Analysis

1. Import the Datasets

In [1]:
```python
# This cell imports the standard pandas library, numpy library, matplotli

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import chardet
```

In [2]:
```
!ls data
```

```
countries.geojson    population_density.csv   world_bank_education_data.csv
happiness_2023.xls   wcvp
```

First, look at the general characteristics of the data

Happiness_2023

In [3]:
```
!head -5 data/happiness_2023.xls
```

```
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 ???�_-;_-* "    ����-@_-      ???�          ???�          ???�
```

Check the file using Microsoft Excel.

head:

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tail:

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In [4]:
```python
excel_file = 'data/happiness_2023.xls'
```

```
In [5]: # Check encoding
        chardet.detect(open(excel_file,'rb').read())
```

```
Out[5]: {'encoding': 'Windows-1254',
         'confidence': 0.33766601783790756,
         'language': 'Turkish'}
```

happiness_2023 file:

- 138 rows with headings
- encoding: Windows-1254

World Bank Education

```
In [6]: !head -5 data/world_bank_education_data.csv
```

```
In [7]: !tail -5 data/world_bank_education_data.csv
```

```
In [8]: !wc -l data/world_bank_education_data.csv
```

```
2610 data/world_bank_education_data.csv
```

```
In [9]: bank_education = 'data/world_bank_education_data.csv'
```

```
In [10]: # Check encoding
         chardet.detect(open(bank_education,'rb').read())
```

```
Out[10]: {'encoding': 'Windows-1252', 'confidence': 0.73, 'language': ''}
```

world_bank_education_data file:

- 2609 rows with headings (there may be potentially missing values towards the end of the rows.)
- encoding: Windows-1252

Import the data

```
In [11]: happiness_df = pd.read_excel(excel_file)
         happiness_df.head()
```

Out[11]:

	Country name	Ladder score	Standard error of ladder score	upperwhisker	lowerwhisker	Logged GDP per capita	Soci
0	Finland	7.8042	0.036162	7.875078	7.733322	10.792010	0.96877
1	Denmark	7.5864	0.041028	7.666815	7.505985	10.962164	0.95411
2	Iceland	7.5296	0.048612	7.624879	7.434321	10.895531	0.98253
3	Israel	7.4729	0.031609	7.534853	7.410946	10.638705	0.94334
4	Netherlands	7.4030	0.029294	7.460416	7.345583	10.942279	0.93049

In [12]:
```
happiness_df.tail()
```

Out[12]:

	Country name	Ladder score	Standard error of ladder score	upperwhisker	lowerwhisker	Logged GDP per capita	Soc
132	Congo (Kinshasa)	3.2072	0.095369	3.394124	3.020277	7.006671	0.6516
133	Zimbabwe	3.2035	0.060865	3.322795	3.084205	7.640998	0.6899
134	Sierra Leone	3.1376	0.082441	3.299184	2.976016	7.394014	0.5552
135	Lebanon	2.3922	0.044495	2.479410	2.304990	9.477677	0.5297
136	Afghanistan	1.8590	0.032506	1.922712	1.795288	7.324032	0.3413

In [13]:
```
happiness_df.shape
```

Out[13]:
```
(137, 19)
```

happiness_df has data with 136 rows and 19 columns

In [14]:
```
# World bank education
wbe = pd.read_csv(bank_education, encoding='Windows-1252')
wbe.head()
```

Out[14]:

	Country Name	Country Code	Series	Series Code	2010 [YR2010]	2011 [YR2011]	[YR
0	Afghanistan	AFG	Proportion of 15-24 year-olds enrolled in voca...	UIS.EV1524P.2T5.V	..	..	
1	Afghanistan	AFG	Proportion of 15-24 year-olds enrolled in voca...	UIS.EV1524P.2T5.V.M	..	..	
2	Afghanistan	AFG	Proportion of 15-24 year-olds enrolled in voca...	UIS.EV1524P.2T5.V.F	..	..	
3	Afghanistan	AFG	Government expenditure on primary education as...	UIS.XGDP.1.FSGOV	2.16201	2.14557	1.
4	Afghanistan	AFG	Government expenditure on education as % of GD...	SE.XPD.TOTL.GD.ZS	3.47945	3.46201	2

In [15]:
```
wbe.tail()
```

Out[15]:

	Country Name	Country Code	Series	Series Code	2010 [YR2010]	2011 [YR2011]	2012 [YR2012]	20 [YR201
2604	NaN	NaN	NaN	NaN	NaN	NaN	NaN	N
2605	NaN	NaN	NaN	NaN	NaN	NaN	NaN	N
2606	NaN	NaN	NaN	NaN	NaN	NaN	NaN	N
2607	Data from database: Education Statistics - All...	NaN	NaN	NaN	NaN	NaN	NaN	N
2608	Last Updated: 12/20/2020	NaN	NaN	NaN	NaN	NaN	NaN	N

In [16]:
```
wbe.shape
```

Out[16]:
```
(2609, 14)
```

The dataset 'wbe' contains 2609 rows and 14 columns, including headers. However, there are many null values at the end of the dataset. Therefore, it requires cleaning.

2. Clean and Reshape the Data

First, clean the data of happiness_df and reshape it.

In [17]:
```
# happiness_df
happiness_df.isnull().sum()
```

Out[17]:
```
Country name                                  0
Ladder score                                  0
Standard error of ladder score                0
upperwhisker                                  0
lowerwhisker                                  0
Logged GDP per capita                         0
Social support                                0
Healthy life expectancy                       1
Freedom to make life choices                  0
Generosity                                    0
Perceptions of corruption                     0
Ladder score in Dystopia                      0
Explained by: Log GDP per capita              0
Explained by: Social support                  0
Explained by: Healthy life expectancy         1
Explained by: Freedom to make life choices    0
Explained by: Generosity                      0
Explained by: Perceptions of corruption       0
Dystopia + residual                           1
dtype: int64
```

Although there are some null values, considering the task, only the columns 'Country name' and 'Ladder score' might be used, and there seems to be no need to remove null values.

