In [1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
from IPython import get_ipython
import warnings
warnings.filterwarnings("ignore")
```

In [2]:

```
data = pd.read_csv('online_education.csv')
```

In [3]:

```
data.head()
```

Out[3]:

	Education Level	Institution Type	Gender	Age	Device	IT Student	Location	Financial Condition	Internet Type	Network Type	F
0	University	Private	Male	23	Tab	No	Town	Mid	Wifi	4G	M
1	University	Private	Female	23	Mobile	No	Town	Mid	Mobile Data	4G	M
2	College	Public	Female	18	Mobile	No	Town	Mid	Wifi	4G	M
3	School	Private	Female	11	Mobile	No	Town	Mid	Mobile Data	4G	M
4	School	Private	Female	18	Mobile	No	Town	Poor	Mobile Data	3G	

In [4]:

```
data.tail()
```

Out[4]:

	Education Level	Institution Type	Gender	Age	Device	IT Student	Location	Financial Condition	Internet Type	Networl Type
1200	College	Private	Female	18	Mobile	No	Town	Mid	Wifi	4C
1201	College	Private	Female	18	Mobile	No	Rural	Mid	Wifi	4C
1202	School	Private	Male	11	Mobile	No	Town	Mid	Mobile Data	3C
1203	College	Private	Female	18	Mobile	No	Rural	Mid	Wifi	4C
1204	School	Private	Female	11	Mobile	No	Town	Poor	Mobile Data	3C

In [5]:

```
1 data.shape
```

Out[5]:

```
(1205, 11)
```

In [6]:

```
1 data.columns
```

Out[6]:

```
Index(['Education Level', 'Institution Type', 'Gender', 'Age', 'Device',
       'IT Student', 'Location', 'Financial Condition', 'Internet Type',
       'Network Type', 'Flexibility Level'],
      dtype='object')
```

In [7]:

```
1 data.duplicated().sum()
```

Out[7]:

```
980
```

In [8]:

```
1 data.isnull().sum()
```

Out[8]:

```
Education Level        0
Institution Type       0
Gender                 0
Age                    0
Device                 0
IT Student             0
Location               0
Financial Condition    0
Internet Type          0
Network Type           0
Flexibility Level      0
dtype: int64
```

In [9]:

```
1 data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1205 entries, 0 to 1204
Data columns (total 11 columns):
 #   Column               Non-Null Count  Dtype 
---  ------               --------------  ----- 
 0   Education Level      1205 non-null   object
 1   Institution Type     1205 non-null   object
 2   Gender               1205 non-null   object
 3   Age                  1205 non-null   int64 
 4   Device               1205 non-null   object
 5   IT Student           1205 non-null   object
 6   Location             1205 non-null   object
 7   Financial Condition  1205 non-null   object
 8   Internet Type        1205 non-null   object
 9   Network Type         1205 non-null   object
 10  Flexibility Level    1205 non-null   object
dtypes: int64(1), object(10)
memory usage: 103.7+ KB
```

In [10]:

```
1 data.describe()
```

Out[10]:

	Age
count	1205.000000
mean	17.065560
std	5.830369
min	9.000000
25%	11.000000
50%	18.000000
75%	23.000000
max	27.000000

In [11]:

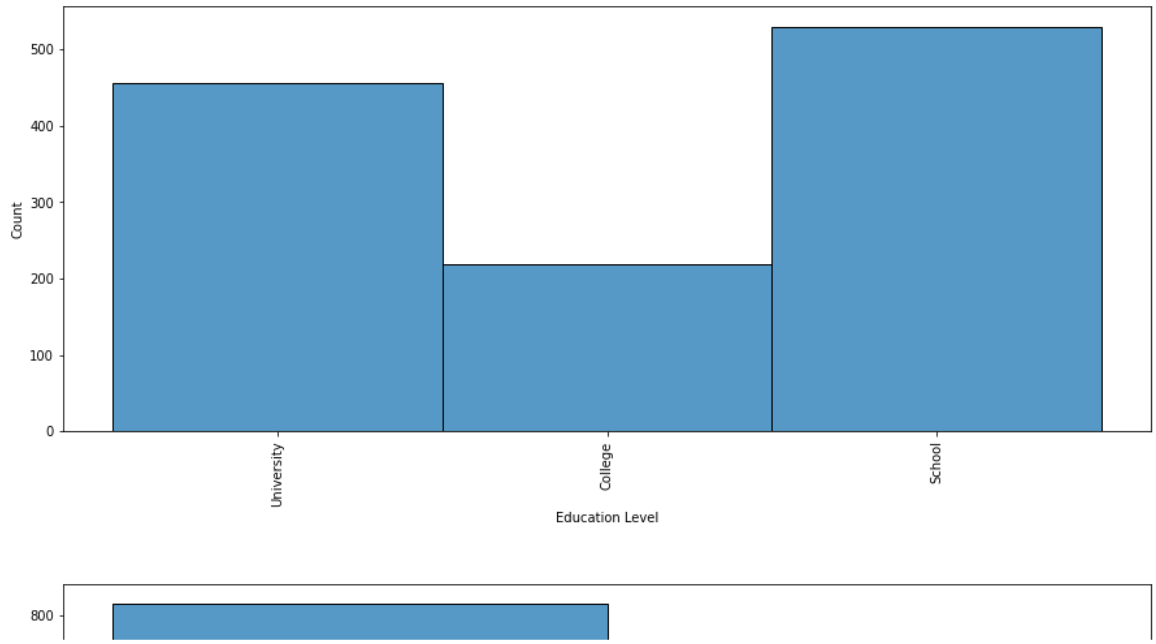
```
1 data.nunique()
```

Out[11]:

```
Education Level         3
Institution Type        2
Gender                  2
Age                     6
Device                  3
IT Student              2
Location                2
Financial Condition     3
Internet Type           2
Network Type            3
Flexibility Level       3
dtype: int64
```

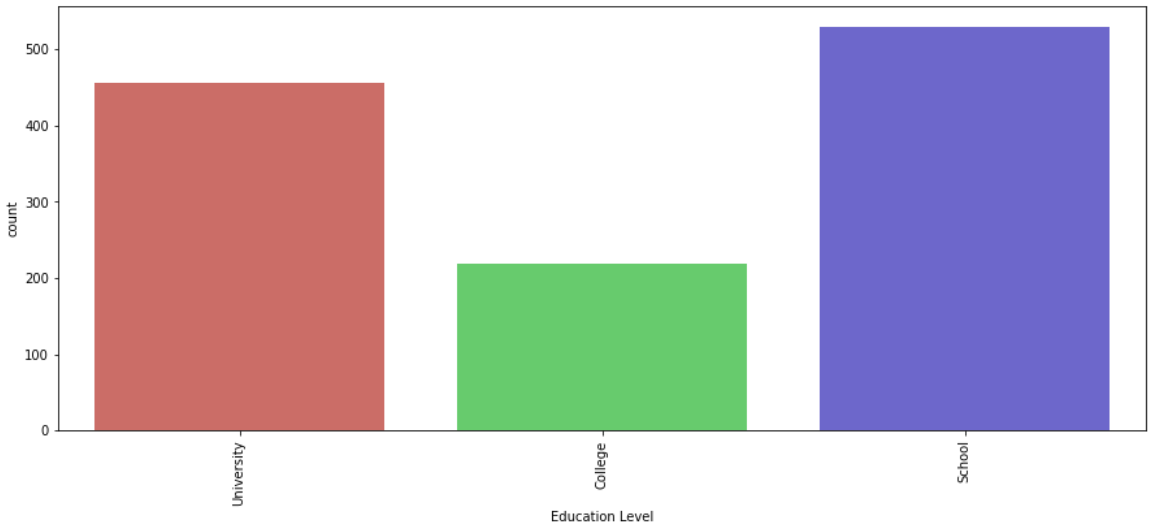
In [12]:

```
1 for i in data.columns:
2     plt.figure(figsize=(15,6))
3     sns.histplot(data[i], bins=10)
4     plt.xticks(rotation = 90)
5     plt.show()
```



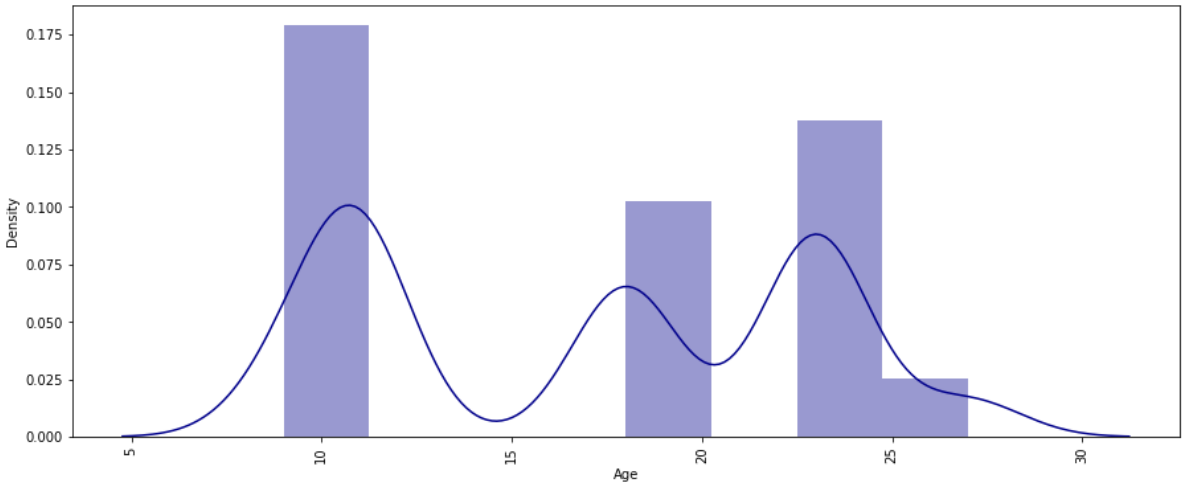
In [13]:

```
for i in data.columns:
    plt.figure(figsize=(15,6))
    sns.countplot(data[i], data = data,
                  palette='hls')
    plt.xticks(rotation = 90)
    plt.show()
```



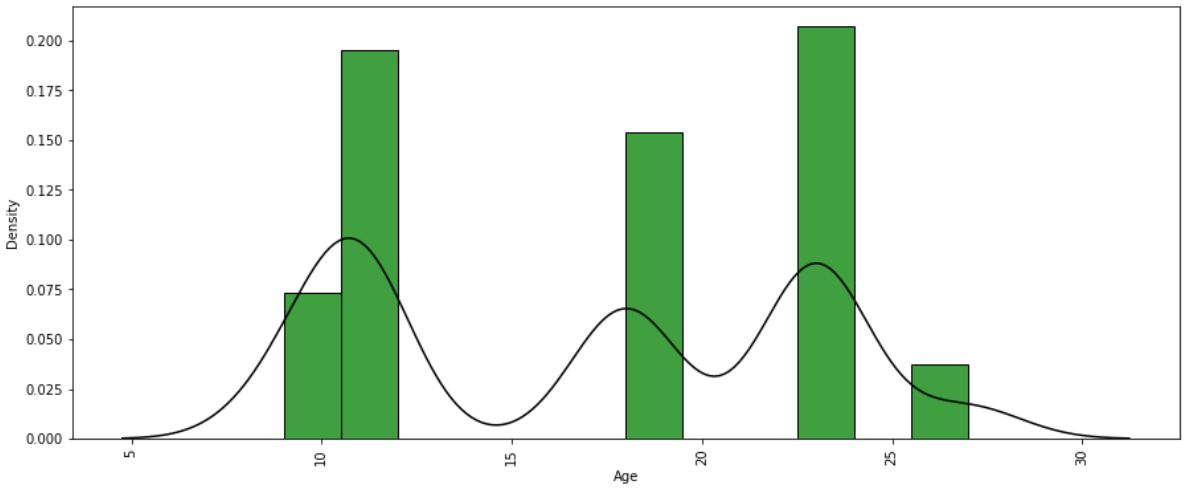
In [14]:

```
plt.figure(figsize=(15,6))
sns.distplot(data['Age'],kde = True,color = 'Darkblue')
plt.xticks(rotation = 90)
plt.show()
```



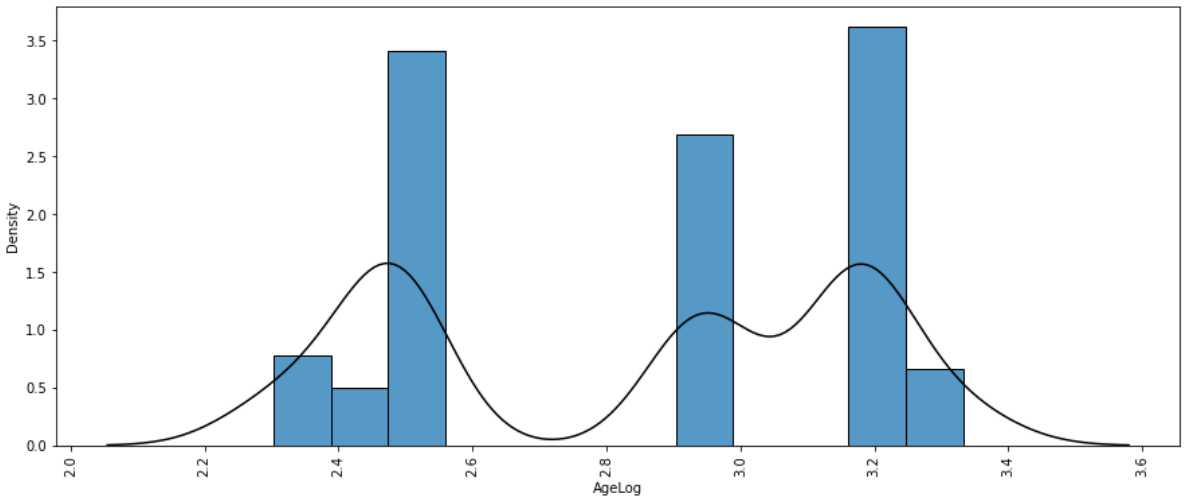
In [15]:

```
plt.figure(figsize=(15,6))
sns.histplot(data["Age"], stat='density',color='green')
sns.kdeplot(data["Age"], color='black')
plt.xticks(rotation = 90)
plt.show()
```



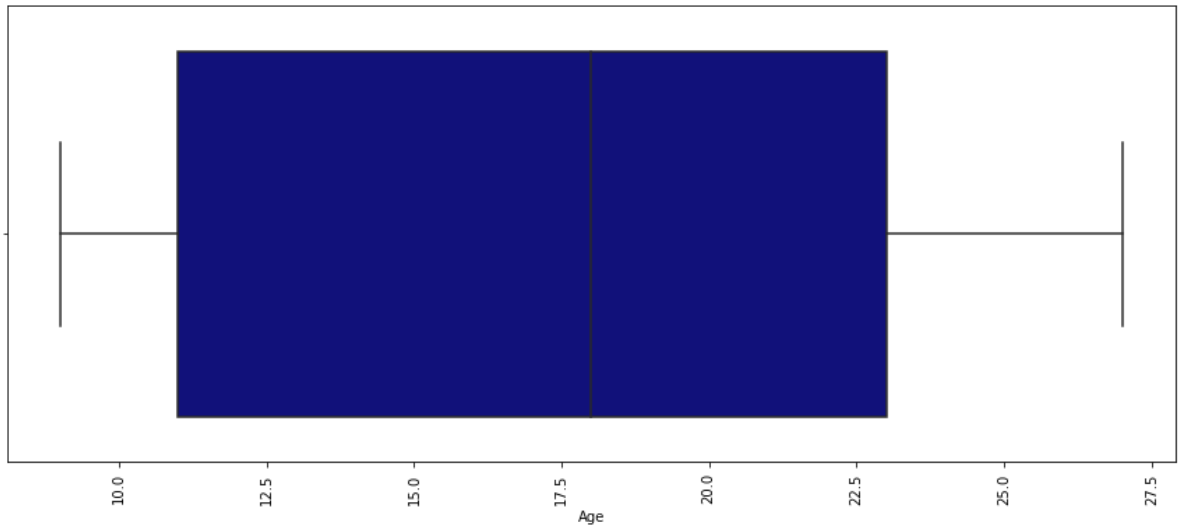
In [16]:

```
plt.figure(figsize=(15,6))
data['AgeLog'] = np.log(data['Age']+1)
sns.histplot(data["AgeLog"], stat='density')
sns.kdeplot(data["AgeLog"], color='black')
plt.xticks(rotation = 90)
plt.show()
```



In [17]:

```
plt.figure(figsize=(15,6))
sns.boxplot(data['Age'],color = 'Darkblue')
plt.xticks(rotation = 90)
plt.show()
```



In [18]:

```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
```

In [19]:

```
FlexibilityLevel = le.fit_transform(data['Flexibility Level'])
data['Flexibility Level'] = FlexibilityLevel
```

In [20]:

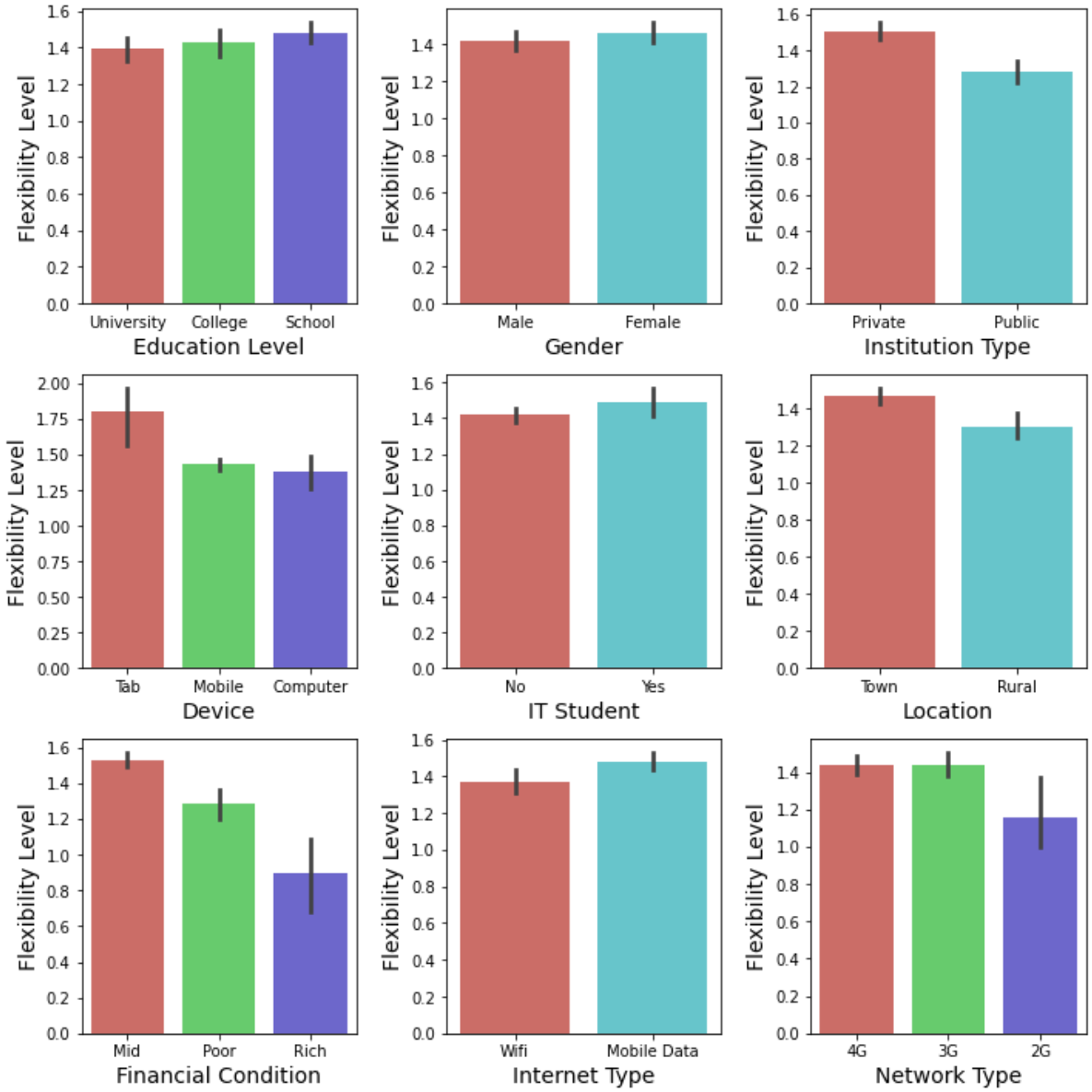
```
categorical_features = ['Education Level','Gender','Institution Type',
                        'Device','IT Student','Location',
                        'Financial Condition','Internet Type',
                        'Network Type']
```

In [21]:

```
fig, axes = plt.subplots(3, 3, figsize=(10,10))
axes = [ax for axes_row in axes for ax in axes_row]
target = 'Flexibility Level'

for i, c in enumerate(categorical_features):
    sns.barplot(data[c], data[target], ax=axes[i],
                palette = 'hls')
    axes[i].set_ylabel('Flexibility Level', fontsize=14)
    axes[i].set_xlabel(c, fontsize=14)

plt.tight_layout()
plt.show()
```



In [22]:

```
EducationLevel= le.fit_transform(data['Education Level'])
Gender = le.fit_transform(data['Gender'])
InstitutionType = le.fit_transform(data['Institution Type'])
Device = le.fit_transform(data['Device'])
ITStudent= le.fit_transform(data['IT Student'])
Location = le.fit_transform(data['Location'])
FinancialCondition = le.fit_transform(data['Financial Condition'])
InternetType = le.fit_transform(data['Internet Type'])
NetworkType = le.fit_transform(data['Network Type'])
```

In [23]:

```
data['Education Level'] = EducationLevel
data['Gender'] = Gender
data['Institution Type'] = InstitutionType
data['Device'] = Device
data['IT Student'] = ITStudent
data['Location'] = Location
data['Financial Condition'] = FinancialCondition
data['Internet Type'] = InternetType
data['Network Type'] = NetworkType
```

In [24]:

```
data.head()
```

Out[24]:

	Education Level	Institution Type	Gender	Age	Device	IT Student	Location	Financial Condition	Internet Type	Network Type	F
0	2	0	1	23	2	0	1	0	1	2	
1	2	0	0	23	1	0	1	0	0	2	
2	0	1	0	18	1	0	1	0	1	2	
3	1	0	0	11	1	0	1	0	0	2	
4	1	0	0	18	1	0	1	1	0	1	

In [25]:

```
x = data.drop('Flexibility Level',axis=1)
y = data['Flexibility Level']
```

In [26]:

```
x.shape
```

Out[26]:

```
(1205, 11)
```

In [27]:

```
y.shape
```

Out[27]:

```
(1205,)
```

In [28]:

```
from sklearn.preprocessing import StandardScaler
```

In [29]:

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(x, y,
                                                    test_size=0.30,
                                                    random_state=42)
```

In [30]:

```
sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.fit_transform(X_test)
```

In [31]:

```
from sklearn.tree import DecisionTreeClassifier
model = DecisionTreeClassifier()
model.fit(X_train,y_train)
```

Out[31]:

```
DecisionTreeClassifier()
```

In [32]:

```
y_pred = model.predict(X_test)
```

In [33]:

```
print("Training Accuracy :", model.score(X_train, y_train))
print("Testing Accuracy :", model.score(X_test, y_test))
```

```
Training Accuracy : 0.8623962040332147
Testing Accuracy : 0.8011049723756906
```

In [34]:

```
1 from sklearn.metrics import classification_report
```

In [35]:

```
1 print(classification_report(y_test, y_pred))
```

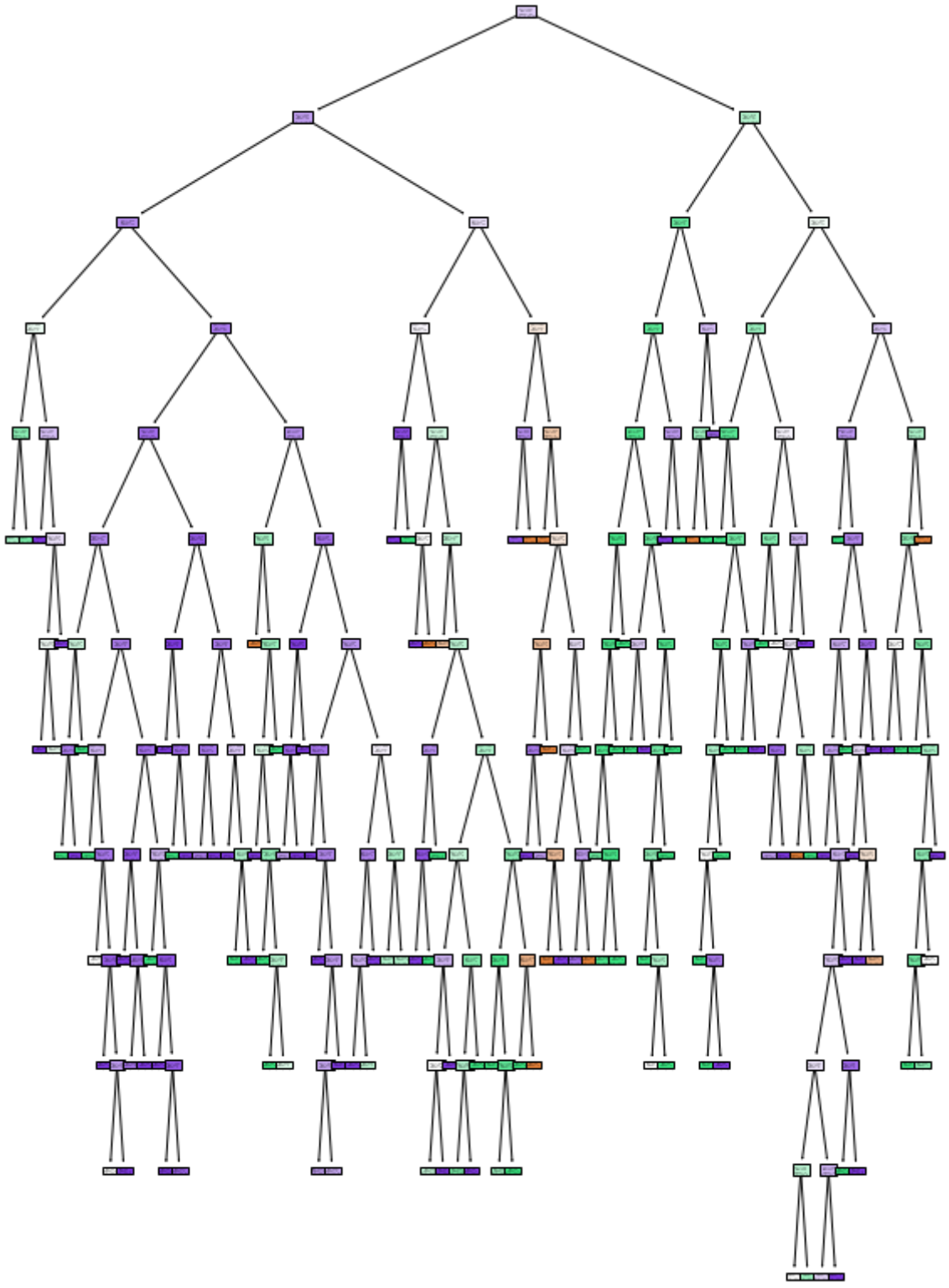
```
              precision    recall  f1-score   support

           0       0.85      0.56      0.68        39
           1       0.82      0.82      0.82       154
           2       0.78      0.84      0.81       169

    accuracy                           0.80       362
   macro avg       0.82      0.74      0.77       362
weighted avg       0.80      0.80      0.80       362
```

