Pisa Data Exploration

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1 Pisa Data Exploration

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1.2 Preliminary Wrangling

PISA program overview

The Programme for International Student Assessment (PISA) is an international assessment of the skills and knowledge of 15-year-old students; in addition, it provides information about a range of factors that contribute to the success of students, schools, and education systems. PISA is a collaborative effort among member countries of the Organisation for Economic Co-operation and Development (OECD).

PISA covers three domains — reading, mathematics, and science. Although each assessment includes questions from all three domains, the focus shifts. In 2000, the emphasis was on reading, with mathematics and science as minor domains. In 2003, mathematics was the major domain, and in 2006, it was science. In 2009, the focus was again reading, and in 2012, mathematics. In the assessment of 2015, the focus was science once again. The repetition of the assessments at regular intervals yields timely data that can be compared internationally and over time.

As PISA is an international assessment, it measures skills that are generally recognized as key outcomes of the educational process. Rather than testing on facts, the assessment focuses on young people near the end of compulsory schooling and their ability to use their knowledge and skills to meet real-life challenges.

Participation

International participation in PISA has grown steadily — from 32 countries/economies in 2000 to 41 in 2003, 57 in 2006, 65 in 2009, and 65 in 2012. In the latest PISA cycle, in 2015, there were 72 countries/economies participating. Canada has participated in PISA since its inception, through a partnership among CMEC, Employment and Social Development Canada, and Statistics Canada.

All 10 provinces have participated in each assessment. Approximately 20,000 Canadian students from about 1,000 schools have taken part in each PISA assessment in either English or French. Schools and the students within schools are selected randomly for participation. This large sample size allows results to be reported for each province, as well as for both the French- and English-language school systems in Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Alberta, and British Columbia. Currently, Yukon, Northwest Territories, and Nunavut do not participate in PISA, nor do Indigenous students from band-operated schools.

The results are valid only on the pan-Canadian and provincial levels. No results are attributed to individual schools or students. PISA does not assess individual student achievement.

The assessment

In addition to two hours of direct assessment of reading, mathematics, and science, students in Canada complete a background questionnaire about themselves and their homes, about information and communication technology, and about their school experiences, work activities, and relationships with others. School principals complete a separate questionnaire.

In order to determine the content of the assessment, experts from OECD Member countries developed definitions for each domain, which guided the preparation of the testing instruments:

Reading literacy: The capacity to understand, use, and reflect on written texts in order to achieve one's goals and potential, develop knowledge, and participate in society. Mathematics literacy: The capacity to identify, understand, and engage in mathematics, and make well-founded judgments about the role that mathematics plays in the private, occupational, and social lives of constructive, concerned, and reflective citizens. Scientific literacy: The capacity to use scientific knowledge, identify questions, and draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity.

One other domain was included in the PISA 2015 cycle, financial literacy, which was administered as an option in some countries, including some Canadian provinces. PISA 2015 was completely computerized.

The benefits of PISA

Canada invests significant public resources in the provision of elementary and secondary education, and Canadians are concerned about the quality of education provided by schools. The skills acquired by the end of secondary school are the essential foundation for further learning and for meeting the social and economic challenges of the future. PISA examines the level of achievement of 15-year-olds, providing an indication of the knowledge and skills they have acquired and their preparedness for continuing their studies or entering the workforce.

Results from PISA are valuable to educators, governments, social-policy analysts, and advocacy groups. Comparative information helps in the evaluation of the effectiveness of existing programs and practices, as well as in the understanding of the influences of socioeconomic and other factors on educational success.

PISA results

On an international level, Canada has performed very well in all of the PISA assessments. For example, in the 2018 assessment, Canadian 15-year-olds placed well above the OECD average and were among the top performers in reading. Of the 79 countries and economies participating in the assessment, only three— Beijing, Shanghai, Jiangsu, Zhejiang (B-S-J-Z) (China), Singapore, and Macao (China)—outperformed Canada.

source: https://www.cmec.ca/251/Programme_for_International_Student_Assessment_(PISA).html

[1]:
```
# import all packages and set plots to be embedded inline
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

```
import seaborn as sb

%matplotlib inline
```

Load in your dataset and describe its properties through the questions below. Try and motivate your exploration goals through this section.

[2]:
```
# failed to read file as utf-8. changed to ISO-8859-1 instead.
df_pisa=pd.read_csv('pisa2012.csv', encoding = "ISO-8859-1")
```

```
C:\Users\saatt\AppData\Local\Continuum\anaconda3\lib\site-
packages\IPython\core\interactiveshell.py:3063: DtypeWarning: Columns (15,16,17,
21,22,23,24,25,26,30,31,36,37,45,65,123,155,156,157,158,159,160,161,162,163,164,
165,166,167,168,169,170,171,284,285,286,287,288,289,290,291,292,293,294,295,296,
297,298,299,300,301,302,303,307,308,309,310,311,312,313,314,315,316,317,318,319,
320,321,322,323,324,325,326,327,328,329,330,331,332,333,334,335,336,337,338,339,
340,341,342,343,344,345,346,347,348,349,350,351,352,353,354,355,356,357,376,377,
378,379,380,381,382,383,384,385,386,387,388,389,390,391,392,393,394,395,396,397,
398,399,400,401,402,403,475) have mixed types.Specify dtype option on import or
set low_memory=False.
  interactivity=interactivity, compiler=compiler, result=result)
```

[3]:
```
# read dataset dictionary
df_dict = pd.read_csv('pisadict2012.csv',encoding = "ISO-8859-1")
```

[4]:
```
df_pisa.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 485490 entries, 0 to 485489
Columns: 636 entries, Unnamed: 0 to VER_STU
dtypes: float64(250), int64(18), object(368)
memory usage: 2.3+ GB
```

[5]:
```
df_dict.head()
```

[5]:

	CNT	Country code 3-character
0	SUBNATIO	Adjudicated sub-region code 7-digit code (3-di…
1	STRATUM	Stratum ID 7-character (cnt + region ID + orig…
2	OECD	OECD country
3	NC	National Centre 6-digit Code
4	SCHOOLID	School ID 7-digit (region ID + stratum ID + 3-…

[6]:
```
df_pisa.shape, df_dict.shape
```

[6]:
```
((485490, 636), (634, 2))
```

[7]:
```
df_pisa['ST04Q01'].value_counts()
```

[7]:
```
Female    245064
Male      240426
Name: ST04Q01, dtype: int64
```

[8]:
```
# Age counts
df_pisa['AGE'].value_counts()
```

[8]:
```
15.58    42762
15.67    42353
15.75    41664
15.83    41402
15.92    41084
16.00    41049
15.42    40437
15.50    40291
16.08    39313
16.17    38356
15.33    28354
16.25    26139
15.25    11986
16.33    10183
15.17        1
Name: AGE, dtype: int64
```

[9]:
```
df_pisa['CNT'].value_counts()
```

[9]:
```
Mexico                       33806
Italy                        31073
Spain                        25313
Canada                       21544
Brazil                       19204
                             …
Florida (USA)                 1896
Perm(Russian Federation)      1761
Massachusetts (USA)           1723
Connecticut (USA)             1697
Liechtenstein                  293
Name: CNT, Length: 68, dtype: int64
```

[10]:
```
# Unique countries
df_pisa['CNT'].nunique()
```

[10]:
```
68
```

[11]:
```
df_pisa.dtypes
```

[11]:
```
Unnamed: 0      int64
CNT            object
SUBNATIO        int64
STRATUM        object
OECD           object
               …
W_FSTR80      float64
WVARSTRR        int64
VAR_UNIT        int64
SENWGT_STU    float64
VER_STU        object
Length: 636, dtype: object
```

[12]:
```
df_pisa.head()
```

[12]:

	Unnamed: 0	CNT	SUBNATIO	STRATUM	OECD	NC	SCHOOLID	\
0	1	Albania	80000	ALB0006	Non-OECD	Albania	1	
1	2	Albania	80000	ALB0006	Non-OECD	Albania	1	
2	3	Albania	80000	ALB0006	Non-OECD	Albania	1	
3	4	Albania	80000	ALB0006	Non-OECD	Albania	1	
4	5	Albania	80000	ALB0006	Non-OECD	Albania	1	

	STIDSTD	ST01Q01	ST02Q01	…	W_FSTR75	W_FSTR76	W_FSTR77	W_FSTR78	\
0	1	10	1.0	…	13.7954	13.9235	13.1249	13.1249	
1	2	10	1.0	…	13.7954	13.9235	13.1249	13.1249	
2	3	9	1.0	…	12.7307	12.7307	12.7307	12.7307	
3	4	9	1.0	…	12.7307	12.7307	12.7307	12.7307	
4	5	9	1.0	…	12.7307	12.7307	12.7307	12.7307	

	W_FSTR79	W_FSTR80	WVARSTRR	VAR_UNIT	SENWGT_STU	VER_STU
0	4.3389	13.0829	19	1	0.2098	22NOV13
1	4.3389	13.0829	19	1	0.2098	22NOV13
2	4.2436	12.7307	19	1	0.1999	22NOV13
3	4.2436	12.7307	19	1	0.1999	22NOV13
4	4.2436	12.7307	19	1	0.1999	22NOV13

[5 rows x 636 columns]

[13]:
```
df_pisa.NC.value_counts()
```

[13]:
```
Mexico                  33806
Italy                   31073
Spain                   25313
Canada                  21544
Brazil                  19204
                        …
New Zealand              4291
```

```
Iceland                          3508
United Kingdom (Scotland)        2945
Perm (Russian Federation)        1761
Liechtenstein                     293
Name: NC, Length: 66, dtype: int64
```

[14]:
```
df_pisa.info(verbose=True, null_counts=True)
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 485490 entries, 0 to 485489
Data columns (total 636 columns):
 #   Column       Non-Null Count   Dtype
---  ------       --------------   -----
 0   Unnamed: 0   485490 non-null  int64
 1   CNT          485490 non-null  object
 2   SUBNATIO     485490 non-null  int64
 3   STRATUM      485490 non-null  object
 4   OECD         485490 non-null  object
 5   NC           485490 non-null  object
 6   SCHOOLID     485490 non-null  int64
 7   STIDSTD      485490 non-null  int64
 8   ST01Q01      485490 non-null  int64
 9   ST02Q01      485438 non-null  float64
 10  ST03Q01      485490 non-null  int64
 11  ST03Q02      485490 non-null  int64
 12  ST04Q01      485490 non-null  object
 13  ST05Q01      476166 non-null  object
 14  ST06Q01      457994 non-null  float64
 15  ST07Q01      436690 non-null  object
 16  ST07Q02      431278 non-null  object
 17  ST07Q03      305687 non-null  object
 18  ST08Q01      479143 non-null  object
 19  ST09Q01      479131 non-null  object
 20  ST115Q01     479269 non-null  float64
 21  ST11Q01      460559 non-null  object
 22  ST11Q02      441036 non-null  object
 23  ST11Q03      400076 non-null  object
 24  ST11Q04      390768 non-null  object
 25  ST11Q05      348180 non-null  object
 26  ST11Q06      337638 non-null  object
 27  ST13Q01      457979 non-null  object
 28  ST14Q01      390481 non-null  object
 29  ST14Q02      407641 non-null  object
 30  ST14Q03      382441 non-null  object
 31  ST14Q04      304215 non-null  object
 32  ST15Q01      467751 non-null  object
 33  ST17Q01      443261 non-null  object
```

```
34  ST18Q01      371415 non-null  object
35  ST18Q02      387796 non-null  object
36  ST18Q03      362834 non-null  object
37  ST18Q04      292093 non-null  object
38  ST19Q01      451410 non-null  object
39  ST20Q01      476363 non-null  object
40  ST20Q02      472518 non-null  object
41  ST20Q03      469141 non-null  object
42  ST21Q01      32728 non-null   float64
43  ST25Q01      465496 non-null  object
44  ST26Q01      473079 non-null  object
45  ST26Q02      469693 non-null  object
46  ST26Q03      472020 non-null  object
47  ST26Q04      473877 non-null  object
48  ST26Q05      463178 non-null  object
49  ST26Q06      473182 non-null  object
50  ST26Q07      465860 non-null  object
51  ST26Q08      467094 non-null  object
52  ST26Q09      467249 non-null  object
53  ST26Q10      471242 non-null  object
54  ST26Q11      463566 non-null  object
55  ST26Q12      474039 non-null  object
56  ST26Q13      469115 non-null  object
57  ST26Q14      474076 non-null  object
58  ST26Q15      485490 non-null  int64
59  ST26Q16      485490 non-null  int64
60  ST26Q17      485490 non-null  int64
61  ST27Q01      477079 non-null  object
62  ST27Q02      476548 non-null  object
63  ST27Q03      473459 non-null  object
64  ST27Q04      472499 non-null  object
65  ST27Q05      469643 non-null  object
66  ST28Q01      473765 non-null  object
67  ST29Q01      315911 non-null  object
68  ST29Q02      315473 non-null  object
69  ST29Q03      314928 non-null  object
70  ST29Q04      314737 non-null  object
71  ST29Q05      315231 non-null  object
72  ST29Q06      314746 non-null  object
73  ST29Q07      315066 non-null  object
74  ST29Q08      315232 non-null  object
75  ST35Q01      315860 non-null  object
76  ST35Q02      315315 non-null  object
77  ST35Q03      314873 non-null  object
78  ST35Q04      315160 non-null  object
79  ST35Q05      314843 non-null  object
80  ST35Q06      313389 non-null  object
81  ST37Q01      314644 non-null  object
```

