

# Evaluating the Impact of Artificial Intelligence on YouTube Viewership

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## ABSTRACT

This research paper examines whether artificial intelligence technology, especially Spotter Studio, can help YouTubers gain more viewers. Spotter Studio, which launched in September 2024, provides AI assistance through forms such as video ideas, title suggestions, thumbnail suggestions, and content organization. It primarily focuses on four pairs of YouTubers, with only one pair receiving Spotter Studio assistance and the other not. The YouTubers are: Lemons to Lemonade Home vs. Katie Scott Salvaged; Colin & Samir vs. Sam Harris; System Zee vs. Knarfy; and Smokin' and Grillin' with AB vs. Island Vibe Cooking. The research uses 3-video rolling averages on graphs to compare viewers in each pair over 6 months, including 3 months before and after  $t=0$ , where  $t=0$  is the release date of Spotter Studio.  $t=0$  is used as a reference point rather than the verified adoption date of AI for each individual channel. Across channel pairs, view trajectories were highly variable, and observed spikes or increases were not consistently attributable to Spotter Studio. Although ' $t=0$ ' factors, such as seasonal variation and content change, are examined, the data suggest no consistent, sustained correspondence between videos released after  $t=0$  and increased viewership.

**Keywords:** Artificial Intelligence; YouTube Viewership; Spotter Studio; Content Optimization; Creator Growth; Video Performance Analytics

## INTRODUCTION

Algorithmic systems are increasingly influential in organizing the social media environment, shaping content surfacing and distribution for users. Recent literature on this topic suggests that algorithmic systems should be considered mechanisms for allocating attention to content through algorithmic logic that determines what content is visible to different groups of users (1).

Prior literature reveals that many ranking algorithms are designed to optimize the revealed preferences of the users, which include clicking, liking, and sharing; however, the evidence reveals that the system that is based on user engagement is not necessarily aligned with the users' stated preferences or their reflective satisfaction with the content that they are consuming (2). By 2025, more than 80% of the content recommendations users see on social networks will be driven by AI-powered algorithms (3). Furthermore, evidence indicates that algorithmic personalization increases user engagement and enjoyment, suggesting that visibility and consumption on social media platforms are shaped by content and its effects on individual users (4). Marketing agencies, newsrooms, and creators use AI to generate ideas, analyze audiences, and even design thumbnails.

This research paper aims to determine whether the

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use of artificial intelligence tools, such as Spotter Studio, is associated with changes in YouTube video viewership compared to similar creators who do not use AI tools. A descriptive, observational design is used to compare the trends in the mean number of views per video, measured by a three-video rolling average, over a six-month period after the release date of Spotter Studio ( $t = 0$ ). A sustained upward shift for at least 2 consecutive post-reference points, relative to the average views per video after  $t=0$ , excluding spikes in views, is considered an increase. The null hypothesis is that there is no difference in post-reference viewership trends between channels that use Spotter Studio and non-AI comparison channels over the observed period. The channel comparisons analyzed in this study are as follows: Lemons to Lemonade Home (AI) and Katie Scott Salvaged (non-AI) (1); Colin and Samir (AI) and Sam Harris (non-AI) (2); System Zee (AI) and Knarfy (non-AI) (4); and Smokin' and Grillin' with AB (AI) and Island Vibe Cooking (non-AI) (3). View trends are examined before and after Spotter Studio's release date, specifically three months before and three months after (referred to as  $t = 0$ ), and the findings are incorporated alongside previous research on AI and social media platforms.

Emerging statistics reflect just how deeply AI is integrated into mainstream media consumption experiences. As of mid-2025, over 5.4 billion people, or two-thirds of the global population, are social media users, and more than 70% of all images shared on social media involve AI (5).

Promotional statements issued by vendors of AI tools, including the one under investigation in this research, Spotter Studio, claim that the tool can achieve view increases of up to 49% in the first week. However, this statistic comes from internal beta testing and the company's marketing materials and has not been independently verified or supported by peer-reviewed research.

