Student Performance Data Analysis and Visualization

1. Introduction

This data set consists of the marks secured by the students in various subjects. Let's try to understand the influence of the parents background, test preparation etc on students performance.

Why is it important to analyze student performance?

Analyzing student work is an essential aspect of teaching. Teachers regularly assign, collect, and examine student work to assess their learning and to refine and enhance their teaching methods. Ongoing assessment of student learning enables teachers to engage in continuous quality improvement of their courses. Several factors can influence a student's performance, such as the impact of parental educational background, test preparation, and student health.

2. Loading libraries and data

In [1]:
```
import pandas as pd
import missingno as msno
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns


%matplotlib inline
```

In [2]:
```
import warnings
warnings.filterwarnings("ignore")
```

In [3]:
```
df=pd.read_csv("../input/students-performance-in-exams/StudentsPerformance.csv")
```

---

3. Quick look at the data

In [4]:
```
df.shape
```

Out[4]:
```
(1000, 8)
```

In [5]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 8 columns):
 #   Column                       Non-Null Count  Dtype 
---  ------                       --------------  ----- 
 0   gender                       1000 non-null   object
 1   race/ethnicity               1000 non-null   object
 2   parental level of education  1000 non-null   object
 3   lunch                        1000 non-null   object
 4   test preparation course      1000 non-null   object
 5   math score                   1000 non-null   int64 
 6   reading score                1000 non-null   int64 
 7   writing score                1000 non-null   int64 
dtypes: int64(3), object(5)
memory usage: 62.6+ KB
```

take a look at data

In [6]:
```
df
```

Out[6]:

	gender	race/ethnicity	parental level of education	lunch	test preparation course	math score	reading score	writing score
0	female	group B	bachelor's degree	standard	none	72	72	74
1	female	group C	some college	standard	completed	69	90	88
2	female	group B	master's degree	standard	none	90	95	93
3	male	group A	associate's degree	free/reduced	none	47	57	44
4	male	group C	some college	standard	none	76	78	75
...	...	...	...	...	...	...	...	...
995	female	group E	master's degree	standard	completed	88	99	95
996	male	group C	high school	free/reduced	none	62	55	55
997	female	group C	high school	free/reduced	completed	59	71	65
998	female	group D	some college	standard	completed	68	78	77
999	female	group D	some college	free/reduced	none	77	86	86

1000 rows × 8 columns

In [7]:
```
df.columns
```

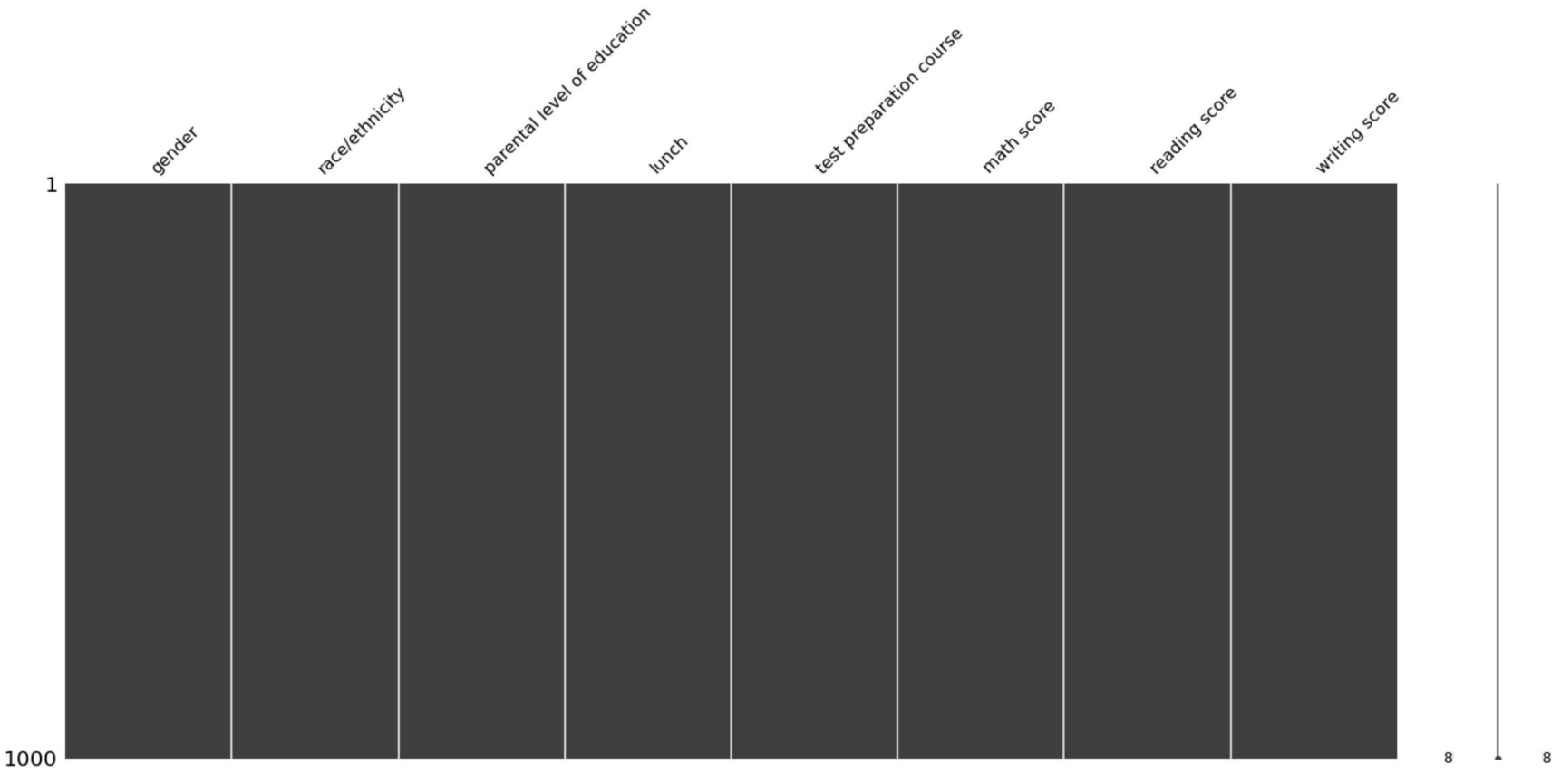
Out[7]:
```
Index(['gender', 'race/ethnicity', 'parental level of education', 'lunch',
       'test preparation course', 'math score', 'reading score',
       'writing score'],
      dtype='object')
```

Attribute Information

Column Name	Description
gender	Male/ Female
race/ethnicity	Group division from A to E
parental level of education	Details of parental education varying from high school to master's degree
lunch	Type of lunch selected
test preparation course	Course details
math score	Marks secured by a student in Mathematics
reading score	Marks secured by a student in Reading
writing score	Marks secured by a student in Writing

4. Visualize missing values

In [8]:
```
msno.matrix(df);
```



Using this matrix you can very quickly find the pattern of missingness in the dataset.

From the above visualisation we can observe that no peculiar pattern can be found.

In [9]:
```
df.isna().sum()
```

Out[9]:
```
gender                         0
race/ethnicity                 0
parental level of education    0
lunch                          0
test preparation course        0
math score                     0
reading score                  0
writing score                  0
dtype: int64
```

There are no missing values in the dataset

5. Data Prep

For a particular course, the total marks is 100. So let's set passmark has 35 marks.

In [10]:
```
#initializing the passmarks
passmark=35
```

Let's create three new columns: `Total_Marks` , `Percentage` and `grade`

In [11]:
```
df['Percentage'] = (df['math score']+df['reading score']+df['writing score'])/3
```

Grading System

Percentage Range	Grade	Qualification
>= 95	O	Outstanding
>= 81	A	Very Good
>= 71	B	Good
>= 61	C	Average
>= 51	D	Sufficient
>= 41	E	Passable
< 41	F	Fail

In [12]:
```
def Grade(Percentage):
    if (Percentage >= 95):return 'O'
    if (Percentage >= 81):return 'A'
    if (Percentage >= 71):return 'B'
    if (Percentage >= 61):return 'C'
    if (Percentage >= 51):return 'D'
    if (Percentage >= 41):return 'E'
    else: return 'F'