```
82  ST37Q02      314624 non-null  object
83  ST37Q03      313883 non-null  object
84  ST37Q04      313416 non-null  object
85  ST37Q05      313970 non-null  object
86  ST37Q06      313678 non-null  object
87  ST37Q07      314070 non-null  object
88  ST37Q08      314112 non-null  object
89  ST42Q01      313855 non-null  object
90  ST42Q02      313502 non-null  object
91  ST42Q03      312176 non-null  object
92  ST42Q04      311980 non-null  object
93  ST42Q05      312624 non-null  object
94  ST42Q06      312327 non-null  object
95  ST42Q07      312583 non-null  object
96  ST42Q08      312456 non-null  object
97  ST42Q09      312223 non-null  object
98  ST42Q10      312853 non-null  object
99  ST43Q01      314971 non-null  object
100 ST43Q02      314182 non-null  object
101 ST43Q03      313494 non-null  object
102 ST43Q04      313420 non-null  object
103 ST43Q05      313228 non-null  object
104 ST43Q06      313470 non-null  object
105 ST44Q01      314119 non-null  object
106 ST44Q03      313405 non-null  object
107 ST44Q04      312645 non-null  object
108 ST44Q05      312996 non-null  object
109 ST44Q07      312970 non-null  object
110 ST44Q08      313374 non-null  object
111 ST46Q01      313898 non-null  object
112 ST46Q02      313567 non-null  object
113 ST46Q03      312994 non-null  object
114 ST46Q04      312997 non-null  object
115 ST46Q05      313043 non-null  object
116 ST46Q06      312900 non-null  object
117 ST46Q07      312854 non-null  object
118 ST46Q08      312989 non-null  object
119 ST46Q09      313040 non-null  object
120 ST48Q01      294410 non-null  object
121 ST48Q02      289827 non-null  object
122 ST48Q03      298479 non-null  object
123 ST48Q04      267716 non-null  object
124 ST48Q05      287992 non-null  object
125 ST49Q01      313495 non-null  object
126 ST49Q02      313025 non-null  object
127 ST49Q03      312168 non-null  object
128 ST49Q04      312378 non-null  object
129 ST49Q05      312582 non-null  object
```

```
130 ST49Q06      312571 non-null  object
131 ST49Q07      312425 non-null  object
132 ST49Q09      312752 non-null  object
133 ST53Q01      309947 non-null  object
134 ST53Q02      309880 non-null  object
135 ST53Q03      309272 non-null  object
136 ST53Q04      308931 non-null  object
137 ST55Q01      307761 non-null  object
138 ST55Q02      308171 non-null  object
139 ST55Q03      306090 non-null  object
140 ST55Q04      304130 non-null  object
141 ST57Q01      301367 non-null  float64
142 ST57Q02      269808 non-null  float64
143 ST57Q03      283813 non-null  float64
144 ST57Q04      279657 non-null  float64
145 ST57Q05      289502 non-null  float64
146 ST57Q06      289428 non-null  float64
147 ST61Q01      312799 non-null  object
148 ST61Q02      312284 non-null  object
149 ST61Q03      311616 non-null  object
150 ST61Q04      310304 non-null  object
151 ST61Q05      311698 non-null  object
152 ST61Q06      311376 non-null  object
153 ST61Q07      311797 non-null  object
154 ST61Q08      311498 non-null  object
155 ST61Q09      309084 non-null  object
156 ST62Q01      306484 non-null  object
157 ST62Q02      307481 non-null  object
158 ST62Q03      306602 non-null  object
159 ST62Q04      306319 non-null  object
160 ST62Q06      306733 non-null  object
161 ST62Q07      306627 non-null  object
162 ST62Q08      306640 non-null  object
163 ST62Q09      307479 non-null  object
164 ST62Q10      306316 non-null  object
165 ST62Q11      305550 non-null  object
166 ST62Q12      306327 non-null  object
167 ST62Q13      306158 non-null  object
168 ST62Q15      306297 non-null  object
169 ST62Q16      306406 non-null  object
170 ST62Q17      306784 non-null  object
171 ST62Q19      307729 non-null  object
172 ST69Q01      299618 non-null  float64
173 ST69Q02      298601 non-null  float64
174 ST69Q03      291943 non-null  float64
175 ST70Q01      296878 non-null  float64
176 ST70Q02      298339 non-null  float64
177 ST70Q03      289068 non-null  float64
```

```
178 ST71Q01      255665 non-null  float64
179 ST72Q01      294163 non-null  float64
180 ST73Q01      309601 non-null  object
181 ST73Q02      308965 non-null  object
182 ST74Q01      309845 non-null  object
183 ST74Q02      309303 non-null  object
184 ST75Q01      309289 non-null  object
185 ST75Q02      308663 non-null  object
186 ST76Q01      308980 non-null  object
187 ST76Q02      308489 non-null  object
188 ST77Q01      315248 non-null  object
189 ST77Q02      314913 non-null  object
190 ST77Q04      314368 non-null  object
191 ST77Q05      314827 non-null  object
192 ST77Q06      314807 non-null  object
193 ST79Q01      314909 non-null  object
194 ST79Q02      314328 non-null  object
195 ST79Q03      313955 non-null  object
196 ST79Q04      313906 non-null  object
197 ST79Q05      313637 non-null  object
198 ST79Q06      313875 non-null  object
199 ST79Q07      314093 non-null  object
200 ST79Q08      314201 non-null  object
201 ST79Q10      313979 non-null  object
202 ST79Q11      313782 non-null  object
203 ST79Q12      313472 non-null  object
204 ST79Q15      313846 non-null  object
205 ST79Q17      314039 non-null  object
206 ST80Q01      314171 non-null  object
207 ST80Q04      313521 non-null  object
208 ST80Q05      312593 non-null  object
209 ST80Q06      312490 non-null  object
210 ST80Q07      312521 non-null  object
211 ST80Q08      312591 non-null  object
212 ST80Q09      311814 non-null  object
213 ST80Q10      312305 non-null  object
214 ST80Q11      312865 non-null  object
215 ST81Q01      313982 non-null  object
216 ST81Q02      313546 non-null  object
217 ST81Q03      312716 non-null  object
218 ST81Q04      312994 non-null  object
219 ST81Q05      313436 non-null  object
220 ST82Q01      311690 non-null  object
221 ST82Q02      311243 non-null  object
222 ST82Q03      310986 non-null  object
223 ST83Q01      313505 non-null  object
224 ST83Q02      313112 non-null  object
225 ST83Q03      312943 non-null  object
```

```
226 ST83Q04      312945 non-null  object
227 ST84Q01      310981 non-null  object
228 ST84Q02      311399 non-null  object
229 ST84Q03      310713 non-null  object
230 ST85Q01      312474 non-null  object
231 ST85Q02      312120 non-null  object
232 ST85Q03      311832 non-null  object
233 ST85Q04      311727 non-null  object
234 ST86Q01      313223 non-null  object
235 ST86Q02      312591 non-null  object
236 ST86Q03      312188 non-null  object
237 ST86Q04      312294 non-null  object
238 ST86Q05      311904 non-null  object
239 ST87Q01      311776 non-null  object
240 ST87Q02      312138 non-null  object
241 ST87Q03      310821 non-null  object
242 ST87Q04      310998 non-null  object
243 ST87Q05      310587 non-null  object
244 ST87Q06      310952 non-null  object
245 ST87Q07      310281 non-null  object
246 ST87Q08      310735 non-null  object
247 ST87Q09      311101 non-null  object
248 ST88Q01      311250 non-null  object
249 ST88Q02      310964 non-null  object
250 ST88Q03      310980 non-null  object
251 ST88Q04      311371 non-null  object
252 ST89Q02      311522 non-null  object
253 ST89Q03      311233 non-null  object
254 ST89Q04      311243 non-null  object
255 ST89Q05      311138 non-null  object
256 ST91Q01      311430 non-null  object
257 ST91Q02      310396 non-null  object
258 ST91Q03      309826 non-null  object
259 ST91Q04      309398 non-null  object
260 ST91Q05      309610 non-null  object
261 ST91Q06      309656 non-null  object
262 ST93Q01      312856 non-null  object
263 ST93Q03      312140 non-null  object
264 ST93Q04      311311 non-null  object
265 ST93Q06      312270 non-null  object
266 ST93Q07      312259 non-null  object
267 ST94Q05      312404 non-null  object
268 ST94Q06      312185 non-null  object
269 ST94Q09      311413 non-null  object
270 ST94Q10      311747 non-null  object
271 ST94Q14      312001 non-null  object
272 ST96Q01      311381 non-null  object
273 ST96Q02      311460 non-null  object
```

```
274 ST96Q03      311078 non-null  object
275 ST96Q05      311319 non-null  object
276 ST101Q01     311290 non-null  float64
277 ST101Q02     310906 non-null  float64
278 ST101Q03     310321 non-null  float64
279 ST101Q05     310655 non-null  float64
280 ST104Q01     310449 non-null  float64
281 ST104Q04     309969 non-null  float64
282 ST104Q05     310366 non-null  float64
283 ST104Q06     310156 non-null  float64
284 IC01Q01      296977 non-null  object
285 IC01Q02      297068 non-null  object
286 IC01Q03      295602 non-null  object
287 IC01Q04      297305 non-null  object
288 IC01Q05      296587 non-null  object
289 IC01Q06      294773 non-null  object
290 IC01Q07      296116 non-null  object
291 IC01Q08      297109 non-null  object
292 IC01Q09      296855 non-null  object
293 IC01Q10      297451 non-null  object
294 IC01Q11      295118 non-null  object
295 IC02Q01      296975 non-null  object
296 IC02Q02      295618 non-null  object
297 IC02Q03      294625 non-null  object
298 IC02Q04      296944 non-null  object
299 IC02Q05      296167 non-null  object
300 IC02Q06      295830 non-null  object
301 IC02Q07      294249 non-null  object
302 IC03Q01      293216 non-null  object
303 IC04Q01      296305 non-null  object
304 IC05Q01      485490 non-null  int64
305 IC06Q01      485490 non-null  int64
306 IC07Q01      485490 non-null  int64
307 IC08Q01      294123 non-null  object
308 IC08Q02      293646 non-null  object
309 IC08Q03      293162 non-null  object
310 IC08Q04      293249 non-null  object
311 IC08Q05      293822 non-null  object
312 IC08Q06      293744 non-null  object
313 IC08Q07      293570 non-null  object
314 IC08Q08      293053 non-null  object
315 IC08Q09      293496 non-null  object
316 IC08Q11      293431 non-null  object
317 IC09Q01      292880 non-null  object
318 IC09Q02      292463 non-null  object
319 IC09Q03      291964 non-null  object
320 IC09Q04      292024 non-null  object
321 IC09Q05      291721 non-null  object
```

```
322 IC09Q06      291982 non-null  object
323 IC09Q07      292051 non-null  object
324 IC10Q01      291811 non-null  object
325 IC10Q02      291025 non-null  object
326 IC10Q03      290262 non-null  object
327 IC10Q04      290907 non-null  object
328 IC10Q05      291025 non-null  object
329 IC10Q06      290268 non-null  object
330 IC10Q07      290565 non-null  object
331 IC10Q08      290770 non-null  object
332 IC10Q09      290815 non-null  object
333 IC11Q01      289894 non-null  object
334 IC11Q02      289427 non-null  object
335 IC11Q03      288868 non-null  object
336 IC11Q04      289085 non-null  object
337 IC11Q05      289082 non-null  object
338 IC11Q06      289269 non-null  object
339 IC11Q07      289277 non-null  object
340 IC22Q01      290487 non-null  object
341 IC22Q02      290000 non-null  object
342 IC22Q04      289671 non-null  object
343 IC22Q06      289239 non-null  object
344 IC22Q07      288871 non-null  object
345 IC22Q08      288959 non-null  object
346 EC01Q01      156043 non-null  object
347 EC02Q01      156008 non-null  object
348 EC03Q01      160533 non-null  object
349 EC03Q02      165310 non-null  object
350 EC03Q03      165197 non-null  object
351 EC03Q04      165164 non-null  object
352 EC03Q05      164984 non-null  object
353 EC03Q06      164935 non-null  object
354 EC03Q07      165136 non-null  object
355 EC03Q08      164921 non-null  object
356 EC03Q09      164992 non-null  object
357 EC03Q10      132539 non-null  object
358 EC04Q01A     169730 non-null  float64
359 EC04Q01B     169765 non-null  float64
360 EC04Q01C     169779 non-null  float64
361 EC04Q02A     169783 non-null  float64
362 EC04Q02B     169784 non-null  float64
363 EC04Q02C     169798 non-null  float64
364 EC04Q03A     169796 non-null  float64
365 EC04Q03B     169786 non-null  float64
366 EC04Q03C     169799 non-null  float64
367 EC04Q04A     169655 non-null  float64
368 EC04Q04B     169641 non-null  float64
369 EC04Q04C     169656 non-null  float64
```