## LITERATURE REVIEW

### How AI Tools Influence Content Creation and Views

Spotter Studio, an AI application, assists YouTubers in creative tasks by searching through YouTube's vast database for video concepts, helping creators optimize video thumbnails and titles for search success. Title suggestions highlight the role of numbers and emotional keywords, while thumbnail creation emphasizes high-contrast colors and layout. Spotter Studio highlights outlier videos that achieve better search results than the

average, helping artists capitalize on their success (6).

AI-augmented thumbnails are noted as important for engagement, as predictive thumbnails utilize algorithms to identify user behavior and preferences, adjusting themselves to enhance click-through rates. This aligns with broader findings in social media research showing that algorithmic systems amplify content that successfully captures user attention in early exposure phases, reinforcing feedback loops in which higher click-through and engagement metrics increase subsequent visibility (7). Minor modifications to thumbnails have resulted in increases in engagement levels among users, with case studies demonstrating that an online series doubled its click-through rate by incorporating AI-augmented concepts (8).

In addition to ideation and thumbnail development, Spotter Studio offers a suite of applications combining AI and analytics. Its dashboard identifies trends, recommends relevant ideas, and helps content creators arrange schedules and manage workflows. Spotter Studio's 'Spotter Labs' refines algorithms for content curation focused on audience preference (6). Implementing AI requires a learning curve, and excessive reliance on AI may diminish personal creativity. Spotter Studio costs \$49 per month or \$299 annually (6).

The promise of AI content creation extends beyond Spotter Studio. Creators use LLMs to draft scripts, summarize research, and create voice-overs. Tools like Descript and Runway ML automate video editing, while D-ID and Synthesia generate talking-head avatars. AI-generated backgrounds, music, and effects, made possible through YouTube's integration with DeepMind's Veo model, enhance production efficiency, allowing creators to focus on narrative and originality (3).

Algorithmic personalization is an essential design element on several social media sites; however, existing research on the extent to which personalization impacts engagement is scarce. To address this research gap, Dekker, Baumgartner, and Sumter conducted a preregistered within-subjects experiment with 88 TikTok users, comparing their experience with their regular, highly personalized TikTok feed to an experimental week with a less personalized feed (9). Users experienced reduced usage frequency and duration, increased self-regulation, and decreased enjoyment when using the less personalized TikTok feed (9). The aforementioned observations underscore the crucial role that interest-based personalization plays in maintaining engagement; however, they also imply that less personalized feeds could encourage self-regulation, perhaps at the expense

of reduced enjoyment, which may make users reluctant to use them (9).

According to surveys, creative professionals have mixed feelings about the use of generative AI. Adobe's study found that 90% of creators believe generative AI saves time and aids brainstorming (6), yet 56% worry that AI tools are trained on their work without their consent. Most creators call for transparency, with 91% willing to use a utility for valid attribution and 89% wanting AI-generated content to be labeled. Over half believe that current legal protections for creators need to be enhanced.

## METHODS AND MATERIALS

### Study Design and Channel Selection

The study analyzed eight channels grouped into four pairs, with each pair consisting of one channel that used the AI tool Spotter Studio and one that did not. Channels were selected via the official Spotter Studio website, which lists YouTubers who have used the tool. Channel pairings were based on similarity in content niche and a relatively similar number of uploaded videos, defined as channels that differed by no more than  $\pm 5$  videos over the same six-month period. The four channel pairs analyzed were Lemons to Lemonade Home (AI) and Katie Scott Salvaged (non-AI), Colin and Samir (AI) and Sam Harris (non-AI), System Zee (AI) and Knarfy (non-AI), and Smokin' and Grillin with AB (AI) and Island Vibe Cooking (non-AI).

### Definition of AI-Augmented Videos

The graphs constructed show viewership over the approximate six-month span (90 days before  $t=0$  and 90 days after  $t=0$ ).  $t=0$  is defined uniformly as the release date of Spotter Studio. Because exact AI adoption events are not publicly available,  $t=0$  is treated as a reference point in this study rather than a verified adoption date for individual creators. An AI-augmented video is defined as any video posted after  $t=0$ .

### Data Collection

All video views were counted manually by checking the publicly listed total views for each video. Non-public analytics, such as click-through rate, watch time, impressions, and audience demographics, were not available. For each video, the total view count was recorded as a single snapshot at the time of data collection (i.e., views were not tracked longitudinally after upload).

