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import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.cluster import KMeans
from sklearn.decomposition import PCA

# Load the newly provided CSV file
df = pd.read_csv('updated_responses.csv')

# Mapping academic hours to numerical values
hours_mapping = {
    "Less than 10 Hours": 5,
    "10-20 Hours": 15,
    "21-30 Hours": 25,
    "31-40 Hours": 35,
    "41-50 Hours": 45,
    "51-60 Hours": 55,
    "More than 60 Hours": 65
}
df["Academic_Hours"] = df["Academic_Hours"].map(hours_mapping)

# Selecting numerical columns for clustering
numerical_df = df.select_dtypes(include=[np.number]).drop(columns=["Unnamed: 0"], errors='ignore')

# Ensuring no NaN values exist before clustering
numerical_df = numerical_df.fillna(0)

# Finding the optimal number of clusters using the Elbow Method
wcss = []
K_range = range(1, 11)

for k in K_range:
    kmeans = KMeans(n_clusters=k, random_state=42, n_init=10)
    kmeans.fit(numerical_df)
    wcss.append(kmeans.inertia_)

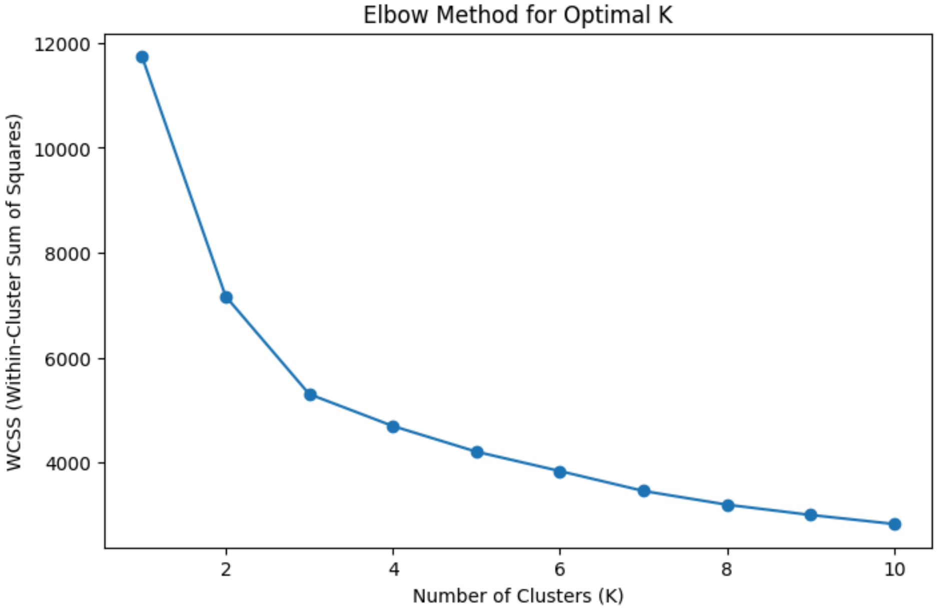
# Plot the Elbow Method
plt.figure(figsize=(8, 5))
plt.plot(K_range, wcss, marker="o", linestyle="-")
plt.xlabel("Number of Clusters (K)")
plt.ylabel("WCSS (Within-Cluster Sum of Squares)")
plt.title("Elbow Method for Optimal K")
plt.show()