```
370 EC04Q05A     169716 non-null  float64
371 EC04Q05B     169716 non-null  float64
372 EC04Q05C     169725 non-null  float64
373 EC04Q06A     169643 non-null  float64
374 EC04Q06B     169640 non-null  float64
375 EC04Q06C     169636 non-null  float64
376 EC05Q01      129658 non-null  object
377 EC06Q01      40345 non-null   object
378 EC07Q01      44012 non-null   object
379 EC07Q02      43219 non-null   object
380 EC07Q03      42277 non-null   object
381 EC07Q04      42832 non-null   object
382 EC07Q05      42864 non-null   object
383 EC08Q01      43633 non-null   object
384 EC08Q02      43393 non-null   object
385 EC08Q03      43489 non-null   object
386 EC08Q04      43330 non-null   object
387 EC09Q03      118588 non-null  object
388 EC10Q01      43293 non-null   object
389 EC11Q02      118637 non-null  object
390 EC11Q03      118659 non-null  object
391 EC12Q01      42909 non-null   object
392 ST22Q01      40721 non-null   object
393 ST23Q01      13730 non-null   object
394 ST23Q02      13512 non-null   object
395 ST23Q03      13497 non-null   object
396 ST23Q04      13411 non-null   object
397 ST23Q05      13450 non-null   object
398 ST23Q06      13373 non-null   object
399 ST23Q07      13411 non-null   object
400 ST23Q08      13382 non-null   object
401 ST24Q01      13457 non-null   object
402 ST24Q02      13351 non-null   object
403 ST24Q03      13281 non-null   object
404 CLCUSE1      412337 non-null  object
405 CLCUSE301    485490 non-null  int64
406 CLCUSE302    485490 non-null  int64
407 DEFFORT      485490 non-null  int64
408 QUESTID      485490 non-null  object
409 BOOKID       485490 non-null  object
410 EASY         485490 non-null  object
411 AGE          485374 non-null  float64
412 GRADE        484617 non-null  float64
413 PROGN        485490 non-null  object
414 ANXMAT       314764 non-null  float64
415 ATSCHL       312584 non-null  float64
416 ATTLNACT     311675 non-null  float64
417 BELONG       313399 non-null  float64
```

```
418 BFMJ2        416150 non-null  float64
419 BMMJ1        364814 non-null  float64
420 CLSMAN       312708 non-null  float64
421 COBN_F       481825 non-null  object
422 COBN_M       481843 non-null  object
423 COBN_S       481836 non-null  object
424 COGACT       314557 non-null  float64
425 CULTDIST     13380 non-null   float64
426 CULTPOS      471357 non-null  float64
427 DISCLIMA     314777 non-null  float64
428 ENTUSE       295195 non-null  float64
429 ESCS         473648 non-null  float64
430 EXAPPLM      313279 non-null  float64
431 EXPUREM      312602 non-null  float64
432 FAILMAT      314448 non-null  float64
433 FAMCON       310304 non-null  float64
434 FAMCONC      308442 non-null  float64
435 FAMSTRUC     429058 non-null  float64
436 FISCED       452903 non-null  object
437 HEDRES       477772 non-null  float64
438 HERITCUL     13496 non-null   float64
439 HISCED       473091 non-null  object
440 HISEI        450621 non-null  float64
441 HOMEPOS      479807 non-null  float64
442 HOMSCH       293194 non-null  float64
443 HOSTCUL      13598 non-null   float64
444 ICTATTNEG    289744 non-null  float64
445 ICTATTPOS    290490 non-null  float64
446 ICTHOME      298740 non-null  float64
447 ICTRES       477754 non-null  float64
448 ICTSCH       297995 non-null  float64
449 IMMIG        471793 non-null  object
450 INFOCAR      165792 non-null  float64
451 INFOJOB1     83305 non-null   float64
452 INFOJOB2     83305 non-null   float64
453 INSTMOT      316322 non-null  float64
454 INTMAT       316708 non-null  float64
455 ISCEDD       485438 non-null  object
456 ISCEDL       485438 non-null  object
457 ISCEDO       485438 non-null  object
458 LANGCOMM     44094 non-null   float64
459 LANGN        481765 non-null  object
460 LANGRPPD     43137 non-null   float64
461 LMINS        282866 non-null  float64
462 MATBEH       313847 non-null  float64
463 MATHEFF      315948 non-null  float64
464 MATINTFC     301360 non-null  float64
465 MATWKETH     314501 non-null  float64
```

```
466 MISCED       467085 non-null  object
467 MMINS        283303 non-null  float64
468 MTSUP        313599 non-null  float64
469 OCOD1        483887 non-null  object
470 OCOD2        482936 non-null  object
471 OPENPS       312766 non-null  float64
472 OUTHOURS     308799 non-null  float64
473 PARED        473091 non-null  float64
474 PERSEV       313172 non-null  float64
475 REPEAT       461117 non-null  object
476 SCMAT        314607 non-null  float64
477 SMINS        270914 non-null  float64
478 STUDREL      313860 non-null  float64
479 SUBNORM      316323 non-null  float64
480 TCHBEHFA     314678 non-null  float64
481 TCHBEHSO     315114 non-null  float64
482 TCHBEHTD     315519 non-null  float64
483 TEACHSUP     316371 non-null  float64
484 TESTLANG     484697 non-null  object
485 TIMEINT      297074 non-null  float64
486 USEMATH      290260 non-null  float64
487 USESCH       292585 non-null  float64
488 WEALTH       479597 non-null  float64
489 ANCATSCHL    306835 non-null  float64
490 ANCATTLNACT  306487 non-null  float64
491 ANCBELONG    307640 non-null  float64
492 ANCCLSMAN    308467 non-null  float64
493 ANCCOGACT    308150 non-null  float64
494 ANCINSTMOT   155221 non-null  float64
495 ANCINTMAT    155280 non-null  float64
496 ANCMATWKETH  153879 non-null  float64
497 ANCMTSUP     308631 non-null  float64
498 ANCSCMAT     306948 non-null  float64
499 ANCSTUDREL   308058 non-null  float64
500 ANCSUBNORM   155233 non-null  float64
501 PV1MATH      485490 non-null  float64
502 PV2MATH      485490 non-null  float64
503 PV3MATH      485490 non-null  float64
504 PV4MATH      485490 non-null  float64
505 PV5MATH      485490 non-null  float64
506 PV1MACC      473031 non-null  float64
507 PV2MACC      473031 non-null  float64
508 PV3MACC      473031 non-null  float64
509 PV4MACC      473031 non-null  float64
510 PV5MACC      473031 non-null  float64
511 PV1MACQ      473031 non-null  float64
512 PV2MACQ      473031 non-null  float64
513 PV3MACQ      473031 non-null  float64
```

```
514 PV4MACQ      473031 non-null  float64
515 PV5MACQ      473031 non-null  float64
516 PV1MACS      473031 non-null  float64
517 PV2MACS      473031 non-null  float64
518 PV3MACS      473031 non-null  float64
519 PV4MACS      473031 non-null  float64
520 PV5MACS      473031 non-null  float64
521 PV1MACU      473031 non-null  float64
522 PV2MACU      473031 non-null  float64
523 PV3MACU      473031 non-null  float64
524 PV4MACU      473031 non-null  float64
525 PV5MACU      473031 non-null  float64
526 PV1MAPE      471439 non-null  float64
527 PV2MAPE      471439 non-null  float64
528 PV3MAPE      471439 non-null  float64
529 PV4MAPE      471439 non-null  float64
530 PV5MAPE      471439 non-null  float64
531 PV1MAPF      471439 non-null  float64
532 PV2MAPF      471439 non-null  float64
533 PV3MAPF      471439 non-null  float64
534 PV4MAPF      471439 non-null  float64
535 PV5MAPF      471439 non-null  float64
536 PV1MAPI      471439 non-null  float64
537 PV2MAPI      471439 non-null  float64
538 PV3MAPI      471439 non-null  float64
539 PV4MAPI      471439 non-null  float64
540 PV5MAPI      471439 non-null  float64
541 PV1READ      485490 non-null  float64
542 PV2READ      485490 non-null  float64
543 PV3READ      485490 non-null  float64
544 PV4READ      485490 non-null  float64
545 PV5READ      485490 non-null  float64
546 PV1SCIE      485490 non-null  float64
547 PV2SCIE      485490 non-null  float64
548 PV3SCIE      485490 non-null  float64
549 PV4SCIE      485490 non-null  float64
550 PV5SCIE      485490 non-null  float64
551 W_FSTUWT     485490 non-null  float64
552 W_FSTR1      485490 non-null  float64
553 W_FSTR2      485490 non-null  float64
554 W_FSTR3      485490 non-null  float64
555 W_FSTR4      485490 non-null  float64
556 W_FSTR5      485490 non-null  float64
557 W_FSTR6      485490 non-null  float64
558 W_FSTR7      485490 non-null  float64
559 W_FSTR8      485490 non-null  float64
560 W_FSTR9      485490 non-null  float64
561 W_FSTR10     485490 non-null  float64
```

```
562 W_FSTR11     485490 non-null  float64
563 W_FSTR12     485490 non-null  float64
564 W_FSTR13     485490 non-null  float64
565 W_FSTR14     485490 non-null  float64
566 W_FSTR15     485490 non-null  float64
567 W_FSTR16     485490 non-null  float64
568 W_FSTR17     485490 non-null  float64
569 W_FSTR18     485490 non-null  float64
570 W_FSTR19     485490 non-null  float64
571 W_FSTR20     485490 non-null  float64
572 W_FSTR21     485490 non-null  float64
573 W_FSTR22     485490 non-null  float64
574 W_FSTR23     485490 non-null  float64
575 W_FSTR24     485490 non-null  float64
576 W_FSTR25     485490 non-null  float64
577 W_FSTR26     485490 non-null  float64
578 W_FSTR27     485490 non-null  float64
579 W_FSTR28     485490 non-null  float64
580 W_FSTR29     485490 non-null  float64
581 W_FSTR30     485490 non-null  float64
582 W_FSTR31     485490 non-null  float64
583 W_FSTR32     485490 non-null  float64
584 W_FSTR33     485490 non-null  float64
585 W_FSTR34     485490 non-null  float64
586 W_FSTR35     485490 non-null  float64
587 W_FSTR36     485490 non-null  float64
588 W_FSTR37     485490 non-null  float64
589 W_FSTR38     485490 non-null  float64
590 W_FSTR39     485490 non-null  float64
591 W_FSTR40     485490 non-null  float64
592 W_FSTR41     485490 non-null  float64
593 W_FSTR42     485490 non-null  float64
594 W_FSTR43     485490 non-null  float64
595 W_FSTR44     485490 non-null  float64
596 W_FSTR45     485490 non-null  float64
597 W_FSTR46     485490 non-null  float64
598 W_FSTR47     485490 non-null  float64
599 W_FSTR48     485490 non-null  float64
600 W_FSTR49     485490 non-null  float64
601 W_FSTR50     485490 non-null  float64
602 W_FSTR51     485490 non-null  float64
603 W_FSTR52     485490 non-null  float64
604 W_FSTR53     485490 non-null  float64
605 W_FSTR54     485490 non-null  float64
606 W_FSTR55     485490 non-null  float64
607 W_FSTR56     485490 non-null  float64
608 W_FSTR57     485490 non-null  float64
609 W_FSTR58     485490 non-null  float64
```

```
 610 W_FSTR59     485490 non-null  float64
 611 W_FSTR60     485490 non-null  float64
 612 W_FSTR61     485490 non-null  float64
 613 W_FSTR62     485490 non-null  float64
 614 W_FSTR63     485490 non-null  float64
 615 W_FSTR64     485490 non-null  float64
 616 W_FSTR65     485490 non-null  float64
 617 W_FSTR66     485490 non-null  float64
 618 W_FSTR67     485490 non-null  float64
 619 W_FSTR68     485490 non-null  float64
 620 W_FSTR69     485490 non-null  float64
 621 W_FSTR70     485490 non-null  float64
 622 W_FSTR71     485490 non-null  float64
 623 W_FSTR72     485490 non-null  float64
 624 W_FSTR73     485490 non-null  float64
 625 W_FSTR74     485490 non-null  float64
 626 W_FSTR75     485490 non-null  float64
 627 W_FSTR76     485490 non-null  float64
 628 W_FSTR77     485490 non-null  float64
 629 W_FSTR78     485490 non-null  float64
 630 W_FSTR79     485490 non-null  float64
 631 W_FSTR80     485490 non-null  float64
 632 WVARSTRR     485490 non-null  int64
 633 VAR_UNIT     485490 non-null  int64
 634 SENWGT_STU   485490 non-null  float64
 635 VER_STU      485490 non-null  object
dtypes: float64(250), int64(18), object(368)
memory usage: 2.3+ GB
```

1.3 Quick data analysis

1. Dataset has 485490 rows, and 635 columns
2. this is a huge dataset, we need to filter out columns based on question we need to answer. since the focus of PISA is math, science and reading. we need to get columns with such important details or have impact. such as:

- math/reading/science score
- internet
- mother, father education
- gender
- mother still available and at home
- father still available and at home
- mother highest schooling
- father highest schooling
- Math scores (5 items)
- reading scores (5 items)
- science scores (5 items)

3. Ration of females to male also 50/50 (more female)

4. students coming from 68 countries (67 to be exact, USA represented by two records Connecticut & Massachusetts. Liechtenstein with total count of 293, while mixco comes first with total rows of 33806. Wonder why Mixco gets the lion share?

[ ]:

1.4 Data wrangling

During my analysis i will try answering the following quetions:

1. How will student from various countries perform in math, reading, and science cosidering mother, father education, work, availability of internet, and textbox?
2. Are there countries that perform better than others?
3. compare results based on gender?

[15]:
```
#Rename some of the columns to be more intiuitive and useful
cols=['CNT','STIDSTD','AGE','ST04Q01','ST11Q01',␣
 ↪'ST11Q02','ST13Q01','ST15Q01','ST17Q01','ST19Q01','ST26Q06','ST26Q10','PV1MATH','PV2MATH','
df_pisa_clean = pd.read_csv('pisa2012.csv', usecols=cols, encoding =␣
 ↪"ISO-8859-1")
```

