

## Extended Essay

To what extent does the graphical user interface and machine learning algorithm of YouTube impact the cognitive development and mental well-being of adolescents?

An interdisciplinary study of a social media platform and its impacts on young users.

## World Studies

(Psychology & Computer Science)

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## Introduction

“There are only two industries that call their customers ‘users’: illegal drugs and software” - Edward Tufte, American statistician and professor.

In contemporary society, social media has seen widespread adoption which has had various benefits but also detrimental consequences. At times, it is easy to overlook the positive, meaningful changes social media has brought to society; for example its remarkable impact on the global economy or the voice it has given to billions of people. However, this “overlooking” is not groundless. Indeed, social media has affected us in ways that are not readily apparent. Thus, this essay will explore these pernicious effects on our daily lives.

This essay is interdisciplinary in that it uses knowledge from Psychology and Computer Science to effectively answer the research question. Psychology refers to the study of the cognitive processes and behavior in humans. This field is crucial in developing the research required for answering a major part of this issue: the cognitive development and mental well-being of adolescents. However, to conclusively satisfy the needs of the question, Computer Science-related aspects are necessary. This is because social media platforms like YouTube have intricate graphical user interfaces (GUI), machine learning algorithms (MLA), and other high-level technologies in their respective models. An in-depth analysis of this would allow this essay to accurately identify the extent to which these sites affect the youth.

This essay will also focus on the impacts on adolescents aged thirteen to eighteen, as this age group still has developing brains that are highly susceptible to the effects of social media. Moreover, they will play an active role in shaping the future, and social media's side effects may impede their ability to effectively do so.

Of the countless social media platforms, this essay will specifically focus on YouTube and Instagram, as these are among the most frequently used platforms among teenagers. On average, teens spend 7 hours and 22 minutes looking at screens each day. Among U.S. teens, 1.9 hours are spent on YouTube and 1.5 hours a day are spent on Instagram (Rothwell). Additionally, in the United Kingdom, 90% of the same cohort use YouTube, making it the most used social media platform in the country.

Furthermore, this investigation will look at how these algorithms work and how they are designed to maximize user attention, simultaneously affecting several aspects of our cognition as well as mental health. The discussion will demonstrate an in-depth outlook on the issue using relevant psychological theories and company software usage.

Social media was created in 1997 by Andrew Weinreich. It was simply a site named SixDegrees.com, where one could create a profile, connect with friends, and send messages. SixDegrees paved the way for numerous other social media platforms. Eventually, YouTube was launched on December 15, 2005, by Jawed Karim, Steve Chen, and Chad Hurley. Its mission statement is "to give everyone a voice and show them the world. It is actively achieving this mission with " more than 2.70 billion monthly users as of August 2024" ("Youtube Statistics 2024").

Nearly all social media companies have advanced algorithms designed to personalize each user's experience. This is done by "feeding" content pertaining to the preferences of the

user. Time Kendall, a former executive of Facebook and former president of Pinterest, said that these companies' true aim is to “figure out how to get as much of this person’s attention as we can possible can. How much time can we get you to spend? How much of your life can we get you to give us” (Orlowski, 2020). Accordingly, these algorithms subtly probe users’ behavior, accumulating copious amounts of data; i.e., likes, watch time, and following lists. This allows, just as Time Kendall mentioned, the company to feed photos or videos that lure users for long amounts of time. This aim to maximize user engagement results in larger revenues for the companies through mediums like advertisement. According to Tritan Harris, a former design ethicist at Google, “YouTube, companies like this, their business model is to keep people engaged on the screen” (Orlowski, 2020).

YouTube has several features that make it a prominent social media application. It not only has long content in the form of “YouTube Videos” but also has YouTube Shorts, which works similarly to TikTok and Instagram reels. The search page allows users to find videos that they exactly want to watch at a specific time and the extensive amount of videos available allows YouTube users to “consume over 1 billion hours of videos daily, which roughly equates to 5 billion videos.” (*YouTube Statistics 2024 [Users by Country + Demographics]*, 2024).