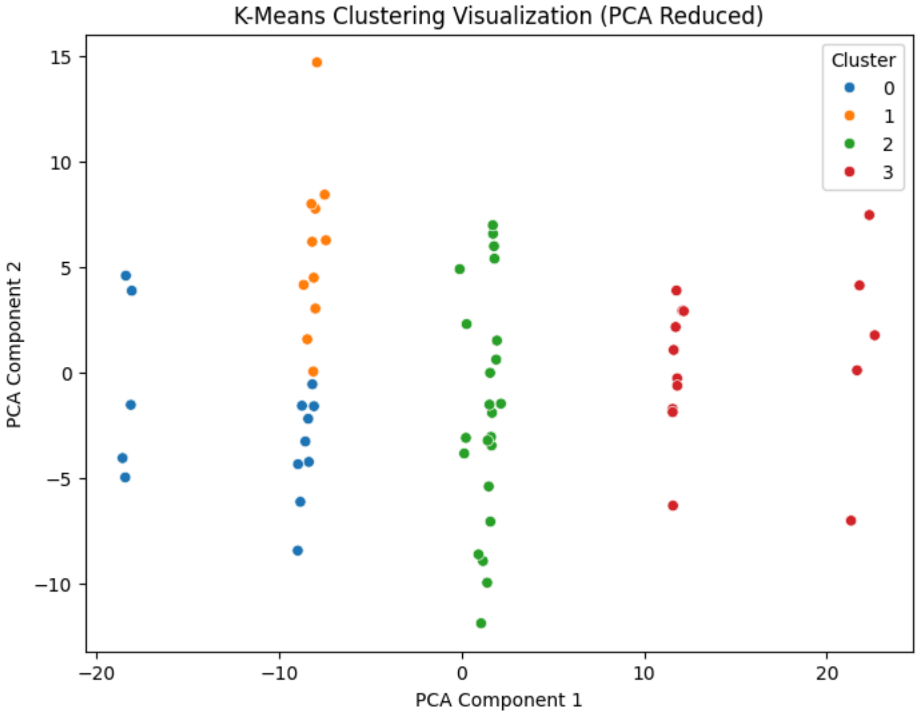
# Applying K-Means clustering with K=4
kmeans = KMeans(n_clusters=4, random_state=42, n_init=10)
numerical_df["Cluster"] = kmeans.fit_predict(numerical_df)

# Reducing dimensions for visualization
pca = PCA(n_components=2, random_state=42)
numerical_df["PCA1"] = pca.fit_transform(numerical_df.drop(columns=["Cluster"]))[:, 0]
numerical_df["PCA2"] = pca.fit_transform(numerical_df.drop(columns=["Cluster"]))[:, 1]

# Scatter plot of clusters
plt.figure(figsize=(8, 6))
sns.scatterplot(x="PCA1", y="PCA2", hue=numerical_df["Cluster"], palette="tab10", data=numerical_df)
plt.title("K-Means Clustering Visualization (PCA Reduced)")
plt.xlabel("PCA Component 1")
plt.ylabel("PCA Component 2")
plt.legend(title="Cluster")
plt.show()

# Summarizing the characteristics of each cluster
cluster_summary = numerical_df.groupby("Cluster").mean()
print("Cluster Summary:")
print(cluster_summary)
```





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Cluster Summary:
               Age      Units  Academic_Hours  Academic_Satisfication  \
Cluster
0        21.071429  13.071429             0.0                6.071429
1        20.818182  17.545455             0.0                4.909091
2        21.652174  14.086957             0.0                6.956522
3        21.400000  15.733333             0.0                6.333333

         Academic_Stress  Job_Club_Satisfaction  Job_Club_Stress  Sleep_Hours  \
Cluster
0               6.571429               6.642857         4.000000     6.714286
1               8.545455               6.636364         6.000000     6.818182
2               7.434783               5.739130         4.913043     7.173913
3               8.266667               6.333333         4.333333     6.533333

         Active_Level  Diet_Level  ...  Excitement_freq  Stress_freq  \
Cluster                            ...
0            5.714286    5.500000  ...         1.928571     2.571429
1            5.272727    5.727273  ...         1.909091     2.727273
2            6.304348    6.826087  ...         2.086957     2.434783
3            4.866667    5.733333  ...         2.066667     2.733333

         Tiredness_Fatigue_freq  Unmotived_freq  Meaningless_freq  \
Cluster
0                      2.500000        2.071429          1.428571
1                      3.000000        2.909091          2.363636
```

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2                      2.478261        2.000000          1.521739
3                      2.666667        2.333333          1.533333

         Helpless_freq  Lonely_freq  Overwhelmed_freq       PCA1      PCA2
Cluster
0             1.214286     1.500000          2.142857 -12.064457 -2.449974
1             2.272727     2.181818          2.727273  -8.072114  5.876547
2             1.434783     1.304348          2.043478   1.319290 -1.695920
3             1.466667     1.533333          2.600000  15.156798  0.577585

[4 rows x 23 columns]
```