```
C:\Users\saatt\AppData\Local\Continuum\anaconda3\lib\site-
packages\IPython\core\interactiveshell.py:3063: DtypeWarning: Columns (21,22)
have mixed types.Specify dtype option on import or set low_memory=False.
  interactivity=interactivity, compiler=compiler, result=result)
```

[16]:
```
df_pisa_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 485490 entries, 0 to 485489
Data columns (total 27 columns):
 #   Column    Non-Null Count   Dtype
---  ------    --------------   -----
 0   CNT       485490 non-null  object
 1   STIDSTD   485490 non-null  int64
 2   ST04Q01   485490 non-null  object
 3   ST11Q01   460559 non-null  object
 4   ST11Q02   441036 non-null  object
 5   ST13Q01   457979 non-null  object
 6   ST15Q01   467751 non-null  object
 7   ST17Q01   443261 non-null  object
 8   ST19Q01   451410 non-null  object
 9   ST26Q06   473182 non-null  object
 10  ST26Q10   471242 non-null  object
 11  AGE       485374 non-null  float64
 12  PV1MATH   485490 non-null  float64
 13  PV2MATH   485490 non-null  float64
 14  PV3MATH   485490 non-null  float64
 15  PV4MATH   485490 non-null  float64
```

```
 16  PV5MATH  485490 non-null  float64
 17  PV1READ  485490 non-null  float64
 18  PV2READ  485490 non-null  float64
 19  PV3READ  485490 non-null  float64
 20  PV4READ  485490 non-null  float64
 21  PV5READ  485490 non-null  float64
 22  PV1SCIE  485490 non-null  float64
 23  PV2SCIE  485490 non-null  float64
 24  PV3SCIE  485490 non-null  float64
 25  PV4SCIE  485490 non-null  float64
 26  PV5SCIE  485490 non-null  float64
dtypes: float64(16), int64(1), object(10)
memory usage: 100.0+ MB
```

1.5 fill columns with nan values as below

[17]:
```
#fillna with 'unknown for nan values of mother at home: ST11Q01 & father at␣
 ↪home ST11Q02
#mother at home with unknown
df_pisa_clean['ST11Q01'].fillna('unknown', inplace=True)
# fillna father at home with unknjown
df_pisa_clean['ST11Q02'].fillna('unknown', inplace=True)
#mother highest schooling
df_pisa_clean['ST13Q01'].fillna('unknown', inplace=True)
#mother current job  with unknjown
df_pisa_clean['ST15Q01'].fillna('unknown', inplace=True)
#father highest schooling  with unknjown
df_pisa_clean['ST17Q01'].fillna('unknown', inplace=True)
#father current job  with unknjown
df_pisa_clean['ST19Q01'].fillna('unknown', inplace=True)
#internet  with unknjown
df_pisa_clean['ST26Q06'].fillna('unknown', inplace=True)
#testbook  with unknjown
df_pisa_clean['ST26Q10'].fillna('unknown', inplace=True)
#age with mean age
mean=df_pisa_clean['AGE'].mean()
df_pisa_clean['AGE'].fillna(mean, inplace=True)
```

[18]:
```
df_pisa_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 485490 entries, 0 to 485489
Data columns (total 27 columns):
 #   Column   Non-Null Count   Dtype
---  ------   --------------   -----
 0   CNT      485490 non-null  object
 1   STIDSTD  485490 non-null  int64
 2   ST04Q01  485490 non-null  object
```

```
 3   ST11Q01  485490 non-null  object
 4   ST11Q02  485490 non-null  object
 5   ST13Q01  485490 non-null  object
 6   ST15Q01  485490 non-null  object
 7   ST17Q01  485490 non-null  object
 8   ST19Q01  485490 non-null  object
 9   ST26Q06  485490 non-null  object
 10  ST26Q10  485490 non-null  object
 11  AGE      485490 non-null  float64
 12  PV1MATH  485490 non-null  float64
 13  PV2MATH  485490 non-null  float64
 14  PV3MATH  485490 non-null  float64
 15  PV4MATH  485490 non-null  float64
 16  PV5MATH  485490 non-null  float64
 17  PV1READ  485490 non-null  float64
 18  PV2READ  485490 non-null  float64
 19  PV3READ  485490 non-null  float64
 20  PV4READ  485490 non-null  float64
 21  PV5READ  485490 non-null  float64
 22  PV1SCIE  485490 non-null  float64
 23  PV2SCIE  485490 non-null  float64
 24  PV3SCIE  485490 non-null  float64
 25  PV4SCIE  485490 non-null  float64
 26  PV5SCIE  485490 non-null  float64
dtypes: float64(16), int64(1), object(10)
memory usage: 100.0+ MB
```

[19]:
```
df_pisa_clean['ST11Q02'].value_counts()
```

[19]:
```
Yes        372161
No          68875
unknown     44454
Name: ST11Q02, dtype: int64
```

1.6 Rename columns to be more intuitive and easy to handle

[20]:
```
df_pisa_clean.rename(columns={'CNT': 'country', 'STIDSTD': 'student_id', 'AGE':
 ↪'age','ST04Q01':'gender',
                              'ST11Q01':'mother_at_home','ST11Q02':
 ↪'father_at_home',
                              'ST13Q01':'mother_grade', 'ST15Q01':
 ↪'mother_job','ST17Q01':'father_grade',
                              'ST19Q01':'father_job','ST26Q06':
 ↪'internet','ST26Q10':'textbook'},inplace=True)
```

[21]:
```
df_pisa_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 485490 entries, 0 to 485489
Data columns (total 27 columns):
 #   Column          Non-Null Count   Dtype
---  ------          --------------   -----
 0   country         485490 non-null  object
 1   student_id      485490 non-null  int64
 2   gender          485490 non-null  object
 3   mother_at_home  485490 non-null  object
 4   father_at_home  485490 non-null  object
 5   mother_grade    485490 non-null  object
 6   mother_job      485490 non-null  object
 7   father_grade    485490 non-null  object
 8   father_job      485490 non-null  object
 9   internet        485490 non-null  object
 10  textbook        485490 non-null  object
 11  age             485490 non-null  float64
 12  PV1MATH         485490 non-null  float64
 13  PV2MATH         485490 non-null  float64
 14  PV3MATH         485490 non-null  float64
 15  PV4MATH         485490 non-null  float64
 16  PV5MATH         485490 non-null  float64
 17  PV1READ         485490 non-null  float64
 18  PV2READ         485490 non-null  float64
 19  PV3READ         485490 non-null  float64
 20  PV4READ         485490 non-null  float64
 21  PV5READ         485490 non-null  float64
 22  PV1SCIE         485490 non-null  float64
 23  PV2SCIE         485490 non-null  float64
 24  PV3SCIE         485490 non-null  float64
 25  PV4SCIE         485490 non-null  float64
 26  PV5SCIE         485490 non-null  float64
dtypes: float64(16), int64(1), object(10)
memory usage: 100.0+ MB
```

[22]:
```
# calculate mean value for math, reading, science
# add a new column for total of means
df_pisa_clean['math']=(df_pisa_clean['PV1MATH']+df_pisa_clean['PV2MATH']+df_pisa_clean['PV3MAT
 ↪5
df_pisa_clean['reading']=(df_pisa_clean['PV1READ']+df_pisa_clean['PV2READ']+df_pisa_clean['PV3
 ↪5
df_pisa_clean['science']=(df_pisa_clean['PV1SCIE']+df_pisa_clean['PV2SCIE']+df_pisa_clean['PV3
 ↪5
df_pisa_clean['total']=(df_pisa_clean['math']+df_pisa_clean['reading']+df_pisa_clean['science'
 ↪3
```

[23]:
```
# since we are used the average value for each of Math, reading and science, no␣
↪need to keep the old columns.
df_pisa_clean.drop(columns=['PV1MATH','PV2MATH','PV3MATH','PV4MATH','PV5MATH',
                            'PV1READ','PV2READ','PV3READ','PV4READ','PV5READ',
                            ␣
↪'PV1SCIE','PV2SCIE','PV3SCIE','PV4SCIE','PV5SCIE'],inplace=True)
```

[24]:
```
df_pisa_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 485490 entries, 0 to 485489
Data columns (total 16 columns):
 #   Column          Non-Null Count   Dtype
---  ------          --------------   -----
 0   country         485490 non-null  object
 1   student_id      485490 non-null  int64
 2   gender          485490 non-null  object
 3   mother_at_home  485490 non-null  object
 4   father_at_home  485490 non-null  object
 5   mother_grade    485490 non-null  object
 6   mother_job      485490 non-null  object
 7   father_grade    485490 non-null  object
 8   father_job      485490 non-null  object
 9   internet        485490 non-null  object
 10  textbook        485490 non-null  object
 11  age             485490 non-null  float64
 12  math            485490 non-null  float64
 13  reading         485490 non-null  float64
 14  science         485490 non-null  float64
 15  total           485490 non-null  float64
dtypes: float64(5), int64(1), object(10)
memory usage: 59.3+ MB
```

[25]:
```
df_pisa_clean['mother_grade'].value_counts()
```

[25]:
```
<ISCED level 3A>                          236993
<ISCED level 3B, 3C>                       83048
<ISCED level 2>                            82614
<ISCED level 1>                            36556
unknown                                    27511
She did not complete <ISCED level 1>      18768
Name: mother_grade, dtype: int64
```

[26]:
```
df_pisa_clean['father_grade'].value_counts()
```

[26]:
```
<ISCED level 3A>                          215280
<ISCED level 3B, 3C>                       91179
```

```
<ISCED level 2>                          84329
unknown                                  42229
<ISCED level 1>                          35938
He did not complete <ISCED level 1>      16535
Name: father_grade, dtype: int64
```

[27]:
```
# replace values to be less wordy
df_pisa_clean['mother_grade'].replace({'<ISCED level 3A> ':'ISCED 3A','<ISCED␣
 ↪level 3B, 3C> ': 'ISCED 3B-3C',
                                       '<ISCED level 2> ':'ISCED 2', '<ISCED␣
 ↪level 1> ':'ISCED 1',
                                       'She did not complete <ISCED level 1> ':
 ↪'incomplete ISCED 1'}, inplace=True)

df_pisa_clean['father_grade'].replace({'<ISCED level 3A> ':'ISCED 3A','<ISCED␣
 ↪level 3B, 3C> ': 'ISCED 3B-3C',
                                       '<ISCED level 2> ':'ISCED 2', '<ISCED␣
 ↪level 1> ':'ISCED 1',
                                       'He did not complete <ISCED level 1> ':
 ↪'incomplete ISCED 1'}, inplace=True)
```

[28]:
```
df_pisa_clean['mother_grade'].value_counts()
```

[28]:
```
ISCED 3A              236993
ISCED 3B-3C            83048
ISCED 2                82614
ISCED 1                36556
unknown                27511
incomplete ISCED 1     18768
Name: mother_grade, dtype: int64
```

[29]:
```
df_pisa_clean['father_grade'].value_counts()
```

[29]:
```
ISCED 3A              215280
ISCED 3B-3C            91179
ISCED 2                84329
unknown                42229
ISCED 1                35938
incomplete ISCED 1     16535
Name: father_grade, dtype: int64
```

[30]:
```
df_pisa_clean['internet'].value_counts()
```

[30]:
```
Yes        402040
No          71142
unknown     12308
Name: internet, dtype: int64
```

[31]:
```
df_pisa_clean['textbook'].value_counts()
```

[31]:
```
Yes        389408
No          81834
unknown     14248
Name: textbook, dtype: int64
```

[32]:
```
df_pisa_clean['father_job'].value_counts()
```

[32]:
```
Working full-time <for pay>           339697
Working part-time <for pay>            49503
Other (e.g. home duties, retired)      40588
unknown                                34080
Not working, but looking for a job     21622
Name: father_job, dtype: int64
```

[33]:
```
df_pisa_clean['mother_job'].value_counts()
```

[33]:
```
Working full-time <for pay>            219095
Other (e.g. home duties, retired)      138841
Working part-time <for pay>             78237
Not working, but looking for a job      31578
unknown                                 17739
Name: mother_job, dtype: int64
```

[34]:
```
# replace values to be less wordy
df_pisa_clean['mother_job'].replace({'Working full-time <for pay> ' :␣
 ↪'full-time',
                                     'Other (e.g. home duties, retired) ' :␣
 ↪'others',
                                     'Working part-time <for pay>' :␣
 ↪'part-time',
                                     'Not working, but looking for a job ' :␣
 ↪'unemployed'}, inplace=True)

df_pisa_clean['father_job'].replace({'Working full-time <for pay> ' :␣
 ↪'full-time',
                                     'Other (e.g. home duties, retired) ' :␣
 ↪'others',
                                     'Working part-time <for pay>' :␣
 ↪'part-time',
                                     'Not working, but looking for a job' :␣
 ↪'unemployed'}, inplace=True)
```

[35]:
```
df_pisa_clean['mother_job'].value_counts()
```

[35]:
```
full-time     219095
others        138841
part-time      78237
unemployed     31578
unknown        17739
Name: mother_job, dtype: int64
```

[36]:
```
df_pisa_clean['father_job'].value_counts()
```

[36]:
```
full-time     339697
part-time      49503
others         40588
unknown        34080
unemployed     21622
Name: father_job, dtype: int64
```

[37]:
```
# grades is an ordinal category, assuming unknown as the lowest, and ISCED␣
↪3B-3C is the max
grades_category=['unknown','incomplete ISCED 1','ISCED 1','ISCED 2','ISCED␣
↪3A','ISCED 3B-3C',]
grades=pd.api.types.CategoricalDtype(ordered=True,categories=grades_category)
df_pisa_clean['mother_grade']=df_pisa_clean['mother_grade'].astype(grades)
df_pisa_clean['father_grade']=df_pisa_clean['father_grade'].astype(grades)
```

[38]:
```
# job category is more a nominal datatype, there is not sequence we can use to␣
↪say this is higher than the other.