In [18]:
```
# Check types
happiness_df.dtypes
```

Out[18]:
```
Country name                                   object
Ladder score                                  float64
Standard error of ladder score                float64
upperwhisker                                  float64
lowerwhisker                                  float64
Logged GDP per capita                         float64
Social support                                float64
Healthy life expectancy                       float64
Freedom to make life choices                  float64
Generosity                                    float64
Perceptions of corruption                     float64
Ladder score in Dystopia                      float64
Explained by: Log GDP per capita              float64
Explained by: Social support                  float64
Explained by: Healthy life expectancy         float64
Explained by: Freedom to make life choices    float64
Explained by: Generosity                      float64
Explained by: Perceptions of corruption       float64
Dystopia + residual                           float64
dtype: object
```

```
In [19]: # Further check
         happiness_df.nunique()
```

```
Out[19]: Country name                                  137
         Ladder score                                  137
         Standard error of ladder score                137
         upperwhisker                                  137
         lowerwhisker                                  137
         Logged GDP per capita                         137
         Social support                                137
         Healthy life expectancy                       136
         Freedom to make life choices                  137
         Generosity                                    137
         Perceptions of corruption                     137
         Ladder score in Dystopia                        1
         Explained by: Log GDP per capita              137
         Explained by: Social support                  137
         Explained by: Healthy life expectancy         136
         Explained by: Freedom to make life choices    137
         Explained by: Generosity                      137
         Explained by: Perceptions of corruption       137
         Dystopia + residual                           136
         dtype: int64
```

```
In [20]: # Check the country names
         happiness_df['Country name'].unique()
```

```
Out[20]: array(['Finland', 'Denmark', 'Iceland', 'Israel', 'Netherlands', 'Swede
         n',
                'Norway', 'Switzerland', 'Luxembourg', 'New Zealand', 'Austria',
                'Australia', 'Canada', 'Ireland', 'United States', 'Germany',
                'Belgium', 'Czechia', 'United Kingdom', 'Lithuania', 'France',
                'Slovenia', 'Costa Rica', 'Romania', 'Singapore',
                'United Arab Emirates', 'Taiwan Province of China', 'Uruguay',
                'Slovakia', 'Saudi Arabia', 'Estonia', 'Spain', 'Italy', 'Kosov
         o',
                'Chile', 'Mexico', 'Malta', 'Panama', 'Poland', 'Nicaragua',
                'Latvia', 'Bahrain', 'Guatemala', 'Kazakhstan', 'Serbia', 'Cypru
         s',
                'Japan', 'Croatia', 'Brazil', 'El Salvador', 'Hungary',
                'Argentina', 'Honduras', 'Uzbekistan', 'Malaysia', 'Portugal',
                'South Korea', 'Greece', 'Mauritius', 'Thailand', 'Mongolia',
                'Kyrgyzstan', 'Moldova', 'China', 'Vietnam', 'Paraguay',
                'Montenegro', 'Jamaica', 'Bolivia', 'Russia',
                'Bosnia and Herzegovina', 'Colombia', 'Dominican Republic',
                'Ecuador', 'Peru', 'Philippines', 'Bulgaria', 'Nepal', 'Armenia',
                'Tajikistan', 'Algeria', 'Hong Kong S.A.R. of China', 'Albania',
                'Indonesia', 'South Africa', 'Congo (Brazzaville)',
                'North Macedonia', 'Venezuela', 'Laos', 'Georgia', 'Guinea',
                'Ukraine', 'Ivory Coast', 'Gabon', 'Nigeria', 'Cameroon',
                'Mozambique', 'Iraq', 'State of Palestine', 'Morocco', 'Iran',
                'Senegal', 'Mauritania', 'Burkina Faso', 'Namibia', 'Turkiye',
                'Ghana', 'Pakistan', 'Niger', 'Tunisia', 'Kenya', 'Sri Lanka',
                'Uganda', 'Chad', 'Cambodia', 'Benin', 'Myanmar', 'Bangladesh',
                'Gambia', 'Mali', 'Egypt', 'Togo', 'Jordan', 'Ethiopia', 'Liberi
         a',
                'India', 'Madagascar', 'Zambia', 'Tanzania', 'Comoros', 'Malawi',
                'Botswana', 'Congo (Kinshasa)', 'Zimbabwe', 'Sierra Leone',
                'Lebanon', 'Afghanistan'], dtype=object)
```

Potentially, when concatenating the data of 'happiness_df' and the data of 'wbe', some countries such as Congo (Kinshasa) and Hong Kong S.A.R. of China, might have errors during the combination due to variations in naming countries.

In [21]:
```
happiness_df['Ladder score'].describe()
```

Out[21]:
```
count    137.000000
mean       5.539755
std        1.139908
min        1.859000
25%        4.723900
50%        5.684300
75%        6.333800
max        7.804200
Name: Ladder score, dtype: float64
```

The ladder scores are widely distributed, ranging from 1.85 to 7.80.

Now, select only necessary columns.

In [22]:
```
selected_happiness_df = happiness_df[['Country name', 'Ladder score']]
selected_happiness_df.head(2)
```

Out[22]:

	Country name	Ladder score
0	Finland	7.8042
1	Denmark	7.5864

The values of 'Ladder score' changed to two decimal places, and the column names are also changed.

In [23]:
```
# Rename columns
selected_happiness_df = selected_happiness_df.rename(columns={'Country na

# Round 'Ladder score' to two decimal places
selected_happiness_df['Happiness index'] = selected_happiness_df['Happine


selected_happiness_df.head(2)
```

Out[23]:

	Country	Happiness index
0	Finland	7.80
1	Denmark	7.59

Next, clean the data of wbe and reshape it.

In [24]:
```
#wbe
wbe.isnull().sum()
```

```
Out[24]: Country Name      3
         Country Code      5
         Series            5
         Series Code       5
         2010 [YR2010]     5
         2011 [YR2011]     5
         2012 [YR2012]     5
         2013 [YR2013]     5
         2014 [YR2014]     5
         2015 [YR2015]     5
         2016 [YR2016]     5
         2017 [YR2017]     5
         2018 [YR2018]     5
         2019 [YR2019]     5
         dtype: int64
```

```
In [25]: # Identify the null values
         wbe.tail(10)
```

Out[25]:

	Country Name	Country Code	Series	Series Code	2010 [YR2010]	2011 [YR2011]
2599	Zimbabwe	ZWE	Government expenditure on upper secondary educ...	UIS.XGDP.3.FSGOV	..	.
2600	Zimbabwe	ZWE	Government expenditure on lower secondary educ...	UIS.XGDP.2.FSGOV	..	.
2601	Zimbabwe	ZWE	Government expenditure on pre-primary educatio...	UIS.XGDP.0.FSGOV	..	.
2602	Zimbabwe	ZWE	Government expenditure on secondary and post-s...	UIS.XGDP.2T4.V.FSGOV	..	.
2603	Zimbabwe	ZWE	Government expenditure on tertiary education a...	UIS.XGDP.56.FSGOV	0.35228	.
2604	NaN	NaN	NaN	NaN	NaN	Na
2605	NaN	NaN	NaN	NaN	NaN	Na
2606	NaN	NaN	NaN	NaN	NaN	Na
2607	Data from database: Education Statistics - All...	NaN	NaN	NaN	NaN	Na
2608	Last Updated: 12/20/2020	NaN	NaN	NaN	NaN	Na

Null values and unnecessary data have been removed from the last 5 rows of the DataFrame.

