Load the Data

In [1]:
```
import pandas as pd
import zipfile
import os

# Function to load CSV from a ZIP file with multiple files
def load_csv_from_zip(zip_path, csv_filename):
    with zipfile.ZipFile(zip_path, 'r') as z:
        # Extract and read the specific CSV file
        with z.open(csv_filename) as f:
            return pd.read_csv(f)

# Define the relative path to the datasets folder
datasets_path = os.path.join('..', 'Datasets')

# Load datasets from zipped CSV files specifying the correct CSV filena
df_gb = load_csv_from_zip(os.path.join(datasets_path, 'GBvideos.csv.zip
df_us = load_csv_from_zip(os.path.join(datasets_path, 'USvideos.csv.zip


# Merge 5 files into 1
merged_df = pd.concat([df_gb, df_us], ignore_index=True)

# Check the first few rows of the merged DataFrame
print(merged_df.head())
```

```
      video_id trending_date  \
0  Jw1Y-zhQURU      17.14.11
1  3s1rvMFUweQ      17.14.11
2  n1WpP7iowLc      17.14.11
3  PUTEiSjKwJU      17.14.11
4  rHwDegptbI4      17.14.11

                                               title  \
0      John Lewis Christmas Ad 2017 - #MozTheMonster
1          Taylor Swift: …Ready for It? (Live) - SNL
2         Eminem - Walk On Water (Audio) ft. Beyoncé
3  Goals from Salford City vs Class of 92 and Fri...
4  Dashcam captures truck's near miss with child ...

                channel_title  category_id              publish_tim
e  \
0                  John Lewis           26  2017-11-10T07:38:29.000
Z
1         Saturday Night Live           24  2017-11-12T06:24:44.000
```

Check Missing Values

In [2]:
```
# Check for missing values in the merged DataFrame
print("Missing values")
print(merged_df.isnull().sum())
```

```
Missing values
video_id                        0
trending_date                   0
title                           0
channel_title                   0
category_id                     0
publish_time                    0
tags                            0
views                           0
likes                           0
dislikes                        0
comment_count                   0
thumbnail_link                  0
comments_disabled               0
ratings_disabled                0
video_error_or_removed          0
description                  1182
dtype: int64
```

In [3]:
```
df = merged_df.dropna()
```

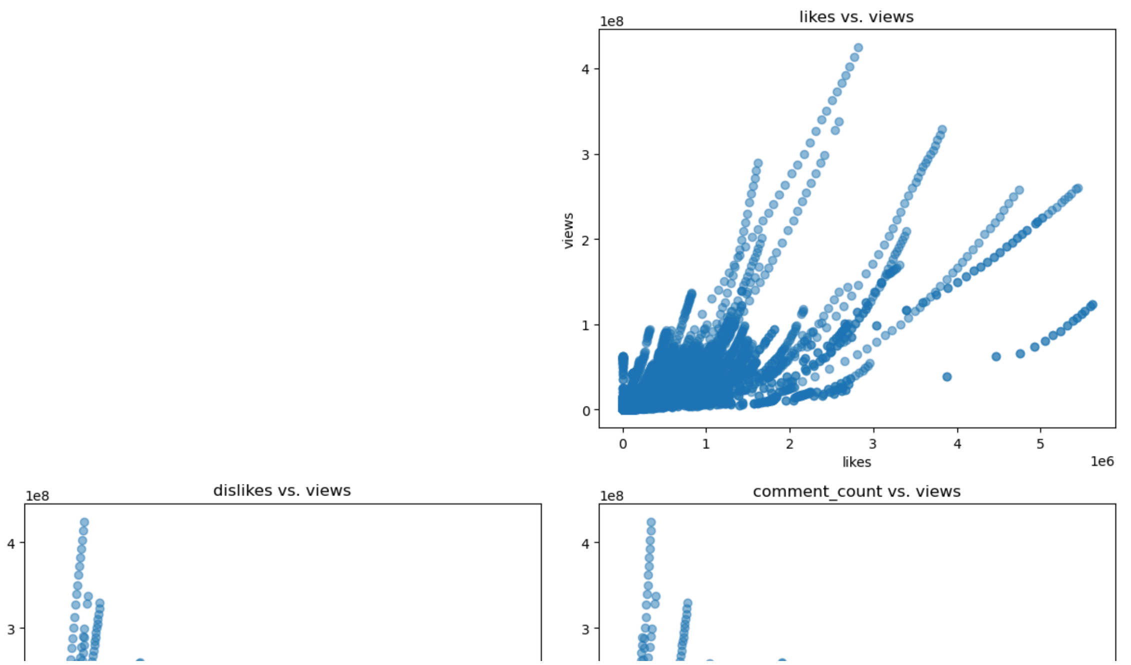
In [4]:
```
# Check for missing values in the merged DataFrame
print("Missing values")
print(df.isnull().sum())
```

```
Missing values
video_id                  0
trending_date             0
title                     0
channel_title             0
category_id               0
publish_time              0
tags                      0
views                     0
likes                     0
dislikes                  0
comment_count             0
thumbnail_link            0
comments_disabled         0
ratings_disabled          0
video_error_or_removed    0
description               0
dtype: int64
```

Exploratory Data Analysis (EDA)

Check Outliers

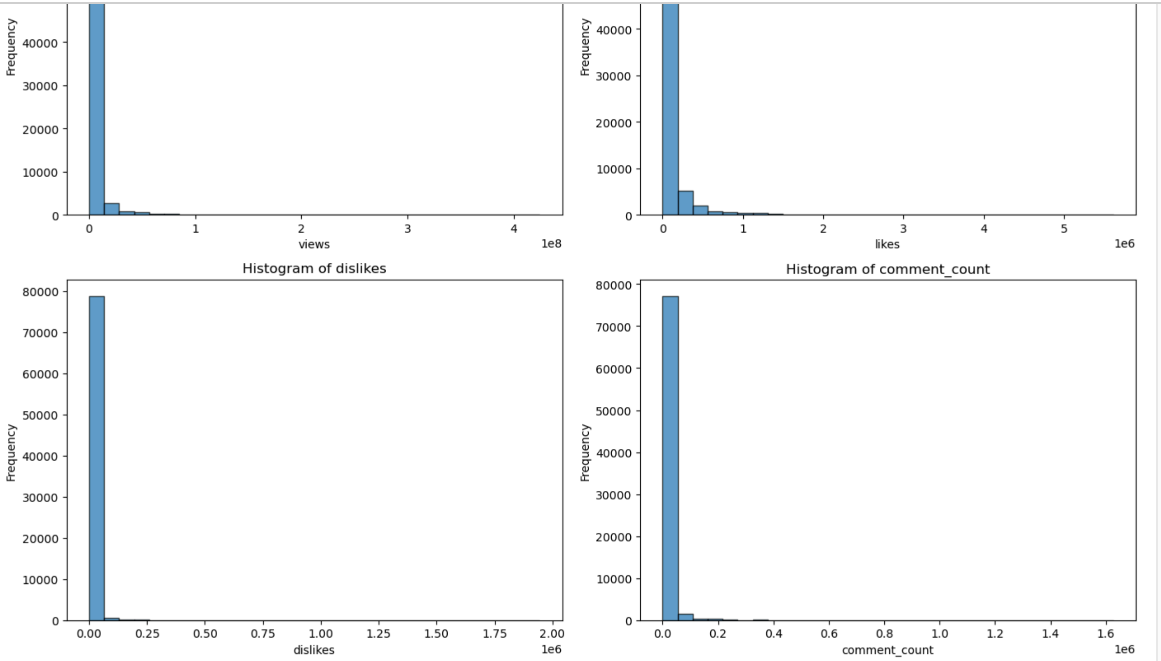
In [5]:
```
import seaborn as sns
import matplotlib.pyplot as plt

# Define numerical columns
numerical_columns = ['views', 'likes', 'dislikes', 'comment_count']


# Scatter plots for each numerical column vs. 'views'
plt.figure(figsize=(12, 10))
for i, column in enumerate(numerical_columns, 1):
    if column != 'views':
        plt.subplot(2, 2, i)
        plt.scatter(merged_df[column], merged_df['views'], alpha=0.5)
        plt.title(f'{column} vs. views')
        plt.xlabel(column)
        plt.ylabel('views')

plt.tight_layout()
plt.show()
```



EDA for Numerical Variables

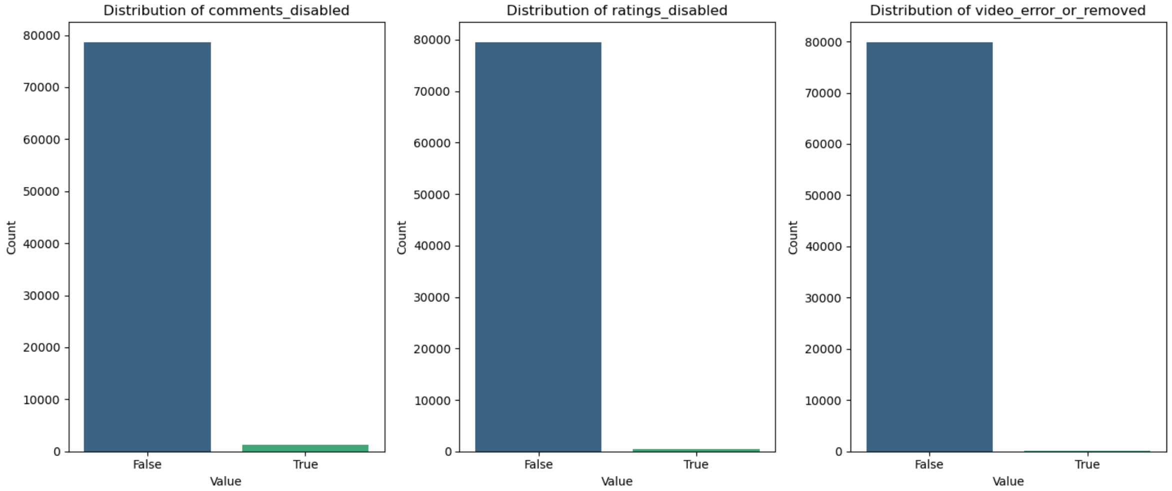
In [6]:

```python
#data exploration for numerical columns
import matplotlib.pyplot as plt

# Define numerical columns
numerical_columns = ['views', 'likes', 'dislikes', 'comment_count']

# Create histograms for each numerical column
plt.figure(figsize=(14, 10))
for i, column in enumerate(numerical_columns, 1):
    plt.subplot(2, 2, i)
    plt.hist(merged_df[column], bins=30, alpha=0.7, edgecolor='black')
    plt.title(f'Histogram of {column}')
    plt.xlabel(column)
    plt.ylabel('Frequency')

plt.tight_layout()
plt.show()
```



