In [64]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import scipy.stats as stats
from statsmodels.stats.outliers_influence import variance_inflation_factor
from sklearn.metrics import mean_squared_error
from sklearn.metrics import r2_score
from sklearn.metrics import mean_absolute_error
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score
import warnings
warnings.filterwarnings('ignore')
```

In [65]:

```
df =  pd.read_csv("C:/Users/KahindiE/Documents/student-mat - student-mat.csv")
df.head()
```

Out[65]:

	school	sex	age	address	famsize	Pstatus	Medu	Fedu	Mjob	Fjob	...	famrel	freeti
0	GP	F	18	U	GT3	A	4	4	at_home	teacher	...	4	
1	GP	F	17	U	GT3	T	1	1	at_home	other	...	5	
2	GP	F	15	U	LE3	T	1	1	at_home	other	...	4	
3	GP	F	15	U	GT3	T	4	2	health	services	...	3	
4	GP	F	16	U	GT3	T	3	3	other	other	...	4	

5 rows × 33 columns

In [66]:

```
df.columns
```

Out[66]:

```
Index(['school', 'sex', 'age', 'address', 'famsize', 'Pstatus', 'Medu', 'Fed
u',
       'Mjob', 'Fjob', 'reason', 'guardian', 'traveltime', 'studytime',
       'failures', 'schoolsup', 'famsup', 'paid', 'activities', 'nursery',
       'higher', 'internet', 'romantic', 'famrel', 'freetime', 'goout', 'Dal
c',
       'Walc', 'health', 'absences', 'G1', 'G2', 'G3'],
      dtype='object')
```

In [67]:

```
df.info() # 395 rows and 33 columns
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 395 entries, 0 to 394
Data columns (total 33 columns):
 #   Column      Non-Null Count  Dtype 
---  ------      --------------  ----- 
 0   school      395 non-null    object
 1   sex         395 non-null    object
 2   age         395 non-null    int64 
 3   address     395 non-null    object
 4   famsize     395 non-null    object
 5   Pstatus     395 non-null    object
 6   Medu        395 non-null    int64 
 7   Fedu        395 non-null    int64 
 8   Mjob        395 non-null    object
 9   Fjob        395 non-null    object
 10  reason      395 non-null    object
 11  guardian    395 non-null    object
 12  traveltime  395 non-null    int64 
 13  studytime   395 non-null    int64 
 14  failures    395 non-null    int64 
 15  schoolsup   395 non-null    object
 16  famsup      395 non-null    object
 17  paid        395 non-null    object
 18  activities  395 non-null    object
 19  nursery     395 non-null    object
 20  higher      395 non-null    object
 21  internet    395 non-null    object
 22  romantic    395 non-null    object
 23  famrel      395 non-null    int64 
 24  freetime    395 non-null    int64 
 25  goout       395 non-null    int64 
 26  Dalc        395 non-null    int64 
 27  Walc        395 non-null    int64 
 28  health      395 non-null    int64 
 29  absences    395 non-null    int64 
 30  G1          395 non-null    int64 
 31  G2          395 non-null    int64 
 32  G3          395 non-null    int64 
dtypes: int64(16), object(17)
memory usage: 102.0+ KB
```

In [68]:

```
df.shape
```

Out[68]:

```
(395, 33)
```

In [69]:
```
df.describe() # 395 rows and 33 columns
```

Out[69]:

	age	Medu	Fedu	traveltime	studytime	failures	famrel	fr
count	395.000000	395.000000	395.000000	395.000000	395.000000	395.000000	395.000000	395.
mean	16.696203	2.749367	2.521519	1.448101	2.035443	0.334177	3.944304	3.2
std	1.276043	1.094735	1.088201	0.697505	0.839240	0.743651	0.896659	0.9
min	15.000000	0.000000	0.000000	1.000000	1.000000	0.000000	1.000000	1.
25%	16.000000	2.000000	2.000000	1.000000	1.000000	0.000000	4.000000	3.
50%	17.000000	3.000000	2.000000	1.000000	2.000000	0.000000	4.000000	3.
75%	18.000000	4.000000	3.000000	2.000000	2.000000	0.000000	5.000000	4.
max	22.000000	4.000000	4.000000	4.000000	4.000000	3.000000	5.000000	5.

In [70]:
```
df.isnull().sum() # 0 null values
```

Out[70]:
```
school        0
sex           0
age           0
address       0
famsize       0
Pstatus       0
Medu          0
Fedu          0
Mjob          0
Fjob          0
reason        0
guardian      0
traveltime    0
studytime     0
failures      0
schoolsup     0
famsup        0
paid          0
activities    0
nursery       0
higher        0
internet      0
romantic      0
famrel        0
freetime      0
goout         0
Dalc          0
Walc          0
health        0
absences      0
G1            0
G2            0
G3            0
dtype: int64
```

In [71]:
```
#duplicates
df.duplicated().sum()
```

Out[71]:
```
0
```

In [72]:
```
df.duplicated()
```

Out[72]:
```
0      False
1      False
2      False
3      False
4      False
       ...
390    False
391    False
392    False
393    False
394    False
Length: 395, dtype: bool
```

In [73]:
```
#1.select column Medu - mother's education (numeric: 0 - none, 1 - primary educ
df['Medu'] # 0, 1, 2, 3, 4
```

Out[73]:
```
0      4
1      1
2      1
3      4
4      3
      ..
390    2
391    3
392    1
393    3
394    1
Name: Medu, Length: 395, dtype: int64
```

In [74]:
```
#2. Fedu - father's education (numeric: 0 - none, 1 - primary education (4th gr
df['Fedu'] # 0, 1, 2, 3, 4
```

Out[74]:
```
0      4
1      1
2      1
3      2
4      3
      ..
390    2
391    1
392    1
393    2
394    1
Name: Fedu, Length: 395, dtype: int64
```

In [75]:
```
#3. famrel - quality of family relationships (numeric: from 1 - very bad to 5 -
df['famrel'] # 1, 2, 3, 4, 5
```

Out[75]:
```
0      4
1      5
2      4
3      3
4      4
      ..
390    5
391    2
392    5
393    4
394    3
Name: famrel, Length: 395, dtype: int64
```

In [76]:
```
#4. freetime - free time after school (numeric: from 1 - very low to 5 - very h
df['freetime']
```

Out[76]:
```
0      3
1      3
2      3
3      2
4      3
      ..
390    5
391    4
392    5
393    4
394    2
Name: freetime, Length: 395, dtype: int64
```

In [77]:
```
#5. goout - going out with friends (numeric: from 1 - very low to 5 - very high
df['goout']
```

Out[77]:
```
0      4
1      3
2      2
3      2
4      2
      ..
390    4
391    5
392    3
393    1
394    3
Name: goout, Length: 395, dtype: int64
```

In [78]:

```
#6. Dalc - workday alcohol consumption (numeric: from 1 - very low to 5 - very
df['Dalc'] # 1, 2, 3, 4, 5
```

Out[78]:

```
0      1
1      1
2      2
3      1
4      1
      ..
390    4
391    3
392    3
393    3
394    3
Name: Dalc, Length: 395, dtype: int64
```

In [79]:

```
#7. Walc - weekend alcohol consumption (numeric: from 1 - very low to 5 - very
df['Walc']
```

Out[79]:

```
0      1
1      1
2      3
3      1
4      2
      ..
390    5
391    4
392    3
393    4
394    3
Name: Walc, Length: 395, dtype: int64
```

In [80]:

```
#8. health - current health status (numeric: from 1 - very bad to 5 - very good
df['health'] # 1, 2, 3, 4, 5
```

Out[80]:

```
0      3
1      3
2      3
3      5
4      5
      ..
390    4
391    2
392    3
393    5
394    5
Name: health, Length: 395, dtype: int64
```

In [81]:

```
#9. absences - number of school absences (numeric: from 0 to 93)
df['absences']
```

Out[81]:

```
0       6
1       4
2      10
3       2
4       4
       ..
390    11
391     3
392     3
393     0
394     5
Name: absences, Length: 395, dtype: int64
```

In [82]:

```
#10. G3 - final grade (numeric: from 0 to 20, output target)
df['G3'] # 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19
```

Out[82]:

```
0       6
1       6
2      10
3      15
4      10
       ..
390     9
391    16
392     7
393    10
394     9
Name: G3, Length: 395, dtype: int64
```

In [83]:

```
#handing missing values
df.isnull().sum() # 0 null values
```

Out[83]:

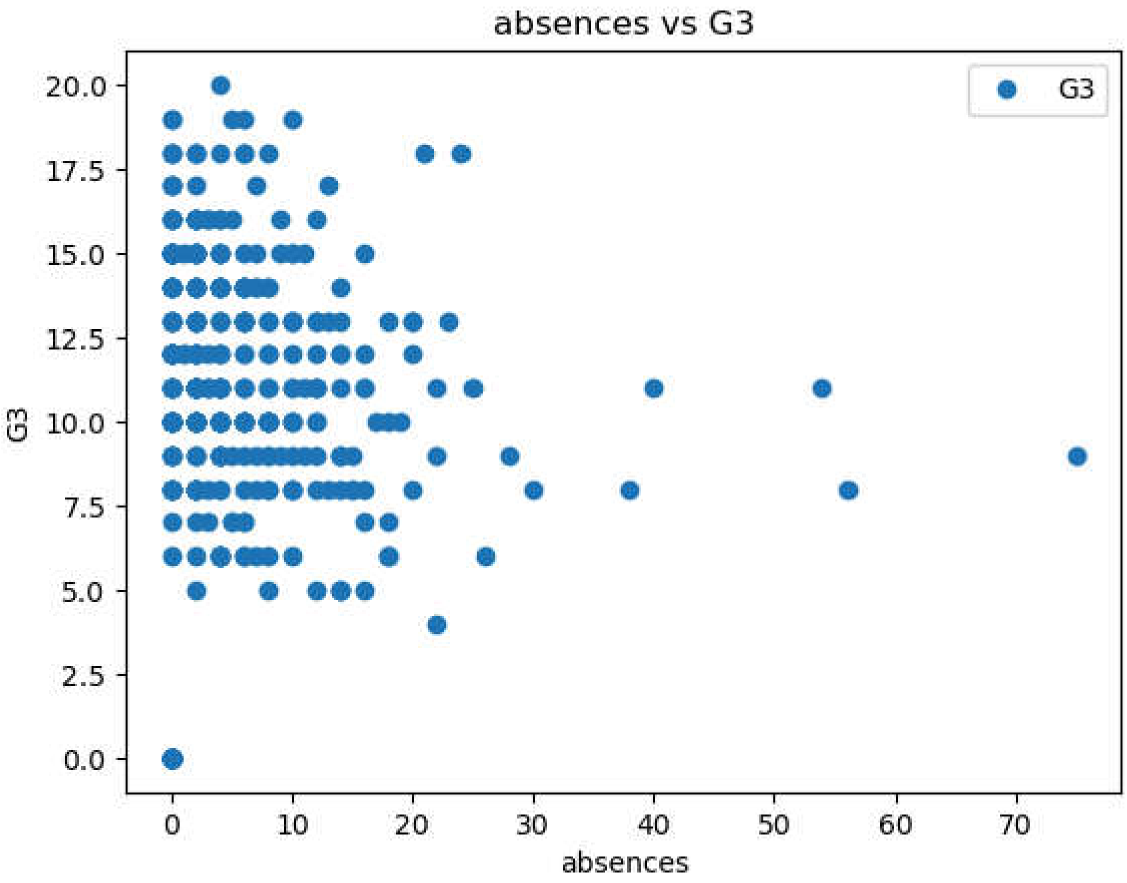
```
school        0
sex           0
age           0
address       0
famsize       0
Pstatus       0
Medu          0
Fedu          0
Mjob          0
Fjob          0
reason        0
guardian      0
traveltime    0
studytime     0
failures      0
schoolsup     0
famsup        0
paid          0
activities    0
nursery       0
higher        0
internet      0
romantic      0
famrel        0
freetime      0
goout         0
Dalc          0
Walc          0
health        0
absences      0
G1            0
G2            0
G3            0
dtype: int64
```

In [101]:

```
#scatter plot
df.plot(x='absences', y='G3', style='o')
plt.title('absences vs G3')
plt.xlabel('absences')
plt.ylabel('G3')
```

Out[101]:

```
Text(0, 0.5, 'G3')
```



In [96]:

```
# Carry out multiple linear regression analysis to predict G3 - final grade (ou
# 1. Select the independent variables (X) and the dependent variable (y)
import statsmodels.api as sm
X = df[['Medu', 'Fedu', 'famrel', 'freetime', 'goout', 'Dalc', 'Walc', 'health'
y = df['G3'] # dependent variable
X= sm.add_constant(X)  # adding a constant
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random
```

In [85]:

```
# 2. Create an instance of the LinearRegression model
model = sm.OLS(y, X).fit()  # Ordinary Least Squares
model.summary()  # Summary of the model
```

Out[85]:

OLS Regression Results

Dep. Variable:	G3	**R-squared:**	0.083
Model:	OLS	**Adj. R-squared:**	0.062
Method:	Least Squares	**F-statistic:**	3.870
Date:	Tue, 11 Jun 2024	**Prob (F-statistic):**	0.000103
Time:	15:54:50	**Log-Likelihood:**	-1144.1
No. Observations:	395	**AIC:**	2308.
Df Residuals:	385	**BIC:**	2348.
Df Model:	9		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
const	8.4165	1.474	5.711	0.000	5.519	11.314

In [86]:

```
# Evaluating the model
y_pred = model.predict(X_test) # Predicted values
print('Mean Squared Error:', mean_squared_error(y_test, y_pred))
print('Mean Absolute Error:', mean_absolute_error(y_test, y_pred))
print('Root Mean Squared Error:', np.sqrt(mean_squared_error(y_test, y_pred)))
print('R-squared:', r2_score(y_test, y_pred))
print('Adjusted R-squared:', 1 - (1-r2_score(y_test, y_pred))*(len(y)-1)/(len(y
```

```
Mean Squared Error: 19.402058229506007
Mean Absolute Error: 3.4955840535276566
Root Mean Squared Error: 4.404776751380938
R-squared: 0.11736865350403947
Adjusted R-squared: 0.09438346218904048
```

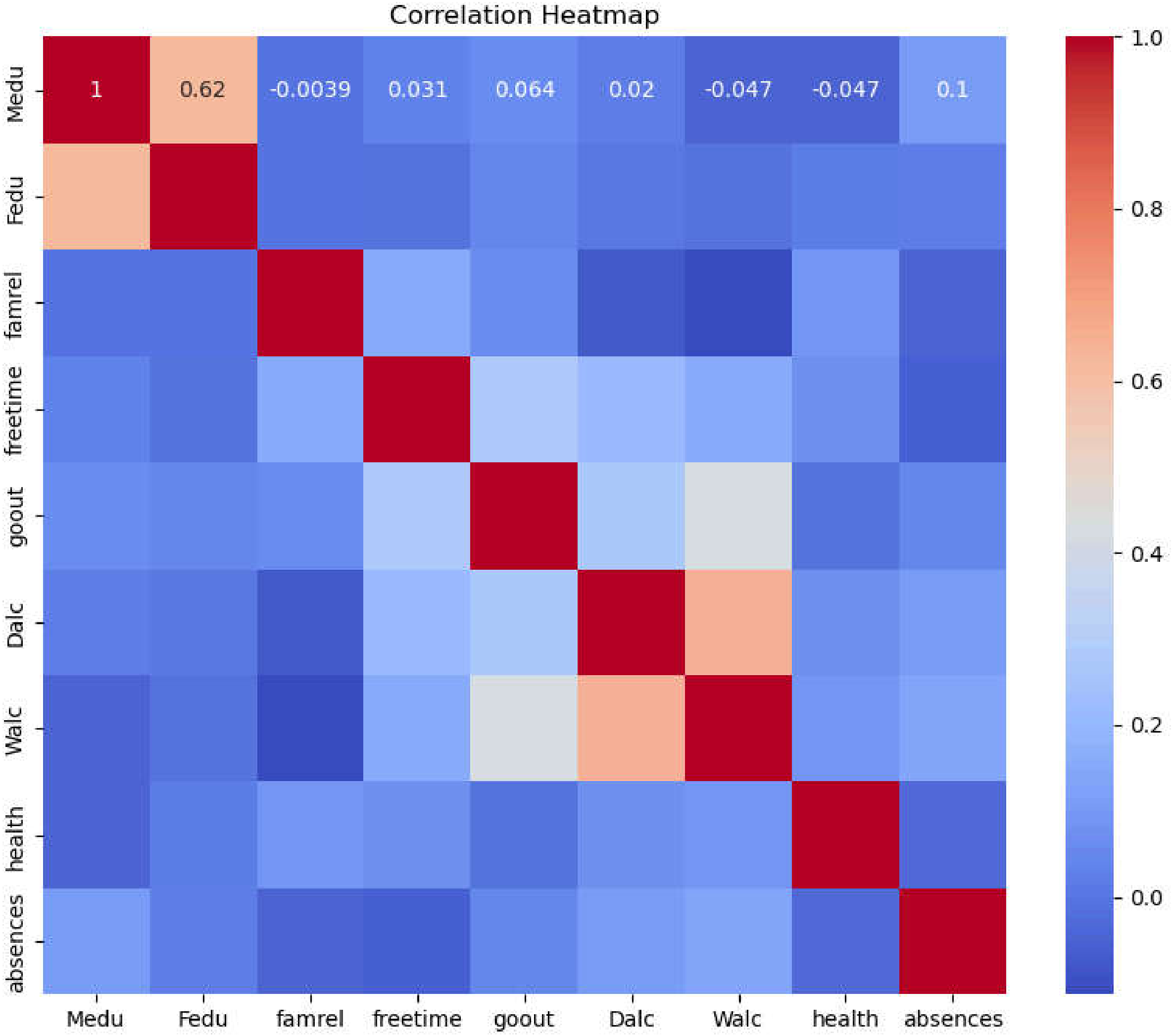
In [87]:

```
#define cleaned_df dataframe
cleaned_df = df[['Medu', 'Fedu', 'famrel', 'freetime', 'goout', 'Dalc', 'Walc',
cleaned_df.head()
```

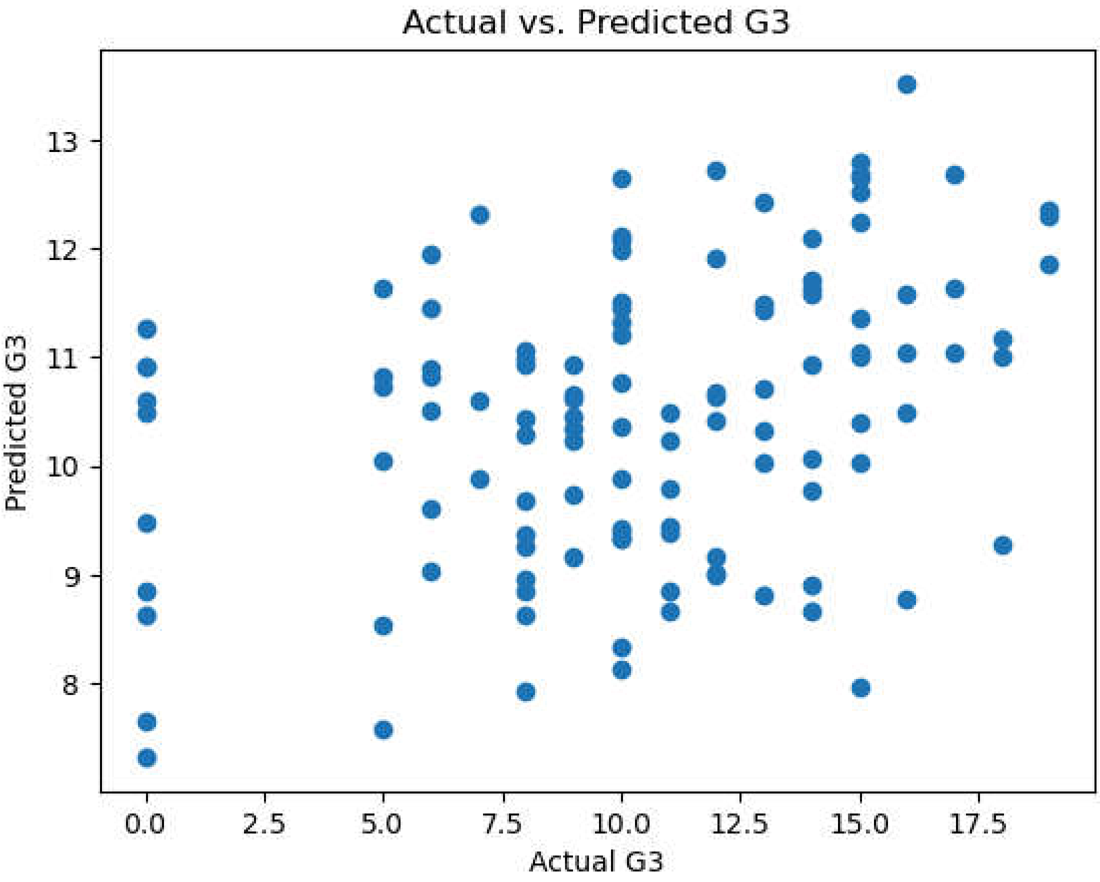
Out[87]:

	Medu	**Fedu**	**famrel**	**freetime**	**goout**	**Dalc**	**Walc**	**health**	**absences**
0	4	4	4	3	4	1	1	3	6
1	1	1	5	3	3	1	1	3	4
2	1	1	4	3	2	2	3	3	10
3	4	2	3	2	2	1	1	5	2
4	3	3	4	3	2	1	2	5	4

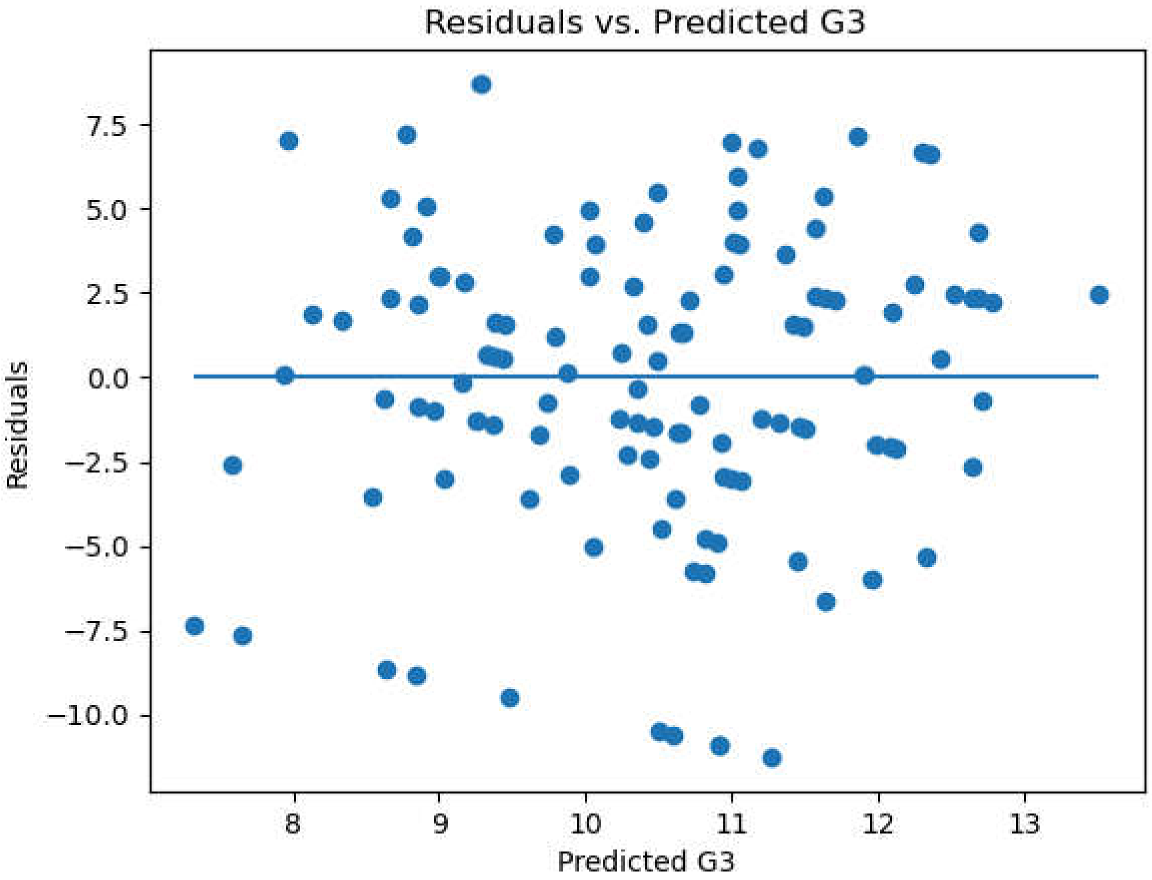
In [88]:
```
#vizualization with heatmap
plt.figure(figsize=(10, 8))
sns.heatmap(cleaned_df.corr(), annot=True, cmap='coolwarm')
plt.title('Correlation Heatmap')
plt.show()
```



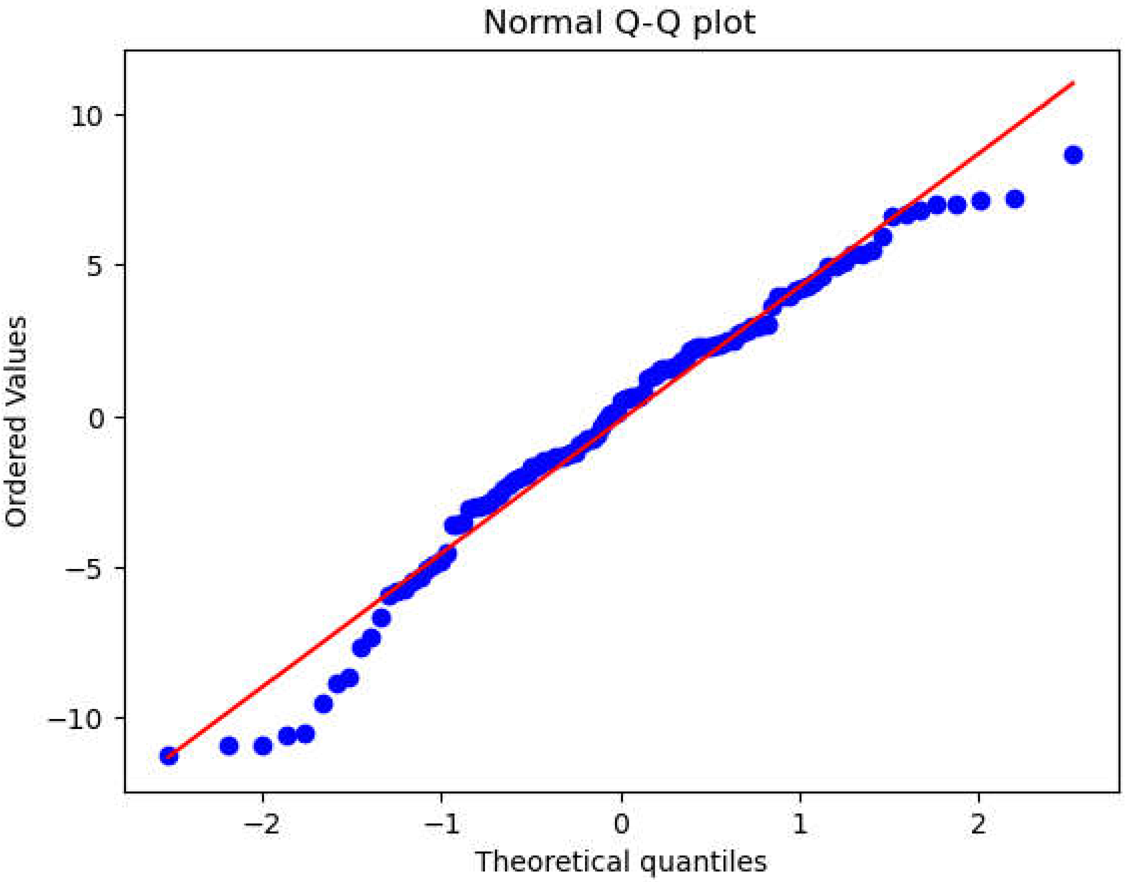