df["grade"] = df.apply(lambda x : Grade(x["Percentage"]), axis=1)
```

In [13]:
```
df.head(10)
```

Out[13]:

	gender	race/ethnicity	parental level of education	lunch	test preparation course	math score	reading score	writing score	Percentage	grade
0	female	group B	bachelor's degree	standard	none	72	72	74	72.666667	B
1	female	group C	some college	standard	completed	69	90	88	82.333333	A
2	female	group B	master's degree	standard	none	90	95	93	92.666667	A
3	male	group A	associate's degree	free/reduced	none	47	57	44	49.333333	E
4	male	group C	some college	standard	none	76	78	75	76.333333	B
5	female	group B	associate's degree	standard	none	71	83	78	77.333333	B
6	female	group B	some college	standard	completed	88	95	92	91.666667	A
7	male	group B	some college	free/reduced	none	40	43	39	40.666667	F
8	male	group D	high school	free/reduced	completed	64	64	67	65.000000	C
9	female	group B	high school	free/reduced	none	38	60	50	49.333333	E

In [14]:
```
df.describe()
```

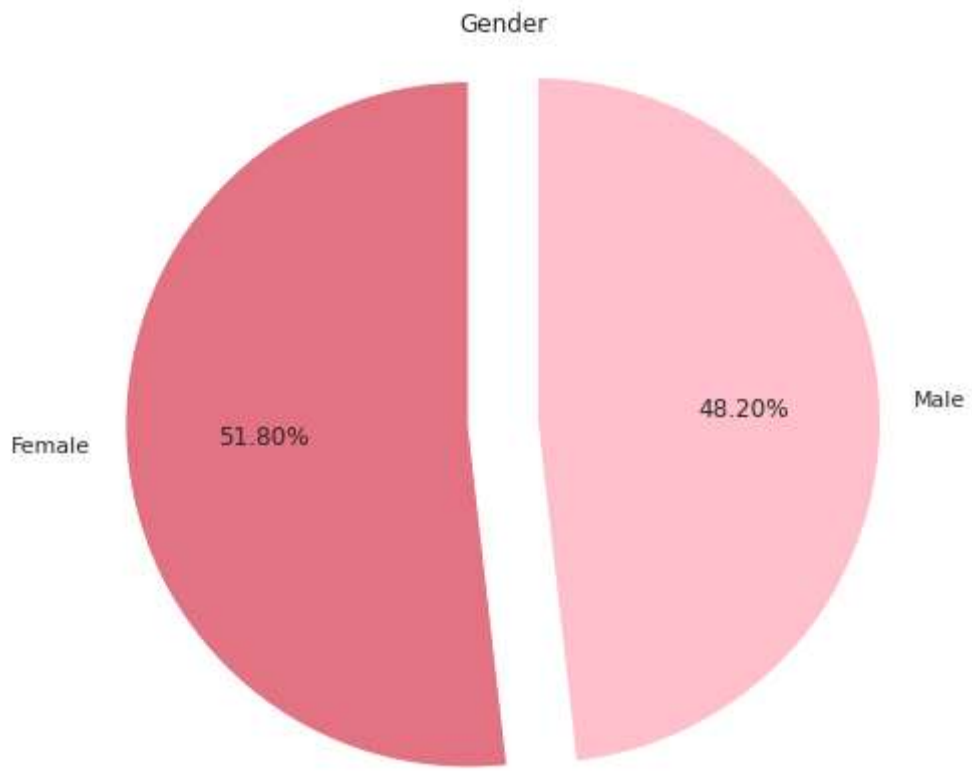
Out[14]:

	math score	reading score	writing score	Percentage
count	1000.00000	1000.000000	1000.000000	1000.000000
mean	66.08900	69.169000	68.054000	67.770667
std	15.16308	14.600192	15.195657	14.257326
min	0.00000	17.000000	10.000000	9.000000
25%	57.00000	59.000000	57.750000	58.333333
50%	66.00000	70.000000	69.000000	68.333333
75%	77.00000	79.000000	79.000000	77.666667
max	100.00000	100.000000	100.000000	100.000000

6. Data Visualization

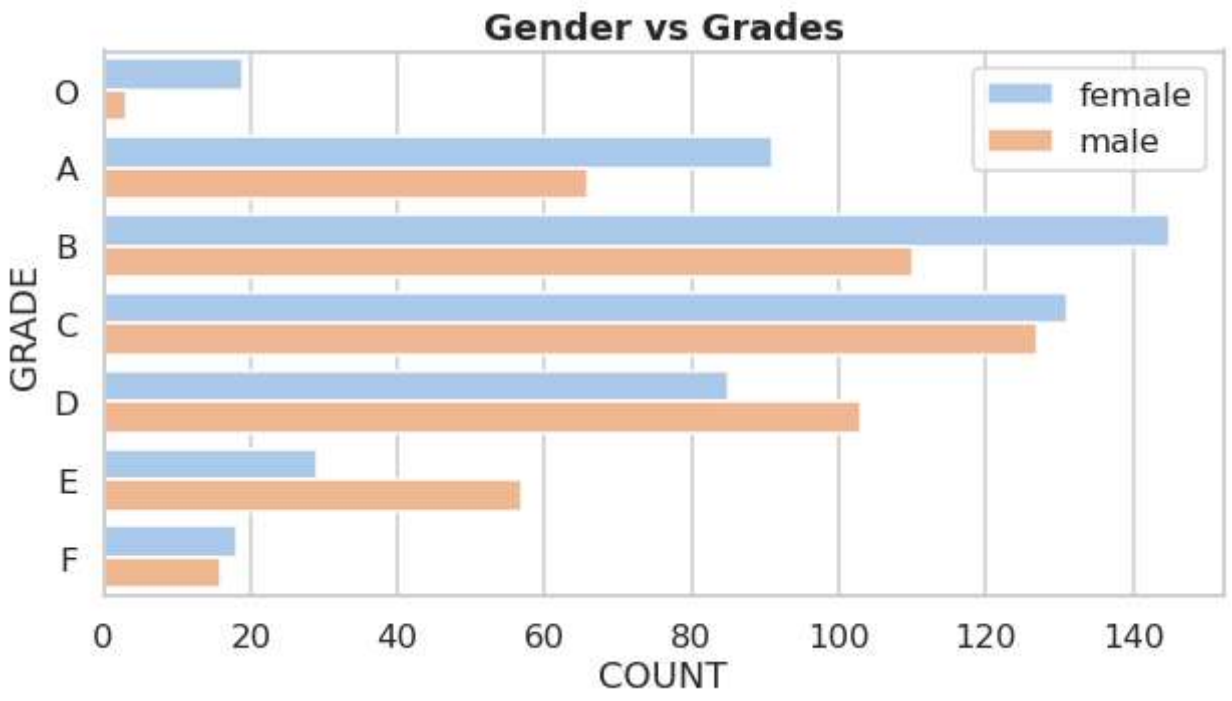
In [15]:
```
sns.set(style='whitegrid')
```

In [16]:
```
plt.figure(figsize=(14, 7))
labels=['Female', 'Male']
plt.pie(df['gender'].value_counts(),labels=labels,explode=[0.1,0.1],
        autopct='%1.2f%%',colors=['#E37383','#FFC0CB'], startangle=90)
plt.title('Gender')
plt.axis('equal')
plt.show()
```

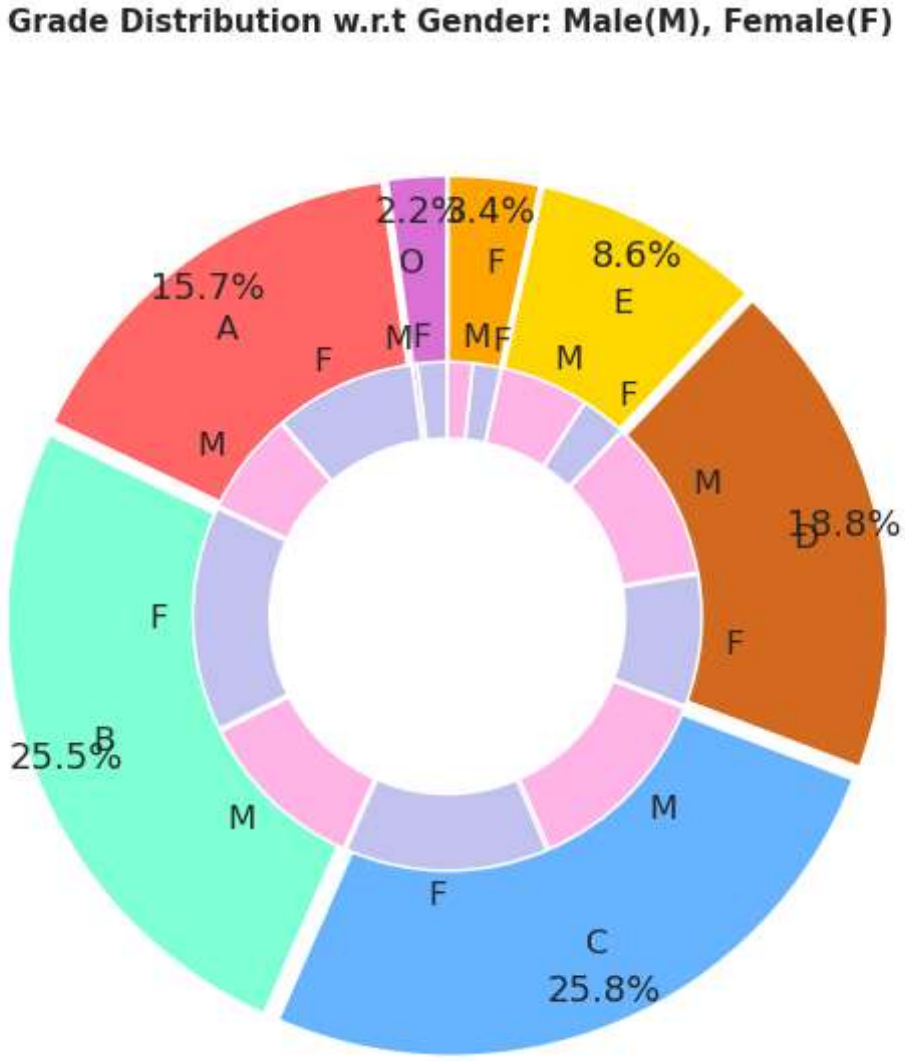


- Out of the total number of students, 51.89% are females while 48.20% are males.

In [17]:
```
plt.figure(figsize=(10,5))
sns.set_context("talk",font_scale=1)
sns.set_palette("pastel")
ax = sns.countplot(y="grade", hue="gender", data=df, order=["O","A","B","C","D","E","F"])
ax.legend(loc='upper right',frameon=True)
plt.title('Gender vs Grades', fontsize=18, fontweight='bold')
ax.set(xlabel='COUNT',ylabel='GRADE')
plt.show()
```



In [18]:
```
plt.figure(figsize=(8, 8))
labels =["O","A","B","C","D","E","F"]
values = [22,157,255,258,188,86,34]
labels_gender = ["F","M","F","M","F","M","F","M","F","M","F","M","F","M"]
sizes_gender = [19,3,91,66,145,110,131,127,85,103,29,57,18,16]
colors = ['orchid', '#ff6666', 'aquamarine', '#66b3ff','chocolate','gold','orange']
colors_gender = ['#c2c2f0','#ffb3e6', '#c2c2f0','#ffb3e6', '#c2c2f0','#ffb3e6', '#c2c2f0','#ffb3e6', '#c2c2f0','#ffb3e6
explode = (0.3,0.3,0.3,0.3,0.3,0.3,0.3)
explode_gender = (0.1,0.1,0.1,0.1,0.1,0.1,0.1,0.1,0.1,0.1,0.1,0.1,0.1,0.1)
#Plot
plt.pie(values, labels=labels,autopct='%1.1f%%' ,pctdistance=0.92, labeldistance=0.80,colors=colors, startangle=90,fram
plt.pie(sizes_gender,labels=labels_gender,colors=colors_gender,startangle=90, explode=explode_gender,radius=7)
#Draw circle
centre_circle = plt.Circle((0,0),5,color='black', fc='white',linewidth=0)
fig = plt.gcf()
fig.gca().add_artist(centre_circle)

plt.title('Grade Distribution w.r.t Gender: Male(M), Female(F)', fontsize=15, fontweight='bold',y=1.1)