In [26]:
```
wbe2 = wbe.dropna(inplace=False)

display(wbe2.isnull().sum())
display(wbe2.tail(2))
```

```
Country Name      0
Country Code      0
Series            0
Series Code       0
2010 [YR2010]     0
2011 [YR2011]     0
2012 [YR2012]     0
2013 [YR2013]     0
2014 [YR2014]     0
2015 [YR2015]     0
2016 [YR2016]     0
2017 [YR2017]     0
2018 [YR2018]     0
2019 [YR2019]     0
dtype: int64
```

	Country Name	Country Code	Series	Series Code	2010 [YR2010]	2011 [YR2011]
2602	Zimbabwe	ZWE	Government expenditure on secondary and post-s...	UIS.XGDP.2T4.V.FSGOV	..	..
2603	Zimbabwe	ZWE	Government expenditure on tertiary education a...	UIS.XGDP.56.FSGOV	0.35228	..

In [27]:
```
# Check types
wbe2.dtypes
```

Out[27]:
```
Country Name      object
Country Code      object
Series            object
Series Code       object
2010 [YR2010]     object
2011 [YR2011]     object
2012 [YR2012]     object
2013 [YR2013]     object
2014 [YR2014]     object
2015 [YR2015]     object
2016 [YR2016]     object
2017 [YR2017]     object
2018 [YR2018]     object
2019 [YR2019]     object
dtype: object
```

The type of each year needs to be changed. For now, the data types are retained, and the data check is continued.

In [28]:
```
# Look at the contents of 'Series'
wbe2['Series'].unique()
```

```
Out[28]: array(['Proportion of 15-24 year-olds enrolled in vocational education,
both sexes (%)',
       'Proportion of 15-24 year-olds enrolled in vocational education,
male (%)',
       'Proportion of 15-24 year-olds enrolled in vocational education,
female (%)',
       'Government expenditure on primary education as % of GDP (%)',
       'Government expenditure on education as % of GDP (%)',
       'Government expenditure on post-secondary non-tertiary education
as % of GDP (%)',
       'Government expenditure on secondary education as % of GDP (%)',
       'Government expenditure on upper secondary education as a percent
age of GDP (%)',
       'Government expenditure on lower secondary education as a percent
age of GDP (%)',
       'Government expenditure on pre-primary education as % of GDP
(%)',
       'Government expenditure on secondary and post-secondary non-terti
ary vocational education as % of GDP (%)',
       'Government expenditure on tertiary education as % of GDP (%)'],
      dtype=object)
```

To execute the task, 'Government expenditure on education as % of GDP (%)' and 'Government expenditure on tertiary education as % of GDP (%)' from the 'Series' should be chosen.

Government expenditure on education as % of GDP (%)

```
In [29]: # Collect the data whose column:Series has 'Government expenditure on edu
education = wbe2[wbe2['Series'] == 'Government expenditure on education a
education.head()
```

Out[29]:

	Country Name	Country Code	Series	Series Code	2010 [YR2010]	2011 [YR2011]	[YI
4	Afghanistan	AFG	Government expenditure on education as % of GD...	SE.XPD.TOTL.GD.ZS	3.47945	3.46201	
16	Albania	ALB	Government expenditure on education as % of GD...	SE.XPD.TOTL.GD.ZS	..	..	
28	Algeria	DZA	Government expenditure on education as % of GD...	SE.XPD.TOTL.GD.ZS	..	..	
40	American Samoa	ASM	Government expenditure on education as % of GD...	SE.XPD.TOTL.GD.ZS	..	..	
52	Andorra	AND	Government expenditure on education as % of GD...	SE.XPD.TOTL.GD.ZS	2.97663	2.98706	

In [30]:

```
# Check the values
education.nunique()
```

Out[30]:

```
Country Name      217
Country Code      217
Series              1
Series Code         1
2010 [YR2010]     125
2011 [YR2011]     119
2012 [YR2012]     111
2013 [YR2013]     121
2014 [YR2014]     116
2015 [YR2015]     110
2016 [YR2016]     110
2017 [YR2017]     118
2018 [YR2018]      64
2019 [YR2019]      17
dtype: int64
```

Each column for the years has the value '..,' and the column for 2010 has the most number of values.

Government expenditure on tertiary education as % of GDP (%)

In [31]:
```
# Collect the data whose column:Series has  'Government expenditure on te
tertiary = wbe2[wbe2['Series'] == 'Government expenditure on tertiary edu
tertiary.head()
```

Out[31]:

	Country Name	Country Code	Series	Series Code	2010 [YR2010]	2011 [YR2011]	[Y
11	Afghanistan	AFG	Government expenditure on tertiary education a...	UIS.XGDP.56.FSGOV	0.31427	0.3111	(
23	Albania	ALB	Government expenditure on tertiary education a...	UIS.XGDP.56.FSGOV	..	..	
35	Algeria	DZA	Government expenditure on tertiary education a...	UIS.XGDP.56.FSGOV	..	..	
47	American Samoa	ASM	Government expenditure on tertiary education a...	UIS.XGDP.56.FSGOV	..	..	
59	Andorra	AND	Government expenditure on tertiary education a...	UIS.XGDP.56.FSGOV	0.11494	0.11472	

In [32]:
```
# Check the values
tertiary.nunique()
```

Out[32]:
```
Country Name      217
Country Code      217
Series              1
Series Code         1
2010 [YR2010]     113
2011 [YR2011]     107
2012 [YR2012]     103
2013 [YR2013]     115
2014 [YR2014]      99
2015 [YR2015]      94
2016 [YR2016]      90
2017 [YR2017]      87
2018 [YR2018]      36
2019 [YR2019]      17
dtype: int64
```

Each column for the years of the DataFrame: tertiary also has the value '..,' and the column for 2013 has the most number of values.

While the data in the World Happiness Report is from the 2023 version, 'world_bank_education' does not contain data for the 2023 version. Additionally, for each year in 'world_bank_education,' values are not distributed to all countries, and each column for the years contains null values. Therefore, the average for the 10 years is calculated for 'Government expenditure on education as a percentage of GDP (%)' and 'Government expenditure on tertiary education as a percentage of GDP (%).'

Government expenditure on education as a percentage of GDP (%)

In [33]:
```
#'Government expenditure on education as a percentage of GDP (%)'

#Remove unnecessary columns
columns_to_drop = ['Country Code', 'Series', 'Series Code']
education_2 = education.drop(columns=columns_to_drop, axis=1)

# replace the values: '..' into null values
education_2.replace('..', np.nan, inplace=True)

# Convert multiple columns to float64
years_columns = ['2010 [YR2010]', '2011 [YR2011]', '2012 [YR2012]', '2013
       '2014 [YR2014]', '2015 [YR2015]', '2016 [YR2016]', '2017 [YR2017]'
       '2018 [YR2018]', '2019 [YR2019]']
education_2[years_columns] = education_2[years_columns].astype(float)

education_2.head()
```

Out[33]:

	Country Name	2010 [YR2010]	2011 [YR2011]	2012 [YR2012]	2013 [YR2013]	2014 [YR2014]	2015 [YR2015]	[Y
4	Afghanistan	3.47945	3.46201	2.6042	3.45446	3.69522	3.25580	
16	Albania	NaN	NaN	NaN	3.53930	NaN	3.43797	
28	Algeria	NaN	NaN	NaN	NaN	NaN	NaN	
40	American Samoa	NaN	NaN	NaN	NaN	NaN	NaN	
52	Andorra	2.97663	2.98706	NaN	2.50616	3.07421	3.28035	