### Outcome Measures

In the graphs, Blue lines indicate channels that embedded artificial intelligence, while red lines indicate parallel channels that did not adopt AI. View metrics are represented as a 3-video rolling average throughout a 6-month duration. The research measured time in days relative to  $t = 0$ , with negative and positive values indicating days before and after the adoption, respectively. Because upload dates differ across channels,  $t$ -values represent time relative to Spotter Studio's release rather than perfectly matched video ages at the time of measurement. A 3-video rolling average was used to smooth out fluctuations when plotting points. For the purposes of this analysis, an increase in viewership is operationally defined as a sustained rise in the 3-video rolling average of views for at least two consecutive post-reference data points ( $t > 0$ ) that exceeds the channel's pre- $t=0$  rolling average baseline.

Inclusion criteria: channels must be listed on Spotter Studio's official website as official users and must have posted for at least 3 months before and 3 months after the release date of Spotter Studio. For non-AI channels, they must operate in a similar content niche to the corresponding AI channel, and they must not have adopted AI tools within the 6-month duration. Exclusion criteria: channels that didn't post for at least 3 months before and 3 months after the release date of Spotter Studio.

The factors considered for possible control in the study, though not carried out since the observational nature of the research and the size of the study population limited the application of full statistical controls, include seasonal factors, virality of content, and the YouTube algorithm. Since the study could not obtain access to click-through rate and viewership demographics, views were used as the performance outcome metric. The publicly known number of views, presented in figures, does not allow us to understand the reasons behind the changes due to the lack of internal analytics.

The sampling was based on the existence of similar channels on YouTube that either used Spotter Studio or did not use it within a six-month window after the tool's release. These channels had to post enough videos to offer insights on trends based on the rolling average of views. While the data collection leans towards sampling rather than a full survey, the information should provide sufficient insights into the trends in the outcomes of using AI tools.

### Statistical Analysis

Confidence intervals were included to quantify

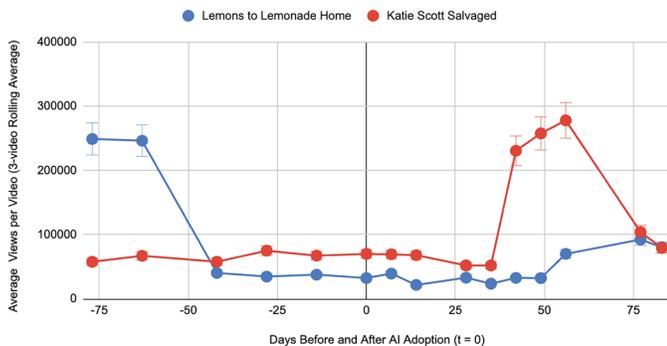
the uncertainty around the average view counts and to account for the variability in YouTube viewership. They were calculated for all channels using raw data post  $t=0$  rather than 3-video rolling averages.

**RESULTS**

Figure 1 shows the average view trends for Lemons to Lemonade home (blue), and Katie Scott Salvaged (red) over the 6-month duration before and after  $t=0$ . As shown, before the implementation of AI technology ( $t < 0$ ), the Lemons to Lemonade Home channel had a pre-implementation maximum of 250,000 views per video, averaging around 70-75 days before  $t = 0$ . After Spotter Studio’s release date, however, this channel does not return to its pre-AI maximum. Instead, the channel maintains a much lower level of views, mostly oscillating between 10,000 and 100,000, with a maximum of 90,000-95,000 around +75 days.

Meanwhile, the Katie Scott Salvaged channel shows relatively stable view counts before  $t = 0$ , mostly below 100,000 per video. After the release date of Spotter Studio, however, this channel shows a post-implementation maximum of 280,000-300,000 views per video, averaged over 3 videos, within a range of +55 to +60 days. This is significantly higher than all the post- $t=0$  maximums of the Lemons to Lemonade Home channel and is actually closer to the pre-AI maximum of the AI-augmented channel.