# show plot

plt.axis('equal')
plt.tight_layout()
plt.show()
```



From the above visualization, we can infer the following:

The majority of students who earned an 'O' grade were female.

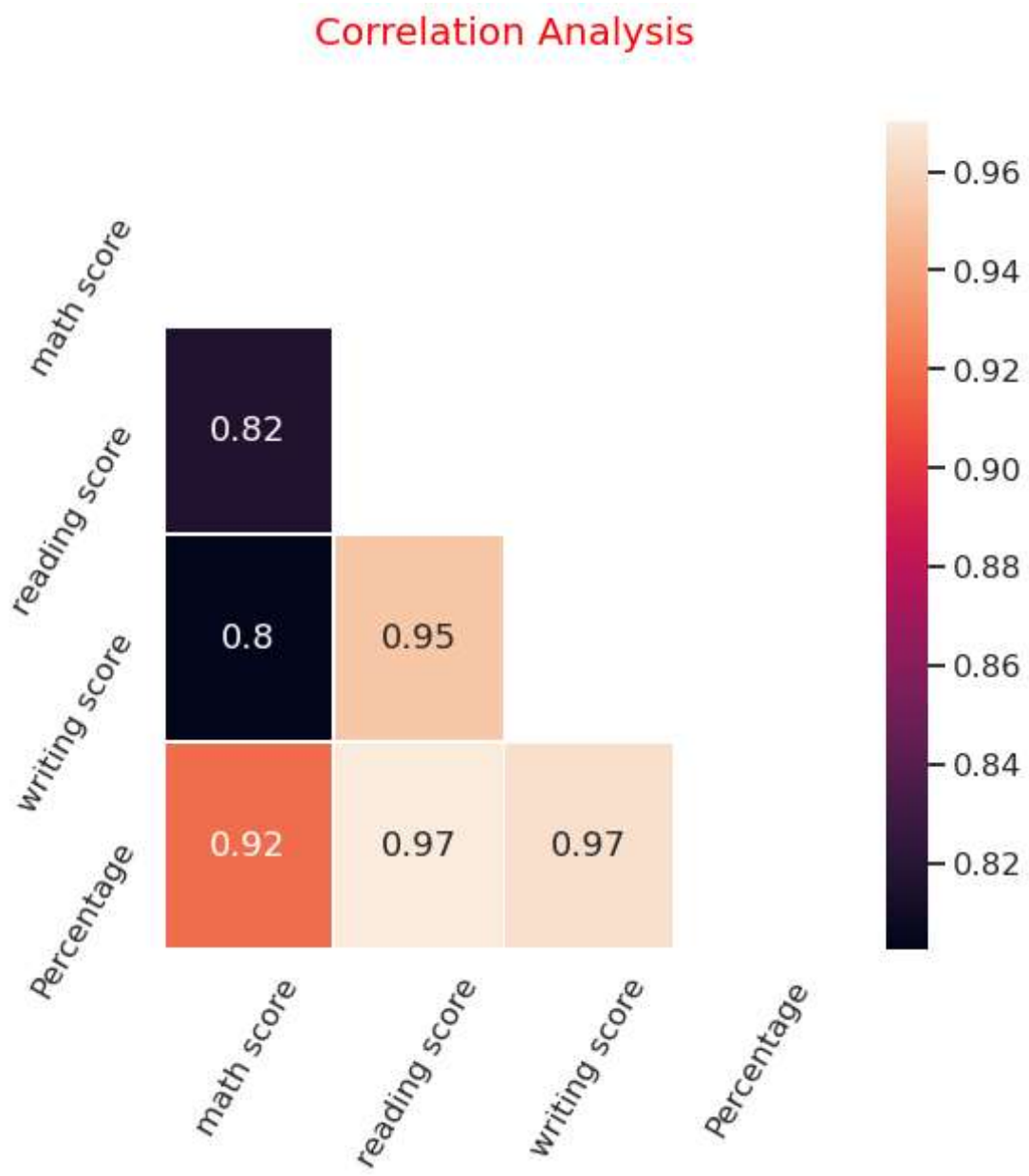
The majority of students received a 'B' grade, followed by 'C.'

More female students received 'A' and 'B' grades relative to male students.

A greater number of boys received 'D' and 'E' grades.

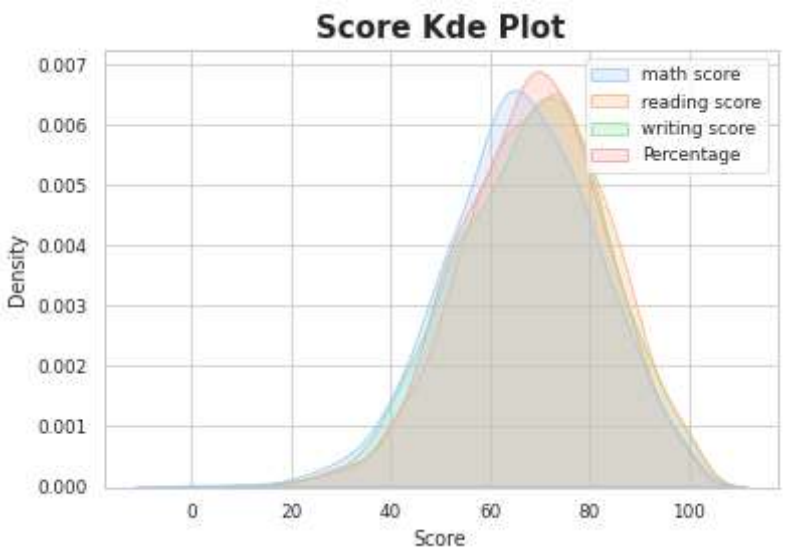
Almost an equal number of both male and female students received an 'F' grade.

In [19]:
```
plt.figure(figsize=(8,8))
plt.title('Correlation Analysis',color='Red',fontsize=20,pad=40)