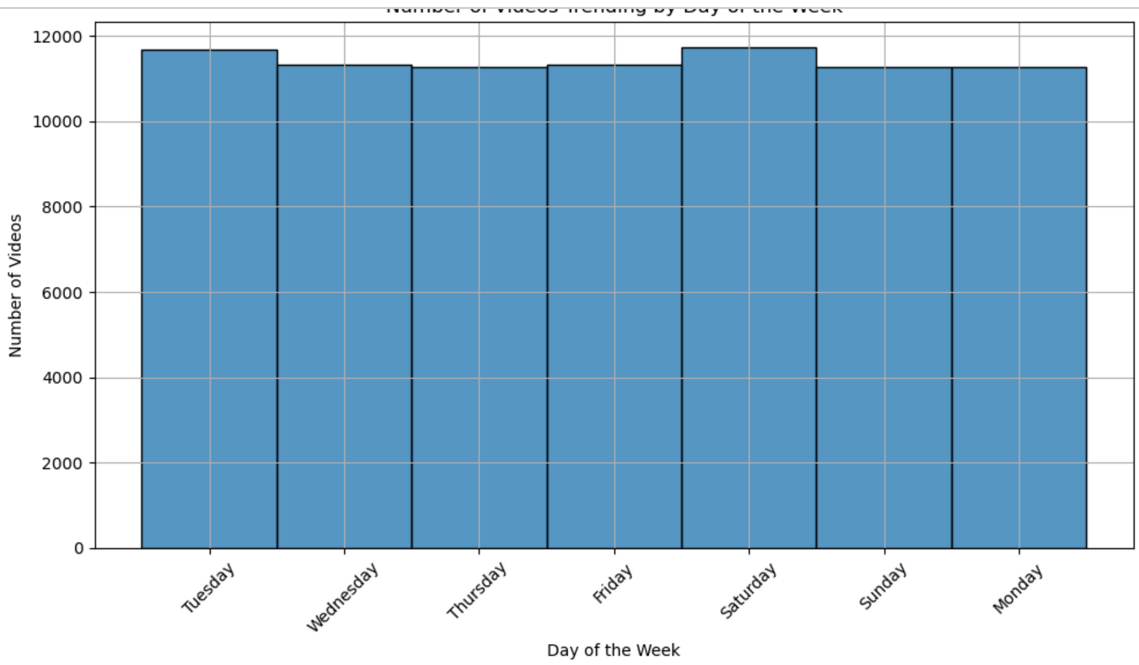
EDA for Boolean Variables

In [7]:
```
import seaborn as sns

# Define boolean columns
boolean_columns = ['comments_disabled', 'ratings_disabled', 'video_erro

# Plot bar plots for each boolean column
plt.figure(figsize=(14, 6))
for i, column in enumerate(boolean_columns, 1):
    plt.subplot(1, 3, i)
    # Count the occurrences of each boolean value
    counts = merged_df[column].value_counts()
    # Plot bar plot
    sns.barplot(x=counts.index, y=counts.values, palette='viridis')
    plt.title(f'Distribution of {column}')
    plt.xlabel('Value')
    plt.ylabel('Count')

plt.tight_layout()
plt.show()
```



EDA for Date-Time Variables

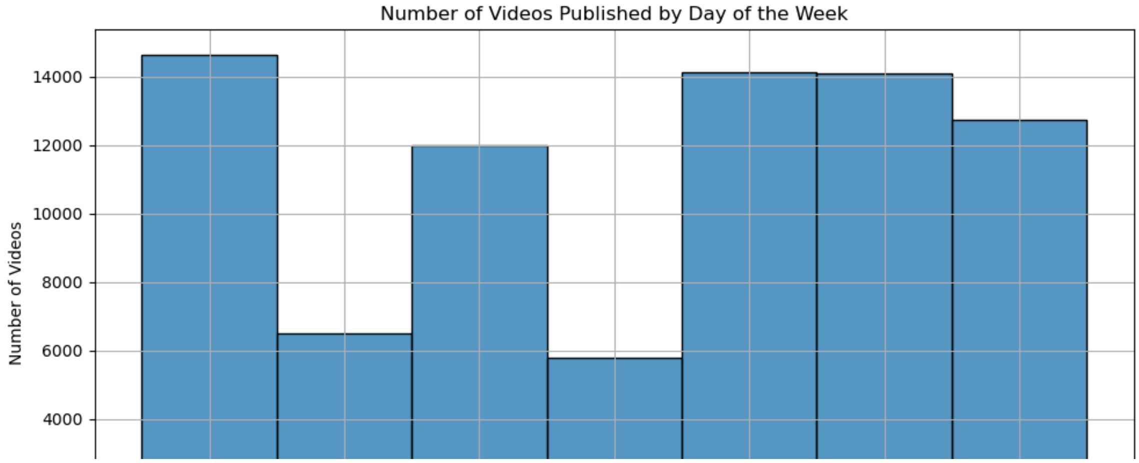
In [8]:
```
# convert the trending_date to datetime type
merged_df['trending_date'] = pd.to_datetime(merged_df['trending_date'],
# Extract day of the week from 'trending_date'
merged_df['trending_day_of_week'] = merged_df['trending_date'].dt.day_n

# Plot histogram of trending day of the week
plt.figure(figsize=(10, 6))
sns.histplot(merged_df['trending_day_of_week'], discrete=True, palette=
plt.title('Number of Videos Trending by Day of the Week')
plt.xlabel('Day of the Week')
plt.ylabel('Number of Videos')
plt.xticks(rotation=45)  # Rotate x-axis labels for better readability
plt.grid(True)
plt.tight_layout()
plt.show()
```



In [9]:

```
#convert the publish_date to datetime type
merged_df['publish_time'] = pd.to_datetime(merged_df['publish_time'], 
# Extract day of the week from 'publish_time'
merged_df['day_of_week'] = merged_df['publish_time'].dt.day_name()

# Plot histogram of day of the week
plt.figure(figsize=(10, 6))
sns.histplot(merged_df['day_of_week'], discrete=True, palette='viridis
plt.title('Number of Videos Published by Day of the Week')
plt.xlabel('Day of the Week')
plt.ylabel('Number of Videos')
plt.xticks(rotation=45)
plt.grid(True)
plt.tight_layout()
plt.show()
```

```
/var/folders/yn/hnpfh1r15tq8t0xq_j4_rzmh0000gn/T/ipykernel_37366/13
46077495.py:8: UserWarning: Ignoring `palette` because no `hue` var
iable has been assigned.
  sns.histplot(merged_df['day_of_week'], discrete=True, palette='vi
ridis')
```



Statistical Description

In [10]:
```
numerical_description = merged_df.describe()
print(numerical_description)
```

```
                       trending_date   category_id  \
count                          79865  79865.000000   
mean   2018-02-25 07:57:45.132410880     18.440205   
min              2017-11-14 00:00:00      1.000000   
25%              2018-01-02 00:00:00     10.000000   
50%              2018-02-23 00:00:00     22.000000   
75%              2018-04-21 00:00:00     24.000000   
max              2018-06-14 00:00:00     43.000000   
std                              NaN      7.818304   

                        publish_time         views         likes  \
count                          79865  7.986500e+04  7.986500e+04   
mean   2018-01-30 08:51:14.599436544  4.091166e+06  1.036262e+05   
min              2006-07-23 08:24:11  5.490000e+02  0.000000e+00   
25%              2017-12-22 15:58:16  2.464170e+05  5.642000e+03   
50%              2018-02-14 05:01:24  7.961060e+05  2.092200e+04   
75%              2018-04-09 08:59:51  2.535704e+06  7.824800e+04   
max              2018-06-14 01:31:53  4.245389e+08  5.613827e+06   
std                              NaN  1.439125e+07  2.957265e+05   
```

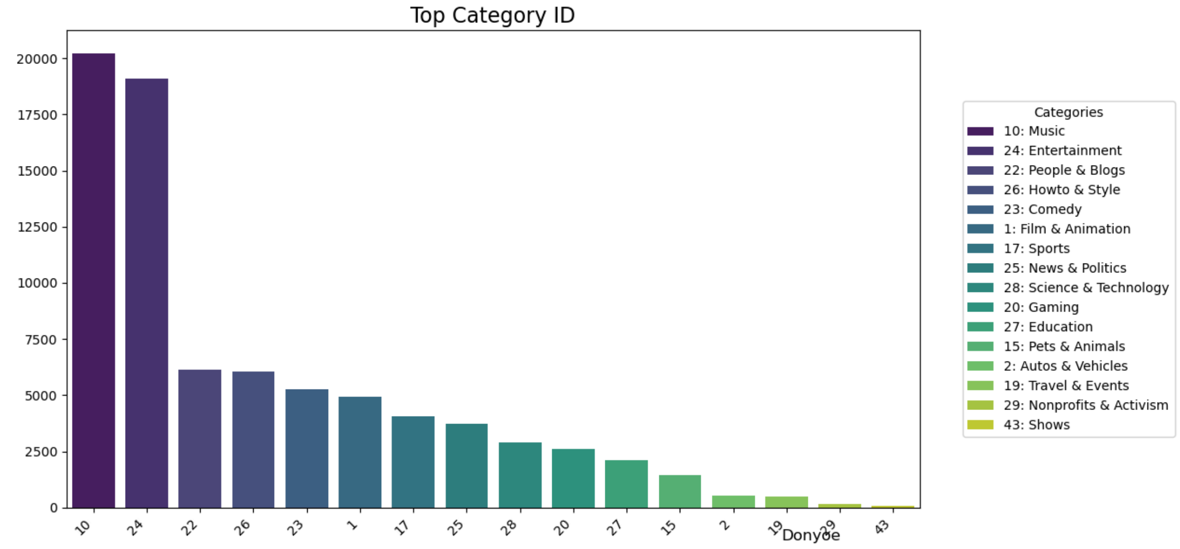
In [11]:
```
# Statistical description of categorical columns
categorical_description = merged_df[['category_id']].describe()
print(categorical_description)
```

```
        category_id
count  79865.000000
mean      18.440205
std        7.818304
min        1.000000
25%       10.000000
50%       22.000000
75%       24.000000
max       43.000000
```

Visualization for Categorical ID

In [12]:

```
import matplotlib.pyplot as plt
import seaborn as sns
import pandas as pd

# Group by 'category_id' and count occurrences
category_counts = merged_df.groupby('category_id').size().reset_index(

# Sort by 'N' in descending order
category_counts = category_counts.sort_values(by='N', ascending=False)
category_counts['category_id'] = pd.Categorical(category_counts['catego

# Create a dictionary to map 'category_id' to descriptive names
category_names = {
    1: "1: Film & Animation",
    2: "2: Autos & Vehicles",
    10: "10: Music",
    15: "15: Pets & Animals",
    17: "17: Sports",
    18: "18: Short Movies",
    19: "19: Travel & Events",
    20: "20: Gaming",
    21: "21: Videoblogging",
    22: "22: People & Blogs",
    23: "23: Comedy",
    24: "24: Entertainment",
    25: "25: News & Politics",
    26: "26: Howto & Style",
    27: "27: Education",
    28: "28: Science & Technology",
    29: "29: Nonprofits & Activism",
    30: "30: Movies",
    31: "31: Anime/Animation",
    32: "32: Action/Adventure",
    33: "33: Classics",
    34: "34: Comedy",
    35: "35: Documentary",
    36: "36: Drama",
    37: "37: Family",
    38: "38: Foreign",
    39: "39: Horror",
    40: "40: Sci-Fi/Fantasy",
    41: "41: Thriller",
    42: "42: Shorts",
    43: "43: Shows",
    44: "44: Trailers"
}

# Map 'category_id' to names in the 'category_counts' DataFrame
category_counts['category_name'] = category_counts['category_id'].map(

# Plot using seaborn
plt.figure(figsize=(10, 6))
barplot = sns.barplot(data=category_counts, x='category_id', y='N', pa

# Customize the plot to match your ggplot2 example
plt.title("Top Category ID", fontsize=16)
plt.xlabel(None)
plt.ylabel(None)
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.figtext(0.9, 0.02, "Donyoe", horizontalalignment='right', fontsize=

# Add a custom legend for category names on the side
handles = barplot.patches
legend_labels = [category_names[int(c)] for c in category_counts['categ

# Position the legend on the right of the plot using 'bbox_to_anchor'
plt.legend(handles=handles[:len(legend_labels)], labels=legend_labels,
           bbox_to_anchor=(1.05, 0.5), loc='center left', borderaxespac

plt.show()
```



Data Transformation-Create Engagement Metrics

In [13]:

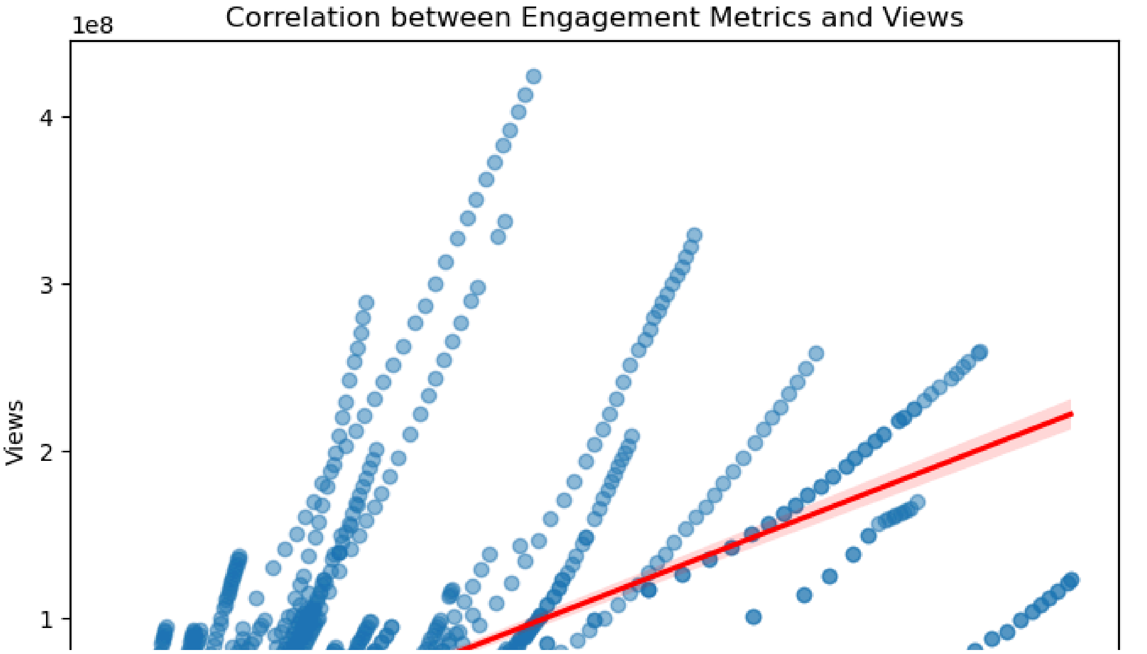
```
# Create a new column
merged_df['Engagement Metrics'] = merged_df['likes'] + merged_df['disl
# Display the DataFrame to check the new column
print(merged_df[['likes', 'dislikes', 'comment_count', 'Engagement Metr
```

```
    likes  dislikes  comment_count  Engagement Metrics
0   55681     10247           9479               75407
1   25561      2294           2757               30612
2  787420     43420         125882              956722
3     193        12             37                 242
4      30         2             30                  62
```

Visualization-Engagement Metrics

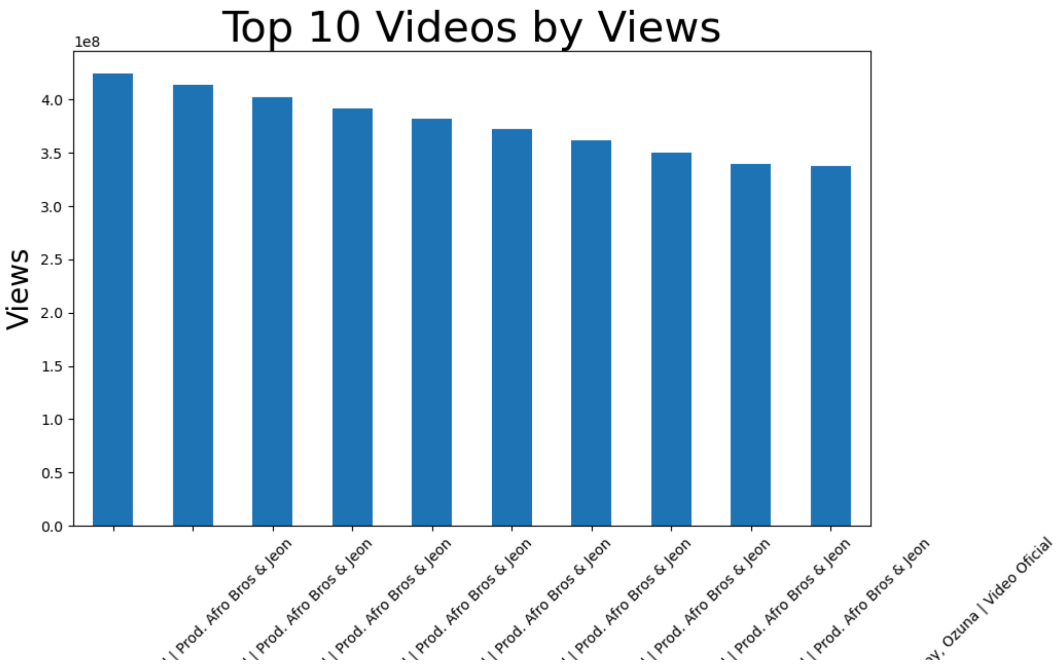
In [14]:

```
# Create a scatter plot with a regression line
plt.figure(figsize=(8, 6))
sns.regplot(x='Engagement Metrics', y='views', data=merged_df, scatter_
plt.title('Correlation between Engagement Metrics and Views')
plt.xlabel('Engagement Metrics')
plt.ylabel('Views')
plt.show()
```



In [15]:

```
top_videos = merged_df.nlargest(10, 'views')[['title', 'views']]


top_videos.set_index('title')['views'].plot(kind='bar', figsize=(10, 6
plt.xlabel('Video Title',fontsize=20)
plt.ylabel('Views',fontsize=20)
plt.title('Top 10 Videos by Views',fontsize=30)
plt.xticks(rotation=45)
plt.show()
```

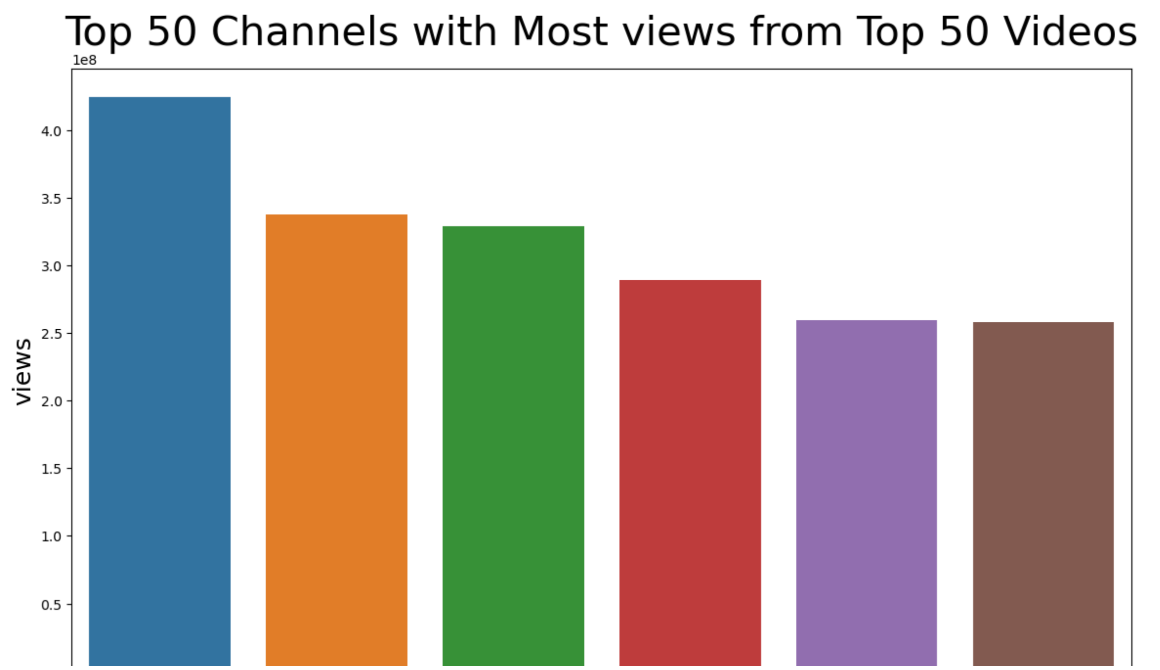


In [16]:

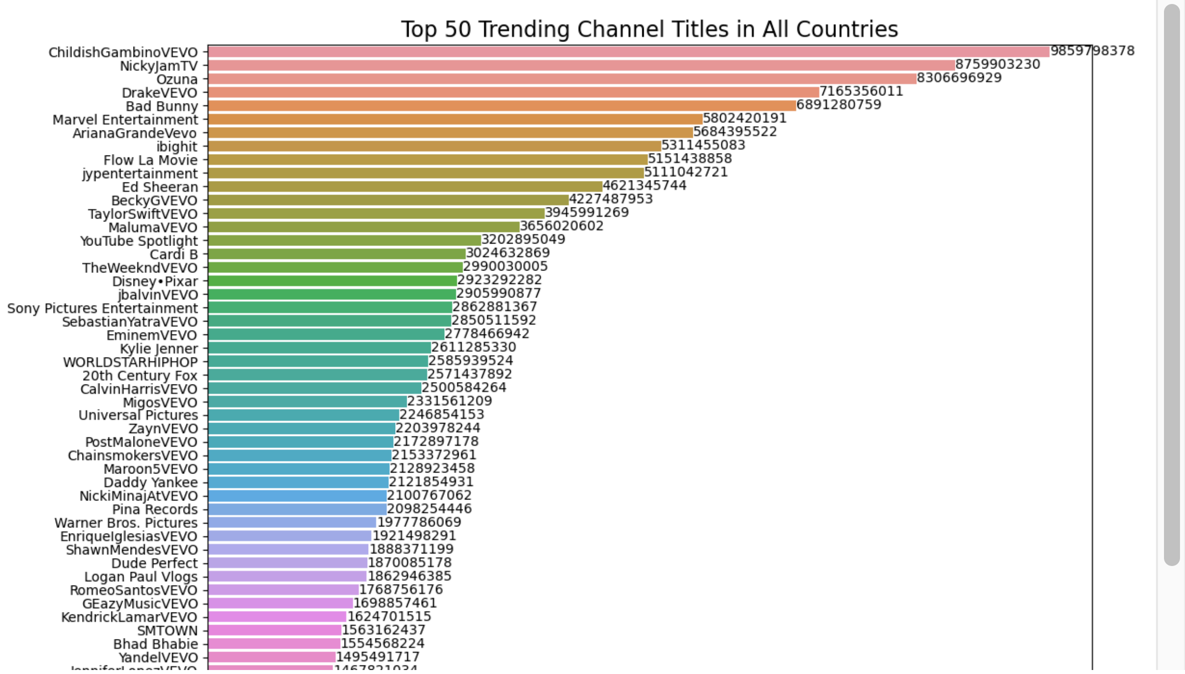
```
# Engagement metrics for top 50 videos
top_50_videos = merged_df.nlargest(50, 'views')
print(top_50_videos[['title', 'Engagement Metrics']])
```

```
                                                      title  Engagemen
t Metrics
28412  Nicky Jam x J. Balvin - X (EQUIS) | Video Ofic...
3067426
28212  Nicky Jam x J. Balvin - X (EQUIS) | Video Ofic...
3011515
28008  Nicky Jam x J. Balvin - X (EQUIS) | Video Ofic...
2956724
27811  Nicky Jam x J. Balvin - X (EQUIS) | Video Ofic...
2902891
27615  Nicky Jam x J. Balvin - X (EQUIS) | Video Ofic...
2845332
27424  Nicky Jam x J. Balvin - X (EQUIS) | Video Ofic...
2786627
27241  Nicky Jam x J. Balvin - X (EQUIS) | Video Ofic...
2723032
27052  Nicky Jam x J. Balvin - X (EQUIS) | Video Ofic...
2650114
26861  Nicky Jam x J. Balvin - X (EQUIS) | Video Ofic...
```