This research is relevant today as it addresses an issue of global significance: social media’s pervasive alteration of the mind. Teachers, parents, children, and society as a whole must understand how these platforms affect cognitive development and mental well-being. By looking at the opposing perspectives, this essay will offer a balanced view of the role of social media and make suggestions for reducing its negative effects.

## Methodology

For primary research, a questionnaire was created regarding adolescents' personal experiences with the impacts of social media. The survey questions are attached in the relevant appendix section.

The questionnaire was sent to students in the school via email and 43 responses were received. The results were analyzed and the findings were compared with published research papers and studies.

The second primary research method was an interview with a former head of media marketing for a large global corporation, Universal McCann, which is part of the Interpublic Group headquartered in New York (2023 revenue: 10.89 billion dollars). We discussed how many companies including YouTube advertise using social media applications and algorithms. An insight into how social media applications like YouTube utilize user interface designs and algorithms in their business model to further engage users was given. This extended engagement directly correlates to more time spent on these applications and thus magnifies the cognitive and emotional impacts on users.

Secondary research was conducted using published studies and credible research to support analysis. This allowed for a comparison of the findings with established research and thus achieved a holistic view and clear understanding of the extent to which YouTube's software affects the minds of adolescents.

## Findings and Analysis

This extended essay studies the cause-and-effect relationship between YouTube's user interface and machine learning algorithm and the impact it has on the youth. Hence, the analysis will be structured in the following categories for the purpose of clarity:

- YouTube's GUI and MLA, how they function, their purpose and effects
- The impact on the minds of adolescents

## The Graphical User Interface of YouTube

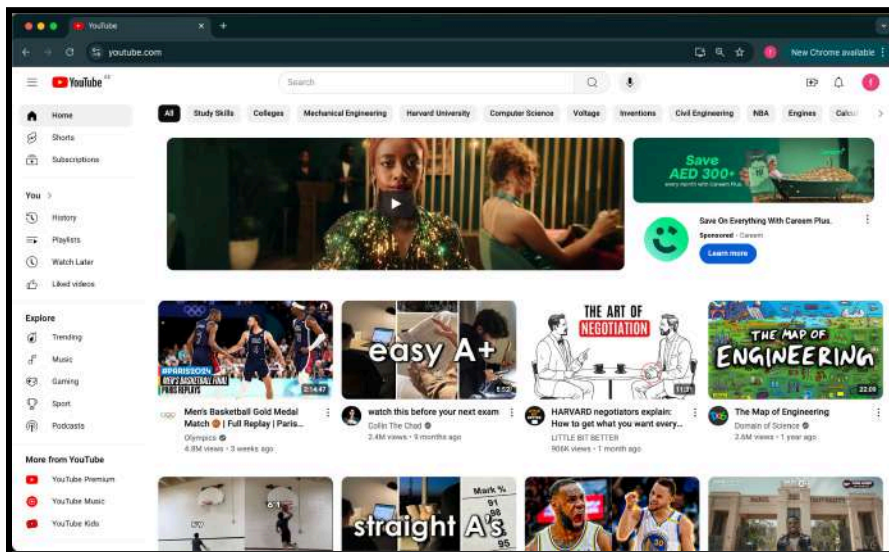
A graphical user interface is a digital interface that uses graphical elements to allow users to interact with the computer. GUIs are inherent in nearly all digital platforms used in society, from desktop websites to phone applications. YouTube has an ornate GUI that is composed of several features: recommended videos, shorts, widgets like comments; subscriptions; likes; and dislikes, video thumbnail designs, and countless others.

Specific widgets such as the like, dislike, subscribe, and comment buttons heavily engage users. Liking videos allows YouTube to determine which videos users find the most entertaining, while Dislikes does the same using the opposite idea. The subscriptions widget is a tool that is used as a follower button, creating a sense of community and interest for users. Furthermore, the commenting tool allows users to share their ideas about a video and express their thoughts among the other commenters. As a whole, these small features assist in creating an interactive interface for YouTube which lets users connect with the application more.

