audience perceives these. We framed them as gamification elements [14], as these are becoming more common in live-streaming channels these days: The streaming platform Beam.pro integrates a gamification concept for viewers directly into their platform, and external tools exist that allow streamers on other platforms to use game elements in their streams. Moreover, in the absence of a streamer in TPP-like channels, adding more sources of motivation to engage channel visitors to participate seems relevant. As gamification is also used for this kind of goal (see for example [29]), it seems reasonable to investigate the perception of such elements directly in a TPP setting as well. Both the aggregators and gamificaton elements have the goal to raise engagement (as positively applied in social TV approaches such as [1]) and the level of audience self-administration.

System

A server and a web application were developed in order to be able to manipulate the setup more easily than it could be using Twitch. As a basis, we adapted elements used there, i.e. the chat and the streaming capability, as well as the option to enter commands into the chat that are interpreted in the game (see Figure 5). We added an option to directly use keystrokes to carry out commands (instead of using the chat) and added more aggregators and gamification elements:

Aggregators

For the aggregators (see Table 2) we provided a mode in which all commands are executed ("Mob"), one in which non-experts have more weight ("Proletarian"), a mode in which the audience can give certain viewers more influence ("Expertise Weighted Vote"), modes in which the best conforming decision is selected ("Majority Vote", "Crowd Weighted Vote") and modes in which an individual decides ("Active", "Leader"). Every user can change the desired mode, but only the most often selected becomes active and is shown on the webpage.

Gamification elements

We use two values, called *influence* and *reputation*. While reputation is a permanent value (used in "Expertise Weighted Vote"), influence is used for buying items. Every user can "up-vote" other users, e.g. after they have provided good suggestions. The amount of up-votes a user can spend is limited, but refreshes over time. Every up-vote generates influence and reputation for this user. Influence can be spent on these items:

- *Agenda*: A user-generated short-term goal (e.g., "Go to city X") can be established, which might be beneficial for motivation [31]. It is shown to the audience and they can vote on whether the goal has been reached or not, or state that they do not want to pursue this goal. If a decision has reached a majority (among all logged-in users), or the majority has cast their vote, the agenda ends. Participating users gain a small amount of influence independent from the outcome, in order to prevent incentives to manipulate agenda votes for influence gain. Only one agenda can be active and no agenda items can be bought during this time.

Aggregator name	Aggregator functionality
Mob	“Anarchy” mode in TPP and Mob/Multi in [28]. Every vote is processed and carried out.
Majority Vote	“Democracy” mode in TPP. Time frames are considered and the most-selected command is used.
Crowd Weighted Vote	Based on [28]. Crowd Weighted Vote is an iterative aggregator that provides a weighted majority vote, where the user’s weight is based on their conformity to the crowd. The weight of all users is continuously adapted based on their voting and the most popular vote, i.e. increased (decreased) if the choice is (not) congruent with the most popular vote.
Active	Based on [28]. If this aggregator is chosen, one user is randomly selected and takes control over the game. As long as the user provides inputs, he remains in control (if the aggregator is not changed).
Leader	Based on “Legion Leader” [28]. Leader combines Active and Crowd Weighted Vote; a user is selected not randomly, but based on his or her conformity to the crowd.
Expertise Weighted Vote	A weighted majority vote with weights based on the expertise of the users (often used in crowd-based systems [42]). In our case, the individual expertise is generated by the crowd itself, as users can receive up-votes (which improves the “Reputation”) for their actions, i.e. the crowd can identify people they want to provide with more weight in decisions.
Proletarian	The inverse of the Expertise Weighted Vote, i.e. the crowd can empower the non-experts.

Table 2. The aggregators used and an explanation of how they work.

- *User Spotlight*: One detrimental factor in user motivation within a crowd is the invisibility of one’s own contributions [3]. This item tries to motivate users by highlighting their actions for all others. The featured person is chosen randomly and showcased for a fixed period of time, after which the next one is selected. Players can cumulatively increase their chance of being chosen by buying this item.
- *Repay*: This item distributes its influence cost evenly among peer players. The concept behind this item is motivated by the variety of player types. Loparev et al. introduced a passive game mode (control mode) which allowed users to aid their fellow players without directly influencing the game state [32]. Additionally, in cases of a skewed distribution of influence, which for example might occur when one or a few players are favored by the crowd due to their expertise, this item can be used to re-balance.

We evaluated this system in a user study, to learn how both the aggregators and the gamification elements are perceived and used by an audience and what further expectations users might have. Moreover, we were interested in assessing the overall perception of a TPP-like setting. It can be expected that the dynamics in such streams differ, the more viewers take part. As it was shown that more TPP-like channels attract only a smaller viewership, we aimed also for a smaller group of participants in parallel for this first evaluation.

