```
# This Python 3 environment comes with many helpful analytics libraries installed
# It is defined by the kaggle/python docker image: https://github.com/kaggle/docker-python
# For example, here's several helpful packages to load in

import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

# Input data files are available in the "../input/" directory.
# For example, running this (by clicking run or pressing Shift+Enter) will list all files under the input direct
ory

# import os
# for dirname, _, filenames in os.walk('/kaggle/input'):
#     for filename in filenames:
#         print(os.path.join(dirname, filename))

# Any results you write to the current directory are saved as output.
```

In [2]:

```
import numpy as np
import os
import pandas as pd
import cv2
from PIL import Image
import scipy

import tensorflow as tf
from tensorflow.keras.applications import *
from tensorflow.keras.optimizers import *
from tensorflow.keras.losses import *
from tensorflow.keras.layers import *
from tensorflow.keras.models import *
from tensorflow.keras.callbacks import *
from tensorflow.keras.preprocessing.image import *
from tensorflow.keras.utils import *
from sklearn.neural_network import MLPClassifier
# import pydot
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import *
from sklearn.model_selection import *
import tensorflow.keras.backend as K

from tqdm import tqdm, tqdm_notebook
from colorama import Fore
import json
import matplotlib.pyplot as plt
import seaborn as sns
from glob import glob
from skimage.io import *
%config Completer.use_jedi = False
import time
from sklearn.decomposition import PCA
from sklearn.svm import SVC
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score
import lightgbm as lgb
from xgboost import XGBClassifier
from sklearn.ensemble import AdaBoostClassifier,RandomForestClassifier

from sklearn.metrics import confusion_matrix

import numpy as np
import pandas as pd
from pathlib import Path
import os.path
import matplotlib.pyplot as plt
from IPython.display import Image, display, Markdown
import matplotlib.cm as cm
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix
import tensorflow as tf
from time import perf_counter
import seaborn as sns
```

```
def printmd(string):
    # Print with Markdowns
    display(Markdown(string))

print("All modules have been imported")
```

```
All modules have been imported
```

In [3]:

```
image_dir = Path('../input/diabetic-retinopathy-224x224-2019-data/colored_images')

# Get filepaths and labels
filepaths = list(image_dir.glob(r'**/*.png'))
labels = list(map(lambda x: os.path.split(os.path.split(x)[0])[1], filepaths))
```

In [6]:

```
df = pd.read_csv("/kaggle/input/diabetic-retinopathy-224x224-2019-data/train.csv")
df
```

Out[6]:

	id_code	diagnosis
0	000c1434d8d7	2
1	001639a390f0	4
2	0024cdab0c1e	1
3	002c21358ce6	0
4	005b95c28852	0
...	...	...
3657	ffa47f6a7bf4	2
3658	ffc04fed30e6	0
3659	ffcf7b45f213	2
3660	ffd97f8cd5aa	0
3661	ffec9a18a3ce	2

3662 rows × 2 columns

In [11]:

```
filepaths
```

Out[11]:

```
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```

In [12]:

```
filepaths = pd.Series(filepaths, name='Filepath').astype(str)
labels = pd.Series(labels, name='Label')

# Concatenate filepaths and labels
image_df = pd.concat([filepaths, labels], axis=1)

# Shuffle the DataFrame and reset index
image_df = image_df.sample(frac=1).reset_index(drop = True)

# Show the result
image_df.head()
```

Out[12]:

	Filepath	Label
0	../input/diabetic-retinopathy-224x224-2019-dat...	Moderate
1	../input/diabetic-retinopathy-224x224-2019-dat...	No_DR
2	../input/diabetic-retinopathy-224x224-2019-dat...	Proliferate_DR
3	../input/diabetic-retinopathy-224x224-2019-dat...	Moderate
4	../input/diabetic-retinopathy-224x224-2019-dat...	Moderate

In [13]:

```
image_df
```

Out[13]:

	Filepath	Label
0	../input/diabetic-retinopathy-224x224-2019-dat...	Moderate
1	../input/diabetic-retinopathy-224x224-2019-dat...	No_DR
2	../input/diabetic-retinopathy-224x224-2019-dat...	Proliferate_DR
3	../input/diabetic-retinopathy-224x224-2019-dat...	Moderate
4	../input/diabetic-retinopathy-224x224-2019-dat...	Moderate
...	...	...
3657	../input/diabetic-retinopathy-224x224-2019-dat...	No_DR
3658	../input/diabetic-retinopathy-224x224-2019-dat...	No_DR
3659	../input/diabetic-retinopathy-224x224-2019-dat...	No_DR
3660	../input/diabetic-retinopathy-224x224-2019-dat...	No_DR
3661	../input/diabetic-retinopathy-224x224-2019-dat...	No_DR

3662 rows × 2 columns

In [14]:

```
level = []
for i in image_df['Label']:
    if i=='No_DR':
        level.append(0)
    elif i=='Mild':
        level.append(1)
    elif i=='Moderate':
        level.append(2)
    elif i=='Severe':
        level.append(3)
    else:
        level.append(4)
```

In [15]:

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level
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Out[15]:

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4,
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...]
```

In [16]:

```
image_df['Level'] = level
image_df.head()
```

Out[16]:

	Filepath	Label	Level
0	../input/diabetic-retinopathy-224x224-2019-dat...	Moderate	2
1	../input/diabetic-retinopathy-224x224-2019-dat...	No_DR	0
2	../input/diabetic-retinopathy-224x224-2019-dat...	Proliferate_DR	4
3	../input/diabetic-retinopathy-224x224-2019-dat...	Moderate	2
4	../input/diabetic-retinopathy-224x224-2019-dat...	Moderate	2

Different image labels taken into different folders with their label name, and a dataframe was created with file path, label name, level (this is just integer representation)..

In [17]:
```
X = []
for i in image_df['Filepath']:
    image = cv2.imread(i)
    X.append(image)

X = np.asarray(X)
y = image_df['Level']
Y = np.asarray(y)
```

In [23]:
```
image.shape   ## Creates the RGB component of image
```

Out[23]:
```
(224, 224, 3)
```

In [21]:
```
X.shape   ## append RGB component of image to itself
```

Out[21]:
```
(3662, 224, 224, 3)
```

In [24]:
```
y
```

Out[24]:
```
0       2
1       0
2       4
3       2
4       2
       ..
3657    0
3658    0
3659    0
3660    0
3661    0
Name: Level, Length: 3662, dtype: int64
```

The images were taken and found their RGB component, then that further appended into the each images creating an array of (3662, 224, 224, 3). The level column also converted into array format.

In [25]:
```
# Y=to_categorical(Y,5)
x_train, x_test1, y_train, y_test1 = train_test_split(X, Y, test_size=0.3, random_state=42)
x_val, x_test, y_val, y_test = train_test_split(x_test1, y_test1, test_size=0.3, random_state=42)
print(len(x_train),len(x_val),len(x_test))
```

```
2563 769 330
```

In [26]:
```
print(x_train.shape)
print(x_val.shape)
print(x_test.shape)
```

```
(2563, 224, 224, 3)
(769, 224, 224, 3)
(330, 224, 224, 3)
```

Train, Test and evaluation set prepared.