job_category=['unknown', 'unemployed','part-time', 'full-time', 'others']
jobs=pd.api.types.CategoricalDtype(ordered=False,categories=job_category)
df_pisa_clean['mother_job']=df_pisa_clean['mother_job'].astype(jobs)
df_pisa_clean['father_job']=df_pisa_clean['father_job'].astype(jobs)
```

[39]:
```
# modify type to category for internet, textbook, father_at_home, mother_at_home

df_pisa_clean = df_pisa_clean.astype({'internet':'category', 'textbook':
↪'category',
                                      'gender':'category','mother_at_home':
↪'category','father_at_home':'category'})
```

[40]:
```
df_pisa_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 485490 entries, 0 to 485489
Data columns (total 16 columns):
 #   Column          Non-Null Count   Dtype
---  ------          --------------   -----
 0   country         485490 non-null  object
```

```
 1   student_id      485490 non-null  int64
 2   gender          485490 non-null  category
 3   mother_at_home  485490 non-null  category
 4   father_at_home  485490 non-null  category
 5   mother_grade    485490 non-null  category
 6   mother_job      485490 non-null  category
 7   father_grade    485490 non-null  category
 8   father_job      485490 non-null  category
 9   internet        485490 non-null  category
 10  textbook        485490 non-null  category
 11  age             485490 non-null  float64
 12  math            485490 non-null  float64
 13  reading         485490 non-null  float64
 14  science         485490 non-null  float64
 15  total           485490 non-null  float64
dtypes: category(9), float64(5), int64(1), object(1)
memory usage: 30.1+ MB
```

[41]:
```
df_pisa_clean.head()
```

[41]:

	country	student_id	gender	mother_at_home	father_at_home	\
0	Albania	1	Female	Yes	Yes	
1	Albania	2	Female	Yes	Yes	
2	Albania	3	Female	Yes	Yes	
3	Albania	4	Female	Yes	Yes	
4	Albania	5	Female	Yes	Yes	

	mother_grade	mother_job	father_grade	father_job	internet	textbook	\
0	ISCED 3A	others	ISCED 3A	part-time	No	Yes	
1	ISCED 3A	full-time	ISCED 3A	full-time	Yes	Yes	
2	ISCED 3B-3C	full-time	ISCED 3A	full-time	Yes	Yes	
3	ISCED 3B-3C	full-time	ISCED 3A	full-time	Yes	Yes	
4	incomplete ISCED 1	part-time	ISCED 3B-3C	part-time	Yes	Yes	

	age	math	reading	science	total
0	16.17	366.18634	261.01424	371.91348	333.038020
1	16.17	470.56396	384.68832	478.12382	444.458700
2	15.58	505.53824	405.18154	486.60946	465.776413
3	15.67	449.45476	477.46376	453.97240	460.296973
4	15.50	385.50398	256.01010	367.15778	336.223953

[42]:
```
# Saving clearn dataset to local file
df_pisa_clean.to_csv('df_pisa_clean.csv', index=False)
```

1.6.1 What is the structure of your dataset?

the data structure is very wide, has consideration for many many cases and factors such as job of the father, job for mother, every aspect of living details like if child got a

separte room, type of electornic devices, and so much more. Such details seems to have purposes beyod the objectives of the project, and need deep analysis for optimal use, and probably other aspect which i am not aware of.

1.6.2 What is/are the main feature(s) of interest in your dataset?

Main aspect of my interest is math, science, and reading. this is where i will focus my analysis on.

1.6.3 What features in the dataset do you think will help support your investigation into your feature(s) of interest?

Math, science, and reading each has five separate scores. i have used the mean for each as a separate column. this new value will be used by focus my analysis on.

1.7 Univariate Exploration

In this section, investigate distributions of individual variables. If you see unusual points or outliers, take a deeper look to clean things up and prepare yourself to look at relationships between variables.

Make sure that, after every plot or related series of plots, that you include a Markdown cell with comments about what you observed, and what you plan on investigating next.

[43]:
```
df_pisa_clean[['math','reading','science','total']].describe()
```

[43]:

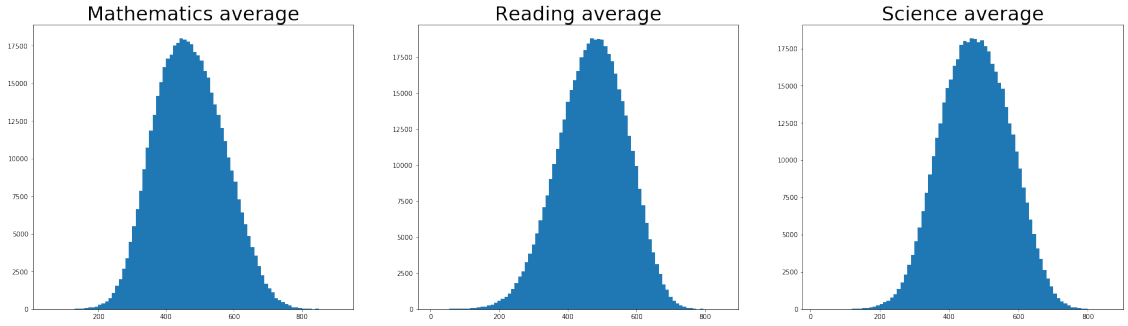
	math	reading	science	total
count	485490.000000	485490.000000	485490.000000	485490.000000
mean	469.651234	472.006964	475.808094	472.488764
std	100.786610	98.863310	97.998470	96.036271
min	54.767080	6.445400	25.158540	77.114593
25%	396.019620	405.044200	405.762800	403.992595
50%	465.734520	475.477980	475.512860	472.046460
75%	540.123060	542.831195	546.381920	541.455700
max	903.107960	849.359740	857.832900	826.592027

[45]:
```
math_bins=np.arange(50,df_pisa_clean['math'].max()+10,10)
reading_bins=np.arange(5,df_pisa_clean['reading'].max()+10,10)
science_bins=np.arange(20,df_pisa_clean['science'].max()+10,10)

plt.figure(figsize=(30,8))
plt.subplot(1, 3, 1)
plt.hist(df_pisa_clean['math'],bins=math_bins);
plt.title('Mathematics average',fontsize=30)


plt.subplot(1, 3, 2)
plt.hist(df_pisa_clean['reading'],bins=reading_bins);
plt.title('Reading average',fontsize=30)
```

```
plt.subplot(1, 3, 3)
plt.hist(df_pisa_clean['science'],bins=science_bins);
plt.title('Science average',fontsize=30);
```



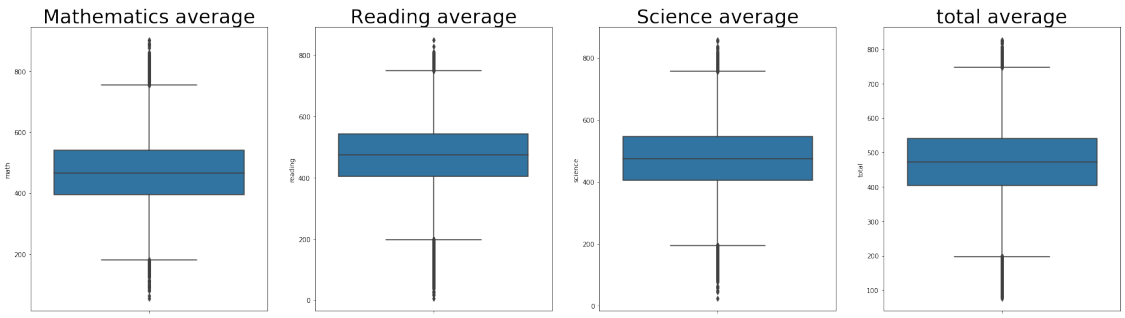
1. All seems like normal ditribution
2. further investigation needs to be done considering country, and gender as well as other categorica variables like internet, mother/father grade, job, etc..

[46]:
```
plt.figure(figsize=(30,8))
plt.subplot(1, 4, 1)
sb.boxplot(y=df_pisa_clean['math'])
plt.title('Mathematics average',fontsize=30)


plt.subplot(1, 4, 2)
sb.boxplot(y=df_pisa_clean['reading'])
plt.title('Reading average',fontsize=30)


plt.subplot(1, 4, 3)
sb.boxplot(y=df_pisa_clean['science'])
plt.title('Science average',fontsize=30);

plt.subplot(1, 4, 4)
sb.boxplot(y=df_pisa_clean['total'])
plt.title('total average',fontsize=30);
```

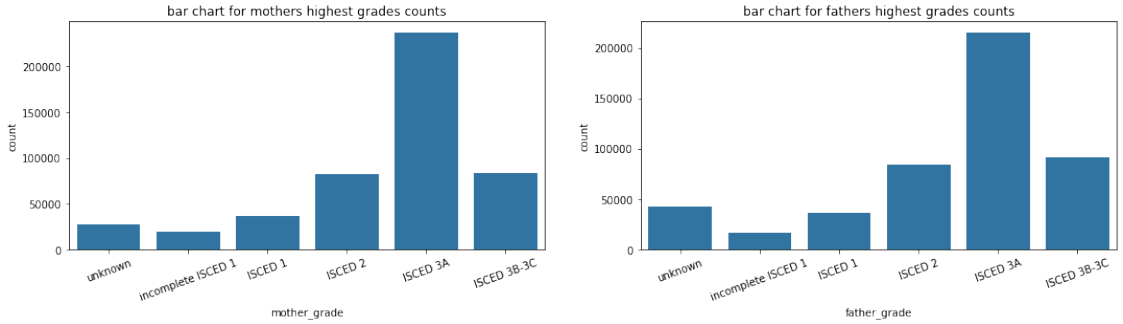


[47]:
```
color=sb.color_palette()[0]
plt.figure(figsize=(18,4))

plt.subplot(1, 2, 1)
sb.countplot(data=df_pisa_clean,x='mother_grade',color=color)
plt.title('bar chart for mothers highest grades counts')
plt.xticks(rotation=20)

plt.subplot(1, 2, 2)
sb.countplot(data=df_pisa_clean,x='father_grade',color=color)
plt.title('bar chart for fathers highest grades counts')
plt.xticks(rotation=20)
```

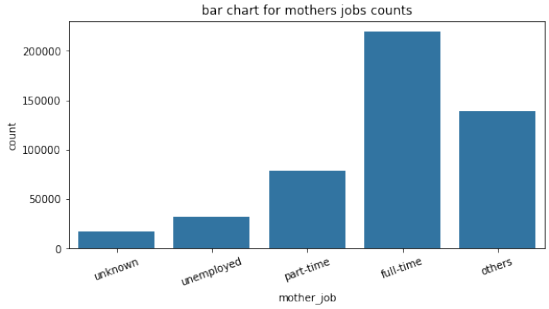
[47]: (array([0, 1, 2, 3, 4, 5]), <a list of 6 Text xticklabel objects>)

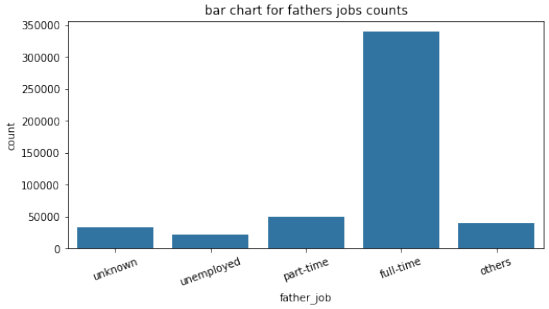


[48]:
```
color=sb.color_palette()[0]
plt.figure(figsize=(18,4))

plt.subplot(1, 2, 1)
sb.countplot(data=df_pisa_clean,x='mother_job',color=color);
plt.title('bar chart for mothers jobs counts');
plt.xticks(rotation=20);
```