corr = df.corr()
mask = np.triu(np.ones_like(corr,dtype = bool))
sns.heatmap(df.corr(),mask=mask,annot=True,linewidths=.5);
plt.xticks(rotation=60)
plt.yticks(rotation = 60)
plt.show()
```

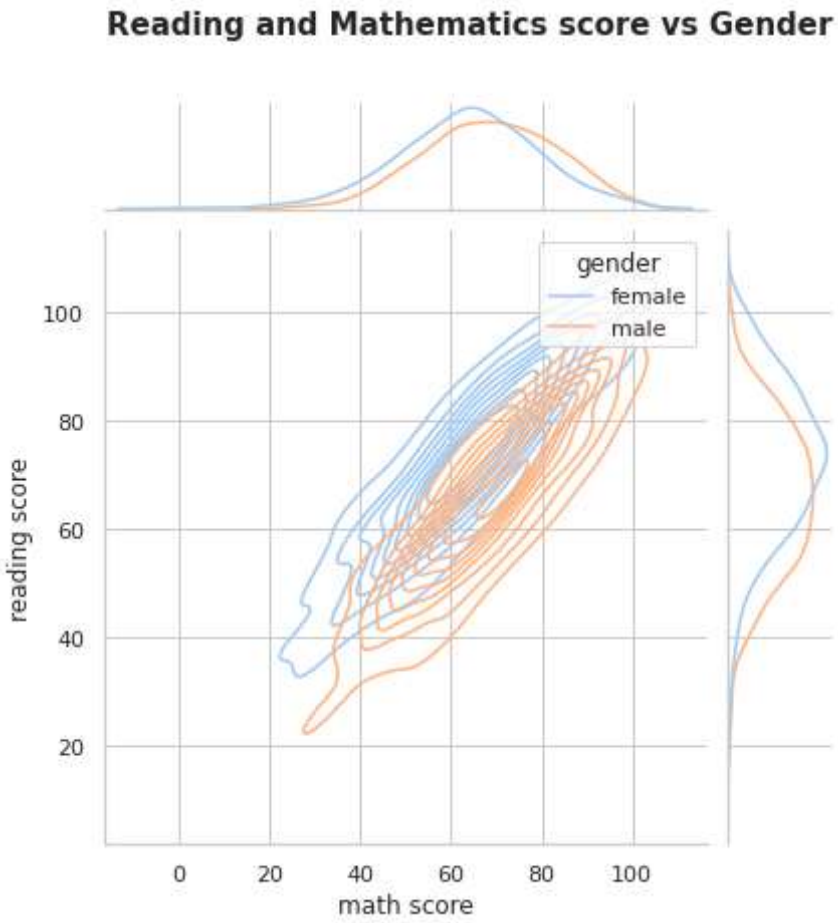


- Almost all the scores are close to each other. There is average success in all three course.

In [20]:
```
sns.set_context("paper",font_scale=1)
sns.kdeplot(data=df,shade = True)
plt.xlabel('Score')
plt.title('Score Kde Plot', fontsize=15, fontweight='bold')
plt.show()
```

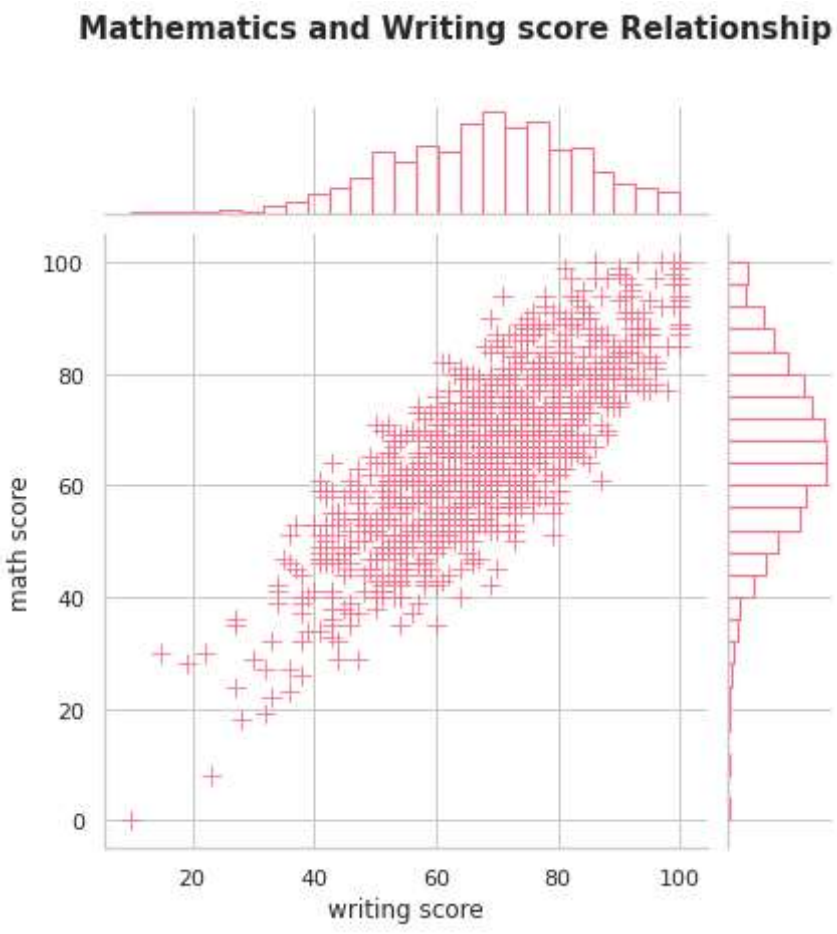


In [21]:
```
sns.set_context("notebook")
sns.jointplot(data=df, x="math score", y="reading score", hue="gender", kind="kde")
plt.title('Reading and Mathematics score vs Gender', fontsize=15, fontweight='bold',y=1.3,loc="right")
plt.show()
```



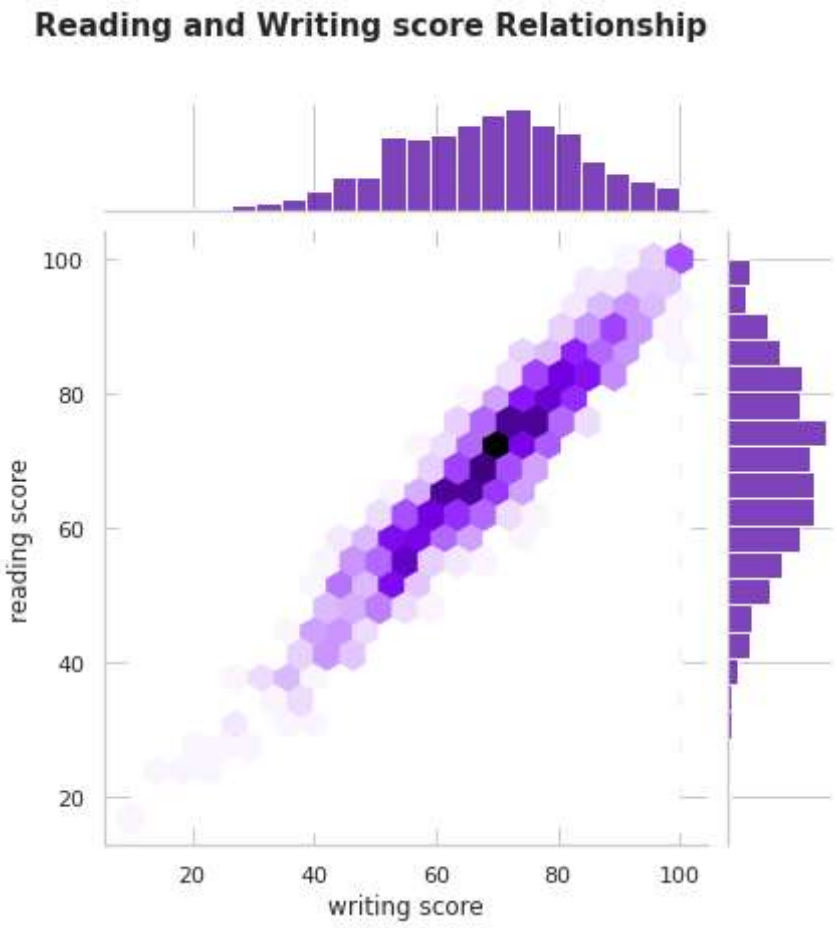
- We can see the relationship between reading and mathematical score and their gender distribution.

In [22]:
```
sns.set_palette("husl", 9)
sns.jointplot(
    data=df, x="writing score", y="math score",
    marker="+", s=100, marginal_kws=dict(bins=25, fill=False),
)
plt.title('Mathematics and Writing score Relationship', fontsize=15, fontweight='bold',y=1.3,loc="right")
plt.show()
```



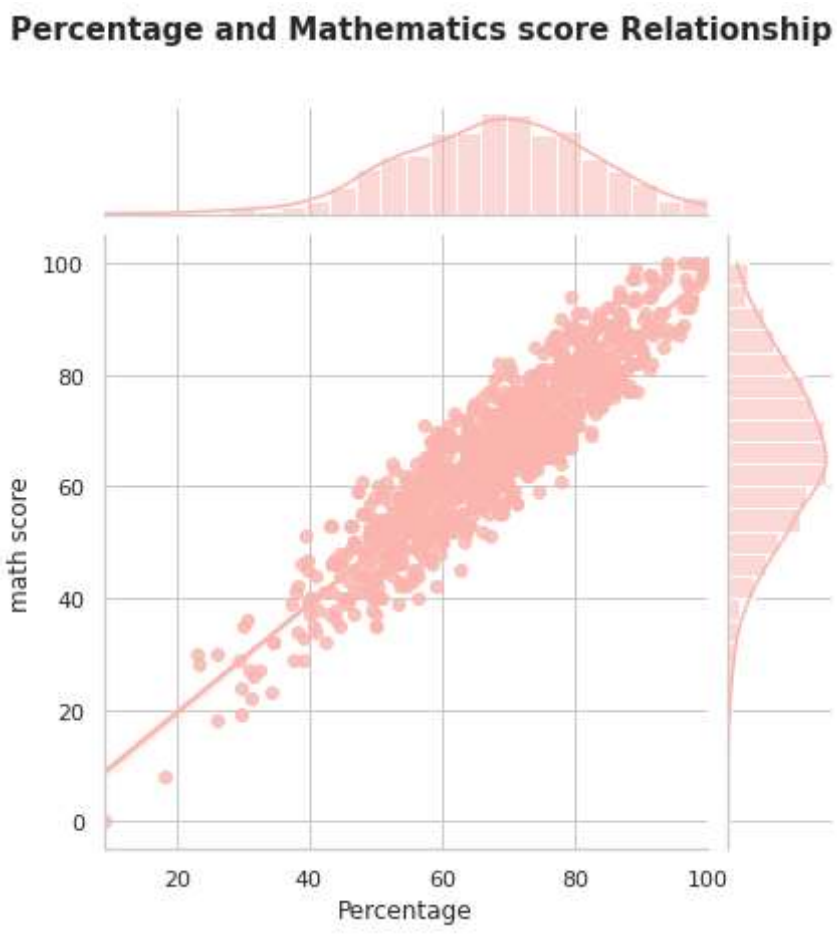
- Most students fall between the range of 40 to 85 marks in both the courses, mathematics and writing.

In [23]:
```
sns.set_palette("plasma")
sns.jointplot(data=df, x="writing score", y="reading score", kind="hex")
plt.title('Reading and Writing score Relationship', fontsize=15, fontweight='bold',y=1.3,loc="right")
plt.show()
```



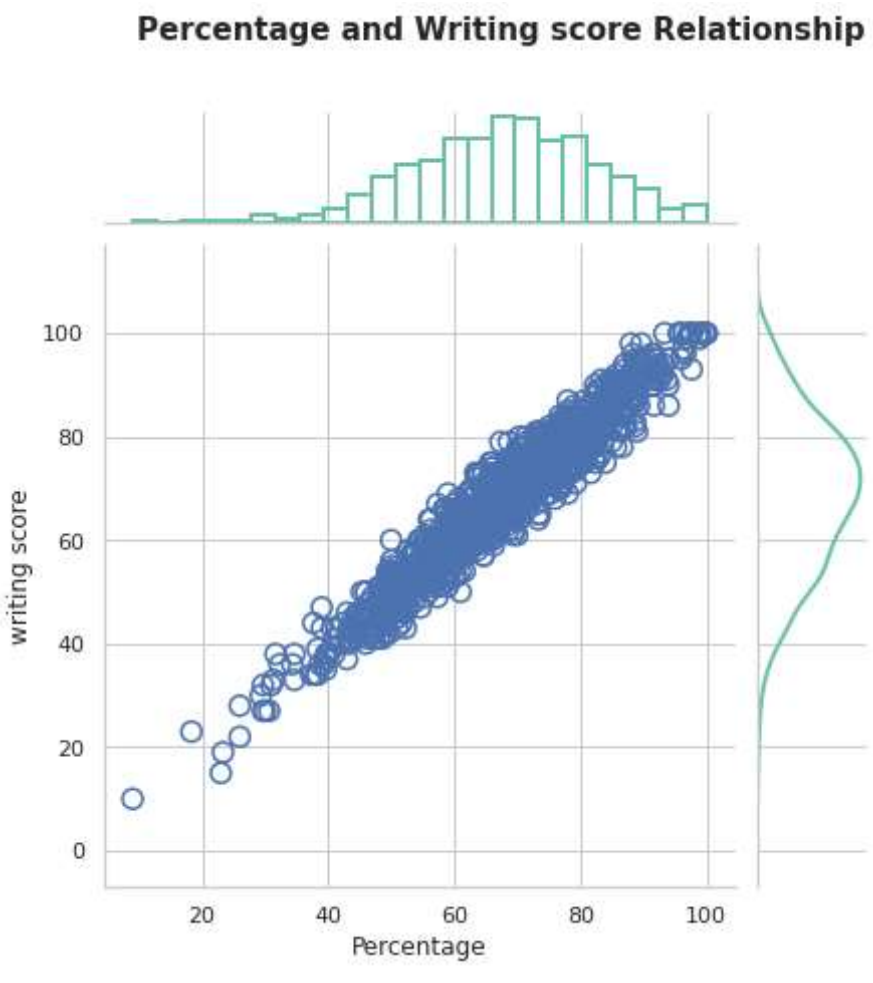
- The average score in both courses, reading and writing, is around 70.

In [24]:
```
sns.set_palette("Pastel1")
sns.jointplot(data=df, x="Percentage", y="math score", kind="reg")
plt.title('Percentage and Mathematics score Relationship', fontsize=15, fontweight='bold',y=1.3,loc="right")
plt.show()
```



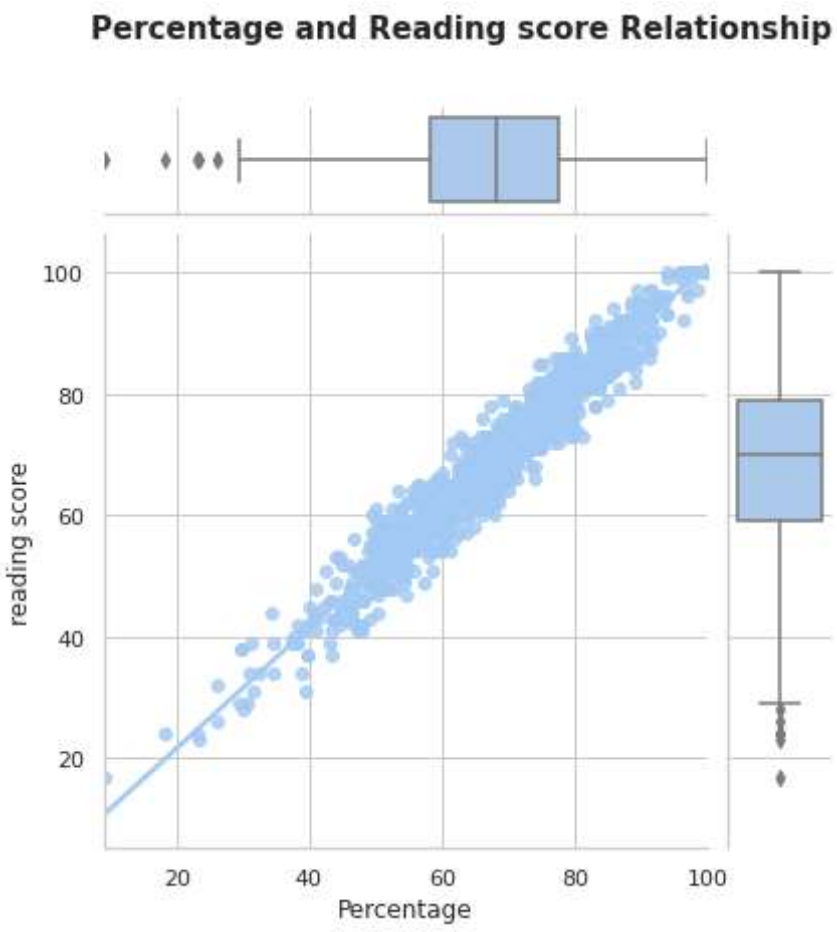
- We can find that in the relationship between the percentage and the mathematics score, most student have scored in the range of 50 to 80.

In [25]:
```
sns.set_palette("Set2")
g = sns.JointGrid()
x, y = df["Percentage"], df["writing score"]
sns.scatterplot(x=x, y=y, ec="b", fc="none", s=100, linewidth=1.5, ax=g.ax_joint)
sns.histplot(x=x, fill=False, linewidth=2, ax=g.ax_marg_x)
sns.kdeplot(y=y, linewidth=2, ax=g.ax_marg_y)
plt.title('Percentage and Writing score Relationship', fontsize=15, fontweight='bold',y=1.3,loc="right")
plt.show()
```



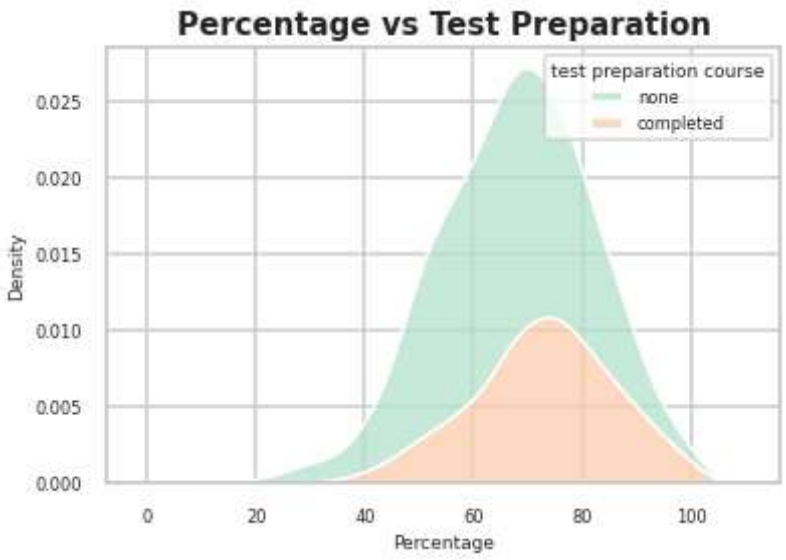
- From the above visualization, we infer that most student have scored in the range of 60 to 80 which is constituting to the overall percentage as well.

In [26]:
```
sns.set_context("notebook")
sns.set_palette("pastel")
g = sns.JointGrid(data=df, x="Percentage", y="reading score")
g.plot(sns.regplot, sns.boxplot)
plt.title('Percentage and Reading score Relationship', fontsize=15, fontweight='bold',y=1.3,loc="right")
plt.show()
```

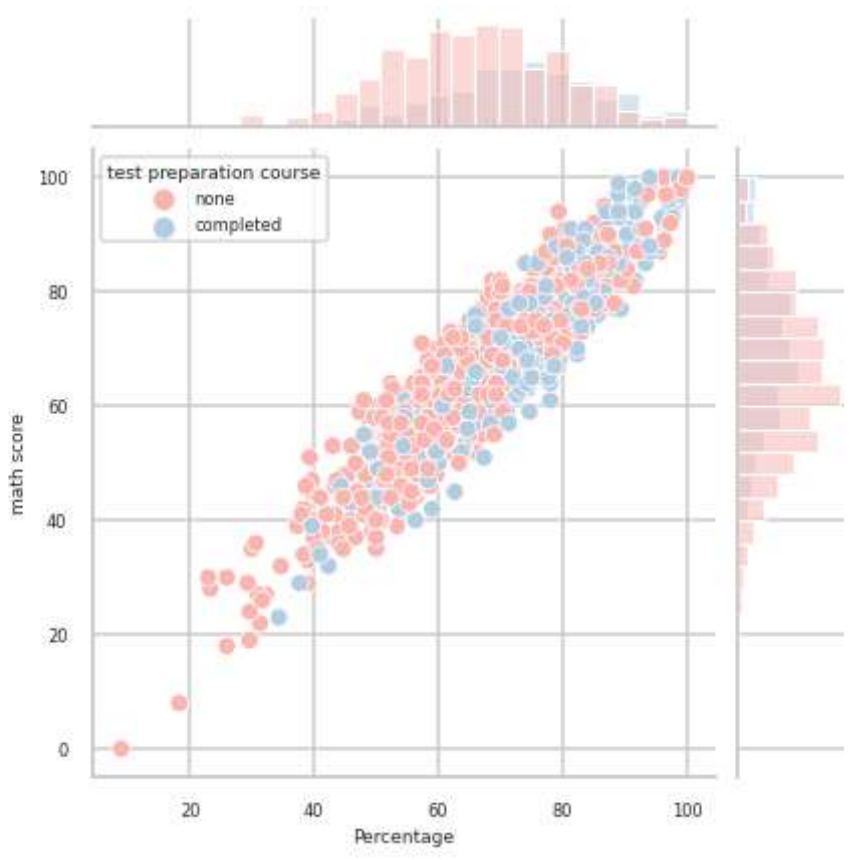


- We can conclude that most students have a good reading score, except a few.

In [27]:
```
sns.set_context("talk",font_scale=0.5)
sns.set_palette("Pastel2")
sns.kdeplot(data=df, x="Percentage", hue="test preparation course", multiple="stack")
plt.title('Percentage vs Test Preparation',fontsize=15, fontweight='bold')