In [17]:
```
import seaborn as snb
content = top_50_videos.groupby('channel_title')['views'].max()

# Sort values to get the top 50 channels with the most views
content = content.sort_values(ascending=False).head(50)
content = content.reset_index()  # Convert index to column

# Plotting the results
plt.figure(figsize=(14, 8))
snb.barplot(x='channel_title', y='views', data=content)
plt.title('Top 50 Channels with Most views from Top 50 Videos', fontsi
plt.ylabel('views', fontsize=18)
plt.xlabel('Channel', fontsize=18)
plt.xticks(rotation=90)
plt.show()
```



In [18]:
```
channel_counts = merged_df.groupby('channel_title')['views'].sum().rese

# Sort values and select top 10 channels
top_10_channels = channel_counts.sort_values(by='views', ascending=Fals

# Plot using seaborn
plt.figure(figsize=(12, 8))
ax = sns.barplot(x='views', y='channel_title', data=top_10_channels,or

# Add labels
for index, value in enumerate(top_10_channels['views']):
    ax.text(value, index, str(value), va='center', ha='left', color='b

# Customize the plot
plt.title('Top 50 Trending Channel Titles in All Countries', fontsize=
plt.xlabel('Views', fontsize=12)
plt.ylabel(None)
plt.xticks(rotation=0)  # x-axis ticks don't need rotation in horizonta
plt.tight_layout()

# Add caption
plt.figtext(0.95, 0.02, "Donyoe", horizontalalignment='right', fontsize

# Show the plot
plt.show()
```

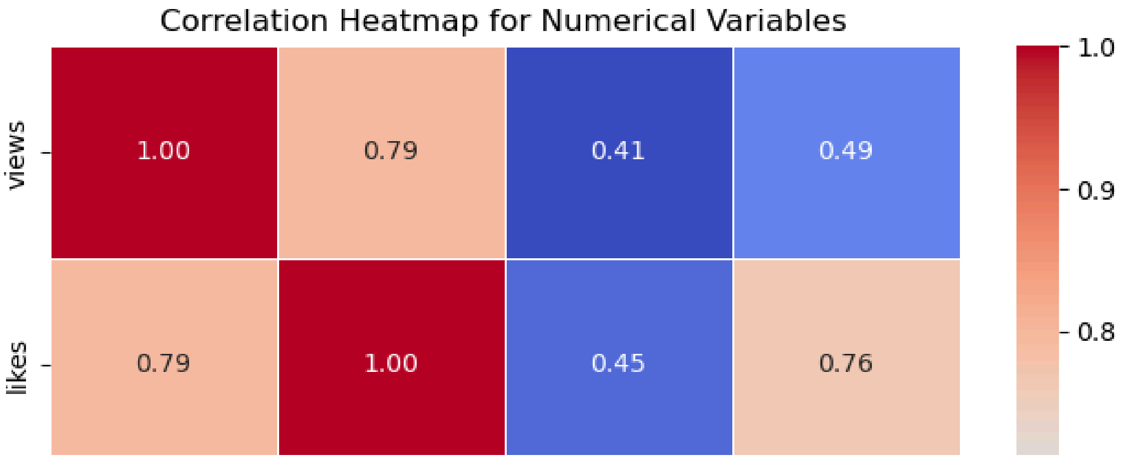


Normalize and Standardize Data

Correlation Metrics for Variables

In [19]:
```
# add category_id to numerical columns
numerical_columns = ['views', 'likes', 'dislikes', 'comment_count', ]

# Compute the correlation matrix
correlation_matrix = merged_df[numerical_columns].corr()
# Display the correlation matrix
print(correlation_matrix)

# Plot the correlation matrix as a heatmap
plt.figure(figsize=(8, 6))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt='.2f',
plt.title('Correlation Heatmap for Numerical Variables')
plt.show()
```

```
                  views     likes  dislikes  comment_count
views          1.000000  0.791670  0.405290       0.485986
likes          0.791670  1.000000  0.448010       0.763192
dislikes       0.405290  0.448010  1.000000       0.745064
comment_count  0.485986  0.763192  0.745064       1.000000
```


Correlation Heatmap for Numerical Variables

Assign Score for Numerical Values

In [20]:

```
import pandas as pd

# Assuming the correlation values are manually entered from the heatma
correlation_values = {
    'likes': 0.784,          # Correlation of likes with views
    'dislikes': 0.416,       # Correlation of dislikes with views
    'comment_count': 0.502 # Correlation of comment_count with views
}

# Convert the correlation values to absolute values
abs_correlations = {key: abs(value) for key, value in correlation_value

# Calculate the total sum of absolute correlations
total_correlation = sum(abs_correlations.values())

# Calculate weights by normalizing the absolute correlation values
weights = {key: value / total_correlation for key, value in abs_correla

# Convert the weights to a DataFrame for better visualization
weights_df = pd.DataFrame(list(weights.items()), columns=['Variable',

# Display the weights
print("Calculated Weights of Independent Variables Relative to 'Views'
print(weights_df)
```

```
Calculated Weights of Independent Variables Relative to 'Views':
        Variable    Weight
0          likes  0.460635
1       dislikes  0.244418
2  comment_count  0.294947
```

In [21]:

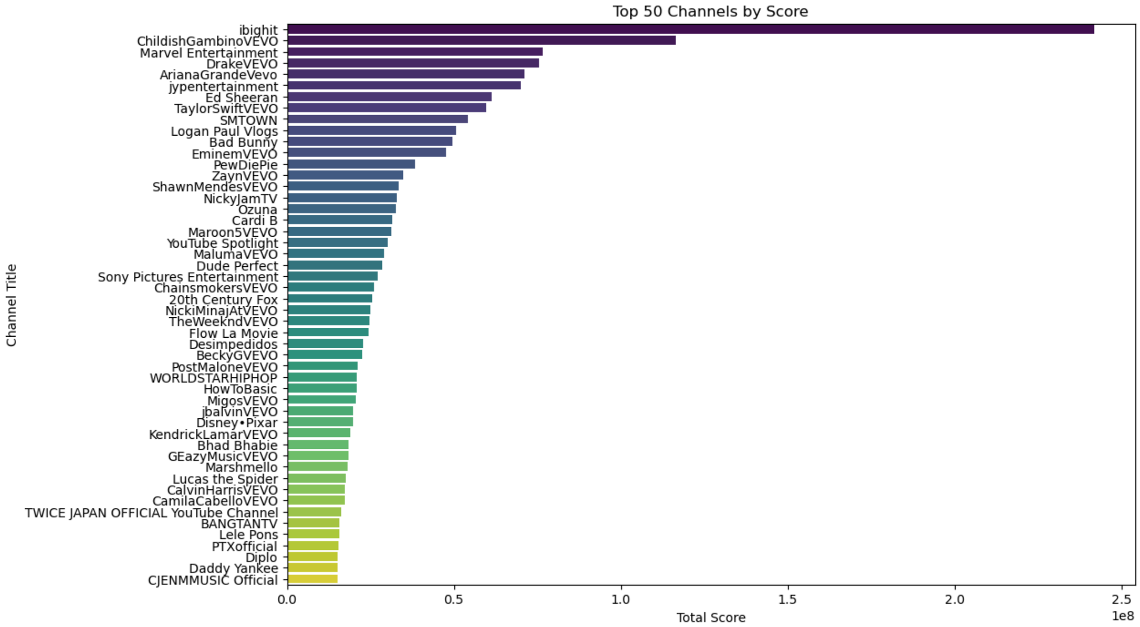
```
import pandas as pd

weights = {
    'likes': 0.460435,
    'dislikes': 0.244418,
    'comment_count': 0.294947
}

merged_df['score'] = (
    weights['likes'] * merged_df['likes'] -
    weights['dislikes'] * merged_df['dislikes'] +
    weights['comment_count'] * merged_df['comment_count']
)

merged_df['rank'] = merged_df['score'].rank(ascending=False, method='m

df_sorted = merged_df.sort_values(by='rank')

print(df_sorted)

#output_filename = 'ranked_videos_combined.csv'
#df_sorted.to_csv(output_filename, index=False)

#print("Listing of Every Video with Individual Scores and Ranks Across
#print(df_sorted[['video_id', 'views', 'likes', 'dislikes', 'comment_c
#print(f"\nThe ranking of all videos from all locations has been saved
```

```
          video_id trending_date                                      t
itle  \
36638  7C2z4GqqS5E    2018-06-01    BTS (방탄소년단) 'FAKE LOVE' Offic
ial MV
77189  7C2z4GqqS5E    2018-06-01    BTS (방탄소년단) 'FAKE LOVE' Offic
ial MV
76988  7C2z4GqqS5E    2018-05-31    BTS (방탄소년단) 'FAKE LOVE' Offic
ial MV
36468  7C2z4GqqS5E    2018-05-31    BTS (방탄소년단) 'FAKE LOVE' Offic
ial MV
36288  7C2z4GqqS5E    2018-05-30    BTS (방탄소년단) 'FAKE LOVE' Offic
ial MV
...            ...           ...
...
9146   LFhT6H6pRWg    2017-12-29  PSA from Chairman of the FCC Ajit
Pai
9354   LFhT6H6pRWg    2017-12-30  PSA from Chairman of the FCC Ajit
Pai
9575   LFhT6H6pRWg    2017-12-31  PSA from Chairman of the FCC Ajit
Pai
```

EDA for Score for Top 50 Channels

In [22]:

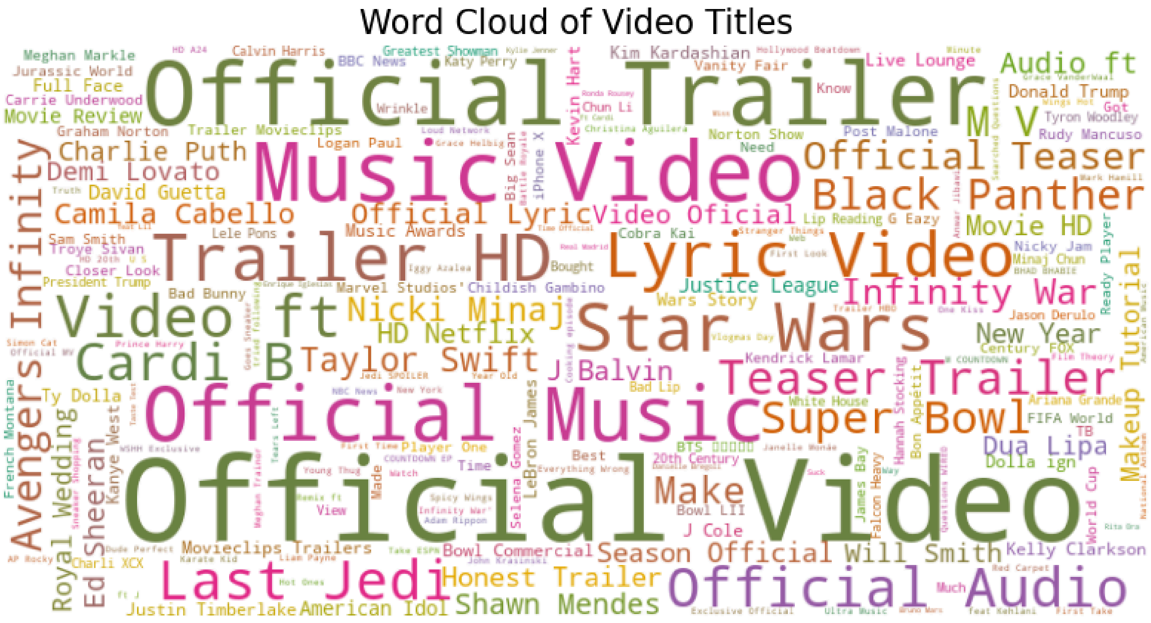
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