In [89]:
```
#Test whether all the multiple linear regression assumptions are met.
plt.scatter(y_test, y_pred)
plt.xlabel('Actual G3')
plt.ylabel('Predicted G3')
plt.title('Actual vs. Predicted G3')
plt.show()
```



```
In [90]: #2. Homoscedasticity
         plt.scatter(y_pred, y_test - y_pred)
         plt.hlines(y=0, xmin=y_pred.min(), xmax=y_pred.max())
         plt.xlabel('Predicted G3')
         plt.ylabel('Residuals')
         plt.title('Residuals vs. Predicted G3')
         plt.show()
```



In [91]:
```
#3. Normality
import scipy.stats as stats  # Importing the stats module from the scipy librar
residuals = y_test - y_pred  # Calculating the residuals
stats.probplot(residuals, dist="norm", plot=plt)  # Plotting the normal probabi
plt.title("Normal Q-Q plot")
plt.show()
```



In [92]:
```
#4. Multicollinearity
vif = [variance_inflation_factor(X.values, i) for i in range(X.shape[1])]  # Ca
pd.DataFrame({'VIF': vif}, index=X.columns)  # VIF values for each independent
```

Out[92]:

	VIF
const	43.554418
Medu	1.691386
Fedu	1.651711
famrel	1.063832
freetime	1.156675
goout	1.325336
Dalc	1.778884
Walc	2.033048
health	1.034931
absences	1.044119

In [93]:

```
#Thanks finally I reached the end of the Assigment.
```