plt.show()
```



In [28]:
```
sns.set_palette("Pastel1")
g = sns.JointGrid(data=df, x="Percentage", y="math score", hue="test preparation course")
g.plot(sns.scatterplot, sns.histplot)
plt.title('Percentage and Mathematics score vs Test Preparation ', fontsize=15, fontweight='bold',y=1.3,loc="right")
plt.show()
```



From the above visualization, we can infer the following:

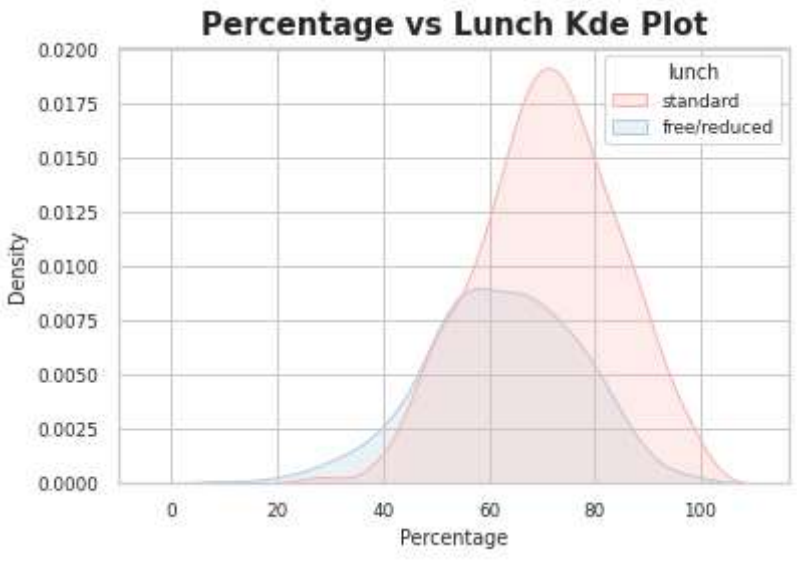
Students who completed their test preparations scored better.

Conversely, a few students who did not complete their test preparations did not perform as well.

It is evident that some students scored exceptionally well compared to others even when they did not complete their test preparations.

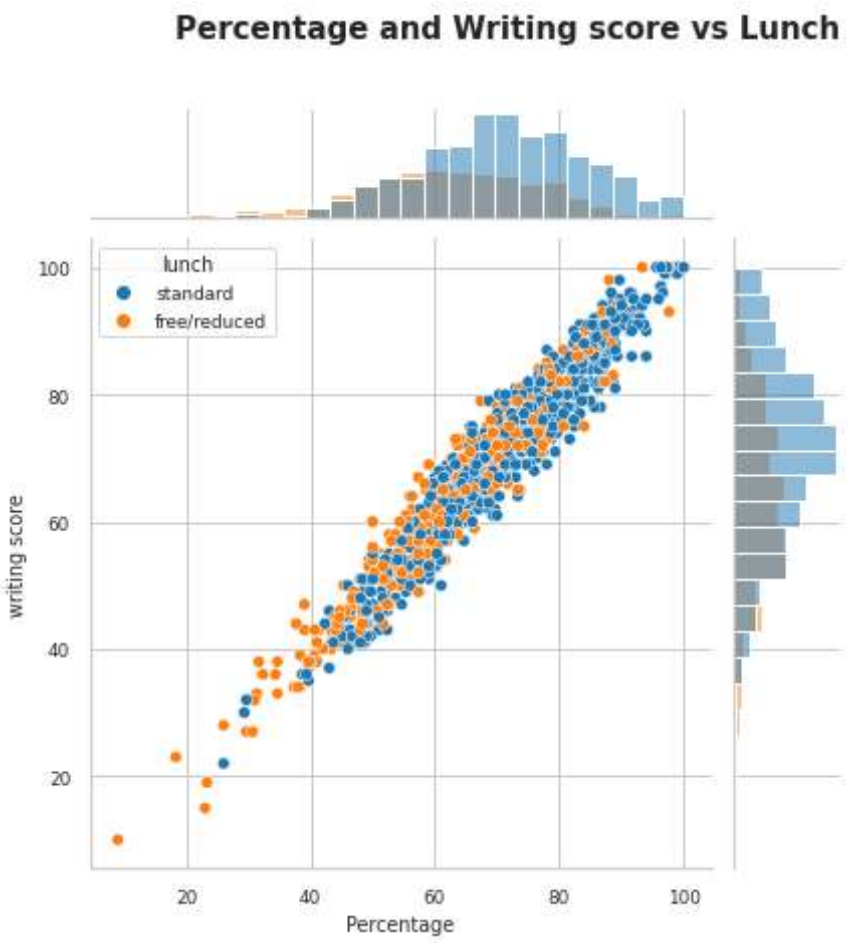
Additionally, there are very few instances where students completed their test preparations but still scored a low percentage.

In [29]:
```
sns.set_context("notebook",font_scale=0.8)
sns.kdeplot(data=df, x="Percentage", hue="lunch", multiple="layer",fill=True)
plt.xlabel('Percentage')
plt.title('Percentage vs Lunch Kde Plot',fontsize=15, fontweight='bold')

plt.show()
```



In [30]:
```
sns.set_palette("tab10")
g = sns.JointGrid(data=df, x="Percentage", y="writing score", hue="lunch")
g.plot(sns.scatterplot, sns.histplot)
```