In [34]:
```
# Check values of years
education_2.describe()
```

Out[34]:

	2010 [YR2010]	2011 [YR2011]	2012 [YR2012]	2013 [YR2013]	2014 [YR2014]	2015 [YR2015]	
count	124.000000	118.000000	110.000000	120.000000	115.000000	109.000000	1
mean	4.609494	4.276345	4.306278	4.435780	4.514015	4.609555	
std	1.975784	1.695065	1.661988	1.621027	1.580435	1.633203	
min	1.117610	0.787440	1.496170	1.024500	1.021950	1.465560	
25%	3.369240	3.037935	2.971745	3.271940	3.369035	3.437970	
50%	4.502010	4.151365	4.127135	4.547150	4.617430	4.599540	
75%	5.587668	5.324125	5.527228	5.534128	5.565300	5.455770	
max	12.837310	10.075700	7.919140	8.494430	7.695040	12.407920	

In [35]:

```
# Calculate the average for each row, skipping null values
education_2['average_of_education'] = education_2[years_columns].mean(axi

education_2.head()
```

Out[35]:

	Country Name	2010 [YR2010]	2011 [YR2011]	2012 [YR2012]	2013 [YR2013]	2014 [YR2014]	2015 [YR2015]	[Y
4	Afghanistan	3.47945	3.46201	2.6042	3.45446	3.69522	3.25580	
16	Albania	NaN	NaN	NaN	3.53930	NaN	3.43797	
28	Algeria	NaN	NaN	NaN	NaN	NaN	NaN	
40	American Samoa	NaN	NaN	NaN	NaN	NaN	NaN	
52	Andorra	2.97663	2.98706	NaN	2.50616	3.07421	3.28035	

In [36]:

```
# Select required columns
education_3 = education_2[['Country Name','average_of_education']]

# Change column names
education_3 = education_3.rename(columns={'Country name': 'Country', 'ave

# Round 'average_of_education' to two decimal places
education_3['Overall spending on education (as % of GDP)'] = education_3[

education_3.head(2)
```

Out[36]:

	Country Name	Overall spending on education (as % of GDP)
4	Afghanistan	3.53
16	Albania	3.64

In [37]:

```
# Check the values
education_3.describe()
```

Out[37]:

	Overall spending on education (as % of GDP)
count	165.000000
mean	4.457636
std	1.823083
min	1.110000
25%	3.170000
50%	4.300000
75%	5.400000
max	12.840000

In [38]:
```
# Check null values
education_3.isnull().sum()
```

Out[38]:
```
Country Name                                    0
Overall spending on education (as % of GDP)    52
dtype: int64
```

Government expenditure on tertiary education as a percentage of GDP (%)

In [39]:
```
#'Government expenditure on tertiary education as a percentage of GDP (%)

# Remove unnecessary columns
columns_to_drop = ['Country Code', 'Series', 'Series Code']
tertiary_2 = tertiary.drop(columns=columns_to_drop, axis=1)

# Replace the values: '..' into null values
tertiary_2.replace('..', np.nan, inplace=True)

# Convert multiple columns to float64
years_columns = ['2010 [YR2010]', '2011 [YR2011]', '2012 [YR2012]', '2013
       '2014 [YR2014]', '2015 [YR2015]', '2016 [YR2016]', '2017 [YR2017]'
       '2018 [YR2018]', '2019 [YR2019]']
tertiary_2[years_columns] = tertiary_2[years_columns].astype(float)

tertiary_2.head()
```

Out[39]:

	Country Name	2010 [YR2010]	2011 [YR2011]	2012 [YR2012]	2013 [YR2013]	2014 [YR2014]	2015 [YR2015]	[Y
11	Afghanistan	0.31427	0.31110	0.33182	0.40614	0.45862	0.51942	
23	Albania	NaN	NaN	NaN	0.77613	NaN	0.72734	
35	Algeria	NaN	NaN	NaN	NaN	NaN	NaN	
47	American Samoa	NaN	NaN	NaN	NaN	NaN	NaN	
59	Andorra	0.11494	0.11472	NaN	0.11500	0.18677	0.17959	

In [40]:
```
# Check values of years
tertiary_2.describe()
```

Out[40]:

	2010 [YR2010]	2011 [YR2011]	2012 [YR2012]	2013 [YR2013]	2014 [YR2014]	2015 [YR2015]	[Y
count	112.000000	106.000000	102.000000	114.000000	98.000000	93.00000	89.(
mean	0.899601	0.896254	0.917397	0.963835	0.990073	0.94787	0.9
std	0.516920	0.546907	0.523561	0.525316	0.538465	0.48499	0.4
min	0.089680	0.080670	0.004540	0.048770	0.046020	0.00014	0.
25%	0.429947	0.380163	0.570062	0.607603	0.568952	0.55661	0.
50%	0.909400	0.910790	0.887235	0.890775	0.954660	0.87808	0
75%	1.238938	1.237792	1.208505	1.325690	1.331808	1.31395	1.
max	2.339230	2.461860	2.607340	2.500580	2.412970	2.26720	2.

The maximum value of '2019' seems to be anomalous. Therefore, further investigation is executed.

In [41]:
```
# Find the index where the maximum value occurs in the 'average_of_tertia
max_index = tertiary_2['2019 [YR2019]'].idxmax()

# Retrieve the entire row with the maximum 'average_of_tertiary' value
row_with_max_average = tertiary_2.loc[max_index]

# Display the row
print(row_with_max_average)
```

```
Country Name           Ecuador
2010 [YR2010]          1.61311
2011 [YR2011]          1.58125
2012 [YR2012]          1.60151
2013 [YR2013]          1.61402
2014 [YR2014]          2.12409
2015 [YR2015]          2.17512
2016 [YR2016]              NaN
2017 [YR2017]              NaN
2018 [YR2018]              NaN
2019 [YR2019]     1186147.6045
Name: 695, dtype: object
```

The value of 1186147.6045 for Ecuador in 2019 seems anomalous, and it might be a mistake. Therefore, it has been removed.

In [42]:
```
tertiary_2['2019 [YR2019]'].replace(1186147.6045, np.nan, inplace=True)



# Calculate the average for each row, skipping null values again
tertiary_2['average_of_tertiary'] = tertiary_2[years_columns].mean(axis=1


# Check the value
tertiary_2.describe()
```

Out[42]:

	2010 [YR2010]	2011 [YR2011]	2012 [YR2012]	2013 [YR2013]	2014 [YR2014]	2015 [YR2015]	[Y
count	112.000000	106.000000	102.000000	114.000000	98.000000	93.00000	89.
mean	0.899601	0.896254	0.917397	0.963835	0.990073	0.94787	0.
std	0.516920	0.546907	0.523561	0.525316	0.538465	0.48499	0.
min	0.089680	0.080670	0.004540	0.048770	0.046020	0.00014	0.
25%	0.429947	0.380163	0.570062	0.607603	0.568952	0.55661	0.
50%	0.909400	0.910790	0.887235	0.890775	0.954660	0.87808	0
75%	1.238938	1.237792	1.208505	1.325690	1.331808	1.31395	1.
max	2.339230	2.461860	2.607340	2.500580	2.412970	2.26720	2.