In [36]:

```
from sklearn import tree
plt.figure(figsize=(10,15))
tree.plot_tree(model,filled=True)
plt.show()
```



In [37]:

```
1 model.feature_importances_
```

Out[37]:

```
array([0.12189951, 0.09626619, 0.1171519 , 0.02145348, 0.04924518,
       0.06726136, 0.05672186, 0.12951326, 0.06101387, 0.12435672,
       0.15511667])
```

In [38]:

```
1 from sklearn.ensemble import RandomForestClassifier
2 classifier= RandomForestClassifier(n_estimators= 10,
3                                    criterion="entropy")
```

In [39]:

```
classifier.fit(X_train, y_train)
```

Out[39]:

```
RandomForestClassifier(criterion='entropy', n_estimators=10)
```

In [40]:

```
y_pred = classifier.predict(X_test)
```

In [41]:

```
print("Training Accuracy :", classifier.score(X_train, y_train))
print("Testing Accuracy :", classifier.score(X_test, y_test))
```

```
Training Accuracy : 0.8588374851720048
Testing Accuracy : 0.787292817679558
```

In [42]:

```
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.95      0.54      0.69        39
           1       0.78      0.84      0.81       154
           2       0.77      0.80      0.78       169

    accuracy                           0.79       362
   macro avg       0.84      0.72      0.76       362
weighted avg       0.80      0.79      0.78       362
```

In [43]:

```
classifier.feature_importances_
```

Out[43]:

```
array([0.07576819, 0.08319807, 0.11572646, 0.0980481 , 0.05521592,
       0.06144166, 0.06213362, 0.18141846, 0.07569019, 0.08614288,
       0.10521646])
```

In [44]:

```
grid_param = {
    'criterion': ['gini', 'entropy'],
    'max_depth' : range(2,32,1),
    'min_samples_leaf' : range(1,10,1),
    'min_samples_split': range(2,10,1),
    'splitter' : ['best', 'random']
}
```

In [46]:

```
from sklearn.model_selection import GridSearchCV
grid_search = GridSearchCV(estimator=model,
                     param_grid=grid_param,
                     cv=5,
                    n_jobs =2, verbose=1)
```

In [47]:

```
grid_search.fit(X_train,y_train)
```

```
Fitting 5 folds for each of 8640 candidates, totalling 43200 fits
```

Out[47]:

```
GridSearchCV(cv=5, estimator=DecisionTreeClassifier(), n_jobs=2,
             param_grid={'criterion': ['gini', 'entropy'],
                         'max_depth': range(2, 32),
                         'min_samples_leaf': range(1, 10),
                         'min_samples_split': range(2, 10),
                         'splitter': ['best', 'random']},
             verbose=1)
```

In [48]:

```
best_parameters = grid_search.best_params_
print(best_parameters)
```

```
{'criterion': 'gini', 'max_depth': 16, 'min_samples_leaf': 1, 'min_samples
_split': 2, 'splitter': 'random'}
```