```
plt.title('Percentage and Writing score vs Lunch', fontsize=15, fontweight='bold',y=1.3,loc="right")
plt.show()
```



Notice the range 75 to 100 in the above visualization.

Students who had the standard lunch performed very well.

Conversely, students who had the free/reduced lunch did not perform as well.

It is evident that food and nutrition play a vital role in the growth of a student, both physically and academically. Nutrition is crucial for the healthy development of children. Nutritious foods provide the body and mind with the energy needed to grow, feel well, be active, stay healthy, and learn. Students can learn better when they are well-nourished, and eating healthy meals has been linked to higher grades, better memory and alertness, and faster information processing.

Healthy students are better learners.

In [31]:
```
df[(df['race/ethnicity']=='group B')]
```

Out[31]:

	gender	race/ethnicity	parental level of education	lunch	test preparation course	math score	reading score	writing score	Percentage	grade
0	female	group B	bachelor's degree	standard	none	72	72	74	72.666667	B
2	female	group B	master's degree	standard	none	90	95	93	92.666667	A
5	female	group B	associate's degree	standard	none	71	83	78	77.333333	B
6	female	group B	some college	standard	completed	88	95	92	91.666667	A
7	male	group B	some college	free/reduced	none	40	43	39	40.666667	F
...	...	...	...	...	...	...	...	...	...	...
969	female	group B	bachelor's degree	standard	none	75	84	80	79.666667	B
976	male	group B	some college	free/reduced	completed	60	62	60	60.666667	D
980	female	group B	high school	free/reduced	none	8	24	23	18.333333	F
982	male	group B	some high school	standard	completed	79	85	86	83.333333	A
991	female	group B	some high school	standard	completed	65	82	78	75.000000	B

190 rows × 10 columns

In [32]:
```
df["grade"].value_counts()
```

Out[32]:
```
C    258
B    255
D    188
A    157
E     86
F     34
O     22
Name: grade, dtype: int64
```

In [33]:
```
df["grade"].index.sort_values()
```

Out[33]:
```
Int64Index([  0,   1,   2,   3,   4,   5,   6,   7,   8,   9,
            ...
            990, 991, 992, 993, 994, 995, 996, 997, 998, 999],
           dtype='int64', length=1000)
```

In [34]:
```
df[df['grade']=='F'].groupby('gender').count()
```

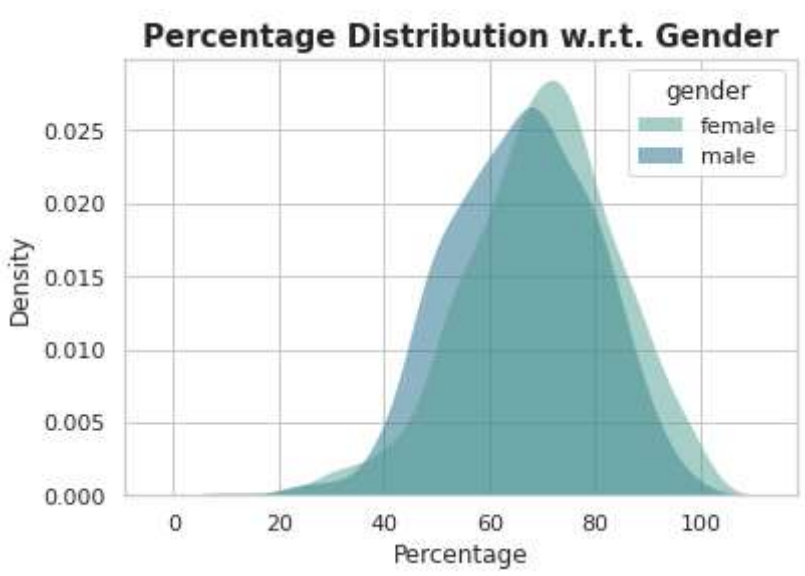
Out[34]:

gender	race/ethnicity	parental level of education	lunch	test preparation course	math score	reading score	writing score	Percentage	grade
female	18	18	18	18	18	18	18	18	18
male	16	16	16	16	16	16	16	16	16

In [35]:
```
df["race/ethnicity"].value_counts()
```

Out[35]:
```
group C    319
group D    262
group B    190
group E    140
group A     89
Name: race/ethnicity, dtype: int64
```

In [36]:
```
sns.set_context("notebook",font_scale=1)

sns.kdeplot(
   data=df, x="Percentage", hue="gender",
   fill=True, common_norm=False, palette="crest",
   alpha=.5, linewidth=0,
)
plt.title('Percentage Distribution w.r.t. Gender',fontsize=15, fontweight='bold')

plt.show()
```

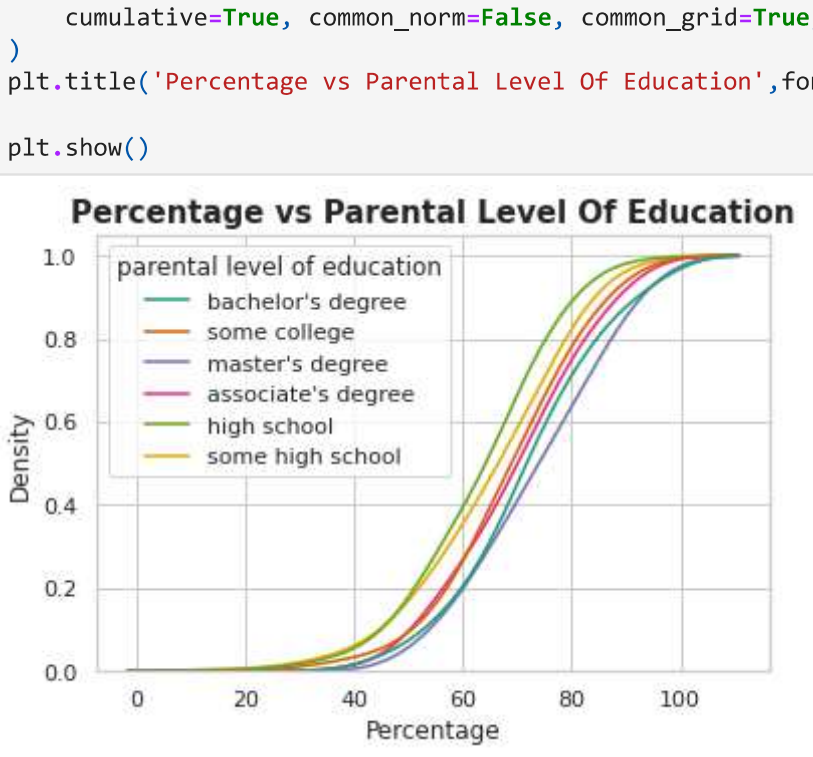


- From the visualization above, it is quite evident that the female students have performed exceptionally well.

In [37]:
```
df.columns
```

Out[37]:
```
Index(['gender', 'race/ethnicity', 'parental level of education', 'lunch',
       'test preparation course', 'math score', 'reading score',
       'writing score', 'Percentage', 'grade'],
      dtype='object')
```

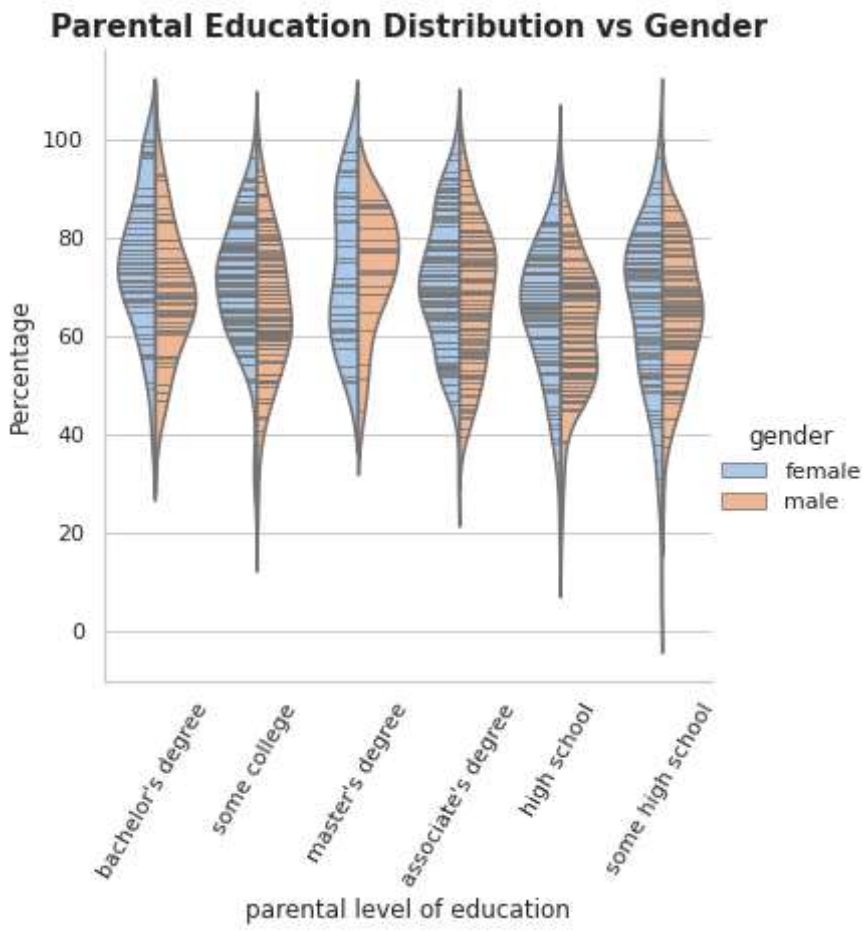
In [38]:
```
sns.set_palette("Dark2")
sns.set_context("notebook",font_scale=1)
sns.kdeplot(
    data=df, x="Percentage", hue="parental level of education",
    cumulative=True, common_norm=False, common_grid=True,
)
plt.title('Percentage vs Parental Level Of Education',fontsize=15, fontweight='bold')