It seems to be fine. Therefore, carry on

In [43]:
```python
# Select required columns
tertiary_3 = tertiary_2[['Country Name','average_of_tertiary']]

# Change column names
tertiary_3 = tertiary_3.rename(columns={'Country name': 'Country', 'avera

# Round 'average_of_education' to two decimal places
tertiary_3['Spending on tertiary education (as % of GDP)'] = tertiary_3['

tertiary_3.head(2)
```

Out[43]:

	Country Name	Spending on tertiary education (as % of GDP)
11	Afghanistan	0.39
23	Albania	0.74

In [44]:
```python
# Check the values
tertiary_3.describe()
```

Out[44]:

	Spending on tertiary education (as % of GDP)
count	155.000000
mean	0.868065
std	0.494004
min	0.100000
25%	0.445000
50%	0.810000
75%	1.170000
max	2.370000

In [45]:
```python
tertiary_3.isnull().sum()
```

Out[45]:
```
Country Name                                     0
Spending on tertiary education (as % of GDP)    62
dtype: int64
```

In [46]:
```
# Merge two dataframes of World bank education

world_bank_education = pd.merge(education_3, tertiary_3,left_on=['Country
                               right_on=['Country Name'], how='inner')
world_bank_education
```

Out[46]:

	Country Name	Overall spending on education (as % of GDP)	Spending on tertiary education (as % of GDP)
0	Afghanistan	3.53	0.39
1	Albania	3.64	0.74
2	Algeria	NaN	NaN
3	American Samoa	NaN	NaN
4	Andorra	3.08	0.16
...	...	...	...
212	Virgin Islands (U.S.)	NaN	NaN
213	West Bank and Gaza	5.57	NaN
214	Yemen, Rep.	NaN	NaN
215	Zambia	4.18	0.45
216	Zimbabwe	5.24	0.93

217 rows × 3 columns

Regarding null values, since they cannot be replaced and are not useful to visualize the data, they are removed.

In [47]:
```
world_bank_education_2 = world_bank_education.dropna(inplace=False).reset
```

In [48]:
```
# Check

display(world_bank_education_2.head())
display(world_bank_education_2.isnull().sum())
```

	Country Name	Overall spending on education (as % of GDP)	Spending on tertiary education (as % of GDP)
0	Afghanistan	3.53	0.39
1	Albania	3.64	0.74
2	Andorra	3.08	0.16
3	Argentina	5.40	1.10
4	Armenia	2.79	0.33

```
Country Name                                    0
Overall spending on education (as % of GDP)     0
Spending on tertiary education (as % of GDP)    0
dtype: int64
```

Cleaned and reshaped data are as follows:

In [49]:
```
# world happiness report

world_happiness_report = selected_happiness_df.copy()

world_happiness_report.head()
```

Out[49]:

	Country	Happiness index
0	Finland	7.80
1	Denmark	7.59
2	Iceland	7.53
3	Israel	7.47
4	Netherlands	7.40

In [50]:
```
# world bank education

world_bank_education_2.head()
```

Out[50]:

	Country Name	Overall spending on education (as % of GDP)	Spending on tertiary education (as % of GDP)
0	Afghanistan	3.53	0.39
1	Albania	3.64	0.74
2	Andorra	3.08	0.16
3	Argentina	5.40	1.10
4	Armenia	2.79	0.33

3. Put the data into an appropriate form for plotting

To combine two data frames by country names, the countries' names have to be identical. Therefore, country names are examined carefully using Set function.

In [51]:
```
happiness_set = set(world_happiness_report['Country'])
educaation_set = set(world_bank_education_2['Country Name'])
```

In [52]:
```
# Have a look at the country names in 'happiness_set'
happiness_set
```

```
Out[52]: {'Afghanistan',
          'Albania',
          'Algeria',
          'Argentina',
          'Armenia',
          'Australia',
          'Austria',
          'Bahrain',
          'Bangladesh',
          'Belgium',
          'Benin',
          'Bolivia',
          'Bosnia and Herzegovina',
          'Botswana',
          'Brazil',
          'Bulgaria',
          'Burkina Faso',
          'Cambodia',
          'Cameroon',
          'Canada',
          'Chad',
          'Chile',
          'China',
          'Colombia',
          'Comoros',
          'Congo (Brazzaville)',
          'Congo (Kinshasa)',
          'Costa Rica',
          'Croatia',
          'Cyprus',
          'Czechia',
          'Denmark',
          'Dominican Republic',
          'Ecuador',
          'Egypt',
          'El Salvador',
          'Estonia',
          'Ethiopia',
          'Finland',
          'France',
          'Gabon',
          'Gambia',
          'Georgia',
          'Germany',
          'Ghana',
          'Greece',
          'Guatemala',
          'Guinea',
          'Honduras',
          'Hong Kong S.A.R. of China',
          'Hungary',
          'Iceland',
          'India',
          'Indonesia',
          'Iran',
          'Iraq',
          'Ireland',
          'Israel',
          'Italy',
          'Ivory Coast',
'Jamaica',
'Japan',
'Jordan',
'Kazakhstan',
'Kenya',
'Kosovo',
'Kyrgyzstan',
'Laos',
'Latvia',
'Lebanon',
'Liberia',
'Lithuania',
'Luxembourg',
'Madagascar',
'Malawi',
'Malaysia',
'Mali',
'Malta',
'Mauritania',
'Mauritius',
'Mexico',
'Moldova',
'Mongolia',
'Montenegro',
'Morocco',
'Mozambique',
'Myanmar',
'Namibia',
'Nepal',
'Netherlands',
'New Zealand',
'Nicaragua',
'Niger',
'Nigeria',
'North Macedonia',
'Norway',
'Pakistan',
'Panama',
'Paraguay',
'Peru',
'Philippines',
'Poland',
'Portugal',
'Romania',
'Russia',
'Saudi Arabia',
'Senegal',
'Serbia',
'Sierra Leone',
'Singapore',
'Slovakia',
'Slovenia',
'South Africa',
'South Korea',
'Spain',
'Sri Lanka',
'State of Palestine',
'Sweden',
'Switzerland',
'Taiwan Province of China',
 'Tajikistan',
 'Tanzania',
 'Thailand',
 'Togo',
 'Tunisia',
 'Turkiye',
 'Uganda',
 'Ukraine',
 'United Arab Emirates',
 'United Kingdom',
 'United States',
 'Uruguay',
 'Uzbekistan',
 'Venezuela',
 'Vietnam',
 'Zambia',
 'Zimbabwe'}
```