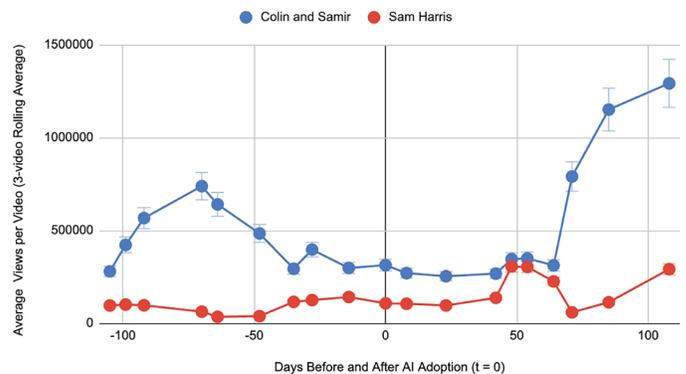
95% confidence intervals were calculated for the



**Figure 1.** Average view trends for Lemons to Lemonade Home and Katie Scott Salvaged, two DIY furniture restoration YouTube channels, before and after the release of Spotter Studio (at  $t=0$ ). This graph represents the 3-video rolling average for views per video. Lemons to Lemonade Home (blue) is listed as a Spotter Studio user, while Katie Scott Salvaged (red) did not utilize AI-based solutions.

mean number of views per video during the post-reference period. The results show that for the AI-augmented channel (Lemons to Lemonade Home), the mean estimate is 46,905 views with a 95% confidence interval between 21,692 and 72,117 views, whereas for the non-AI channel (Katie Scott Salvaged), the mean estimate is approximately 112,923 views with a 95% confidence interval between 26,389 and 199,458 views. There is no clear separation in the mean post-reference viewership between the AI-augmented and non-AI channels, as indicated by the overlap between the confidence intervals. The absence of a post- $t=0$  peak similar to the pre-AI peak for the Lemons to Lemonade Home channel, and the post-reference peak for the non-AI channel, indicates varying view trajectories. Also, sudden peaks may indicate the virality of specific topics or trends.

Figure 2 compares the average views for Colin and Samir (blue) and for Sam Harris (red) over the 6-month period before and after Spotter Studio’s release date. Before this ( $t = 0$ ), Colin and Samir’s views fluctuated, peaking at 700,000 - 800,000 but reaching around 200,000. At about  $t = -10$  days, Sam Harris had a spike of roughly 250,000 views, reaching Colin and Samir’s count at that moment. Although the post-reference peak of Colin and Samir was 1.25 million views, which is significantly higher than the peak of Sam Harris, this is due to a single spike and not a shift in the rolling average, as



**Figure 2.** Average view trends for Colin and Samir and Sam Harris, two YouTube channels with a focus on commentary videos, before and after the release of Spotter Studio (at  $t=0$ ). In this figure, a rolling average of 3 videos is shown to display the average number of views per video. Colin and Samir (blue) are estimated to have adopted AI at approximately  $t=0$ , whereas Sam Harris (red) did not adopt AI software.

suggested by the wide 95% confidence interval of the views of Colin and Samir, which was between 362,657 and 614,358 views. Despite the significant viewership increase for Colin and Samir, both channels experienced fluctuations over the 6-month period, and the timing of the spikes does not align consistently with AI adoption. Comparable increases could be driven by external factors, such as trending content, rather than Spotter Studio's AI itself.

To quantify these observations, 95% t-intervals for the mean number of views per video were computed for each channel. For both Colin and Samir, the confidence interval ranges from 136,156 to 458,511 views, with a mean estimate of 297,333. For the Sam Harris channel, the confidence interval is 111,681-338,186 views, with a mean of 224,933, indicating high variability driven by occasional high-performing videos. The overlap between the confidence intervals for Colin, Samir, and Sam Harris indicates that there is no statistically significant difference after the Spotter Studio release date.

Figure 3 compares the average views for System Zee (blue) and for Knarfy (red) over the 6-month period before and after Spotter Studio's release date. System Zee, compared with the Knarfy graph, shows some substantial trends. The blue line for System Zee, which began utilizing Spotter Studio, is unstable before the use of AI, as seen with fluctuations ranging from 1.4 million to 400,000 views. After Spotter Studio's release date, their viewership decreased to near zero 100 days earlier.