plt.show()
```



- Students whose parents hold a master's degree have a higher overall percentage.
- Students whose parental education level is 'high school' and 'some high school' have lower overall percentage.

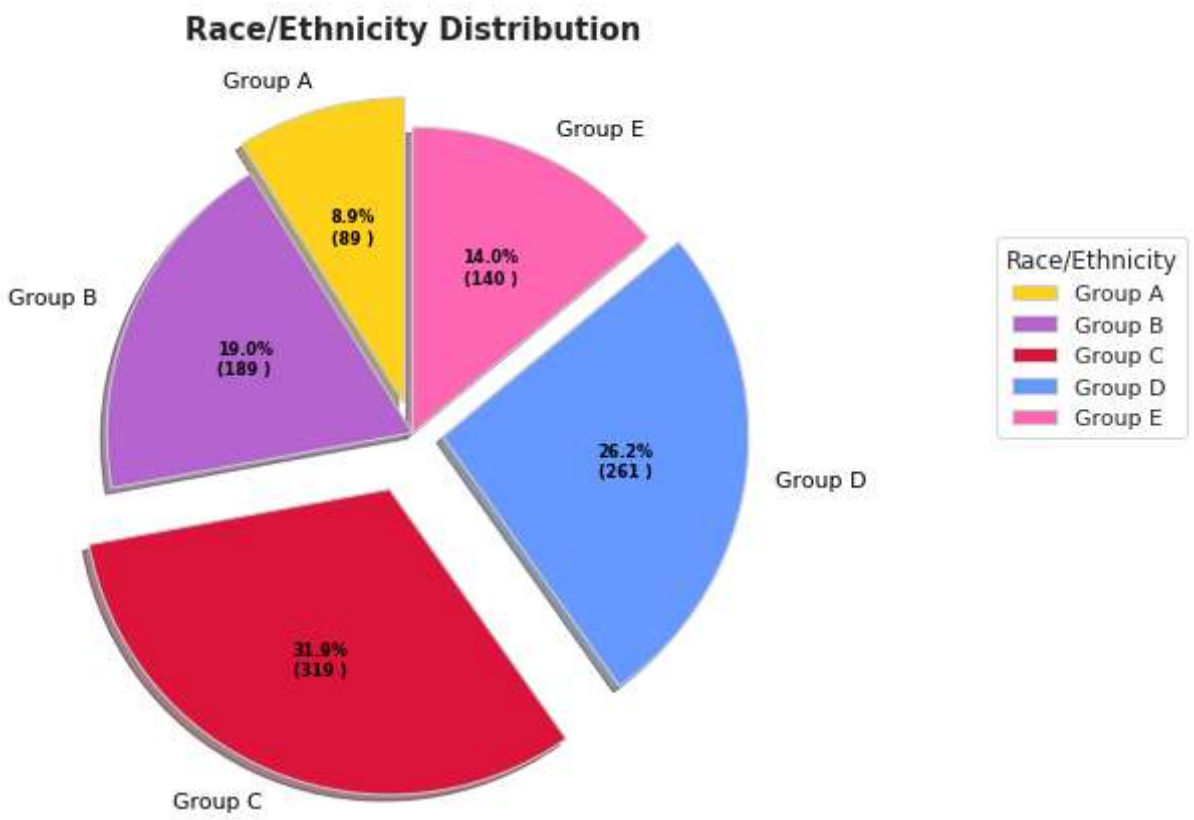
In [39]:
```
sns.catplot(x="parental level of education", y="Percentage", hue="gender",
            kind="violin", inner="stick", split=True,
            palette="pastel", data=df)
plt.title('Parental Education Distribution vs Gender',fontsize=15, fontweight='bold')
```

```
plt.xticks(rotation=60)
plt.show()
```

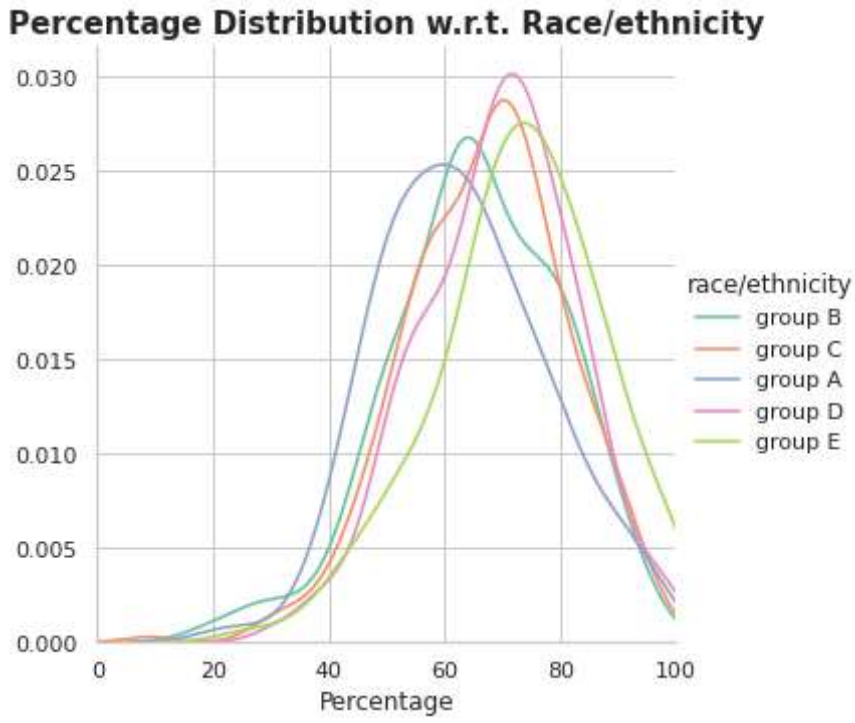


- Females whose parents hold a Bachelor's degree, followed by master's degree,are more successful.
- Males whose parents hold a Bachelor's degree and master's degree have similar academic performance

In [40]:
```
race = ['Group A', 'Group B ', 'Group C',
        'Group D', 'Group E']

data = [89, 190, 319, 262, 140]


# Creating explode data
explode = ( 0.1, 0,0.2, 0.1, 0)

# Creating color parameters
colors = (  "#ffd11a", "#b463cf",
          "#DC143C", "#6699ff", "#ff66b3" )

# Wedge properties
wp = { 'linewidth' : 1, 'edgecolor' : "#cccccc" }

# Creating autocpt arguments
def func(pct, allvalues):
    absolute = int(pct / 100.*np.sum(allvalues))
    return "{:.1f}%\n({:d} )".format(pct, absolute)

# Creating plot
fig, ax = plt.subplots(figsize =(10, 7))
wedges, texts, autotexts = ax.pie(data,
                                  autopct = lambda pct: func(pct, data),
                                  explode = explode,
                                  labels = race,
                                  shadow = True,
                                  colors = colors,
                                  startangle = 90,
                                  wedgeprops = wp,
                                  textprops = dict(color ="#000000"))

# Adding legend
ax.legend(wedges, race,
          title ="Race/Ethnicity",
          loc ="center left",
          bbox_to_anchor =(1.25, 0, 0, 1.25))

plt.setp(autotexts, size = 8, weight ="bold")
ax.set_title("Race/Ethnicity Distribution", fontsize=15, fontweight='bold')

# show plot
plt.show()
```

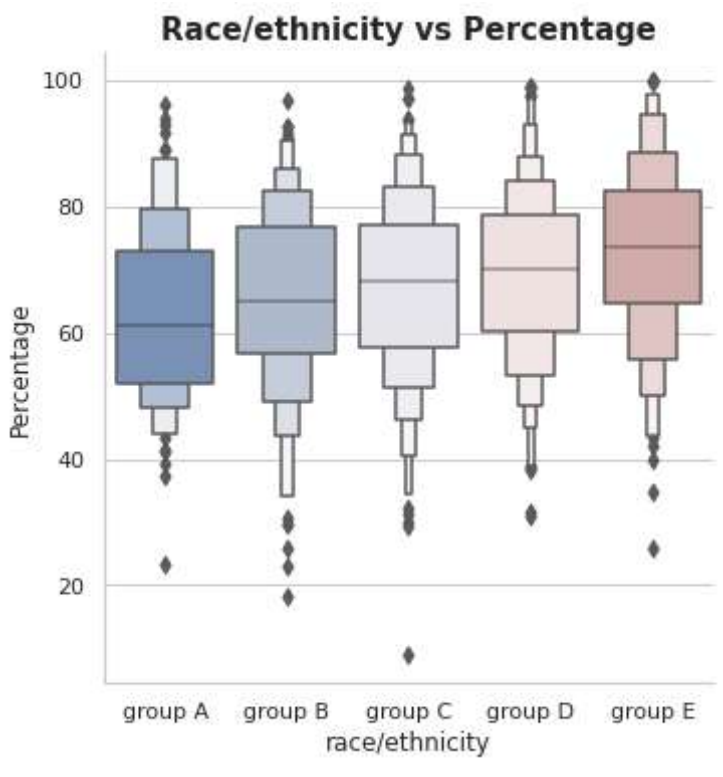


In [41]:
```
sns.set_palette("Set2")
(sns.FacetGrid(df,hue="race/ethnicity", height=5,xlim = (0,100)).map(sns.kdeplot, "Percentage").add_legend())
plt.title('Percentage Distribution w.r.t. Race/ethnicity',fontsize=15, fontweight='bold')