Moving onto video thumbnail designs, they create an instant attraction for users to videos already recommended to them. There are typically 8 videos shown on the home page depending on how zoomed-in users' computers are. These videos are meticulously inputted by YouTube's

machine-learning algorithm based on the aforementioned factors. What makes them more alluring is their thumbnail designs. They usually have eye-catching images and phrases that make users intrigued to watch them. This alongside clickbait titles, titles that intend to attract attention and encourage visitors to click on a link to a particular web page, collectively make up a huge part of YouTube's graphical user interface.

Figure 1: YouTube's Home Page Interface



As seen in Figure 1, there are 2 ads at the forefront of the homepage. These advertisements are strategically placed in YouTube's GUI to maximize user acknowledgment and views. This integral part of YouTube's business model is how various companies around the world market their brand, and exactly how this is done is seen in my interview with Zubair Siddiqui.

Key insights that were discussed in the interview were centered on companies' advertising through YouTube and how it eventually influences user engagement. As mentioned,



YouTube's GUI has a number of advertisements placed in a strategic fashion so that viewers are able to view and interact with them. Siddiqui further cited that variety in ad formats, such as banner ads, video ads, or carousel ads, also helps in attracting viewers and creating engagement for them through visually attractive content. This design philosophy relates to YouTube's interface, which has numerous ads on the homepage, in sidebars, and within the video feeds. By providing users with a greater experience via visual and emotive stimuli, YouTube creates engagement with the website that's directly related to time usage.

With interaction, engineered into the GUI and the algorithms of YouTube, come cognitive and emotional repercussions for adolescents. In the process of continually being presented with personalized content based on their use and viewing history, algorithms at YouTube work to keep users on the website for more extended periods. Siddiqui mentioned that algorithms target users based on demographic and behavioral variables, predicting preference from past consumption. This targeted engagement not only increases the time adolescents spend on the platform but also contributes to cognitive overload since there is a stream of constant content consumption, leading to a possible negative result of poor attention span and addictive behavior. More importantly, Siddiqui mentioned that overconsumption of social media could result in Fear of Missing Out, depression, or low productivity, which echoes the general mental health concerns associated with excessively using YouTube or similar websites.

## Machine Learning Algorithms of YouTube

Machine learning is defined as “the capability of a machine to imitate intelligent human behavior. Artificial intelligence systems are used to perform complex tasks in a way that is

similar to how humans solve problems.” (Brown, 2021). The development of machine learning algorithms has been rampant in the 21st century, and numerous social media companies have been using them at their disposal.

YouTube, as well as several other companies like Netflix and Amazon, uses a machine learning algorithm to supply videos for its users. In 2008, around the time when YouTube first launched, YouTube displayed the most popular videos on a trending page which all users saw (Kieger, 2021). However, as time passed, developers saw that most users viewed their content through searches. Thus, YouTube now uses a machine-learning algorithm that aims to present users with relevant content through collaborative filtering. Collaborative filtering was one of the earliest machine learning predictive algorithms used on YouTube, and it is essentially when predictions are generated for a single user by using information gathered from other users who have watched similar content.

Upon opening the YouTube homepage, users are exposed to an infinite number of videos based on personally recommended content. These recommended videos vary by person and are selected by looking at what users regularly watch, what they search for, their likes and dislikes, and their ‘not interested’ feedback. YouTube itself said, “We track what viewers watch, how long they watch, what they skip over, and more. This helps us figure out what kind of videos they like best and what we can recommend to them next.” (YouTube Support). Additionally, fully watching or ignoring a video indicates to the machine learning ranking system whether to display more or less of that specific content.