Method

We used our system in a LAN setup to minimize streaming delay; all participants were physically separated, a list of usernames was handed out, and it was forbidden for them to reveal their identity. This was meant to mimic the TPP setting, in which participants probably do not know each other. After a pre-session questionnaire (assessing demographics and subjective experience with computer games and TP settings), every participant received access to the “Pokémon Red” game and had ten minutes to get familiar with it. An interactive explanation of how the aggregators work followed: The participants were able to define voting options and values, and could see what a selected aggregator outputs. The user interface was also explained. In the experiment the subjects controlled the avatar (as in TPP). This part was separated into four phases, representing different conditions. The first two phases did not use gamification, restricting the user interface to the login button, stream window, chat, mode vote option (without “Expertise Weighted Vote” and “Proletarian”) and direct input option. In order to avoid demotivation, the phases without gamification had to happen before gamification was introduced, since taking away features could have a negative impact on the user experience [50]. The four phases used were:

1. *Easy, no gamification (ENG):* This phase started in an area in which navigation and fights are easy.
2. *Difficult, no gamification (DNG):* This phase starts in a difficult game area (“the Rock Tunnel”) since the screen will turn almost black, only showing silhouettes of the walls. Using a special ability of the avatar, players can illuminate their surroundings. Combined with a more challenging navigation task, this situation demands coordination from the players. In TPP it took 9 hours to complete this task [40].
3. *Easy, with gamification (EWG):* Reusing or resetting known scenarios could frustrate players who have their achieved progress reset; thus, for the gamification conditions we needed to ensure the use of other states fulfilling the requirements. Thus, we selected a similar but different state compared to ENG, i.e. easy navigation and easy fights.
4. *Difficult, with gamification (DWG):* The phase started in the difficult game area called “Spinning Hell”. A high amount of floor tiles move (spin) the character in different directions, making navigation through the maze hard. This area led to the introduction of the “democracy” mode in TPP, because progress in “anarchy” mode proved impossible [40].

Every phase took 15 minutes of game time. At the beginning of each phase, participants receive information about the available creatures, items, special abilities and the story state. No requirements regarding method of play were given. Between phases they were asked to answer questions regarding their enjoyment, perceived progress, difficulty and usefulness of the available features on a 7-point scale. The last questionnaire contained an additional section including an assessment of the framework. Additionally, a post-session interview was conducted to gather further qualitative feedback. Besides these qualitative measures, we also recorded interactions with the interface and video-taped the game play. The chat was also recorded but led to no conclusive data.

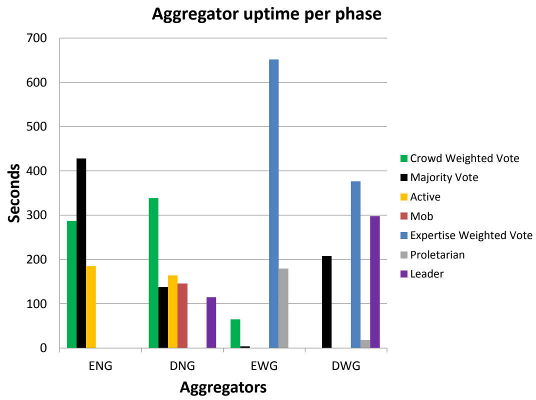

Figure 6. The different aggregators and their uptime.

Participants

Eight German subjects participated (one female) and all were between 21 and 30 years old. People of this age represent the largest user group on Twitch Germany (42%) [41]. Also, the gender imbalance is representative; as only 9% of the German Twitch viewers are women [41]. Six participants were students, two were employed, and all deemed themselves quite experienced with video games (Mode x_D=7; Median Mdn=8.5) on a ten-point scale. One had participated in at least one TPP session; six had already seen footage or heard of it.

Results

The participants were able to solve tasks such as lighting and successfully proceeding within the "Rock Tunnel", navigating parts of the "Spinning Hell" and winning fights against non-player characters throughout all phases, i.e. the group achieved progress. One explanation for this could be that we had no destructive forces amongst the participants ("trolls") and a low participant count, in contrast to TPP. Nonetheless, the participants evaluated their progress as low throughout all phases: lowest in EWG and DWG (both: x_D=1; Mdn=1.5) and highest in DNG (x_D=3; Mdn=4.5). As situations occurred in which advancement was slowed, mostly due to dissent on how to proceed, this could be an explanation. An example failure occurred in EWG where the group steered the character back and forth for minutes. We observed that participants with a lower overall system interaction per minute count, tended to do social actions (chatting, upvoting, polls etc.) instead of issuing commands. This indicates that our audience was also not uniform (fitting into [9]) and different roles might be available in the audience, altering how they interact. This should be analyzed in future work on this topic.