In [53]:
```
# Have a look at the country names in 'education_set'
educaation_set
```

```
Out[53]: {'Afghanistan',
          'Albania',
          'Andorra',
          'Argentina',
          'Armenia',
          'Aruba',
          'Australia',
          'Austria',
          'Azerbaijan',
          'Bahrain',
          'Bangladesh',
          'Barbados',
          'Belarus',
          'Belgium',
          'Belize',
          'Benin',
          'Bermuda',
          'Bhutan',
          'Brazil',
          'British Virgin Islands',
          'Brunei Darussalam',
          'Bulgaria',
          'Burkina Faso',
          'Burundi',
          'Cabo Verde',
          'Cambodia',
          'Cameroon',
          'Canada',
          'Central African Republic',
          'Chad',
          'Chile',
          'Colombia',
          'Comoros',
          'Congo, Dem. Rep.',
          'Congo, Rep.',
          'Costa Rica',
          "Cote d'Ivoire",
          'Croatia',
          'Curacao',
          'Cyprus',
          'Czech Republic',
          'Denmark',
          'Djibouti',
          'Dominica',
          'Ecuador',
          'El Salvador',
          'Estonia',
          'Eswatini',
          'Ethiopia',
          'Fiji',
          'Finland',
          'France',
          'Gabon',
          'Gambia, The',
          'Georgia',
          'Germany',
          'Ghana',
          'Grenada',
          'Guatemala',
          'Guinea',
'Guinea-Bissau',
'Guyana',
'Honduras',
'Hong Kong SAR, China',
'Hungary',
'Iceland',
'India',
'Indonesia',
'Iran, Islamic Rep.',
'Ireland',
'Israel',
'Italy',
'Jamaica',
'Japan',
'Jordan',
'Kazakhstan',
'Kenya',
'Korea, Rep.',
'Kyrgyz Republic',
'Lao PDR',
'Latvia',
'Lebanon',
'Lesotho',
'Liberia',
'Lithuania',
'Luxembourg',
'Macao SAR, China',
'Madagascar',
'Malawi',
'Malaysia',
'Maldives',
'Mali',
'Malta',
'Mauritania',
'Mauritius',
'Mexico',
'Moldova',
'Mongolia',
'Mozambique',
'Myanmar',
'Namibia',
'Nepal',
'Netherlands',
'New Zealand',
'Nicaragua',
'Niger',
'Norway',
'Oman',
'Pakistan',
'Panama',
'Paraguay',
'Peru',
'Poland',
'Portugal',
'Puerto Rico',
'Romania',
'Russian Federation',
'Rwanda',
'Samoa',
'San Marino',
 'Sao Tome and Principe',
 'Senegal',
 'Serbia',
 'Seychelles',
 'Sierra Leone',
 'Singapore',
 'Slovak Republic',
 'Slovenia',
 'South Africa',
 'South Sudan',
 'Spain',
 'Sri Lanka',
 'St. Kitts and Nevis',
 'St. Lucia',
 'St. Vincent and the Grenadines',
 'Sweden',
 'Switzerland',
 'Tajikistan',
 'Tanzania',
 'Thailand',
 'Timor-Leste',
 'Togo',
 'Tunisia',
 'Turkmenistan',
 'Turks and Caicos Islands',
 'Uganda',
 'Ukraine',
 'United Kingdom',
 'United States',
 'Uruguay',
 'Vietnam',
 'Zambia',
 'Zimbabwe'}
```

In [54]:
```
# The number of country names
display(len(happiness_set))
display(len(educaation_set))
```

```
137
153
```

In [55]:
```
# The number of country names that are identical (exactly the same) in bo
len(happiness_set & educaation_set)
```

Out[55]:
```
103
```

In [56]:
```
# The country names that are in 'happiness_set' but not in 'education_set
display(happiness_set - educaation_set)

# The number of country names
display(len(happiness_set - educaation_set))
```

```
{'Algeria',
 'Bolivia',
 'Bosnia and Herzegovina',
 'Botswana',
 'China',
 'Congo (Brazzaville)',
 'Congo (Kinshasa)',
 'Czechia',
 'Dominican Republic',
 'Egypt',
 'Gambia',
 'Greece',
 'Hong Kong S.A.R. of China',
 'Iran',
 'Iraq',
 'Ivory Coast',
 'Kosovo',
 'Kyrgyzstan',
 'Laos',
 'Montenegro',
 'Morocco',
 'Nigeria',
 'North Macedonia',
 'Philippines',
 'Russia',
 'Saudi Arabia',
 'Slovakia',
 'South Korea',
 'State of Palestine',
 'Taiwan Province of China',
 'Turkiye',
 'United Arab Emirates',
 'Uzbekistan',
 'Venezuela'}
34
```

```
In [57]: # The country names that are in 'education_set' but not in ''happiness_se
         display(educaation_set - happiness_set)

         # The number of country names
         display(len(educaation_set - happiness_set))
```

```
{'Andorra',
 'Aruba',
 'Azerbaijan',
 'Barbados',
 'Belarus',
 'Belize',
 'Bermuda',
 'Bhutan',
 'British Virgin Islands',
 'Brunei Darussalam',
 'Burundi',
 'Cabo Verde',
 'Central African Republic',
 'Congo, Dem. Rep.',
 'Congo, Rep.',
 "Cote d'Ivoire",
 'Curacao',
 'Czech Republic',
 'Djibouti',
 'Dominica',
 'Eswatini',
 'Fiji',
 'Gambia, The',
 'Grenada',
 'Guinea-Bissau',
 'Guyana',
 'Hong Kong SAR, China',
 'Iran, Islamic Rep.',
 'Korea, Rep.',
 'Kyrgyz Republic',
 'Lao PDR',
 'Lesotho',
 'Macao SAR, China',
 'Maldives',
 'Oman',
 'Puerto Rico',
 'Russian Federation',
 'Rwanda',
 'Samoa',
 'San Marino',
 'Sao Tome and Principe',
 'Seychelles',
 'Slovak Republic',
 'South Sudan',
 'St. Kitts and Nevis',
 'St. Lucia',
 'St. Vincent and the Grenadines',
 'Timor-Leste',
 'Turkmenistan',
 'Turks and Caicos Islands'}
50
```

The country names are different in the two data frames, even though they refer to the same entities.

These are the different names in the education_set compared to the happiness_set.

(education_set : happiness_set)

'Congo, Rep.' : 'Congo (Brazzaville)',

'Congo, Dem. Rep.' : 'Congo (Kinshasa)',

'Czech Republic' : 'Czechia',

'Dominica' : 'Dominican Republic',

'Gambia, The' : 'Gambia',

'Hong Kong SAR, China' : 'Hong Kong S.A.R. of China',

'Iran, Islamic Rep.' :'Iran',

'Kyrgyz Republic' : 'Kyrgyzstan',

'Lao PDR' : 'Laos',

'Russian Federation' : 'Russia',

'Slovak Republic' : 'Slovakia',

'Korea, Rep.' : 'South Korea'

Now, the country names in 'education_set' are changed to match the version in 'happiness_set'.