```
plt.subplot(1, 2, 2)
sb.countplot(data=df_pisa_clean,x='father_job',color=color);
plt.title('bar chart for fathers jobs counts');
plt.xticks(rotation=20);
```

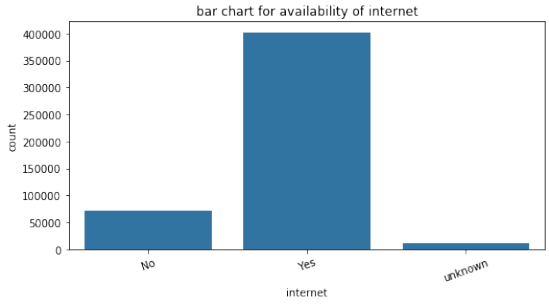


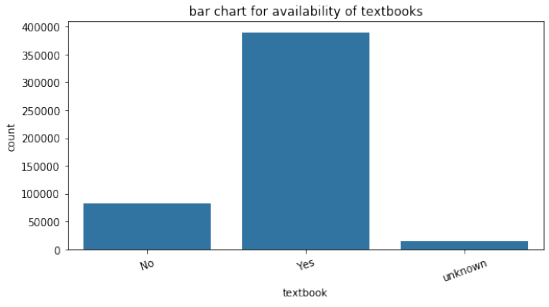


[49]:
```
color=sb.color_palette()[0]
plt.figure(figsize=(18,4))

plt.subplot(1, 2, 1)
sb.countplot(data=df_pisa_clean,x='internet',color=color);
plt.title('bar chart for availability of internet');
plt.xticks(rotation=20);

plt.subplot(1, 2, 2)
sb.countplot(data=df_pisa_clean,x='textbook',color=color);
plt.title('bar chart for availability of textbooks');
plt.xticks(rotation=20);
```



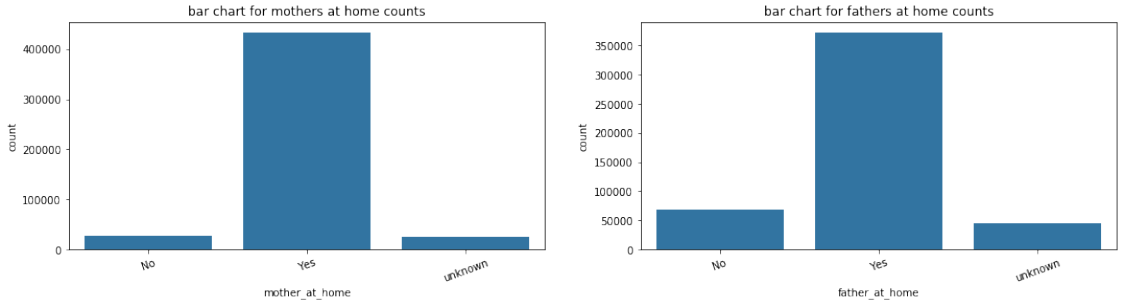


[50]:
```
color=sb.color_palette()[0]
plt.figure(figsize=(18,4))

plt.subplot(1, 2, 1)
sb.countplot(data=df_pisa_clean,x='mother_at_home',color=color);
plt.title('bar chart for mothers at home counts');
```

```
plt.xticks(rotation=20);

plt.subplot(1, 2, 2)
sb.countplot(data=df_pisa_clean,x='father_at_home',color=color);
plt.title('bar chart for fathers at home counts');
plt.xticks(rotation=20);
```



1. using boxplot we notice big range of outliars, this is also clear when we used the describe method for the three columns (math, reading, and science)
2. math average seems to have the lowest median
3. conclusion, we need to investigate data using bivariant exploration on country, gender, age, and other variables

1.7.1 Discuss the distribution(s) of your variable(s) of interest. Were there any unusual points? Did you need to perform any transformations?

using the average value along gives normal distribution, but there are many outliars which indicates variations based on other factors

1.7.2 Of the features you investigated, were there any unusual distributions? Did you perform any operations on the data to tidy, adjust, or change the form of the data? If so, why did you do this?

i used the mean for the three most important features math, reading, science to analyze the data

1.8 Bivariate Exploration

In this section, investigate relationships between pairs of variables in your data. Make sure the variables that you cover here have been introduced in some fashion in the previous section (univariate exploration).

check for math, reading, science average based on counties to find any relation between top permers and countries

[53]:
```
df_pisa_countries = df_pisa_clean.
↪groupby('country')[['math','reading','science','total']].mean()
```

[54]:
```
df_pisa_countries.sort_values(by='total', ascending=False).head(10)
```

[54]:

country	math	reading	science	total
China-Shanghai	611.438933	568.629233	579.556540	586.541569
Hong Kong-China	561.052123	544.521735	554.986433	553.520097
Singapore	568.546974	537.742138	546.822920	551.037344
Korea	553.752034	535.805221	537.831998	542.463084
Japan	535.925248	537.722484	546.413455	540.020395
Chinese Taipei	558.312010	522.185472	522.356935	534.284806
Liechtenstein	538.886608	518.275718	527.598522	528.253616
Estonia	522.340803	518.208090	543.241849	527.930247
Poland	520.522589	520.763584	528.245169	523.177114
Macao-China	538.319791	509.095969	520.690411	522.702057

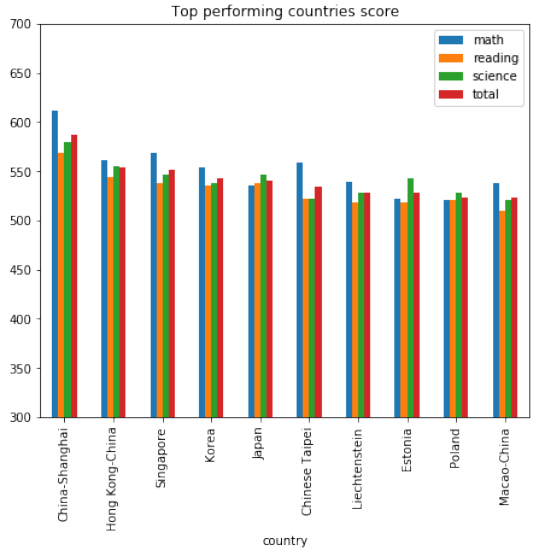
[55]:
```
df_pisa_countries.sort_values(by='total', ascending=False).tail(10)
```

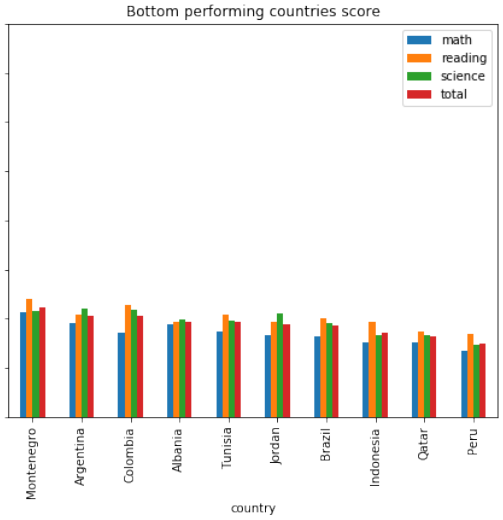
[55]:

country	math	reading	science	total
Montenegro	406.728296	419.983824	408.197858	411.636659
Argentina	395.635711	403.596060	410.478404	403.236725
Colombia	385.972409	414.221547	408.862431	403.018796
Albania	394.878912	396.250245	398.916529	396.681895
Tunisia	387.434260	403.614273	397.831316	396.293283
Jordan	382.739077	396.514701	404.795878	394.683219
Brazil	382.547146	400.421704	395.513221	392.827357
Indonesia	375.621968	397.114815	382.744804	385.160529
Qatar	376.339232	387.407142	383.531664	382.426012
Peru	367.859676	384.453116	373.440303	375.251032

[154]:
```
f,axes = plt.subplots(1,2, figsize=(16,6), sharey=True)
df_pisa_countries.sort_values(by='total', ascending=False).head(10).
 ↪plot(kind='bar',ax=axes[0])
df_pisa_countries.sort_values(by='total', ascending=False).tail(10).
 ↪plot(kind='bar',ax=axes[1]);
axes[0].set_title('Top performing countries score');
axes[1].set_title('Bottom performing countries score');
plt.ylim(300,700)
```

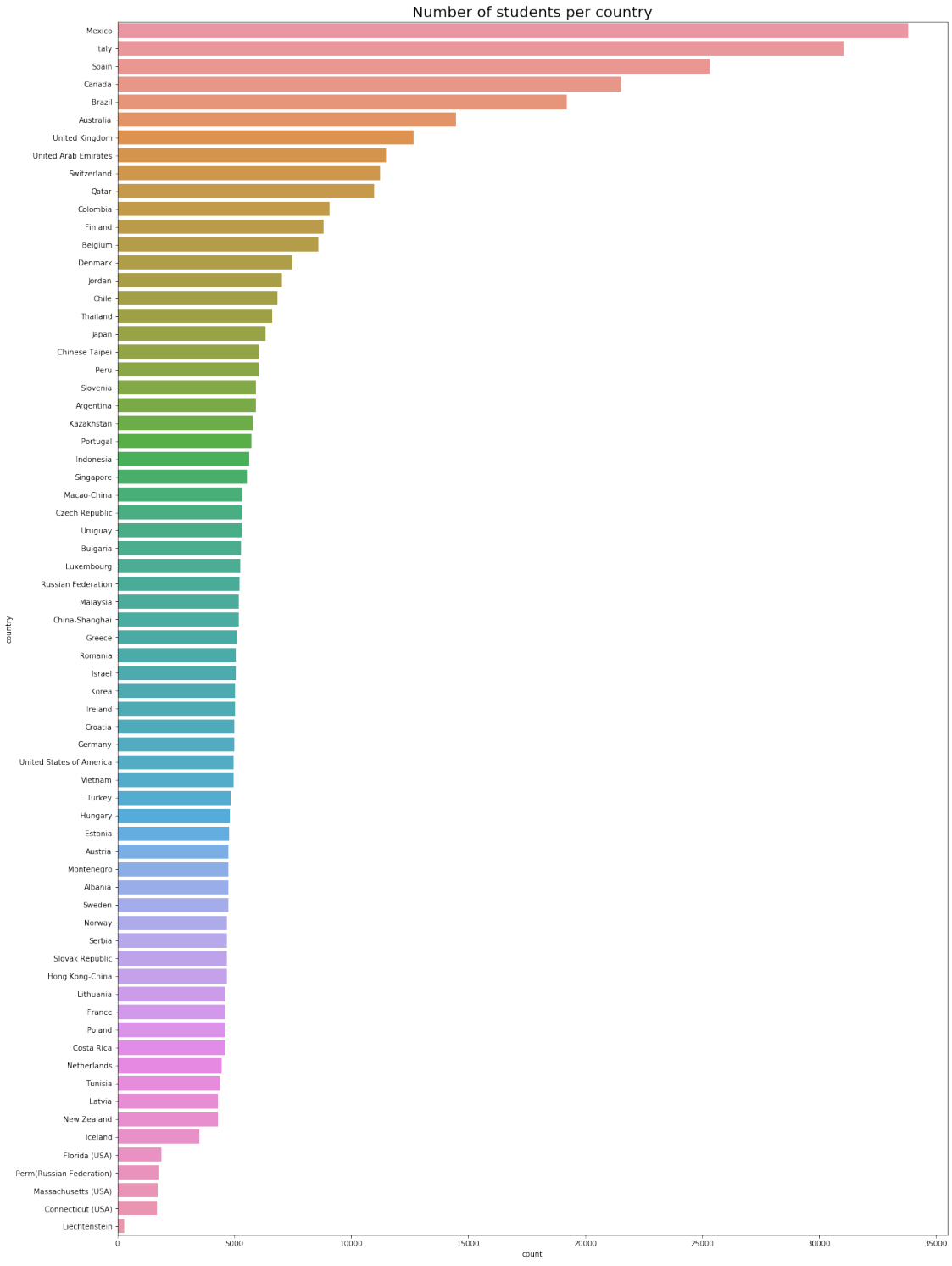
[154]: (300, 700)





1. Around 7 out of 10 top performer countries are in Far east, remaining 3 in Europe
2. Countries coming at the bottom mainly from South America and middle east, Peru coming at last place.
3. more investigation on total average

[56]:
```
order= df_pisa_clean['country'].value_counts().index
plt.figure(figsize=[20,30])
sb.countplot(data=df_pisa_clean,y='country',order=order)
plt.title('Number of students per country',size=20);
```



[57]:
```
df_pisa_gender = df_pisa_clean.
 ↪groupby('gender')[['math','reading','science','total']].mean().reset_index()
df_pisa_gender
```

[57]:

	gender	math	reading	science	total
0	Female	464.060962	489.719710	475.348653	476.376442
1	Male	475.349347	453.952526	476.276398	468.526090

[58]:
```
489.719710-453.95252
```

[58]:
```
35.76719000000003
```

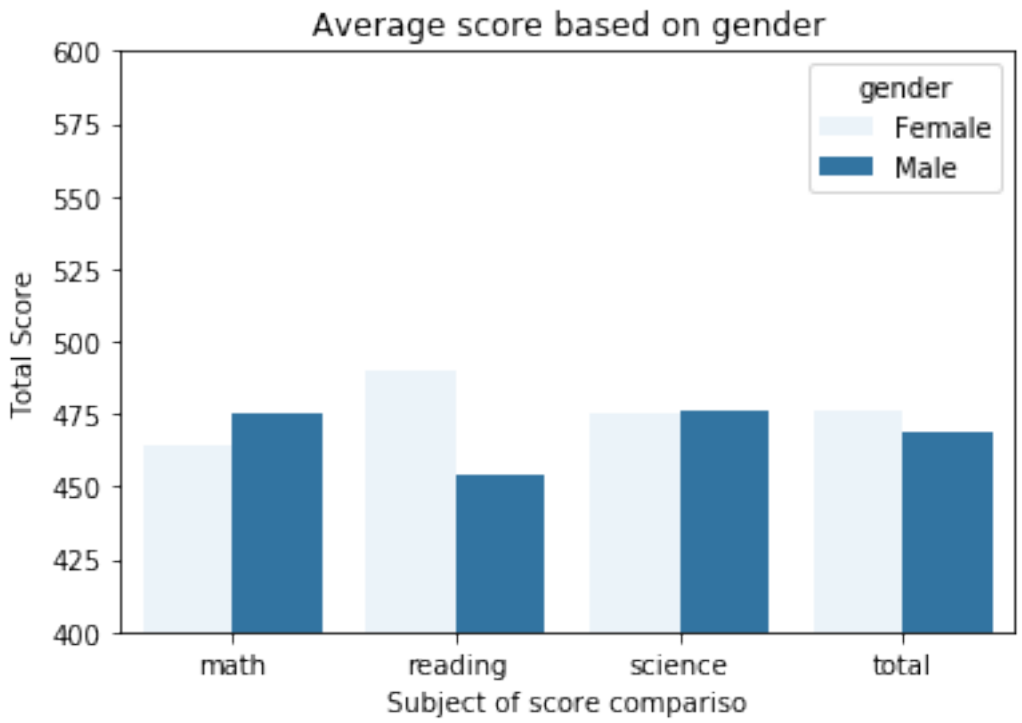
[59]:
```
df_pisa_gender_melt = pd.melt(df_pisa_gender, id_vars=['gender'])
df_pisa_gender_melt
```

[59]:

	gender	variable	value
0	Female	math	464.060962
1	Male	math	475.349347
2	Female	reading	489.719710
3	Male	reading	453.952526
4	Female	science	475.348653
5	Male	science	476.276398
6	Female	total	476.376442
7	Male	total	468.526090

[66]:
```
sb.barplot(data=df_pisa_gender_melt, x="variable",y="value",hue="gender",␣
↪color=sb.color_palette()[0])