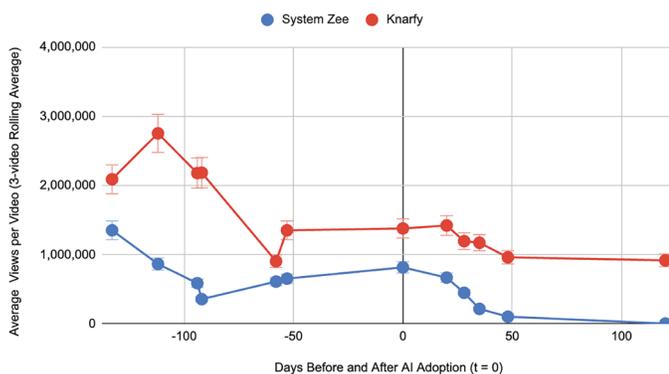
On the other hand, Knarfy's red line indicates they reached a high of close to 2.7 million views around -105 days, then decreased and stabilized at around 1.5 million

views at -50 days. System Zee's views decreased after  $t = 0$ , decreasing to 800,000 views within the first month. Knarfy held steady between 1.5 million and 1.8 million, then increased slightly after  $t=0$ , before decreasing to an average of 900,000 views. To further validate the trends presented in Figure 3, 95% t-intervals were calculated to find the mean views per video for both creators. The interval for System Zee ranges from 265,405 to 975,395 views, with a mean of 620,400. This broad interval is consistent with the considerable variability in the plot for System Zee.

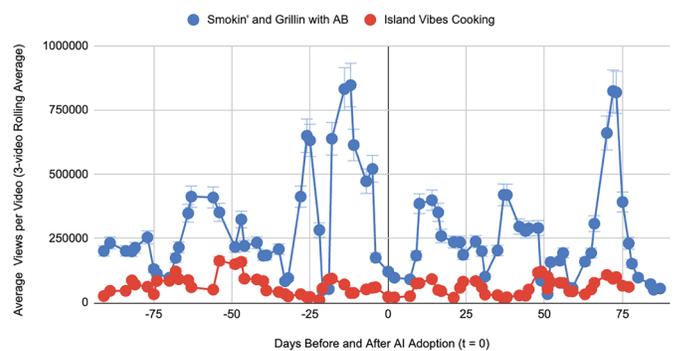
For Knarfy, the ranges are 405,762 to 1,937,666 views, with a mean of 1,171,714. Due to the high-performing outliers, the confidence interval is extremely wide. This suggests that Knarfy's viewership isn't stable and has high fluctuations.

In both cases, the confidence intervals support the trends shown in Figure 3. However, because this study is observational and view counts are highly variable, this change cannot be attributed to Spotter Studio. The broad intervals in both cases indicate considerable variability in YouTube views, warranting cautious interpretation.

Figure 4 presents the average views for Smokin' and Grillin with AB (blue) and for Island Vibes Cooking (red) over the 6-month period before and after  $t=0$ . In comparing Smokin' & Grillin' with AB, Smokin' & Grillin' with AB shows greater variability in the number of viewers around the time of AI adoption, as indicated by  $t = 0$ . Smokin' & Grillin' with AB shows more pronounced ups and downs in viewership before AI adoption, with two significant spikes above 500,000



**Figure 3.** Trends in the average view rates for System Zee and Knarfy, two Minecraft YouTube content creators, before and after the release of Spotter Studio (at  $t=0$ ). This graph presents the 3-video rolling average view rate per video over 6 months.



**Figure 4.** Average view trends for Smokin' and Grillin with AB and Island Vibe Cooking, two cooking-centric YouTube channels, before and after the release of Spotter Studio (at  $t=0$ ). This graph represents a 3-video rolling average for views per video. Smokin' and Grillin with AB (blue) began to employ Spotter Studio AI as of  $t = 0$ , while Island Vibe Cooking (red) did not use any AI software.

viewers: one about 30 days before  $t=0$  and the other just before. Island Vibe Cooking, on the other hand, had a more stable viewership before AI adoption, with the average viewership remaining below 100,000 and never exceeding 350,000.