The algorithm takes into account a range of factors when making recommendations, including the user's watch history, search history, and demographics. It also takes into account the popularity of a video, the number of likes and dislikes, and the content of the video itself. By

analyzing these factors, the algorithm can make highly accurate recommendations that are tailored to the user's interests.

As a whole, the underlying conclusion from YouTube's graphical user interface and machine learning algorithm is that it is addictive, engaging users at all times. This conclusion is further supported by the questionnaire sent directly to adolescents.

## Questionnaire Results

In the questionnaire, the 43 respondents varied in age slightly: 62.8% were seventeen, 27.9% were sixteen, 4.7% were fifteen, and 4.7% were eighteen. Regarding how much time they spend on social media, 37.2% spent 5-6 hours, 34.9% spent 3-4 hours, 18.6% spent 1-2 hours, and 9.3% spent 7 or more hours. The applications that they spend a lot of time on are Instagram at 88.4%, YouTube at 79%, TikTok at 67.4%, Snapchat at 58.1%, and Whatsapp at 41.9% (participants were allowed to pick multiple answer choices). Additionally, 88.4% of respondents said that they believe social media could impact their mental health. 67.4% of participants said that they think social media negatively impacts their brain development. 83.7% of respondents have tried to reduce their social media consumption, and a staggering 97.7% said they think social media is addictive.

Among respondents, there were multiple answers for why they use these social media platforms. Based on the responses, I created different categories to which I allotted the respondents' answers: the first was Entertainment with 18 responses; the second was Socializing with 15 responses; the third was Learning with 6 responses; And the final one was Professional Use with 2 responses. The other 2 responses did not answer the question, answering with a “.”

and “/”. It is most likely that these two respondents did not feel comfortable sharing their reasons for using social media. Furthermore, for the question “How do you feel if you can not access the internet or social Media?” 74.4% of respondents picked “Bored”, 71.9% of respondents picked “Left out”, 65.6% picked “Sad/Upset”, 26.3% of respondents answered “Happy”, and one respondent answered “Other”, saying “I do not feel anything, I am numb to lack of social media”.

## Psychological Analysis

From all of the primary and secondary research conducted, it is understood that social media is addictive to a certain degree, for example, 97.7% of respondents in the questionnaire believe so. From the compelling user interface to the ever-adapting algorithm, adolescents are spending great amounts of time on social media. Despite the unquestionable benefits of social media, the cognitive and emotional impacts of spending great amounts of time on these apps are concerning. A plethora of studies have shown the consequences of an extended use of social media on the developing mind.

Firstly, research has indicated that overuse of social media has been shown to cause memory loss and forgetfulness. Shi and Gong (2021) point out how extensive use of social media impairs the brain in transmitting information. The perpetual stream of fresh content obliges users to hop from one post to another, which can damage the brain’s ability for intense concentration and retention in long-term memory. These findings align well with psychological theories around memory and attention like the cognitive load theory. According to the cognitive load theory (Sweller et al, 2011), the brain can only handle so much information before we start asking our

minds to carry more than it is capable of understanding. As a result, overuse of social media platforms can be overwhelming and can saturate working memory, affecting concentration and information retention.

Furthermore, the excessive use of social media like YouTube often causes high levels of social comparison among adolescents. This comparison usually occurs between teenage social media users and other users their age. Studies suggest that social media usage may impact our sense of self and our level of self-worth. While there is an obvious connection between the two, self-concept and self-esteem are not the same. The term "self-concept" describes how we see ourselves. According to Baumeister (1999), a person's conviction about themselves, including their characteristics and identity, constitutes their self-concept. Our perception of our own personalities, our skills, and our interests are all part of our self-concept. Self-concept is merely our perception of who we are rather than an emotional response to that idea. It has no "judgment" elements. Self-esteem, on the other hand, refers to our emotional response to our self-concept; it is a person's overall subjective evaluation of their worth (Muris, 2023).