plt.show()
```



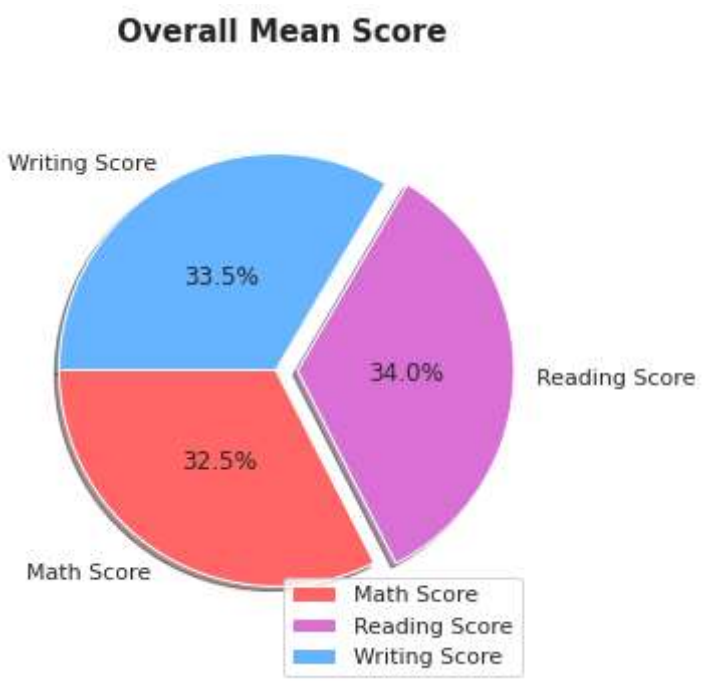
- Performance of Group E is the best among all. While group D and C have nearly similar performance.

In [42]:
```
sns.set_palette("vlag")
sns.catplot(x="race/ethnicity", y="Percentage", kind="boxen",
            data=df.sort_values("race/ethnicity"))
plt.title('Race/ethnicity vs Percentage',fontsize=15, fontweight='bold')

plt.show()
```



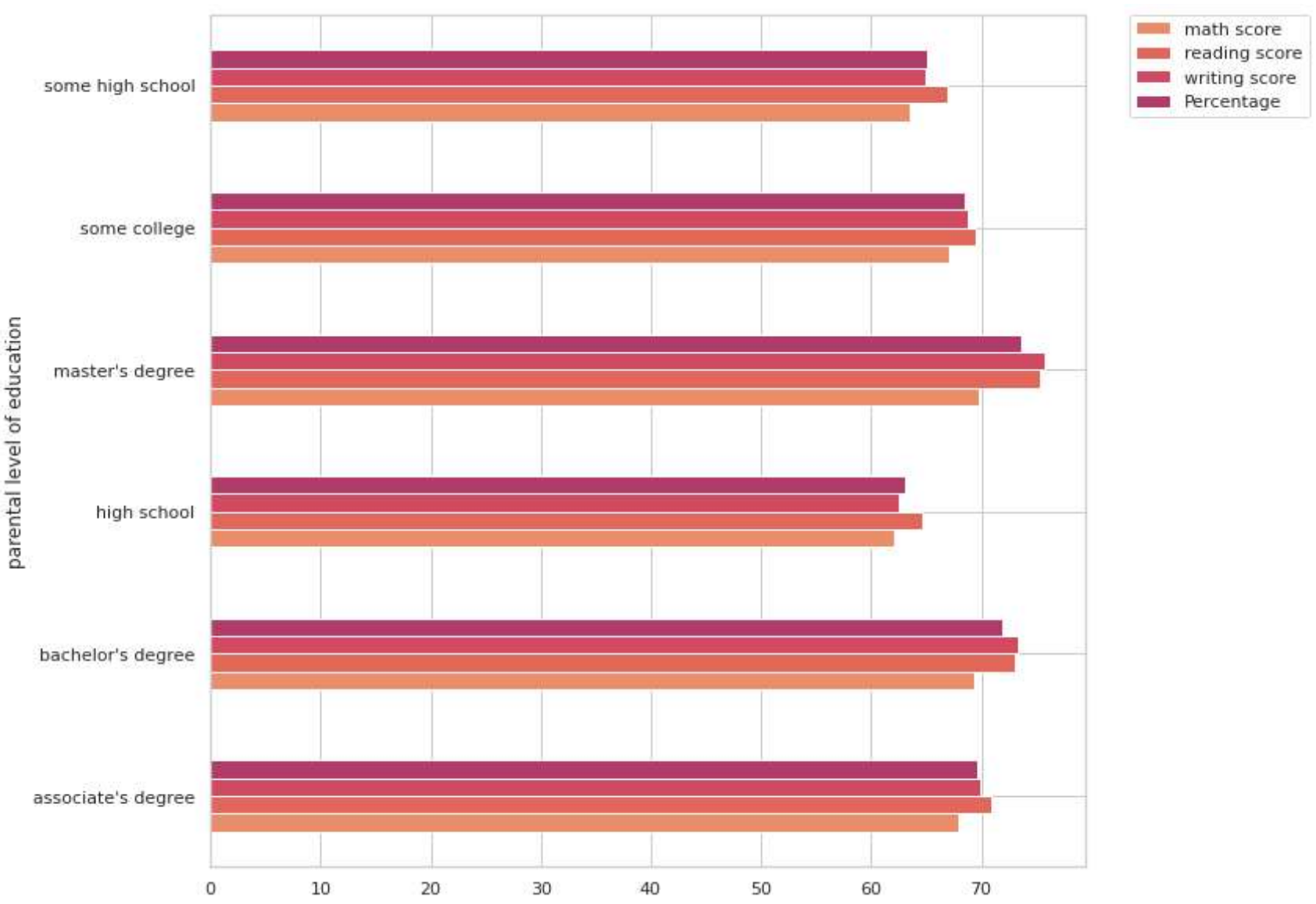
- The average of group E is highest among all the groups while the average of group A is lowest.

In [43]:
```
plt.figure(figsize=(5,5))
labels=['Math Score', 'Reading Score', 'Writing Score']
colors=['#ff6666','orchid','#66b3ff']
explode=[0,0.1,0]
values=[df["math score"].mean(),df["reading score"].mean(),df["writing score"].mean()]

plt.pie(values,labels=labels,colors=colors,explode=explode,autopct='%1.1f%%',shadow=True,startangle=180,pctdistance=0.5
plt.legend(['Math Score', 'Reading Score', 'Writing Score'],loc='lower right')
plt.axis('equal')
plt.title(' Overall Mean Score  ',fontsize=15, fontweight='bold')
plt.tight_layout()
plt.show()
```

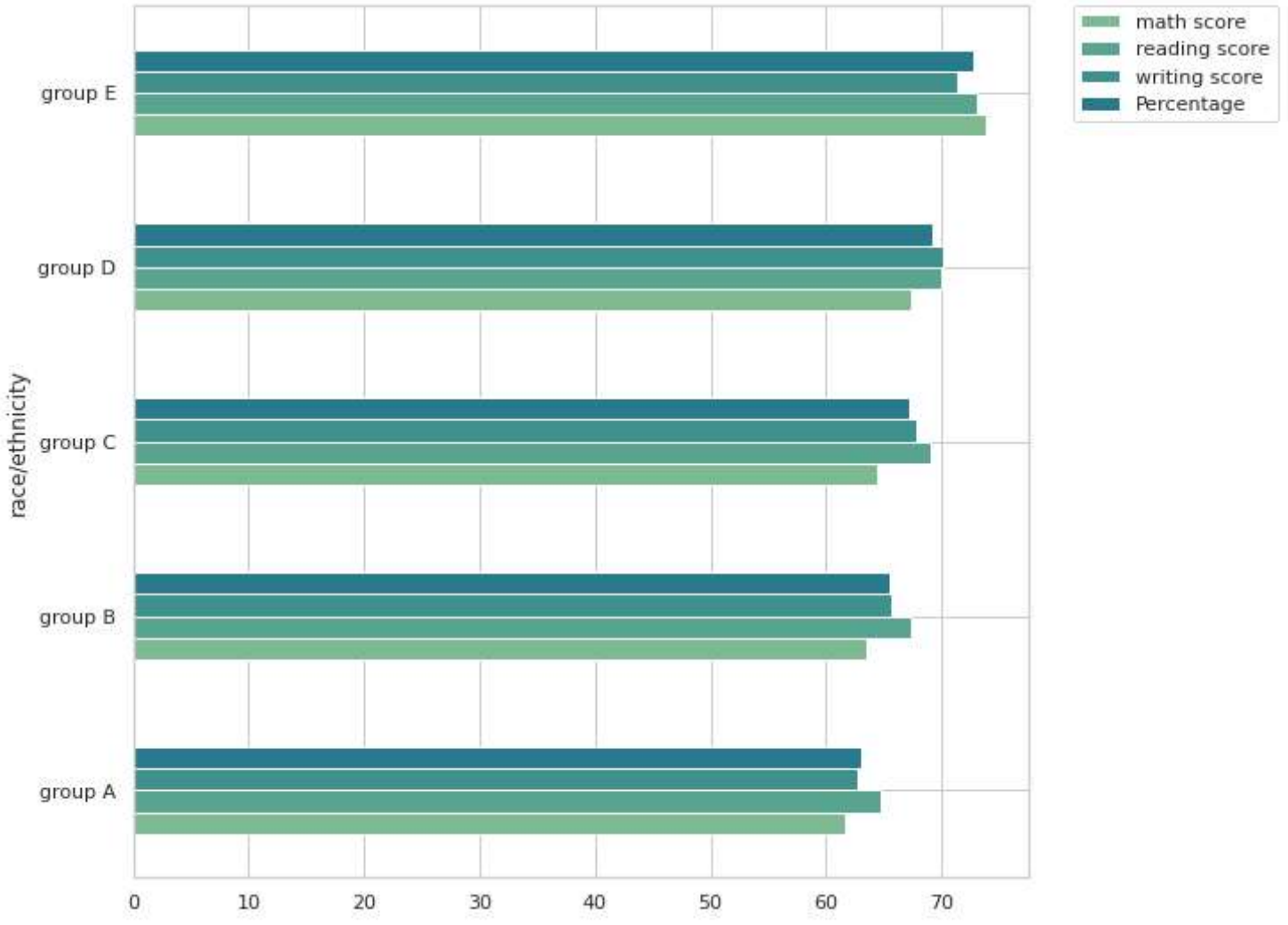


- Reading Score has the highest average.

In [44]:
```
sns.set_palette("flare")
df.groupby('parental level of education').agg('mean').plot(kind='barh',figsize=(10,10))
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.);
```



In [45]:
```
sns.set_palette("crest")
df.groupby('race/ethnicity').agg('mean').plot(kind='barh',figsize=(9,9))
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.);
```



In [46]:
```
sns.set_palette("coolwarm")
df.groupby(['race/ethnicity','gender']).agg('mean').plot(kind='bar',figsize=(12,8))
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.);
```