# Assuming your DataFrame is named 'train'
weights = {
    'likes': 0.460435,
    'dislikes': 0.244418,
    'comment_count': 0.294947
}

# Calculate score and rank
merged_df['score'] = (
    weights['likes'] * merged_df['likes'] -
    weights['dislikes'] * merged_df['dislikes'] +
    weights['comment_count'] * merged_df['comment_count']
)

merged_df['rank'] = merged_df['score'].rank(ascending=False, method='mi

# Group by channel_title and sum the scores
channel_scores = merged_df.groupby('channel_title')['score'].sum().rese

# Sort by total score and get top 50 channels
top_channels = channel_scores.sort_values(by='score', ascending=False).

# Create a bar plot for the top 50 channels
plt.figure(figsize=(12, 8))
sns.barplot(x='score', y='channel_title', data=top_channels, palette='v
plt.title('Top 50 Channels by Score')
plt.xlabel('Total Score')
plt.ylabel('Channel Title')
plt.show()
```



Create Word Cloud

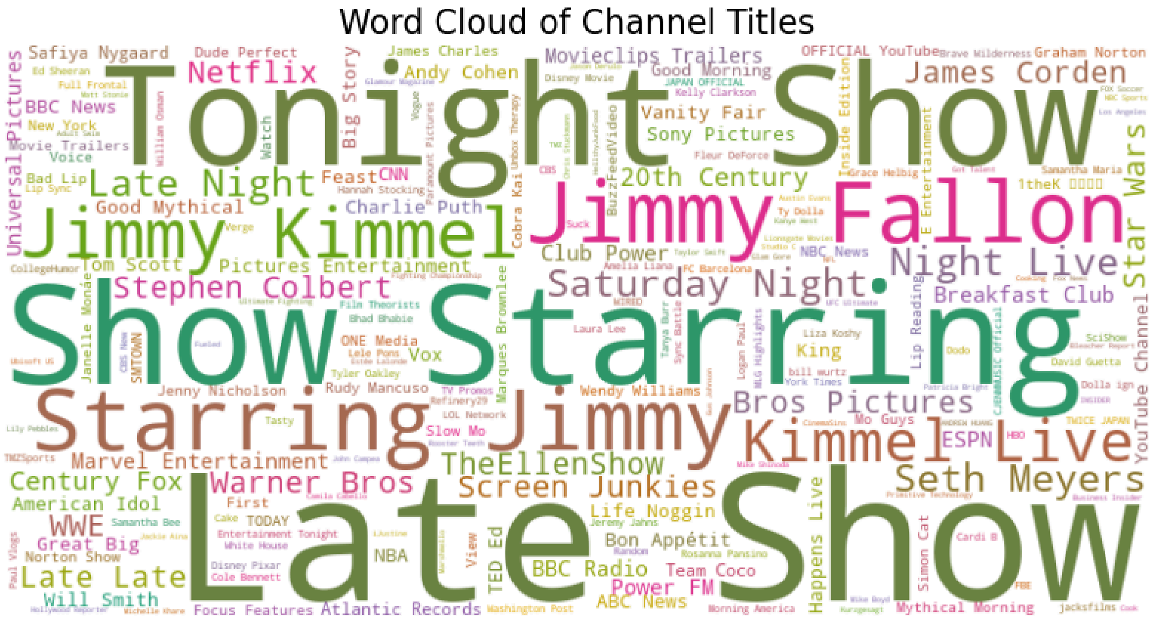
Video Titles

In [23]:
```
from wordcloud import WordCloud
from palettable.colorbrewer.qualitative import Dark2_6

# Assuming your DataFrame is named 'mergeda_df'
# Concatenate all titles into a single string
all_titles = " ".join(merged_df['title'].astype(str))

# Set up the color palette (equivalent to R's "Dark2")
cmap = Dark2_6.mpl_colormap

# Create a WordCloud object
wordcloud = WordCloud(
    background_color="white",
    max_words=200,
    colormap=cmap,
    width=800,
    height=400,
    random_state=42
)

# Generate the word cloud from the titles
wordcloud.generate(all_titles)

# Plot the word cloud
plt.figure(figsize=(10, 6))
plt.imshow(wordcloud, interpolation="bilinear")
plt.axis("off")  # Turn off the axis
plt.title('Word Cloud of Video Titles', fontsize=16)
plt.show()
```



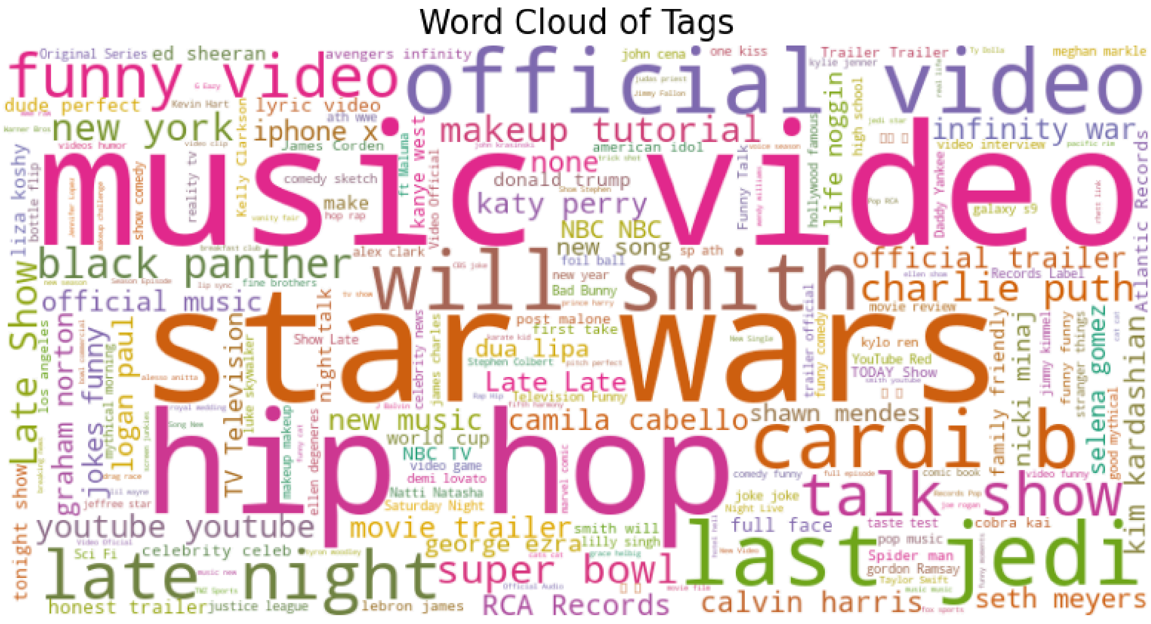
Channel Titles

```
In [24]: all_channel_titles = " ".join(merged_df['channel_title'].astype(str))

         # Set up the color palette (equivalent to R's "Dark2")
         cmap = Dark2_6.mpl_colormap

         # Create a WordCloud object
         wordcloud = WordCloud(
             background_color="white",
             max_words=200,
             colormap=cmap,
             width=800,
             height=400,
             random_state=42
         )

         # Generate the word cloud from the titles
         wordcloud.generate(all_channel_titles)

         # Plot the word cloud
         plt.figure(figsize=(10, 6))
         plt.imshow(wordcloud, interpolation="bilinear")
         plt.axis("off")  # Turn off the axis
         plt.title('Word Cloud of Channel Titles', fontsize=16)
         plt.show()
```



Video Tags

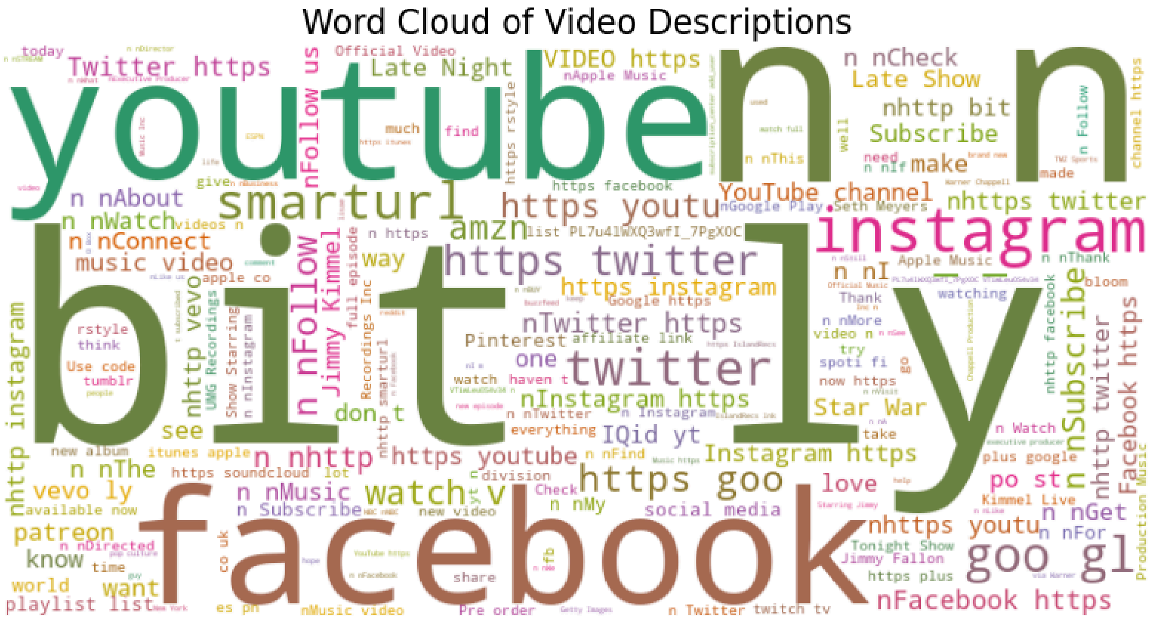
In [25]:
```
# Creating Word Cloud-tags
all_tags = " ".join(merged_df['tags'].astype(str))

# Set up the color palette (equivalent to R's "Dark2")
cmap = Dark2_6.mpl_colormap

# Create a WordCloud object
wordcloud = WordCloud(
    background_color="white",
    max_words=200,
    colormap=cmap,
    width=800,
    height=400,
    random_state=42
)

# Generate the word cloud from the titles
wordcloud.generate(all_tags)

# Plot the word cloud
plt.figure(figsize=(10, 6))
plt.imshow(wordcloud, interpolation="bilinear")
plt.axis("off")  # Turn off the axis
plt.title('Word Cloud of Tags', fontsize=16)
plt.show()
```



Video Descriptions

In [26]:

```
all_description = " ".join(merged_df['description'].astype(str))

# Set up the color palette (equivalent to R's "Dark2")
cmap = Dark2_6.mpl_colormap

# Create a WordCloud object
wordcloud = WordCloud(
    background_color="white",
    max_words=200,
    colormap=cmap,
    width=800,
    height=400,
    random_state=42
)

# Generate the word cloud from the titles
wordcloud.generate(all_description)

# Plot the word cloud
plt.figure(figsize=(10, 6))
plt.imshow(wordcloud, interpolation="bilinear")
plt.axis("off")  # Turn off the axis
plt.title('Word Cloud of Video Descriptions', fontsize=16)
plt.show()
```



Drop Unnecessary Columns

```
In [27]: #drop columns needed
         merged_df.drop(columns=['thumbnail_link', 'video_id','comments_disabled

         print(merged_df.head())
```

```
                                                tags      views   li
kes  \
0  christmas|"john lewis christmas"|"john lewis"|...   7224515   55
681
1  SNL|"Saturday Night Live"|"SNL Season 43"|"Epi...   1053632   25
561
2  Eminem|"Walk"|"On"|"Water"|"Aftermath/Shady/In...  17158579  787
420
3  Salford City FC|"Salford City"|"Salford"|"Clas...     27833
193
4                                             [none]      9815
30

   dislikes  comment_count                                        d
escription  \
0     10247           9479  Click here to continue the story and ma
ke your...
1      2294           2757  Musical guest Taylor Swift performs …Re
ady for...
2     43420         125882  Eminem's new track Walk on Water ft. Be
```

Text Preprocessing

In [28]:

```
import nltk
nltk.download('stopwords')
from nltk.corpus import stopwords
import re

# Get the list of default English stopwords
stop_words = set(stopwords.words('english'))

# Function to remove stopwords and clean text
def clean_text(text):
    # Lowercase the text
    text = text.lower()

    # Remove non-alphabetical characters (retain only letters and space
    text = re.sub(r'[^a-z\s]', '', text)

    # Split text into words
    words = text.split()

    # Remove stopwords
    remove_stopwords = [word for word in words if word not in stop_word

    # Join the cleaned words back into a string
    new_text = ' '.join(remove_stopwords)

    return new_text
    data = {'title','description','text'}

# Apply the clean_text function to the 'title' column in merged_df1
merged_df['new_text'] = merged_df['title'].apply(clean_text)

# Display the cleaned DataFrame
print(merged_df)
```

```
[nltk_data] Downloading package stopwords to
[nltk_data]     /Users/yuhanzhao/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!

      trending_date                                                   ti
tle  \
0        2017-11-14      John Lewis Christmas Ad 2017 - #MozTheMons
ter
1        2017-11-14          Taylor Swift: …Ready for It? (Live) -
SNL
2        2017-11-14         Eminem - Walk On Water (Audio) ft. Beyo
ncé
3        2017-11-14  Goals from Salford City vs Class of 92 and Fr
i...
4        2017-11-14  Dashcam captures truck's near miss with child
...
...             ...
...
79860    2018-06-14                       The Cat Who Caught the La
ser
```

In [29]:

```
# Check the data types of each column
print(merged_df.dtypes)
```

```
trending_date           datetime64[ns]
title                           object
channel_title                   object
category_id                      int64
publish_time            datetime64[ns]
tags                            object
views                            int64
likes                            int64
dislikes                         int64
comment_count                    int64
description                     object
trending_day_of_week            object
day_of_week                     object
Engagement Metrics               int64
score                          float64
rank                           float64
new_text                        object
dtype: object
```

Split the Dataset into Train and Test by 80/20

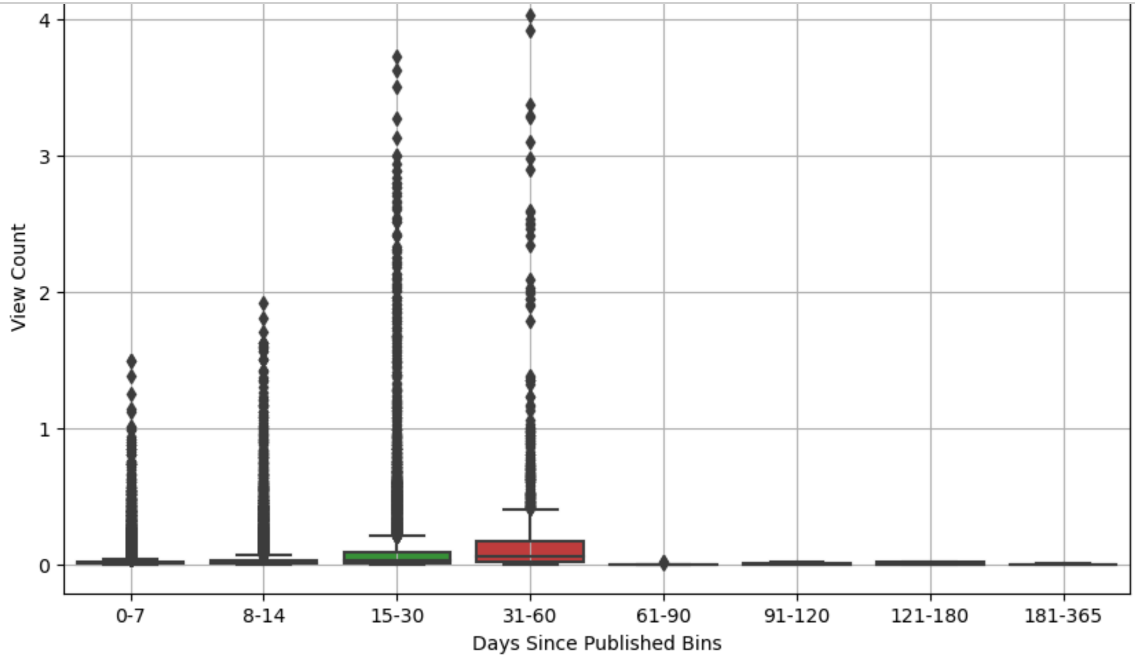
In [30]:

```
from sklearn.model_selection import train_test_split

X = merged_df.drop(columns=['views'])  # Drop 'views' from features to
y = merged_df['views']
# Assuming you have a dataset with features X and target y
X_train, X_test, y_train, y_test = train_test_split(X,y, test_size=0.2,

train = pd.DataFrame(X_train)
train['views'] = y_train.values

test = pd.DataFrame(X_test)
test['views'] = y_test.values
```

Feature Engineering

Days Since Published

In [31]:
```
#convert the type of publish time
train['publish_time'] = pd.to_datetime(train['publish_time'])
train['trending_date'] = pd.to_datetime(train['trending_date'], format=

# Creating a new feature 'days_since_published'
train['days_since_published'] = (train['trending_date'] - train['publis

# Creating bins for days since published
bins = [0, 7, 14, 30, 60, 90, 120, 180, 365]  # Example bins
labels = ['0-7', '8-14', '15-30', '31-60', '61-90', '91-120', '121-180
train['days_bins'] = pd.cut(train['days_since_published'], bins=bins,

plt.figure(figsize=(10, 6))
sns.boxplot(data=train, x='days_bins', y='views')
plt.title('Box Plot of Views by Days Since Published Bins')
plt.xlabel('Days Since Published Bins')
plt.ylabel('View Count')
plt.grid(True)
plt.show()
```



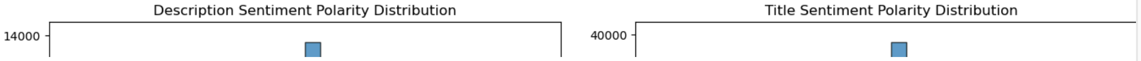
Sentimental Analysis

Sentiment Polarity Distribution

In [32]:

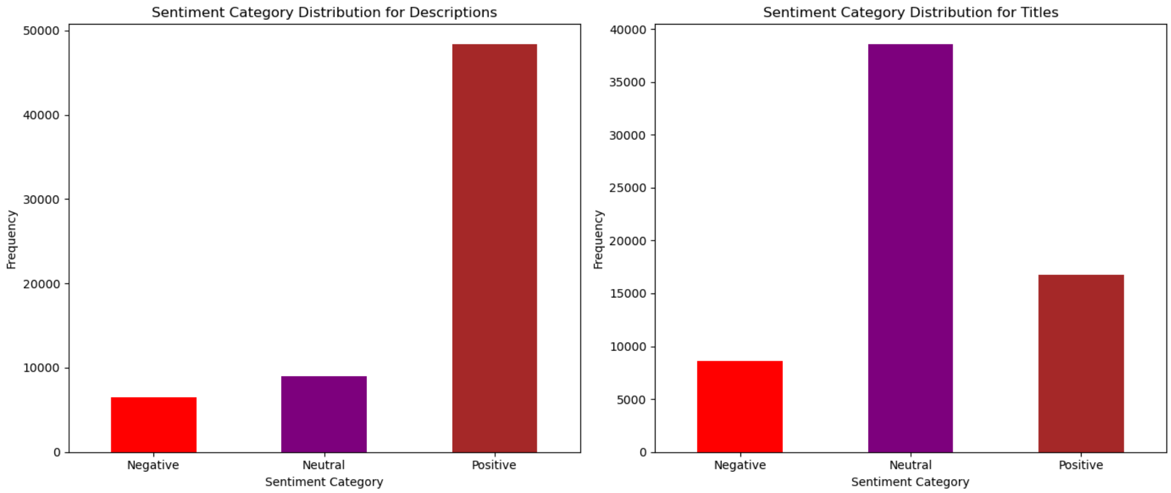
```
from textblob import TextBlob
import matplotlib.pyplot as plt

# Calculate sentiment polarity for description and title
def get_sentiment(text):
    return TextBlob(text).sentiment.polarity

# Apply sentiment analysis
train['description_sentiment'] = train['description'].fillna('').apply
train['title_sentiment'] = train['title'].fillna('').apply(get_sentimen

# Calculate average sentiment scores
avg_description_sentiment = train['description_sentiment'].mean()
avg_title_sentiment = train['title_sentiment'].mean()

print("Average Description Sentiment Score:", avg_description_sentimen
print("Average Title Sentiment Score:", avg_title_sentiment)

# Plotting the sentiment distributions
plt.figure(figsize=(14, 6))

# Description Sentiment Histogram
plt.subplot(1, 2, 1)
plt.hist(train['description_sentiment'], bins=30, alpha=0.7, edgecolor
plt.title('Description Sentiment Polarity Distribution')
plt.xlabel('Sentiment Polarity')
plt.ylabel('Frequency')
plt.xticks([-1, 0, 1])

# Title Sentiment Histogram
plt.subplot(1, 2, 2)
plt.hist(train['title_sentiment'], bins=30, alpha=0.7, edgecolor='blac
plt.title('Title Sentiment Polarity Distribution')
plt.xlabel('Sentiment Polarity')
plt.ylabel('Frequency')
plt.xticks([-1, 0, 1])

plt.tight_layout()
plt.show()
```

```
Average Description Sentiment Score: 0.1716764242965884
Average Title Sentiment Score: 0.0477964529239135
```



Visualize the Sentiment Distrubution Category

In [33]:
```
import pandas as pd
import matplotlib.pyplot as plt

# Define sentiment categories
def categorize_sentiment(polarity):
    if polarity > 0:
        return 'Positive'
    elif polarity < 0:
        return 'Negative'
    else:
        return 'Neutral'

# Apply categorization to sentiment columns
train['description_sentiment_category'] = train['description_sentiment
train['title_sentiment_category'] = train['title_sentiment'].apply(cate

# Plot sentiment category distribution for descriptions and titles
plt.figure(figsize=(14, 6))

# Custom order for categories
category_order = ['Negative', 'Neutral', 'Positive']

# Plot description sentiment distribution
plt.subplot(1, 2, 1)
description_sentiment_counts = train['description_sentiment_category'].
description_sentiment_counts.plot(kind='bar', color=['red', 'purple',
plt.title('Sentiment Category Distribution for Descriptions')
plt.xlabel('Sentiment Category')
plt.ylabel('Frequency')
plt.xticks(rotation=0)