Self-Administration Through Aggregators

In every phase, we started with the "Majority vote" aggregator. In ENG, the first mode change occurred after 63 seconds; in the later phases the first mode change occurred after 4 seconds on average. The ability to change the aggregator was deemed fairly important by our subjects (medians per phase: 4.5; 5.5; 2; 4.5) and they disagreed with the statement that all aggregators were equally important (1.5; 4; 1; 1). Figure 6 shows the measured usage times. The most used aggregator was "Expertise Weighted Vote" with an overall uptime of 1028 seconds, while "Mob" (145 sec) and "Proletarian" (198 sec) were barely used. Considering the assessment of the aggregators, "Crowd Weighted Vote" was always mentioned as important (and got 65 up-votes in EWG and 39 in DWG) and in the difficult phases, aggregators that provide individuals with more weight ("Expertise Weighted Vote") or single user options ("Active", "Leader") were highlighted. While it could be argued that although "Leader" was chosen in DNG, all other aggregators in this phase had more uptime than "Leader", a closer look at the game footage provides more insight. DNG has two major tasks: lighting the rock tunnel (once lighted it stays lighted) and navigating it. In TPP, the first task was never completed (they navigated without seeing the whole map) and thus the overall difficulty of this scenario was quite high. In our study, the participants managed to solve the first task at the four minute mark; during this time "Leader" had its total uptime of 115s. The set of aggregators was rated as complete (x_D=6; Mdn=6) and as containing useless ones (x_D=6; Mdn=6): "Proletarian" was named thrice, "Mob" twice and "Active" once, which coincides with their uptimes. The participants were indifferent to the statement that aggregators provide a good option to self-administer the group (3.5; 4.5; 3; 4), even though they had the feeling that their decisions were in line with the group decisions (5; 4.5; 4; 5.5).

Perception and Self-Administration Through Gamification

The participants agreed only slightly with the statement that they had fun (asked on a single scale) overall (x_D=4; Mdn=5). Breaking it down to the single phases, we see that in ENG and DNG the perceived fun (x_D=3; Mdn=3.5; x_D=2; Mdn=3.5) was low. This could hint that playing games that are not designed primarily for an "unmoderated stream" needs further incentives to be fun. After adding the gamification elements, the self-reports for the perceived fun improved in EWG (x_D=6; Mdn=6) and in DWG (x_D=6; Mdn=5.5), even though the perceived progress was lowest in these phases, as stated. There was a sig. difference in these measurements, as a Friedman ANOVA showed: $\chi^2(3)$=10.87, p=0.012. Post-hoc analysis with Wilcoxon signed-rank tests was conducted with a Bonferroni correction applied, but revealed no sig. differences between the phases. When asked about whether or not gamification elements improved the user interface, users evaluated them clearly as beneficial (x_D=7; Mdn=7) and also that these elements added to their enjoyment (x_D=6; Mdn=6 in EWG and x_D=6; Mdn=5 in DWG). Additionally, these features were deemed helpful regarding self-administration (x_D=6; Mdn=6 in EWG and x_D=4; Mdn=4 in DWG) and added subjectively to a positive group feeling (x_d=6, Mdn=6 in both phases). Overall, 20 spotlight, 15 repay and 11 agenda items were bought. Not surprisingly, the sample also agreed with the statement that gamification is a good idea in this setting overall (x_D=7; Mdn=6). And even though the offered functions were assessed as helpful (4.5; 4.5; 6; 5), apparently they were not enough (6; 5; 5; 5). An issue that was revealed in the interviews was that more shop items would be reasonable, e.g. sub-agendas or an item that provides the leader role for a short time. Two participants also wished for options with more impact: These participants had a lot of up-votes and wanted to spend their influence further. The experience could be improved by adding more statistics, social information and the option to share responsibilities. The most common demand was a static display of the current leader visible to everyone. Additional demands concerned seeing how much influence or reputation users have, and one subject also wanted a display of how much weight the users have in each voting phase.

Discussion

Our study was the first controlled exploration of the TPP phenomenon. The perceived game progress was low, even with the additional elements offered. The perceived fun was low in the no-gamification settings, but higher in the gamification settings. This might explain why TPP-like streams are rare today and considering Figure 4, why viewer counts in many such streams are low. Considering the content of the original TPP setting, the significantly higher numbers can be explained by the novelty, but also the "fandom" that was created (cf. [43]).