According to Festinger's 1954 Social Comparison Theory, people are motivated to have truthful assessments of themselves (Cherry, 2024). Our social and personal values are determined by our relative position to others. Individuals use experience comparison to determine their own self-concept (how they should view themselves) and self-esteem (what kind of person they are). We might assess our own worth and position in the world by contrasting our thoughts, emotions, circumstances, and experiences with those of our friends.

Because they enable users to keep a fairly clear notion of "what everyone else is doing" (through other people's posts on YouTube) and compare this to their own daily routine, many social media networks boost the chance for social comparison. Even though everyone engages in

some degree of this type of social comparison, some people are more impacted by these unhealthy comparisons. These people might be more susceptible to negative cognitive bias, which is the propensity to evaluate oneself poorly in relation to others, which can lower one's self-esteem and possibly have an adverse effect on mood.

Comparisons made from others' posts on social media are upward comparisons—comparisons in which we judge the qualities, experiences, and behaviors of others to be superior to or better than our own— and may exacerbate the risk of negative comparison. This is due to the fact that most people only post the "best image" of who they are. Individuals are considerably more likely to make videos about something exciting and fun they are doing than they are to write something about how bored they are at the moment.

Research by Chou and Edge (2014) indicates that our use of social media readily affects our thinking through the availability heuristic. The instances that are easiest for one to recall are likely the ones on which one builds their sense of self-worth. Essentially, we tend to recall the experiences (for example YouTube videos) that show others living a life we aspire to have, and we use those as a benchmark to compare our own experiences with.

Additionally, an extended use of social media like YouTube can result in other problems like confirmation bias. To understand this phenomenon, one must understand what heuristics are. Heuristics are simply defined “as simple rules or shortcuts that people use to form judgments and make decisions” (*Chen, 2024*). Being dependent on heuristics in System 1 or intuitive thinking may result in cognitive biases. This is a systematic error in thinking that affects the decisions and judgments that people make. Overuse of YouTube can result in cognitive biases like confirmation bias as their machine learning algorithms as users are constantly fed information with information that confirms their views.

## Conclusion

In summation, the graphical user interface and machine learning algorithm of YouTube result in a longer time spent on the application. With this greater spending of time, adolescents become more prone to the adverse effects of social media. It not only impacts adolescents' cognitive abilities through lowered attention spans, memory loss, and forgetfulness but also impacts their emotional well-being through social comparison. The results of the questionnaire showed that this group of adolescents spent most of their time on TikTok and YouTube and the majority of them spent either 5-6 hours or 3-4 hours on social media. In addition, nearly all of them believed social media impacts mental health and the majority believed it impacts brain development. This demonstrates that they are relatively aware of the implications of social media and this is further backed by the fact that 83.7% of them have tried to reduce their social media consumption.

Reduction of social media use is an emerging phenomenon in contemporary society with more people realizing its harmful effects. However, not all people truly stick to this goal of theirs. This is because of the addictive nature of the platforms that is fostered by their graphical user interfaces and machine learning algorithms. Addiction is a ubiquitous human issue that is seen from drugs and alcohol to shopping. But the pervasive addiction to social media is often overlooked. This essay identifies a possible cause for this addiction and uses primary and secondary research to support this claim. The sources used in this study are relatively credible. Furthermore, the findings of the primary research are relatively valid. Although the responses to the questionnaire were anonymous, it was sent via email to Grade 11 students and was only open to students in the school. All responses that were done jokingly were removed from the data set. The entire questionnaire is posted below in Appendix I. Additionally, the interview was held in a

professional environment with all questions answered fully. The entire live interview is posted below in Appendix II.

As a whole, there are countless learnings from this investigation. The interdisciplinary aspect of the essay allows the findings to effectively take two fields into consideration to answer the research question. Thus, in conclusion, the graphical user interface and machine learning algorithm of YouTube impact the cognitive development and mental well-being of adolescents great extent. This is because these components of YouTube create an addictive and excessively engaging platform that magnifies the effects of an already hurtful social media. However, this does not mean that social media like YouTube is a negative thing. The numerous positives of social media, to some extent, outweigh the negatives; yet, it is important that people, especially adolescents, find a balance between using a healthy and beneficial amount of YouTube and using an extreme amount.