There is high variability after  $t=0$  for Smokin' & Grillin' with AB, with a significant spike in viewers about 70 days after the adoption, reaching 800,000 before dropping back to nearly zero. Island Vibe Cooking has a more stable viewership after  $t=0$ , with average viewership remaining below 100,000. To better understand the patterns of the two YouTube channels, 95%  $t$ -intervals were calculated for the average number of views per video for each channel. Smokin' & Grillin' with AB has a considerable interval, ranging from 147,649 to 323,375, with a mean of 235,512. Island Vibe Cooking, on the other hand, has a much smaller interval, ranging from about 42,151 to 70,646, with a mean of 56,399. Smokin' and Grillin' with AB has a higher mean. However, the wide interval doesn't suggest sustained, stable growth but instead shows substantial variability and spikes.

## DISCUSSION

Among the four distinct graph-to-graph pairwise differences, the results showed that AI failed to increase in the view counts systematically. Lemons to Lemonade Home had the highest view count prior to applying Spotter Studio, and no subsequent uploads exceeded the original maximum after using AI. The non-AI test channel, Katie Scott Salvaged, experienced a substantial increase in view counts beyond the AI application interval, suggesting disproportionate gains driven by specific topics and times. Colin and Samir showed irregularities around  $t = 0$ ; although their post-reference peak ( $\approx 1.25$  million) exceeded Sam Harris's peak ( $\approx 400,000$ ), both channels exhibited spikes and fluctuations that were not consistently timed with AI adoption. System Zee's maximum decline prior to the AI application was substantial, with a modest recovery, whereas the opposite occurred in the non-AI test channel, Knarfy, which showed a stable graph and at times even exceeded the AI-augmented channel. Finally, for the last pair, the AI-augmented 'Smokin' & Grillin' with AB' exhibited higher, but more volatile, view counts than 'Island Vibe Cooking,' without evidence of sustained post-reference growth. However, the maximum occurred before the AI application, and the corresponding post- $t=0$  maxima showed no clear association with AI. These outcomes

indicate that view counts might more accurately reflect content choice, retention, and external factors than the application of artificial intelligence technology. This is further made explicit by the fact that evidence related to the role of personalization at the level of the feed indicates it mainly serves as a determinant of the optimization of the creator side, while the engagement-driven ranking algorithm may have unstable patterns in content exposure regardless of user preferences (2, 4). Other academic studies in the area of algorithmic assistance further converge to similar findings and suggest that algorithms play a central role in a broader feedback cycle in which AI tools primarily affect content packaging rather than altering the underlying dynamics of recommendation systems (1).

These findings do not reveal any increase in views; they are consistent with earlier research showing that the use of generative AI in content creation can evoke negative reactions from the audience when AI is revealed. It has been revealed that the use of AI in content creation can reduce perceived authenticity, which, in turn, can lead to negative attitudinal and behavioral responses. (10) Contemporary research performed on the integration of artificial intelligence and social media suggests that it is primarily viewed as an internal strategic tool for content creation. It helps with audience analysis, content optimization, and the smooth running of the content creation process, rather than being a tool with a direct or definitive effect on the audience (11). Spotter Studio has been developed to provide functionality, including topic ideation, analysis, and thumbnail optimization, to address the issues faced by online content creators (6). AI-augmented thumbnail creation enables image customization based on audience preferences, which has been associated with changes in click-through rates (8), though these effects were not observed in this study. However, previous studies have shown that ranking systems based on user engagement can boost content that initially shows strong engagement signals, such as click-through rates, thereby improving its future prominence in the recommendation system (2). Nevertheless, previous studies have shown that improvements in user engagement metrics do not necessarily translate into higher user satisfaction or alignment with user preferences, as algorithms based on engagement metrics may favor attention-grabbing content over content users value most. The ability of AI to generally determine exceptional content also allows creators to re-evaluate their content strategies based upon observation of excellence in others (6).

Additionally, AI tools for content development increase overall efficiency. According to many marketers and content creators, AI helps them generate more content and sustain continuous engagement, though this does not necessarily translate into sustained audience engagement. (9) AI-powered content recommendations and analysis save time on ideating and enable them to concentrate on telling a story or creating content. YouTube AI tools, including Ask Studio and title A/B testing, could enhance content packaging (3).