In [58]:
```
# Define the mapping of old names to new names
name_mapping = {
    'Congo, Rep.': 'Congo (Brazzaville)',
    'Congo, Dem. Rep.': 'Congo (Kinshasa)',
    'Czech Republic': 'Czechia',
    'Dominica': 'Dominican Republic',
    'Gambia, The': 'Gambia',
    'Hong Kong SAR, China': 'Hong Kong S.A.R. of China',
    'Iran, Islamic Rep.': 'Iran',
    'Kyrgyz Republic': 'Kyrgyzstan',
    'Lao PDR': 'Laos',
    'Russian Federation': 'Russia',
    'Slovak Republic': 'Slovakia',
    'Korea, Rep.': 'South Korea'
}

world_bank_education_2['Country Name'] = world_bank_education_2['Country

# Check
world_bank_education_2['Country Name'].unique()
```

Out[58]:
```
array(['Afghanistan', 'Albania', 'Andorra', 'Argentina', 'Armenia',
       'Aruba', 'Australia', 'Austria', 'Azerbaijan', 'Bahrain',
       'Bangladesh', 'Barbados', 'Belarus', 'Belgium', 'Belize', 'Beni
n',
       'Bermuda', 'Bhutan', 'Brazil', 'British Virgin Islands',
       'Brunei Darussalam', 'Bulgaria', 'Burkina Faso', 'Burundi',
       'Cabo Verde', 'Cambodia', 'Cameroon', 'Canada',
       'Central African Republic', 'Chad', 'Chile', 'Colombia', 'Comoro
s',
       'Congo (Kinshasa)', 'Congo (Brazzaville)', 'Costa Rica',
       "Cote d'Ivoire", 'Croatia', 'Curacao', 'Cyprus', 'Czechia',
       'Denmark', 'Djibouti', 'Dominican Republic', 'Ecuador',
       'El Salvador', 'Estonia', 'Eswatini', 'Ethiopia', 'Fiji',
       'Finland', 'France', 'Gabon', 'Gambia', 'Georgia', 'Germany',
       'Ghana', 'Grenada', 'Guatemala', 'Guinea', 'Guinea-Bissau',
       'Guyana', 'Honduras', 'Hong Kong S.A.R. of China', 'Hungary',
       'Iceland', 'India', 'Indonesia', 'Iran', 'Ireland', 'Israel',
       'Italy', 'Jamaica', 'Japan', 'Jordan', 'Kazakhstan', 'Kenya',
       'South Korea', 'Kyrgyzstan', 'Laos', 'Latvia', 'Lebanon',
       'Lesotho', 'Liberia', 'Lithuania', 'Luxembourg',
       'Macao SAR, China', 'Madagascar', 'Malawi', 'Malaysia', 'Maldive
s',
       'Mali', 'Malta', 'Mauritania', 'Mauritius', 'Mexico', 'Moldova',
       'Mongolia', 'Mozambique', 'Myanmar', 'Namibia', 'Nepal',
       'Netherlands', 'New Zealand', 'Nicaragua', 'Niger', 'Norway',
       'Oman', 'Pakistan', 'Panama', 'Paraguay', 'Peru', 'Poland',
       'Portugal', 'Puerto Rico', 'Romania', 'Russia', 'Rwanda', 'Samo
a',
       'San Marino', 'Sao Tome and Principe', 'Senegal', 'Serbia',
       'Seychelles', 'Sierra Leone', 'Singapore', 'Slovakia', 'Sloveni
a',
       'South Africa', 'South Sudan', 'Spain', 'Sri Lanka',
       'St. Kitts and Nevis', 'St. Lucia',
       'St. Vincent and the Grenadines', 'Sweden', 'Switzerland',
       'Tajikistan', 'Tanzania', 'Thailand', 'Timor-Leste', 'Togo',
       'Tunisia', 'Turkmenistan', 'Turks and Caicos Islands', 'Uganda',
       'Ukraine', 'United Kingdom', 'United States', 'Uruguay', 'Vietna
m',
       'Zambia', 'Zimbabwe'], dtype=object)
```

In [59]:
```python
# Combine two data frames

plot_df = pd.merge(world_happiness_report, world_bank_education_2,left_on
                            right_on=['Country Name'], how='inner')

plot_df.head()
```

Out[59]:

	Country	Happiness index	Country Name	Overall spending on education (as % of GDP)	Spending on tertiary education (as % of GDP)
0	Finland	7.80	Finland	6.82	1.94
1	Denmark	7.59	Denmark	8.04	2.33
2	Iceland	7.53	Iceland	7.40	1.43
3	Israel	7.47	Israel	5.79	0.91
4	Netherlands	7.40	Netherlands	5.42	1.65

```
In [60]: # Check the null values
         plot_df.isnull().sum()
```

```
Out[60]: Country                                         0
         Happiness index                                 0
         Country Name                                    0
         Overall spending on education (as % of GDP)     0
         Spending on tertiary education (as % of GDP)    0
         dtype: int64
```

```
In [61]: # Remove an unnecessary column: 'Country Name'
         plot_df = plot_df[['Country', 'Happiness index', 'Overall spending on edu
                            'Spending on tertiary education (as % of GDP)']]

         plot_df
```

Out[61]:

	Country	Happiness index	Overall spending on education (as % of GDP)	Spending on tertiary education (as % of GDP)
0	Finland	7.80	6.82	1.94
1	Denmark	7.59	8.04	2.33
2	Iceland	7.53	7.40	1.43
3	Israel	7.47	5.79	0.91
4	Netherlands	7.40	5.42	1.65
...	...	...	...	...
110	Congo (Kinshasa)	3.21	1.88	0.45
111	Zimbabwe	3.20	5.24	0.93
112	Sierra Leone	3.14	3.95	1.53
113	Lebanon	2.39	1.96	0.56
114	Afghanistan	1.86	3.53	0.39