plt.title('Average score based on gender')
plt.xlabel('Subject of score compariso')
plt.ylabel('Total Score')
plt.ylim(400, 600);
```



1. Based on each subject, females have better scores in reading, while males are better in science and Math.
2. Comparing results based on Total average, Females are doing better.This has to do with the almost 35% diffence in reading.

[63]:
```
df_pisa_internet = df_pisa_clean.
↪groupby('internet')[['math','reading','science','total']].mean().
↪reset_index()
df_pisa_internet
```

[63]:

	internet	math	reading	science	total
0	No	400.018756	408.247075	409.686776	405.984202
1	Yes	484.814701	486.403139	490.411081	487.209640
2	unknown	376.823281	370.298152	380.993168	376.038200

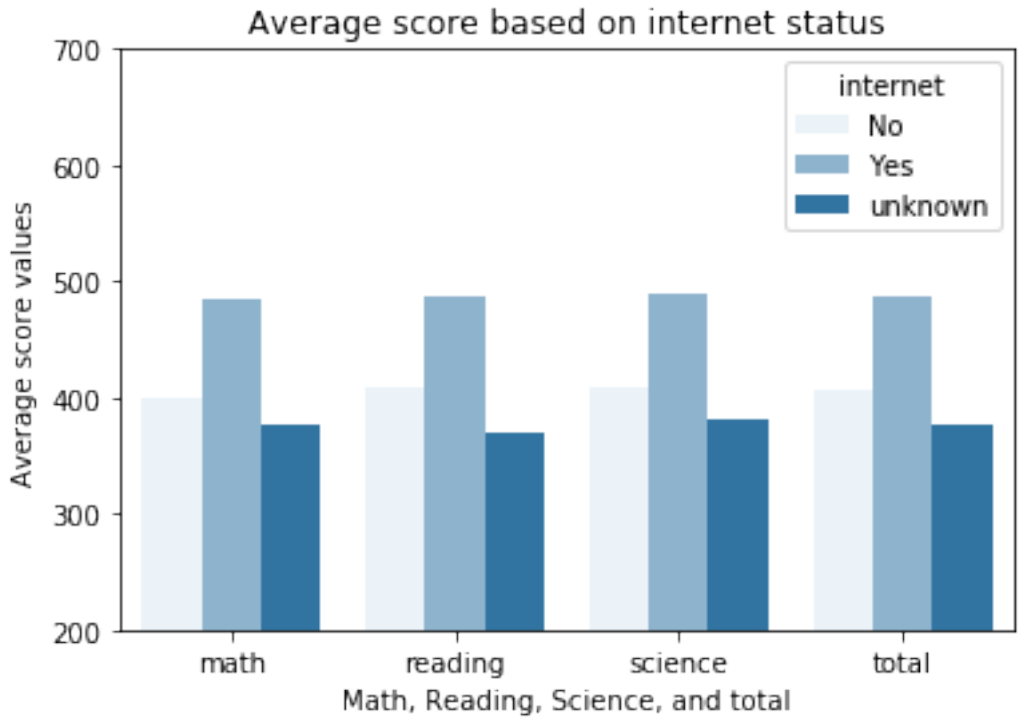
[64]:
```
df_pisa_internet_melt = pd.melt(df_pisa_internet, id_vars=['internet'])
df_pisa_internet_melt
```

[64]:

	internet	variable	value
0	No	math	400.018756
1	Yes	math	484.814701
2	unknown	math	376.823281
3	No	reading	408.247075
4	Yes	reading	486.403139

```
5   unknown  reading  370.298152
6        No  science  409.686776
7       Yes  science  490.411081
8   unknown  science  380.993168
9        No    total  405.984202
10      Yes    total  487.209640
11  unknown    total  376.038200
```

[65]:
```
sb.barplot(data=df_pisa_internet_melt,␣
 ↪x="variable",y="value",hue="internet",color=sb.color_palette()[0])
plt.ylim(200,700)
plt.xlabel('Math, Reading, Science, and total');
plt.ylabel('Average score values');
plt.title('Average score based on internet status');
```

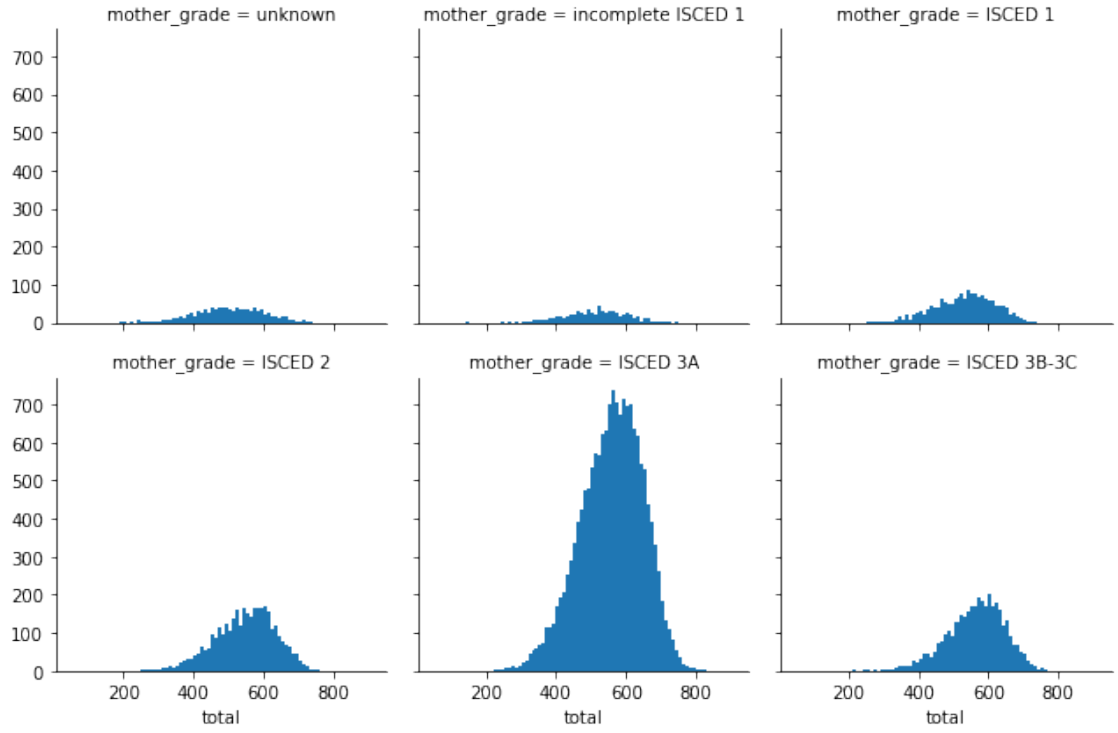


[101]:
```
df_top_5_countries=df_pisa_clean.groupby('country').
 ↪mean()[['math','reading','science','total']].sort_values(by='total',␣
 ↪ascending=False).head(5)
top_countries_list=df_top_5_countries.index.to_list()
df_top_5_countries=df_top_5_countries.reset_index()
df_top_5_countries=df_pisa_clean.loc[df_pisa_clean['country'].
 ↪isin(top_countries_list)]
df_top_5_countries['country'].value_counts()
```

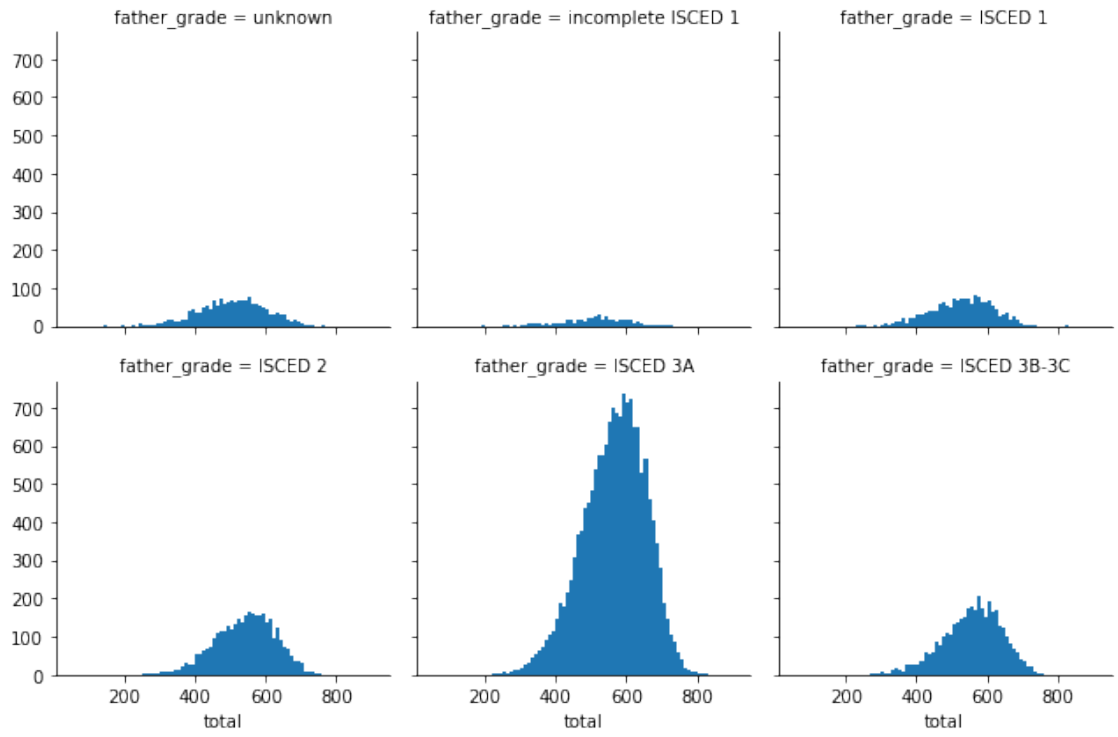
[101]:
```
Japan              6351
Singapore          5546
China-Shanghai     5177
Korea              5033
Hong Kong-China    4670
Name: country, dtype: int64
```

[110]:
```
def plot_facegrid_hist(datafram, col, bins):
    g = sb.FacetGrid(data = datafram, col = col,col_wrap=3,sharey=True)
    g.map(plt.hist, "total",bins=bins)
```

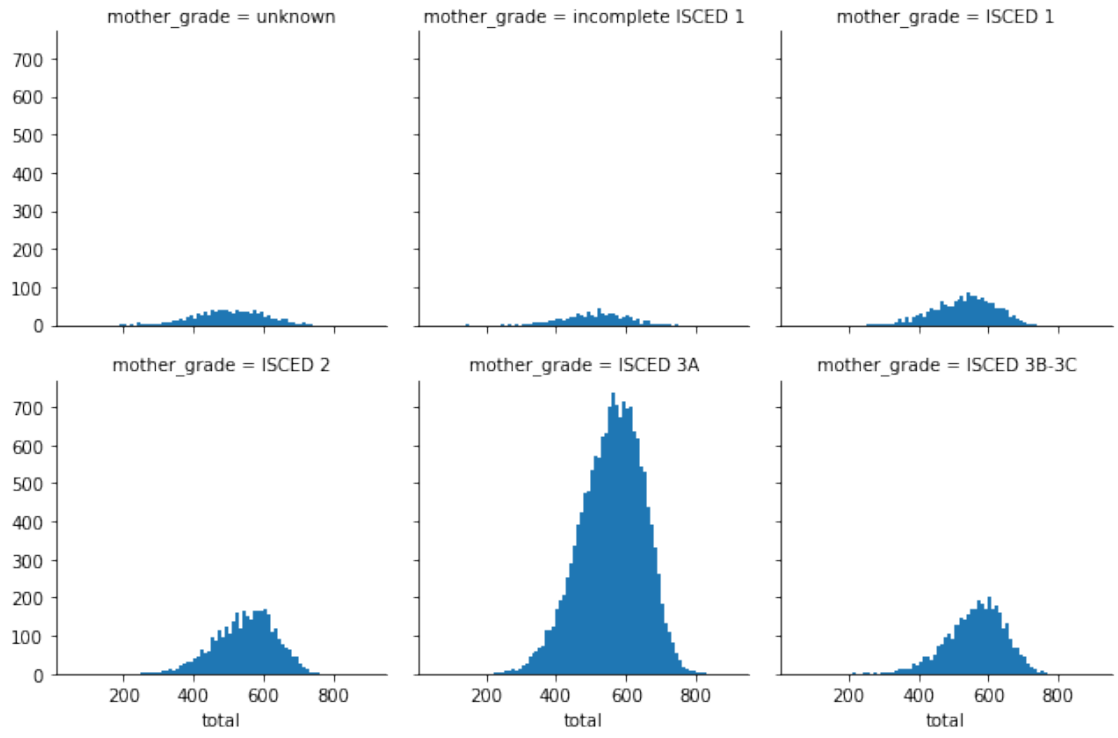
[111]:
```
plot_facegrid_hist(df_top_5_countries, 'mother_grade', math_bins)
```



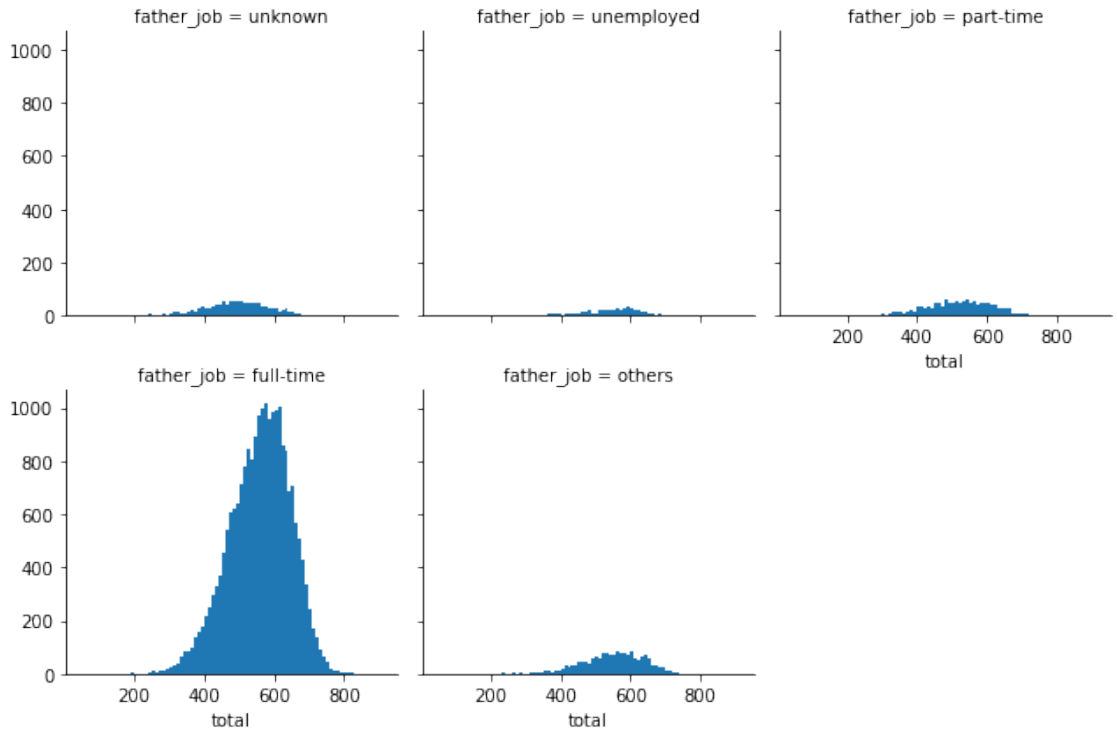
[112]:
```
plot_facegrid_hist(df_top_5_countries, 'father_grade', math_bins)
```



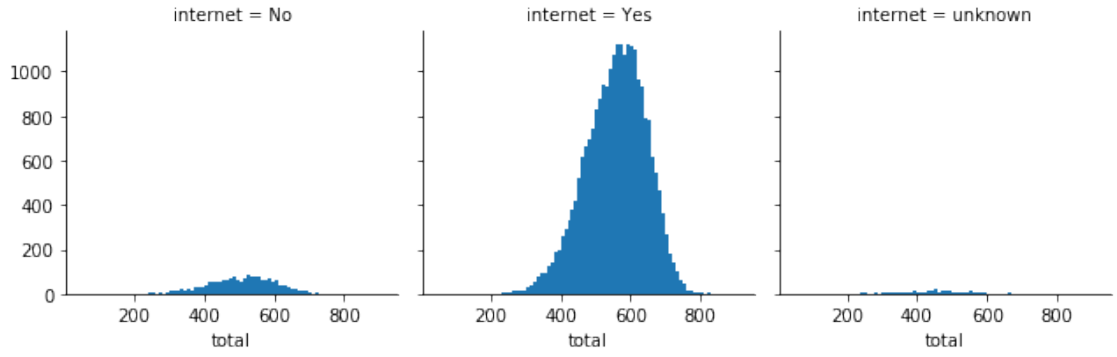
[113]:
```
plot_facegrid_hist(df_top_5_countries, 'mother_grade', math_bins)
```



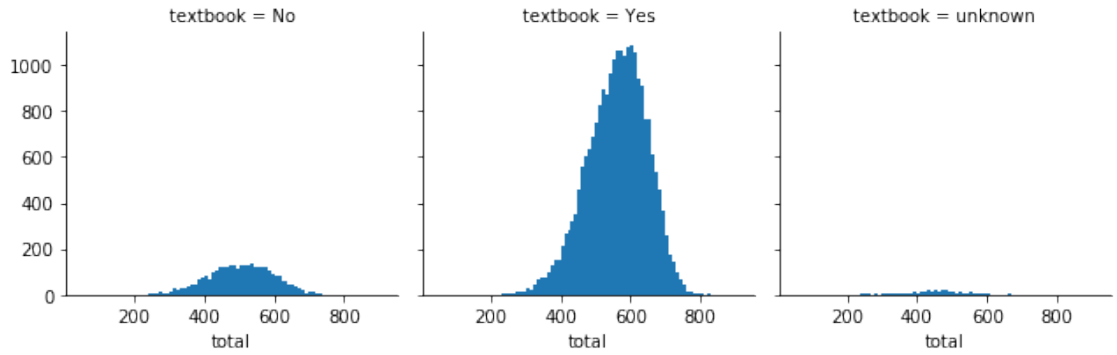
[114]:
```
plot_facegrid_hist(df_top_5_countries, 'father_job', math_bins)
```



[115]:
```
plot_facegrid_hist(df_top_5_countries, 'internet', math_bins)
```



[116]:
```
plot_facegrid_hist(df_top_5_countries, 'textbook', math_bins)
```



1. Data shows that most of the students have parents (mother / father) that finished 'ISCED level 3A' level
2. same for full time working mom / dads
3. most people have internet, and textbook

1.8.1 Talk about some of the relationships you observed in this part of the investigation. How did the feature(s) of interest vary with other features in the dataset?

1. the internet had a huge impact on the scores compared with student who didn't have access to internet

1.8.2 Did you observe any interesting relationships between the other features (not the main feature(s) of interest)?

1. Females in generals had better scores specially in reading
2. Around 7 out of 10 top performer countries are in Far east, remaining 3 in Europe
3. low performing countries range from South America & middle east, Peru at last place.

1.9 Multivariate Exploration

Create plots of three or more variables to investigate your data even further. Make sure that your investigations are justified, and follow from your work in the previous sections.

[122]:
```
df_pisa_clean_copy=df_pisa_clean.copy()
```

[123]:
```
df_pisa_clean_copy.drop(columns=['total'], inplace=True)
```

[124]:
```
df_pisa_clean_melt = df_pisa_clean_copy.
↪melt(id_vars=['country','student_id','gender','mother_at_home','father_at_home','mother_gra