Considering that the audience needs to organize itself in the absence of a moderator, the results indicate that simple majority polls are not sufficient. The audience judged the ability to change the input aggregators as fairly important, and made use of it, as changes occurred during each phase. Depending on the situation, the audience reduced the average player influence for the sake of progress and coordination, either by selecting single-user aggregators ("Leader" or "Active") or empowering a group of individuals ("Expertise Weighted Vote"). This indicates that the audience does not always want everyone to contribute equally, for example to achieve faster progress. The conformity-driven aggregator "Crowd Weighted Vote" was selected in the first two phases but was almost not used at all later. Potentially, as in later phases the "Expertise Weighted Vote" aggregator was available, it appeared more suitable. What can be derived from this is that a fixed aggregator seems insufficient. Demands vary depending on the situation, and there should be different options offered to fit these situations. Using all inputs or only plurality votes, as is being done today in these streams, is probably not enough.

A surprising result was that aggregators were not perceived as useful for the self-administration of the group, even though they were actually used. First, this could be a result of integrating (as stated by the participants) useless aggregators. Potentially, this could have altered the perception of the aggregators overall. Second, it could be that aggregating single-user commands is necessary to make progress, but will still lead to a different feeling than in a single-player game, in which one user has full control. It is most likely that not every decision of a viewer is carried out in a TPP setting (independent of the aggregator), which might lead to such an impression overall. In contrast, considering the introduced gamification elements, we learned that these add to the experience and provide a better feeling of self-administration. The participants requested additional elements, not only for entertainment, but also to better influence the decisions and how the game proceeds. Integrating their suggestions and experimenting with these elements are interesting further research directions. It would also be interesting to see how these are perceived long-term.

Our study had limitations: first, even though in line with the Twitch demographics, the lab study with its small and gender-biased sample. As many available TPP-channels have a similar small audience, our study still provided actionable results. A second limitation was the short time frame the participants had to interact with the game phases. We decided to see this as acceptable, as it is currently unclear how long people interact with a TPP-like setting in general. 15 minutes appears to be a compromise for the participants to report their initial perception. Third, the user study itself had no players hindering progress, in contrast to the original TPP setting. Even though we think that the available aggregators will moderate effects that are introduced with trolls, our study can draw no definite conclusions for this. To account for these limitations we will start a live-stream in-the-wild (with a different setting, as another TPP channel might provoke undesirable viewer responses as long as the original TPP channel is still available). Work such as [25] shows that most channels on Twitch attract only a few viewers; i.e., launching a channel does not automatically mean that a large viewer-base simultaneously can be reached, which is why we decided against this for this first study. Fourth, the decision to do this study within-subject (instead of using a between-subject design/without a control group that plays through the four scenarios without gamification) could have led to learning effects (while cycling through the difficulties) and thus the impact on the gamification elements could have been overestimated by the participants (even though we found that less likely based on the qualitative answers). Fifth, our study used the relatively simple (considering interacting and navigating) Pokémon Red game. The results should be seen as applicable for this genre and not necessarily other genres, as these might demand faster interaction cycles (e.g., shooters), thereby posing different challenges. Those could be reviewed similarly in the future. Sixth (as this was not the main focus), follow-up studies should deploy more sophisticated measurements for the concept of fun and player experience, and not only a single scale question (cf. [4]).

COMPARISON OF STUDIES & LESSONS LEARNED

The selection of streams for our case studies was guided by our goal to consider channels which attract large viewer numbers and see the audience influence as central. Each case study provided actionable results, and even though the selected streams appear different, the results show that properties for audience influence are similar and can influence each other:

Moderated influence – In both studies we see that an individual contribution is not necessarily integrated in the stream; thus the individual alone has no direct influence option. This leads to viewer actions that are simply "thrown away". In CS1, the moderating factor is humans; in CS2 it is an aggregation system. Both studies showed that an individual can (to a certain extent) increase the chance of their contribution being used: in CS1 by providing high quality material (for example a good story element); in CS2, by changing the aggregation system towards one that gives this viewer more influence or by buying elements from the shop. As reported in CS2, it seems impossible to let every viewer contribute unfiltered (cf. the initial attempt to do this in TPP was a failure in terms of progress in the game), but CS2 also showed that more sophisticated, viewer-changeable aggregation mechanisms (than the used plurality vote in CS1) are relevant for the audience and should also be considered in current streams.