DNN Model

In [29]:
```
# Defining our DNN Model

dnn_model=Sequential()
dnn_model.add(Dense(32, input_dim=5, kernel_initializer = 'uniform', activation = 'relu'))
# dnn_model.add(BatchNormalization())
# dnn_model.add(Dropout(0.2))
dnn_model.add(Dense(64, kernel_initializer = 'HeUniform', activation = 'relu' ))
# dnn_model.add(BatchNormalization())
# dnn_model.add(Dropout(0.2))
dnn_model.add(Dense(128, kernel_initializer = 'uniform', activation = 'relu' ))
# dnn_model.add(BatchNormalization())
# dnn_model.add(Dropout(0.2))
dnn_model.add(Dense(256, kernel_initializer = 'uniform', activation = 'relu' ))
# dnn_model.add(BatchNormalization())
# dnn_model.add(Dropout(0.2))
dnn_model.add(Dense(128, kernel_initializer = 'uniform', activation = 'relu' ))
# dnn_model.add(BatchNormalization())
# dnn_model.add(Dropout(0.2))

dnn_model.add(Dense(5,activation='softmax'))
dnn_model.summary()
```

```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_12 (Dense)             (None, 32)                192
_________________________________________________________________
dense_13 (Dense)             (None, 64)                2112
_________________________________________________________________
dense_14 (Dense)             (None, 128)               8320
_________________________________________________________________
dense_15 (Dense)             (None, 256)               33024
_________________________________________________________________
dense_16 (Dense)             (None, 128)               32896
_________________________________________________________________
dense_17 (Dense)             (None, 5)                 645
=================================================================
Total params: 77,189
Trainable params: 77,189
Non-trainable params: 0
_________________________________________________________________
```

In [30]:

```
from sklearn.pipeline import make_pipeline
from sklearn.pipeline import Pipeline
names = [
        "K Nearest Neighbour Classifier",
        'SVM',
        "Random Forest Classifier",
        "AdaBoost Classifier",
        "XGB Classifier"
         ]
classifiers = [
    KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30),
    SVC(),
    RandomForestClassifier(max_depth=9,criterion = 'entropy'),
    AdaBoostClassifier(),
    XGBClassifier()
        ]
zipped_clf = zip(names,classifiers)
```

In [31]:

```
zipped_clf
```

Out[31]:

```
<zip at 0x7e42ac41f500>
```

In [32]:

```
def classifier_summary(pipeline, X_train, y_train, X_val, y_val,X_test,y_test):
    sentiment_fit = pipeline.fit(X_train, y_train)

    y_pred_train= sentiment_fit.predict(X_train)
    y_pred_val = sentiment_fit.predict(X_val)
    y_pred_test = sentiment_fit.predict(X_test)

    y_pred_train = [1 if x>0.5 else 0 for x in y_pred_train]
    y_pred_val = [1 if x>0.5 else 0 for x in y_pred_val]
    y_pred_test = [1 if x>0.5 else 0 for x in y_pred_test]

    train_accuracy = np.round(accuracy_score(y_train, y_pred_train),4)*100
    train_precision = np.round(precision_score(y_train, y_pred_train, average='weighted'),4)
    train_recall = np.round(recall_score(y_train, y_pred_train, average='weighted'),4)
    train_F1 = np.round(f1_score(y_train, y_pred_train, average='weighted'),4)
    train_kappa =  np.round(cohen_kappa_score(y_train, y_pred_train),4)


    val_accuracy = np.round(accuracy_score(y_val, y_pred_val),4)*100
    val_precision = np.round(precision_score(y_val, y_pred_val, average='weighted'),4)
    val_recall = np.round(recall_score(y_val, y_pred_val, average='weighted'),4)
    val_F1 = np.round(f1_score(y_val, y_pred_val, average='weighted'),4)
    val_kappa =  np.round(cohen_kappa_score(y_val, y_pred_val),4)


    test_accuracy = np.round(accuracy_score(y_test, y_pred_test),4)*100
    test_precision = np.round(precision_score(y_test, y_pred_test, average='weighted'),2)
    test_recall = np.round(recall_score(y_test, y_pred_test, average='weighted'),2)
    test_F1 = np.round(f1_score(y_test, y_pred_test, average='weighted'),2)
    test_kappa =  np.round(cohen_kappa_score(y_test, y_pred_test),2)



    print()
    print('----------------------- Train Set Metrics-----------------------')
    print()
    print("Accuracy core : {}%".format(train_accuracy))

    print('----------------------- Validation Set Metrics-----------------------')
    print()
    print("Accuracy score : {}%".format(val_accuracy))

    print('----------------------- Test Set Metrics-----------------------')
    print()
    print("Accuracy score : {}%".format(test_accuracy))
    print("F1_score : {}".format(test_F1))
    print("Kappa Score : {} ".format(test_kappa))
    print("Recall score: {}".format(test_recall))
    print("Precision score : {}".format(test_precision))

    print("-"*80)
    print()
```