There are other applications of artificial intelligence technology, but the performance improvements, such as the 49% increase in view metrics reported by Spotter Studio in the seven days after production, are based on internal beta tests and have not been independently verified (8).

There is other software available that serves as a predictive tool for YouTube videos, providing audience-specific thumbnails that refresh based on demographics and behavior, resulting in significant increases in click-through (8). AI assistants such as Ask Studio can answer questions that would be posed on this channel (“What can I feature next?”), as well as finding new information previously unavailable through analytics software. There would be value created through repeatedly optimizing packaging and ideating, independent of immediate view increases.

Despite the advantages, heavy reliance on AI comes with challenges. However, only 41% of American citizens believe that online content is human-written and true, and most people cannot distinguish between human-generated content and AI-generated content (2). Search engines are fighting low-quality “AI slop,” and untreated AI content can also damage user engagement. Finally, content creators are expressing concern regarding repurposing content for AI models, with 56% believing generative AI is a negative force for content creators. The majority of creators want tools that will automatically credit and tag AI-produced content and appreciate regulation to protect their interests (6).

The other disadvantages include over-dependence and a lack of creativity. Reviewers caution that AI-generated scripts and thumbnails may be generic in some cases, achieving a uniformity that alienates long-term subscribers. The cost of the learning curve and subscription fee of platforms such as Spotter Studio can be prohibitive for smaller channels (6). Creators have also reported finding content suspiciously close to their own; 44% have seen their work seemingly replicated by AI models, fueling concerns about plagiarism. Since

AI systems learn from existing data, they can replicate current biases and reuse earlier tropes. Without proper human oversight, the resulting videos may misrepresent a creator’s brand or mislead audiences. Therefore, it is essential to balance AI efficiencies with human monitoring.

### Limitations

YouTubers may have started using Spotter Studio at different times; however, because there is no public data, it is assumed they all began using it when it launched. This may lead to misclassification bias between the pre- and post-time periods. In addition, because of variation in upload times among YouTubers, the number of videos analyzed over six months varied.

One of the main limitations is the lag in view accumulation. Views accumulate at different rates across channels, depending on channel size and recommendations’ exposure. There may also be spikes that occur after some time. Since the channels have different upload times and frequencies, it is possible that videos with the same t-values may not be the same age when the total views are recorded. Thus, the three-video rolling average may over- or under-estimate the change due to view accumulation lag rather than to effects associated with Spotter Studio. The study also didn’t account for subscriber count, time, or audience demographics affecting viewership trends. Because this study is observational, it is not possible to infer causality between Spotter Studio usage and changes in video view counts.

### CONCLUSION

Across the four channel pairs, the results show no consistent increase in viewership attributable to Spotter Studio adoption. The variation in YouTube viewership appears to be more related to the topics discussed than to AI use. This understanding is consistent with the existing literature, which shows that algorithmic systems, in general, do not guarantee performance increases unless there is underlying audience interest.

Although this study did not support the claim that AI tools increase YouTube views, it does not mean that AI tools are not important for YouTube creators. Instead, the importance of AI tools is found to be outside the scope of this study, i.e., the increase in YouTube views. Moreover, the implementation of AI tools may improve creators’ ability to analyze YouTube trends, independent of measurable effects on view counts.

Overall, there remains skepticism about the role of AI in driving increases in YouTube view counts, especially given that the cited increases, such as the 49% increase reported by Spotter Studio, are based on vendor-controlled beta testing environments rather than actual longitudinal research. (8) These claims were not observed in a long-term setting with diverse types of YouTube channels. The results suggest that AI works best as a complement to human creativity rather than a replacement. Future studies should use a larger sample over a longer period and include additional quantitative measures, such as CTR and watch time, to determine whether AI indirectly contributes to performance outcomes. As AI becomes more integrated into social media platforms, including YouTube, it will be important to consider transparency and ethical disclosure to maintain audience trust within the digital content landscape.

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## CONFLICT OF INTEREST

The author declares that there has been no conflict of interest regarding the publication of this journal.

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