# Plot title sentiment distribution
plt.subplot(1, 2, 2)
title_sentiment_counts = train['title_sentiment_category'].value_counts
title_sentiment_counts.plot(kind='bar', color=['red', 'purple', 'brown
plt.title('Sentiment Category Distribution for Titles')
plt.xlabel('Sentiment Category')
plt.ylabel('Frequency')
plt.xticks(rotation=0)

plt.tight_layout()
plt.show()
```



Create TF-IDF Feature

`description` Column

In [34]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
import numpy as np

# Ensure the 'description' column exists in the DataFrame
if 'description' in train.columns:
    # Assuming 'description' column contains the text data
    text_data = train['description'].fillna('')  # Handle missing value

    # Check if text_data is iterable, not a single string
    if isinstance(text_data, pd.Series):
        # Initialize the TF-IDF Vectorizer
        tfidf_vectorizer = TfidfVectorizer(max_features=100, stop_words

        # Fit and transform the text data to generate the TF-IDF matrix
        tfidf_matrix = tfidf_vectorizer.fit_transform(text_data)

        # Convert the sparse matrix into a DataFrame for easier manipul
        tfidf_df = pd.DataFrame(tfidf_matrix.toarray(), columns=tfidf_v

        # Function to get top N features per row based on TF-IDF score
        def get_top_tfidf_features(row, features, top_n=5):
            top_indices = np.argsort(row)[::-1][:top_n]  # Get the indi
            top_features = [(features[i], row[i]) for i in top_indices]
            return top_features

        # Apply the function to each row in the TF-IDF matrix
        top_tfidf_features = [get_top_tfidf_features(row, tfidf_vectori
                              for row in tfidf_matrix.toarray()]

        # Add the top TF-IDF features as a new column in the original D
        train['top_tfidf_features'] = top_tfidf_features

        # Display the entire first 5 rows of the DataFrame including th
        print(train.head(5))
    else:
        print("The 'description' column should be a pandas Series.")
else:
    print("The DataFrame does not contain a 'description' column.")
```

```
      trending_date                                              titl
e  \
23604    2018-03-14                   Marshmello & Anne-Marie: Friend
s
25630    2018-03-24  Kirby Star Allies' Surprising HD Rumble Secre
t...
68698    2018-04-20  Stephen A.: Kevin Hart 'got his feelings hur
t'...
39559    2017-11-17                              How to be an Aquariu
s
62877    2018-03-16  Charlie Puth - Done For Me (feat. Kehlani) [O
f...

                                channel_title  category_id  \
23604  The Tonight Show Starring Jimmy Fallon           23
25630                              GameXplain           20
68698                                    ESPN           17
39559                                Sailor J           24
62877                            Charlie Puth           10

             publish_time
tags  \
23604 2018-03-07 14:00:03  The Tonight Show|"Jimmy Fallon"|"Marshmell
o"|"...
25630 2018-03-16 04:00:01  Kirby|"Kirby Star Allies"|"Dedede"|"Meta K
nigh...
68698 2018-04-17 14:55:31  espn|"dwyane wade"|"dwayne wade"|"d wad
e"|"76e...
39559 2017-11-15 13:29:28                Zodiac|"makeup"|"comedy"|"aq
uarius"
62877 2018-03-15 16:02:17  Charlie|"Puth"|"charlie puth"|"Charlie Put
h - ...

       likes  dislikes  comment_count  \
23604  45011      1156           2365
25630   2716        52            450
68698   6829       537           1445
39559   5172       453            976
62877  84227       739           8663

                                             description  ...     ran
k  \
23604  Music guest Marshmello & Anne-Marie performs F...  ...  27872.
0
25630  Kirby Star Allies does something pretty fun wi...  ...  67076.
0
68698  First Take's Stephen A. Smith says Kevin Hart ...  ...  57168.
0
39559  Ya'll asked lol. What sign should I do next? D...  ...  60832.
0
62877  Download & Stream Done For Me (feat. Kehlani):...  ...  18947.
0

                                                new_text    views  \
23604                       marshmello annemarie friends  1443792
25630  kirby star allies surprising hd rumble secret ...   106398
68698  stephen kevin hart got feelings hurt dwyane wa...   976783
```

```
39559                                           aquarius    88644
62877      charlie puth done feat kehlani official audio   722009

       days_since_published  days_bins description_sentiment  title_s
entiment  \
23604                     6        0-7              0.232292
0.000000
25630                     7        0-7              0.137500
0.141667
68698                     2        0-7              0.168333
0.250000
39559                     1        0-7              0.400000
0.000000
62877                     0        NaN              0.400000
0.000000

       description_sentiment_category title_sentiment_category  \
23604                        Positive                  Neutral
25630                        Positive                 Positive
68698                        Positive                 Positive
39559                        Positive                  Neutral
62877                        Positive                  Neutral

                                      top_tfidf_features
23604  [(jimmy, 0.6973441834478303), (nbc, 0.47929685...
25630  [(patreon, 0.5185912254067347), (com, 0.407894...
68698  [(http, 0.6127313163416526), (youtube, 0.33885...
39559  [(ll, 0.5094338648331312), (don, 0.47521836732...
62877  [(nhttp, 0.4915874738421169), (com, 0.44499439...

[5 rows x 24 columns]
```

tags Column

In [35]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
import numpy as np

# Ensure the 'description' column exists in the DataFrame
if 'tags' in train.columns:
    # Assuming 'description' column contains the text data
    text_data = train['tags'].fillna('')  # Handle missing values

    # Check if text_data is iterable, not a single string
    if isinstance(text_data, pd.Series):
        # Initialize the TF-IDF Vectorizer
        tfidf_vectorizer = TfidfVectorizer(max_features=100, stop_words

        # Fit and transform the text data to generate the TF-IDF matrix
        tfidf_matrix = tfidf_vectorizer.fit_transform(text_data)

        # Convert the sparse matrix into a DataFrame for easier manipul
        tfidf_df = pd.DataFrame(tfidf_matrix.toarray(), columns=tfidf_v

        # Function to get top N features per row based on TF-IDF score
        def get_top_tfidf_features(row, features, top_n=5):
            top_indices = np.argsort(row)[::-1][:top_n]  # Get the ind
            top_features = [(features[i], row[i]) for i in top_indices]
            return top_features

        # Apply the function to each row in the TF-IDF matrix
        top_tfidf_features = [get_top_tfidf_features(row, tfidf_vector
                              for row in tfidf_matrix.toarray()]

        # Add the top TF-IDF features as a new column in the original D
        train['top_tfidf_features'] = top_tfidf_features

        # Display the entire first 5 rows of the DataFrame including th
        print(train.head(5))
    else:
        print("The 'description' column should be a pandas Series.")
else:
    print("The DataFrame does not contain a 'description' column.")
```

```
      trending_date                                             ti
tle  \
23604    2018-03-14                   Marshmello & Anne-Marie: Frie
nds
25630    2018-03-24  Kirby Star Allies' Surprising HD Rumble Secre
t...
68698    2018-04-20  Stephen A.: Kevin Hart 'got his feelings hur
t'...
39559    2017-11-17                             How to be an Aquar
ius
62877    2018-03-16  Charlie Puth - Done For Me (feat. Kehlani) [O
f...

                                channel_title  category_id  \
23604  The Tonight Show Starring Jimmy Fallon           23
25630                              GameXplain           20
68698                                    ESPN           17
39559                                Sailor J           24
62877                             Charlie Puth           10
```

Dimension Reduction-PCA

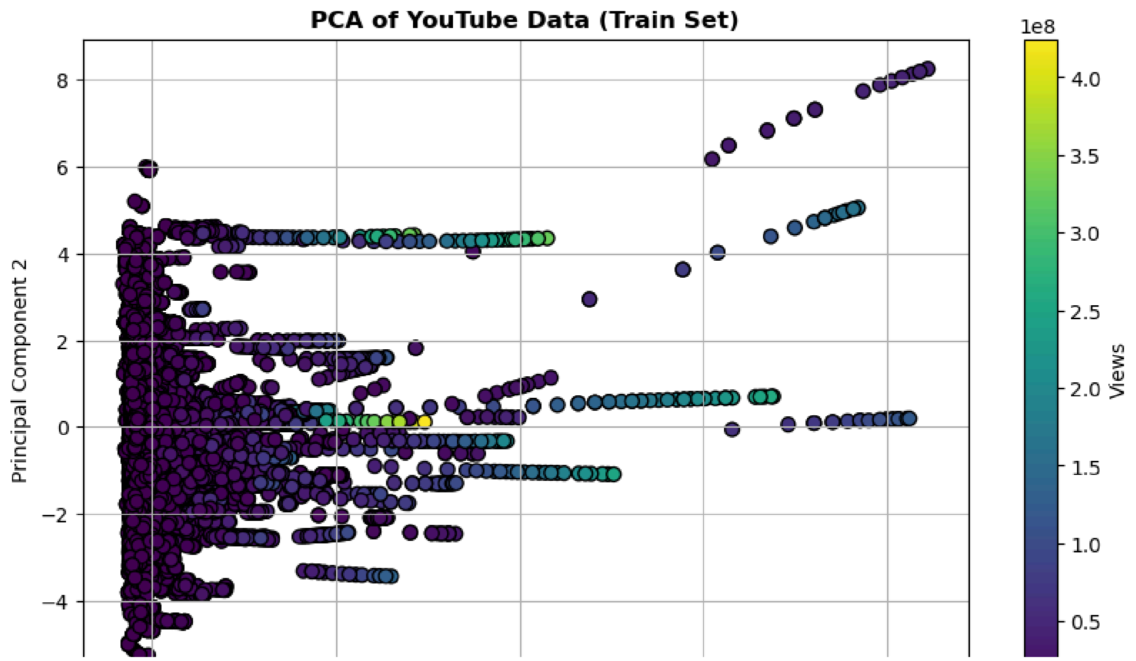
In [36]:

```
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA

non_numeric_cols = ['publish_time', 'title', 'channel_title', 'tags',
X_train_model = train.drop(columns=non_numeric_cols + ['views']).selec
X_test_model = test.drop(columns=non_numeric_cols + ['views']).select_

X_test_model = X_test_model.reindex(columns=X_train_model.columns, fil

scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train_model)
X_test_scaled = scaler.transform(X_test_model)

print("Missing values in X_train_model:\n", X_train_model.isna().sum()
print("Missing values in X_test_model:\n", X_test_model.isna().sum())
```

```
Missing values in X_train_model:
 category_id              0
likes                    0
dislikes                 0
comment_count            0
Engagement Metrics       0
score                    0
rank                     0
days_since_published     0
description_sentiment    0
title_sentiment          0
dtype: int64
Missing values in X_test_model:
 category_id              0
likes                    0
dislikes                 0
comment_count            0
Engagement Metrics       0
score                    0
rank                     0
```

In [37]:

```
# Apply PCA (Reduce to n components to capture 95% of variance)
pca = PCA(n_components=0.95)
X_train_pca = pca.fit_transform(X_train_scaled)
X_test_pca = pca.transform(X_test_scaled)

# Visualize the PCA results (Plot only the first two components)
plt.figure(figsize=(10, 6))
plt.scatter(X_train_pca[:, 0], X_train_pca[:, 1], c=y_train, cmap='vir
plt.colorbar(label='Views')
plt.title('PCA of YouTube Data (Train Set)', weight='bold')
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.grid(True)
plt.show()

# Explained variance for all components selected by PCA
explained_variance = pca.explained_variance_ratio_
print("Explained Variance per component:")
for i, variance in enumerate(explained_variance, start=1):
     print(f"PC{i}: {variance:.2%}")
```



Model Building

In [38]:

```
import xgboost as xgb
from sklearn.metrics import mean_squared_error, r2_score
import numpy as np
import pandas as pd
```

In [39]:
```
# Define a function for calculating model metrics
def calculate_metrics(model, X_train, y_train, X_test, y_test):
    train_preds = model.predict(X_train)
    test_preds = model.predict(X_test)

    # Calculate RMSE and R^2 for training and test sets
    train_rmse = np.sqrt(mean_squared_error(y_train, train_preds))
    test_rmse = np.sqrt(mean_squared_error(y_test, test_preds))
    train_r2 = r2_score(y_train, train_preds)
    test_r2 = r2_score(y_test, test_preds)

    return {
        "Train RMSE": train_rmse, "Test RMSE": val_rmse,
        "Train R^2": train_r2, "Test R^2": val_r2
    }
```

In [40]:
```
# Define a function to train the model with specific hyperparameters
def train_xgboost(X_train, y_train, X_test, y_test, params):
    model = xgb.XGBRegressor(**params, random_state=42)
    model.fit(X_train, y_train)