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## Appendix I

What is your age?

How long do you spend on social media per day?

Which applications do you spend the most time on?

Why do you use these platforms?

Does social media impact your mental health?

Do you think social media negatively impacts your brain development?

How do you feel if you can't access the internet or social media?

Have you ever tried to reduce your social media consumption?

Do you think social media is addictive?

## Appendix II

How do you target people?

In the interview, he mentioned that Over the years, targeting possibilities on social media have evolved tremendously. Some of the various methods include - Demographic targeting using age, gender, location, etc. Behavioral targeting is like using the actual behavior of people on the internet eg the sites they visit, and the kind of content they consume and like and share.

Contextual targeting is like using a specific genre of content around which we place ads. Product Purchase - of late, we can also target people based on the history of their products bought on the internet.

How do you engage people?

Engagement occurs when consumers interact with the advertising or messaging. In order to increase engagement we use various strategies like creating engaging content/ads - using strong emotions, visuals, and audio content. Competitions - Luring people to participate in offers and create value for them. Ad formats - using different ad formats like banners, videos, interstitials, page takeovers, carousels, etc. Polls - Engaging people through polls about subjects they are interested in and related to the product being advertised.

How do you ensure there is purchase of your product on social media?

First, we ensure that the message is directly correlated to the target consumer using the above targeting options. In addition, we incentivize the consumer by giving on-the-spot offers or gratifications. The ad formats of today, have an inbuilt "buy now" button that takes consumers directly to the purchase cart.

Do you care about repurchase? If yes, how do you ensure the repurchase is done successfully?

Yes, repurchase is a crucial element in digital and social marketing. Today's technology allows you to create custom targets of people who have visited your website in the past and/or purchased the products. This is based on cookie data collected on the internet. The remarketing technologies of today can use this data to retarget consumers who have bought the products earlier. In addition, sophisticated methodologies like "look-alike" targeting allow advertisers to reach a wider set of people similar to the ones who have purchased earlier, thereby allowing you to gain additional market share.

Do you have an always-on strategy?

Most advertisers have an always-on strategy for search and social media. These include buying a specific list of keywords on an always-on basis, so that whenever any consumer types such keywords the ads will appear alongside the search results. In social media, advertisers create always-on posts on their social channels and showcase their products in different forms thereby increasing followers on the page and helping increase awareness.

How much money do you spend on digital marketing?

This is confidential information. But I can give you an estimate that it is upwards of 25 Million USD.

What percentage of that money goes towards social media?

50%.

How effective has social media been in your marketing strategies?

Very effective across the consumer funnel. ie effective in creating awareness, driving consideration, and making sales.

Have you seen an increase in expenditure on social media over the past few years?

According to Statista, Global Ad spending in the Social Media Advertising market is projected to reach US\$219.8bn in 2024. Global Ad spending is expected to show an annual growth rate (CAGR 2024-2028) of 3.86%, resulting in a projected market volume of US\$255.8bn by 2028.

Does influencer marketing play a part in your advertising strategy?

Yes, Influencer marketing has become an intrinsic part of social media marketing.

Is influencer marketing more effective than paid advertisements?

It is very effective in creating awareness and brand consideration. Both work in conjunction.

Where do you see more engagement in terms of likes, comments, and shares?

Likes.

Is time spent on your advertisements a key performance indicator?

Time spent on content is key. Today consumers have the option to skip ads after 5 seconds. On average about 15% of people watch the full ads. So yes time spent on both content and advertising is critical to success.

Do you think extensive time using social media results in negative effects on users?

Yes with the rise in social media consumption, we can see the negative effects of over-usage.

Some of the effects include but are not limited to sleep disorders, fear of missing out (FOMO), addictive tendencies, depression, health concerns, reduced productivity, misinformation and disinformation, etc.