Emergence of new experiences – Considering self-determination theory [13], both case studies provided insights in streams that give the audience more autonomy. The stream in CS1 belonged to one of the top formats of the channel we looked at, and the feedback of our participants of CS2 hint that having more autonomy and options in streams seems interesting (even for passive viewers [30]). Merging the results of CS1 and CS2, we could easily imagine new interaction forms that vary with the degree of autonomy and thus shape new experiences: The streamers could keep some form of meta-control and, for example, decide during the stream how the community is allowed to interact. Sometimes the audience could receive full control similar to CS2 (and the streamer would only comment), or could simply choose an aggregator for upcoming polls. We saw in CS2 that there are occasions in which the audience let individuals decide on the course of action; in such new instances this individual could be the content producer; the same is true for CS1, in which the viewers were able to provide game content. Games such as ChoiceChamber [49] are also instances of such new experiences. Twitch tries to encourage these new experiences by their "Stream First" approach [55]. In general, what this also shows is that research on different types of streams can also shape other types. Moreover, this kind of research helps to better understand the need for autonomy in live-streaming.

Engagement in streams – Both studies revealed that different forms of engagement are used to keep viewers motivated. In CS1, the knowledge that one's own contribution gets acknowledged by the content producers might be a reason why so many viewer-generated elements are created. In CS2, we learned that additional gamification elements (for example through the Spotlight item, which is similar to the acknowledgements mentioned before) dramatically increased the fun the participants had during the experiment. Thus, in both cases, engaging viewers to contribute with more than the material which is streamed is relevant. And we see that both studies provided approaches for how this can be achieved, and that the social component is crucial. As discussed, the original TPP setting had the benefit of the large "fandom" that was created around it [43]. Considering the gamification elements, we learned that the participants of CS2 demanded further options. In the context of gaming live-streams it seems reasonable to assume that the audience is already open to game-like elements. Thus, based on the results of CS2 it seems that besides these social elements, sophisticated gamification elements will increase the viewer engagement further.

Different viewer roles exist – Both studies provided hints that not every viewer wants to exert influence. This is in line with the research [9, 30]. In CS1 we saw, for example, that the participation rate in polls is lower than the actual viewer numbers, and in CS2 we learned that some participants focused more on social than game-related interactions. We follow the argumentation of Lessel et al., that viewers who do not want to exert direct influence might still profit when an channel provides more influence options, as the experience for them can also be improved, even though they remain passive [30]. We reason that this should be accounted for, e.g., the influence activities should remain voluntary.

Lack of expressive options – The case studies showed that the chat as medium in live-streaming platforms is not expressive enough by itself and additional efforts or third-party tools are necessary to give the audience more influence: Besides the chat as polling platform in CS1 (which is often done today), all other communication channels used were not directly integrated on Twitch. In CS2, on the other hand, many of the offered functions would not have been smoothly integrable into the Twitch platform. This raises the question of how many channels would be interested in giving the audience more power but refrain because of the required time investment to set up these elements. Obviously, this becomes more important the more viewers a channel attracts. A content creator can ask a question and could review the most frequent answer through a chat with ten participants, but this becomes impossible for larger numbers [20]. Although the platforms provide APIs, they are not yet powerful enough to provide more sophisticated interfaces than text chat. Even though links to external pages are possible, it is unclear whether this is accepted by viewers. The platform Beam [2] allows streamers to alter their channel page with input elements for the audience, which is a step in the right direction according to our findings.

CONCLUSION

We conducted two case studies on streams that have audience influence as a central element for their viewer experience. In the first study, we presented an existing format that tightly integrates the audience's opinion using existing communication channels and that uses different techniques to involve the audience. Our second study investigated a setting similar to the "Twitch Plays Pokémon" stream, but provides more options for the audience to organize itself. From this, we learned that more influence options are appreciated and considered as important. By relating both studies, we learned that even though the stream approach looks different, attitudes towards audience influence are similar. To our knowledge, our paper is the first that investigates this, and our results provide a starting point for further research. Our findings are also relevant for other domains, for example, computer-mediated communication, and are not only applicable to live-streaming.

Besides the options already mentioned throughout the paper, several directions for future work can be followed: our studies focused on technology based on cool media [34], which leads to the question how audience influence can be realized by using hot media and how this changes the experience for the audience and the streamer. Also, an in-the-wild study of a TPP setting enhanced with our findings could be conducted, to learn about individual differences but also to see differences from the small-scale study. Finally, research into different formats and game genres will be helpful to learn whether specific formats/games require specific audience influence options and will also help to generalize the findings on a larger scale. Moreover, this would help in creating a taxonomy in this domain. We only briefly mentioned the different characteristics of the underlying streams (e.g., moderated/unmoderated, synchronous/asynchronous). Such a taxonomy should consider these and relate them to potential effects on the audience influence capabilities. Finally, investigating how content creators perceive the options for their audience is also relevant.

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