In [49]:

```
grid_search.best_score_
```

Out[49]:

```
0.7936038320653704
```

In [51]:

```
clf = DecisionTreeClassifier(criterion = 'gini', max_depth = 25,
                             min_samples_leaf= 1, min_samples_split= 2,
                             splitter ='best')
clf.fit(X_train,y_train)
```

Out[51]:

```
DecisionTreeClassifier(max_depth=25)
```

In [52]:

```
ac2_clf= clf.score(X_test ,y_test)
ac2_clf
```

Out[52]:

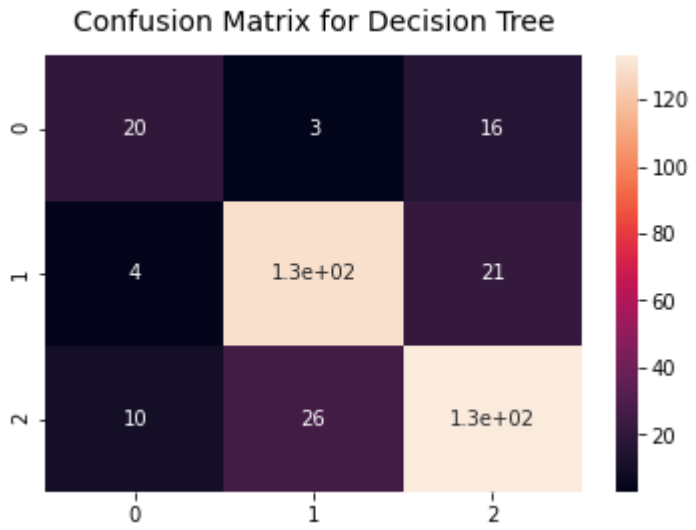
```
0.7790055248618785
```

In [53]:

```
from sklearn.metrics import confusion_matrix
y_pred_clf = clf.predict(X_test)
cf_matrix = confusion_matrix(y_test, y_pred_clf)
sns.heatmap(cf_matrix, annot=True)
plt.title("Confusion Matrix for Decision Tree", fontsize=14,
          fontname="DejaVu Sans", y=1.03)
```

Out[53]:

```
Text(0.5, 1.03, 'Confusion Matrix for Decision Tree')
```



In [55]:

```
y_pred_rf = classifier.predict(X_test)
```

In [58]:

```
from sklearn.metrics import accuracy_score
ac_rf=accuracy_score(y_test,y_pred)
ac_rf
```

Out[58]:

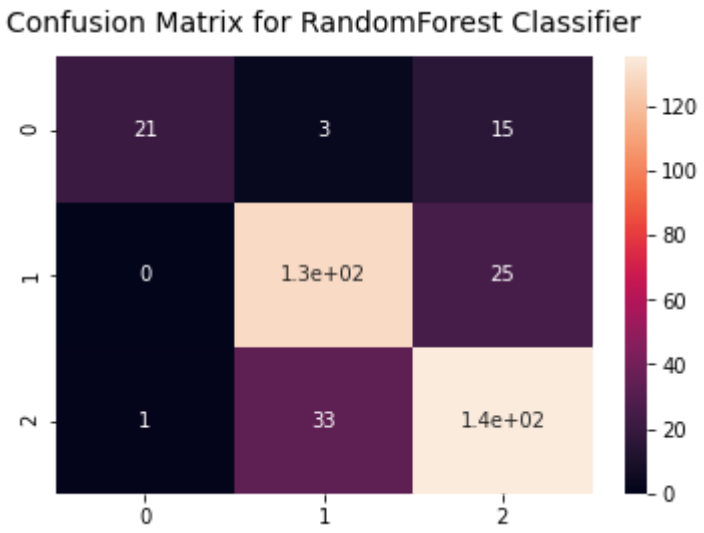
```
0.787292817679558
```

In [56]:

```
cf_matrix = confusion_matrix(y_test, y_pred_rf)
sns.heatmap(cf_matrix, annot=True)
plt.title("Confusion Matrix for RandomForest Classifier",
          fontsize=14, fontname="DejaVu Sans", y=1.03)
```

Out[56]:

```
Text(0.5, 1.03, 'Confusion Matrix for RandomForest Classifier')
```



In [59]:

```
plt.bar(['Decision Tree','Random Forest'],[ac2_clf,ac_rf])
plt.xlabel("Algorithms")
plt.ylabel("Accuracy")
plt.show()
```