↪'father_job','mother_job','internet','textbook','age'],
                    var_name='material',value_name='score')
```

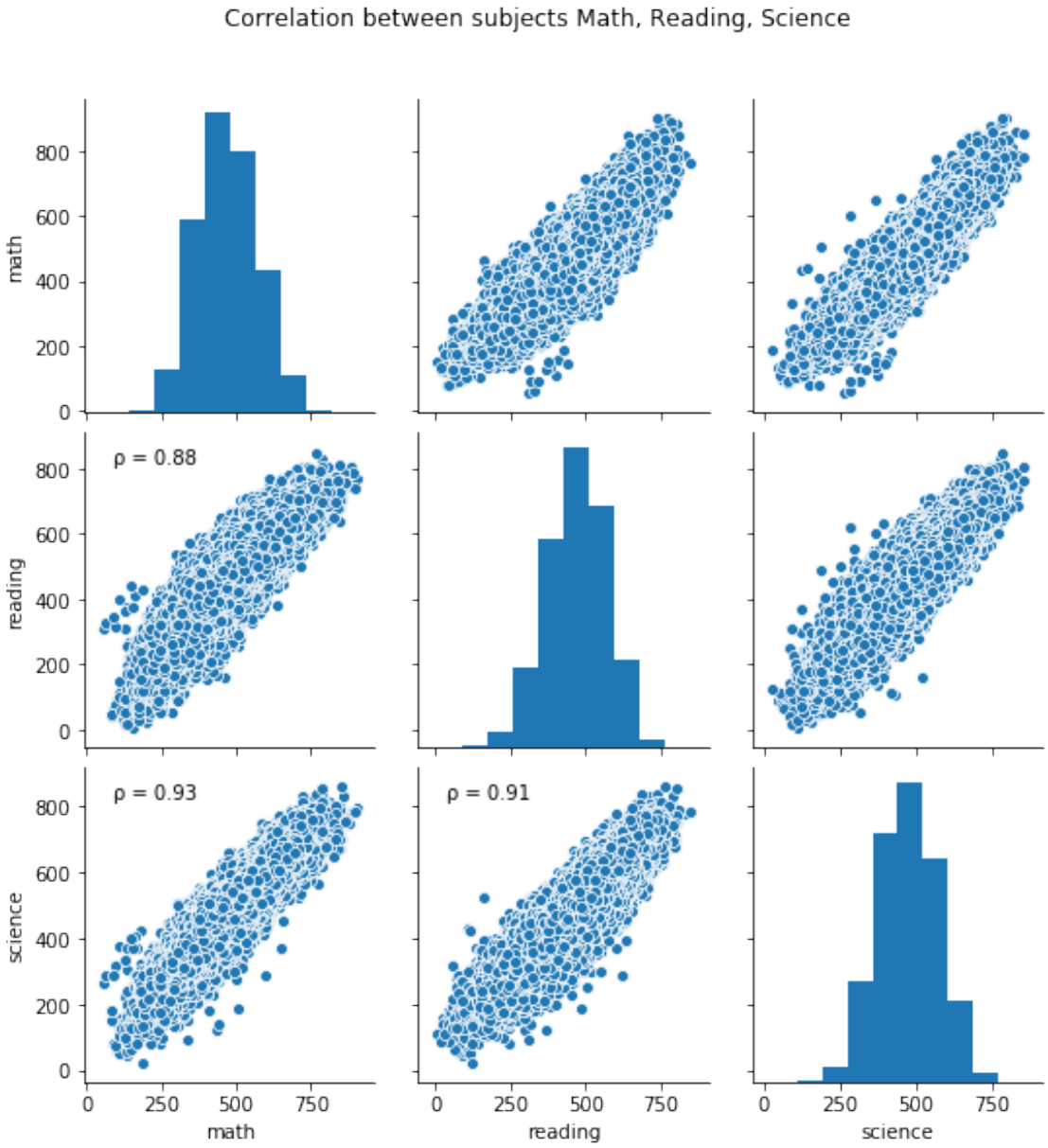
[125]:
```
df_pisa_clean_melt.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1456470 entries, 0 to 1456469
Data columns (total 14 columns):
 #   Column          Non-Null Count    Dtype
---  ------          --------------    -----
 0   country         1456470 non-null  object
 1   student_id      1456470 non-null  int64
 2   gender          1456470 non-null  category
 3   mother_at_home  1456470 non-null  category
 4   father_at_home  1456470 non-null  category
 5   mother_grade    1456470 non-null  category
 6   father_grade    1456470 non-null  category
 7   father_job      1456470 non-null  category
 8   mother_job      1456470 non-null  category
 9   internet        1456470 non-null  category
 10  textbook        1456470 non-null  category
 11  age             1456470 non-null  float64
 12  material        1456470 non-null  object
 13  score           1456470 non-null  float64
dtypes: category(9), float64(2), int64(1), object(2)
memory usage: 68.1+ MB
```

[131]:
```
#source: https://stackoverflow.com/questions/30942577/
 ↪seaborn-correlation-coefficient-on-pairgrid

from scipy.stats import pearsonr

def corrfunc(x,y, ax=None, **kws):
    """Plot the correlation coefficient in the top left hand corner of a plot.
 ↪"""
    r, _ = pearsonr(x, y)
    ax = ax or plt.gca()
    # Unicode for lowercase rho ( )
    rho = '\u03C1'
    ax.annotate(f'{rho} = {r:.2f}', xy=(.1, .9), xycoords=ax.transAxes)
g = sb.pairplot(data = df_pisa_clean, vars=["math", "reading", "science"]);
g.map_lower(corrfunc);
g.fig.suptitle("Correlation between subjects Math, Reading, Science",y=1.08);
```



we see stronge correlation for all plots, highest between math and science.

1.9.1 Talk about some of the relationships you observed in this part of the investigation. Were there features that strengthened each other in terms of looking at your feature(s) of interest?

The dataset used for analysis limited capabilities to make extensive relations for multivariant exploration. most of the details is already clear in the single / bivariant. the correlation diagram indicates stonge relation between scores in math, reading, science and score. highest between math and science.

1.9.2 Were there any interesting or surprising interactions between features?

most surpirsing is the impact on having internet on the students scores.