115 rows × 4 columns

4. Visualise the data

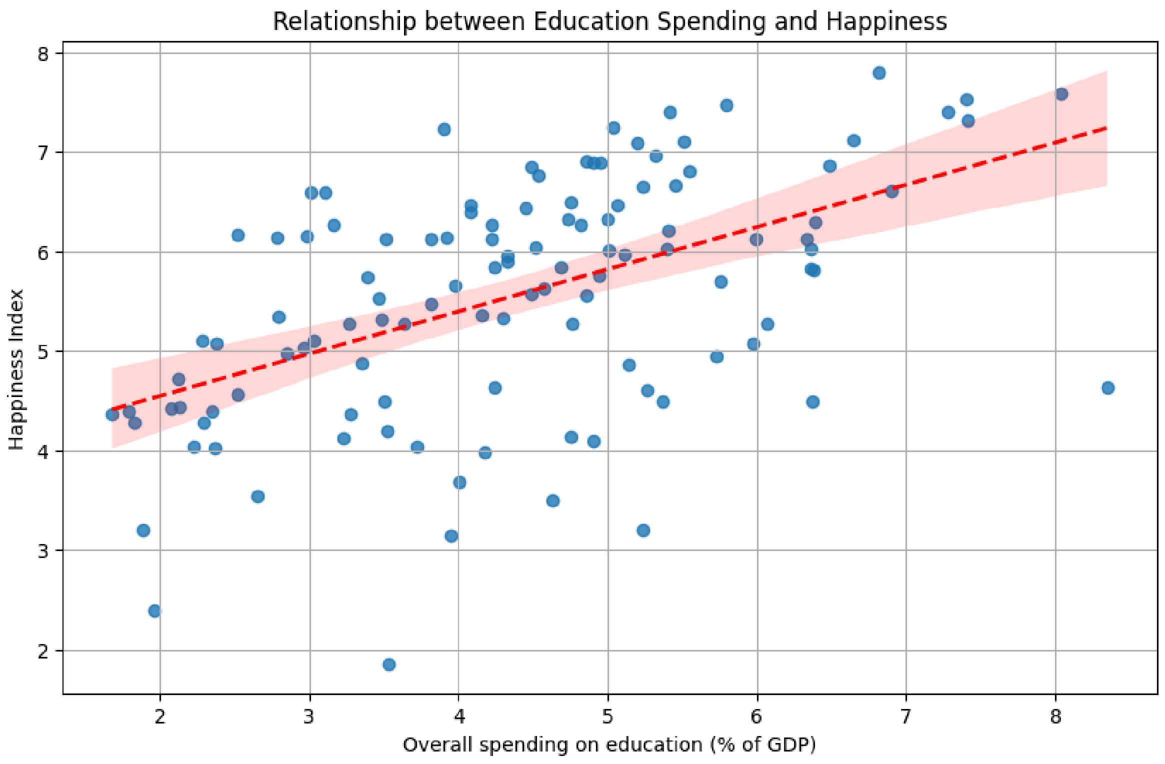
Question 1

Is there a relationship between the amount that a country spends on education as a proportion of its GDP, and the happiness of that country's citizens?

```
In [62]: plt.figure(figsize=(10, 6))

         # Scatter plot with regression line
         sns.regplot(x='Overall spending on education (as % of GDP)',
                     y='Happiness index',
                     data=plot_df,
                     scatter_kws={'alpha':0.8},
                     line_kws={'color': 'red', 'linestyle': 'dashed', 'linewidth':
```

```
plt.title('Relationship between Education Spending and Happiness')
plt.xlabel('Overall spending on education (% of GDP)')
plt.ylabel('Happiness Index')
plt.grid(True)
plt.show()
```



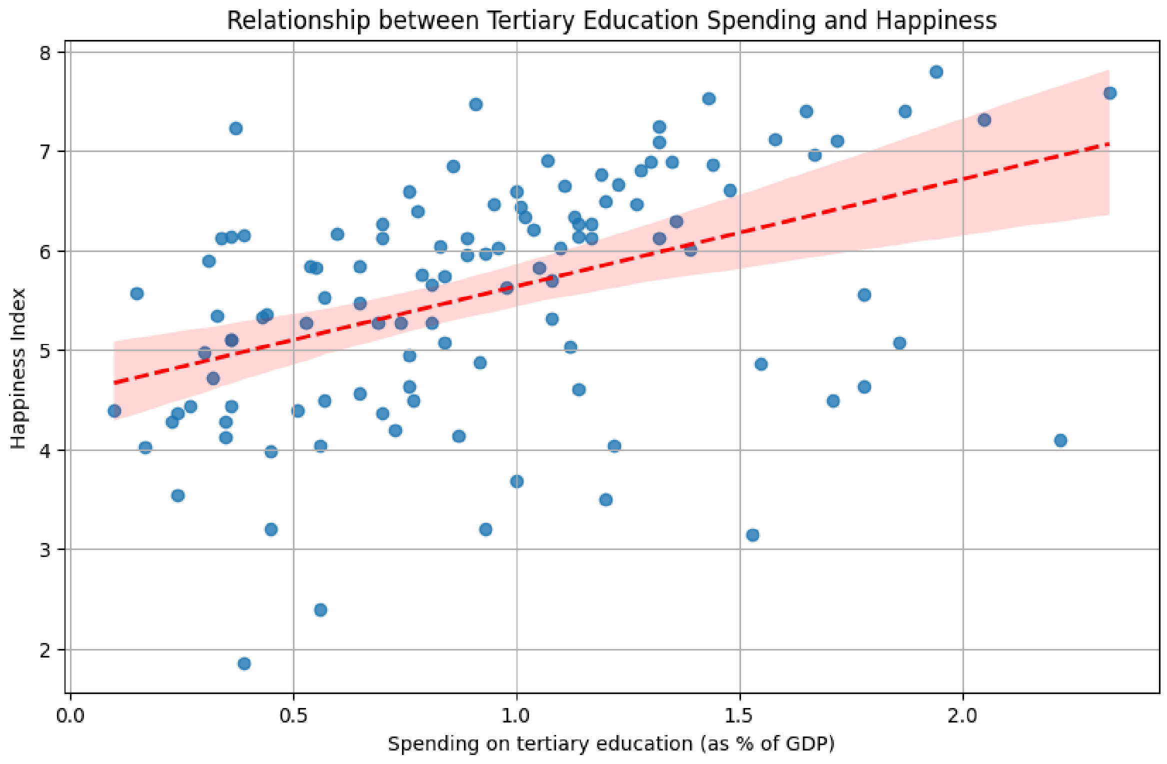
Question 2

Is there a relationship between the amount that a country spends on tertiary education as a proportion of its GDP, and the happiness of that country's citizens?

In [63]:
```
plt.figure(figsize=(10, 6))

# Scatter plot with regression line
sns.regplot(x='Spending on tertiary education (as % of GDP)',
            y='Happiness index',
            data=plot_df,
            scatter_kws={'alpha':0.8},
            line_kws={'color': 'red', 'linestyle': 'dashed', 'linewidth':

plt.title('Relationship between Tertiary Education Spending and Happiness
plt.xlabel('Spending on tertiary education (as % of GDP)')
plt.ylabel('Happiness Index')
plt.grid(True)
plt.show()
```



Conclusion (Interpret the plots)

Relationship between Overall spending on education and Happiness

The observed regression line in the plot implies a positive correlation between the overall spending on education (as a percentage of GDP) and the happiness index. This suggests that, on average, countries tend to experience higher happiness levels with increased investment in education. However, the presence of scattered outliers across the plot is noticeable and shows instances where this correlation is not consistently robust.

Relationship between Spending on Tertiary Education and Happiness

Similar to the previous scenario, the graph describing the relationship between spending on tertiary education and the happiness index reveals a positive correlation. This suggests that, on average, countries investing more in tertiary education tend to enjoy higher happiness levels. However, the correlation's strength is influenced by numerous outliers across the plot, rendering this correlation not consistently robust, much like the previous scenario.

```
In [ ]:
```