    # Calculate and return metrics
    metrics = calculate_metrics(model, X_train, y_train, X_test, y_tes
    return model, metrics
```

In [41]:
```
# Define hyperparameter variations
variations = [
    {"learning_rate": 0.05, "n_estimators": 200, "max_depth": 6}
]
```

In [42]:
```
# Initialize a DataFrame to store results for each variation
results = pd.DataFrame(columns=["Variation", "Train RMSE", "Test RMSE",
```

In [43]:

```
# Create a list of columns to drop if they exist
text_columns = ['title', 'channel_title', 'tags', 'description', 'locat
X_train.drop([col for col in text_columns if col in X_train.columns], a
X_test.drop([col for col in text_columns if col in X_test.columns], axi

# Encode categorical features using one-hot encoding for consistency
categorical_columns = ['trending_day_of_week', 'day_of_week', 'days_bi
X_train = pd.get_dummies(X_train, columns=[col for col in categorical_c
X_test = pd.get_dummies(X_test, columns=[col for col in categorical_co

# Convert datetime columns to relevant features if they exist
if 'trending_date' in X_train.columns:
    X_train['trending_year'] = X_train['trending_date'].dt.year
    X_train['trending_month'] = X_train['trending_date'].dt.month
    X_train['trending_day'] = X_train['trending_date'].dt.day
    X_train.drop(['trending_date'], axis=1, inplace=True)

if 'trending_date' in X_test.columns:
    X_test['trending_year'] = X_test['trending_date'].dt.year
    X_test['trending_month'] = X_test['trending_date'].dt.month
    X_test['trending_day'] = X_test['trending_date'].dt.day
    X_test.drop(['trending_date'], axis=1, inplace=True)

# Drop 'publish_time' if it exists
if 'publish_time' in X_train.columns:
    X_train.drop(['publish_time'], axis=1, inplace=True)

if 'publish_time' in X_test.columns:
    X_test.drop(['publish_time'], axis=1, inplace=True)

# Ensure X_test has the same columns as X_train
X_test = X_test.reindex(columns=X_train.columns, fill_value=0)

# Verify that X_train and X_test now have the same columns
print("X_train columns:", X_train.columns)
print("X_test columns:", X_test.columns)
```

```
X_train columns: Index(['category_id', 'likes', 'dislikes', 'comment_
count',
       'Engagement Metrics', 'score', 'rank', 'trending_day_of_week_M
onday',
       'trending_day_of_week_Saturday', 'trending_day_of_week_Sunda
y',
       'trending_day_of_week_Thursday', 'trending_day_of_week_Tuesda
y',
       'trending_day_of_week_Wednesday', 'day_of_week_Monday',
       'day_of_week_Saturday', 'day_of_week_Sunday', 'day_of_week_Thu
rsday',
       'day_of_week_Tuesday', 'day_of_week_Wednesday', 'trending_yea
r',
       'trending_month', 'trending_day'],
      dtype='object')
X_test columns: Index(['category_id', 'likes', 'dislikes', 'comment_c
ount',
       'Engagement Metrics', 'score', 'rank', 'trending_day_of_week_M
onday',
       'trending_day_of_week_Saturday', 'trending_day_of_week_Sunda
y',
       'trending_day_of_week_Thursday', 'trending_day_of_week_Tuesda
y',
       'trending_day_of_week_Wednesday', 'day_of_week_Monday',
       'day_of_week_Saturday', 'day_of_week_Sunday', 'day_of_week_Thu
rsday',
       'day_of_week_Tuesday', 'day_of_week_Wednesday', 'trending_yea
r',
       'trending_month', 'trending_day'],
      dtype='object')
```

In [44]:

```
def calculate_metrics(model, X_train, y_train, X_test, y_test):
    # Predictions
    train_preds = model.predict(X_train)
    test_preds = model.predict(X_test)

    # Calculate metrics
    train_rmse = np.sqrt(mean_squared_error(y_train, train_preds))
    test_rmse = np.sqrt(mean_squared_error(y_test, test_preds))

    train_r2 = r2_score(y_train, train_preds)
    test_r2 = r2_score(y_test, test_preds)

    return {
        "Train RMSE": train_rmse,
        "Test RMSE": test_rmse,  # Changed from val_rmse to test_rmse
        "Train R^2": train_r2,
        "Test R^2": test_r2
    }
```

In [45]:

```
# Create an empty DataFrame if it isn't already
results = pd.DataFrame()

# Train models for each variation and record results
for i, params in enumerate(variations):
    model, metrics = train_xgboost(X_train, y_train, X_test, y_test, pa

    # Create a DataFrame with the metrics for this variation
    result_row = pd.DataFrame({
        "Variation": [f"Variation {i + 1}"],
        **metrics
    })

    # Concatenate the new row to the results DataFrame
    results = pd.concat([results, result_row], ignore_index=True)
```

In [46]:

```
# Display the comparison table
print("Comparison of XGBoost Model Variations:")
print(results)

# Identify the best model based on Validation RMSE
best_model_index = results["Test RMSE"].idxmin()
best_params = variations[best_model_index]
print(f"\nBest Model Variation: {best_model_index + 1}")
print(f"Hyperparameters: {best_params}")
print(results.iloc[best_model_index])
```

```
Comparison of XGBoost Model Variations:
     Variation    Train RMSE     Test RMSE  Train R^2  Test R^2
0  Variation 1  2.120971e+06  2.909246e+06   0.978047  0.960791

Best Model Variation: 1
Hyperparameters: {'learning_rate': 0.05, 'n_estimators': 200, 'max_de
pth': 6}
Variation       Variation 1
Train RMSE    2120971.173631
Test RMSE     2909245.576456
Train R^2           0.978047
Test R^2            0.960791
Name: 0, dtype: object
```

Explain the model

Feature Importance

In [47]:

```
# Get feature importances directly
feature_importances = model.feature_importances_

# Adjust to take only the first 17 feature importances
feature_importances_adjusted = feature_importances[:len(X.columns)]

# Generate feature importance DataFrame
top_features = pd.DataFrame({'Feature': X.columns, 'Importance': featu
top_10_features = top_features.head(10)

print("Top 10 Features:\n", top_10_features)
```

```
Top 10 Features:
            Feature  Importance
1            title    0.437080
4     publish_time    0.193274
2    channel_title    0.085307
5             tags    0.051353
3      category_id    0.048652
14            rank    0.040345
15        new_text    0.027795
6            likes    0.009272
13           score    0.009106
0    trending_date    0.008889
```

Extracting and Analyzing 5 Individual Predictions

In [48]:

```
import shap
import numpy as np


# Randomly select 5 samples from the test set
random_samples = X_test.sample(5, random_state=42)

explainer = shap.TreeExplainer(model)
shap_values = explainer.shap_values(random_samples)

# Generate and analyze SHAP values for random samples
for i, sample_index in enumerate(random_samples.index):
    print(f"\nExplanation for sample {i+1} (Index: {sample_index}):")

    # Display all columns' information for this prediction
    print("Sample details:")
    display(random_samples.loc[[sample_index]])  # Show the full row de

    # Calculate and display the SHAP force plot for visualization
    shap.initjs()
    shap.force_plot(explainer.expected_value, shap_values[i], random_sa

    # Retrieve SHAP values for the sample and sort by absolute importan
    sample_shap_values = shap_values[i]
    feature_importances = pd.DataFrame({
        'feature': random_samples.columns,
        'shap_value': sample_shap_values
    }).set_index('feature').sort_values(by='shap_value', key=abs, ascen

    # Display the top features that influenced the prediction
    print("Top contributing features:")
    print(feature_importances.head())

    # Suggest changes for flipping the prediction
    current_prediction = model.predict(random_samples.iloc[[i]])[0]
    if current_prediction == 1:
        print(f"To flip from 1 to 0, consider reducing the values of th
    else:
        print(f"To flip from 0 to 1, consider increasing the values of

    # Suggest how to change the feature values
    for feature, shap_value in feature_importances.head().itertuples()
        direction = "increase" if shap_value < 0 else "decrease"
        print(f" - {feature}: Consider a {direction} of {abs(shap_value
```

```
Explanation for sample 1 (Index: 49053):
Sample details:
```

	category_id	likes	dislikes	comment_count	Engagement Metrics	score	rank	trenc
49053	23	2837	86	191	3114	1341.569024	67271.0	

1 rows × 22 columns

Model Deployment, Data Drift and Concept Drift, and Model Monitoring

Serializing the Model with Pickle

In [50]:
```
import pickle

model_filename = 'XGBoost_model.pkl'

# Save the trained model to a file
with open(model_filename, 'wb') as file:
    pickle.dump(model, file)

print(f"Model saved to {model_filename}")
```

```
Model saved to XGBoost_model.pkl
```

In [51]:
```
# Load the model from the file
with open(model_filename, 'rb') as file:
    loaded_model = pickle.load(file)
```

In [52]:
```
predictions = loaded_model.predict(X_test)
```

Save and Load the Data

In [53]:
```
data_filename = 'data.pkl'

# Save datasets to a file
with open(data_filename, 'wb') as file:
    pickle.dump({'X_train': X_train, 'X_test': X_test, 'y_train': y_tra

print(f"Datasets saved to {data_filename}")
```

```
Datasets saved to data.pkl
```

In [54]:

```
# Load datasets from the file
with open(data_filename, 'rb') as file:
    data = pickle.load(file)

# Extract datasets
X_train = data['X_train']
X_test = data['X_test']
y_train = data['y_train']
y_test = data['y_test']
```

In [55]:

```
import platform
import sys
import pkg_resources

# Collect OS and Python version information
print("OS:", platform.system(), platform.version())
print(f"Operating System: {platform.system()} {platform.release()}")
print("Python Version:", sys.version)
```

```
OS: Darwin Darwin Kernel Version 23.3.0: Wed Dec 20 21:28:58 PST 202
3; root:xnu-10002.81.5~7/RELEASE_X86_64
Operating System: Darwin 23.3.0
Python Version: 3.11.5 (main, Sep 11 2023, 08:19:27) [Clang 14.0.6 ]
```

In [56]:

```python
import importlib
import pkg_resources

# List of packages identified from notebook
packages = [
    "matplotlib.pyplot", "nltk", "numpy", "os", "palettable.colorbrewe
    "pandas", "re", "seaborn", "shap", "sklearn.decomposition",
    "sklearn.feature_extraction.text", "sklearn.metrics", "sklearn.mode
    "sklearn.preprocessing", "textblob", "wordcloud", "xgboost", "zipf
]

# Function to get package version
def get_package_version(package):
    try:
        # Handle "matplotlib.pyplot" style imports
        if '.' in package:
            package = package.split('.')[0]
        # Try pkg_resources first
        version = pkg_resources.get_distribution(package).version
    except pkg_resources.DistributionNotFound:
        # If not found, try importlib
        try:
            module = importlib.import_module(package)
            version = getattr(module, '__version__', 'Version not foun
        except ImportError:
            version = 'Not installed'
    return version

# Collect versions
package_versions = {pkg: get_package_version(pkg) for pkg in packages}

# Display package versions
print("Package Versions:")
for pkg, version in package_versions.items():
    print(f"{pkg}: {version}")
```

```
Package Versions:
matplotlib.pyplot: 3.7.2
nltk: 3.8.1
numpy: 1.24.3
os: Version not found
palettable.colorbrewer.qualitative: 3.3.3
pandas: 2.0.3
re: 2.2.1
seaborn: 0.12.2
shap: 0.46.0
sklearn.decomposition: 1.3.0
sklearn.feature_extraction.text: 1.3.0
sklearn.metrics: 1.3.0
sklearn.model_selection: 1.3.0
sklearn.preprocessing: 1.3.0
textblob: 0.18.0.post0
wordcloud: 1.9.3
xgboost: 2.0.3
zipfile: Version not found
```