In [33]:

```
def classifier_comparator(X_train,y_train,X_val,y_val,X_test,y_test,classifier=zipped_clf):
    result = []
    for n,c in classifier:
        checker_pipeline = Pipeline([('Classifier', c)])
        print("------------------------------Fitting {} on input_data-------------------------------
".format(n))
        #print(c)
        classifier_summary(checker_pipeline,X_train, y_train, X_val, y_val,X_test,y_test)
```

ResNet50

In [35]:

```
base_model= ResNet50(input_shape=(224,224,3), weights='imagenet', include_top=False)
x = base_model.output
# x = Dropout(0.5)(x)
x = Flatten()(x)
# x = BatchNormalization()(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(256,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
predictions = Dense(5, activation='softmax')(x)

model_feat = Model(inputs=base_model.input,outputs=predictions)

train_features = model_feat.predict(x_train)
val_features=model_feat.predict(x_val)
test_features=model_feat.predict(x_test)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/resnet/resnet50_
weights_tf_dim_ordering_tf_kernels_notop.h5
94773248/94765736 [==============================] - 3s 0us/step
```

In [36]:

```
from sklearn.pipeline import make_pipeline
from sklearn import pipeline
from sklearn.pipeline import Pipeline
names = [
        "K Nearest Neighbour Classifier",
        'SVM',
        "Random Forest Classifier",
        "AdaBoost Classifier",
        "XGB Classifier"
         ]
classifiers = [
    KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30),
    SVC(),
    RandomForestClassifier(max_depth=9,criterion = 'entropy'),
    AdaBoostClassifier(),
    XGBClassifier()
        ]
zipped_clf = zip(names,classifiers)
def classifier_summary(pipeline, X_train, y_train, X_val, y_val,X_test,y_test):
    sentiment_fit = pipeline.fit(X_train, y_train)

    y_pred_train= sentiment_fit.predict(X_train)
    y_pred_val = sentiment_fit.predict(X_val)
    y_pred_test = sentiment_fit.predict(X_test)

    train_accuracy = np.round(accuracy_score(y_train, y_pred_train),4)*100
    train_precision = np.round(precision_score(y_train, y_pred_train, average='weighted'),4)
    train_recall = np.round(recall_score(y_train, y_pred_train, average='weighted'),4)
    train_F1 = np.round(f1_score(y_train, y_pred_train, average='weighted'),4)
    train_kappa =  np.round(cohen_kappa_score(y_train, y_pred_train),4)


    val_accuracy = np.round(accuracy_score(y_val, y_pred_val),4)*100
    val_precision = np.round(precision_score(y_val, y_pred_val, average='weighted'),4)
    val_recall = np.round(recall_score(y_val, y_pred_val, average='weighted'),4)
    val_F1 = np.round(f1_score(y_val, y_pred_val, average='weighted'),4)
    val_kappa =  np.round(cohen_kappa_score(y_val, y_pred_val),4)


    test_accuracy = np.round(accuracy_score(y_test, y_pred_test),4)*100
    test_precision = np.round(precision_score(y_test, y_pred_test, average='weighted'),2)
    test_recall = np.round(recall_score(y_test, y_pred_test, average='weighted'),2)
    test_F1 = np.round(f1_score(y_test, y_pred_test, average='weighted'),2)
    test_kappa =  np.round(cohen_kappa_score(y_test, y_pred_test),2)



    print()
    print('----------------------- Train Set Metrics-----------------------')
    print()
    print("Accuracy core : {}%".format(train_accuracy))

    print('----------------------- Validation Set Metrics-----------------------')
    print()
    print("Accuracy score : {}%".format(val_accuracy))
```

```
    print('------------------------ Test Set Metrics-----------------------')
    print("Accuracy score : {}%".format(test_accuracy))

    print()
    print("Accuracy score : {}%".format(test_accuracy))
    print("F1_score : {}".format(test_F1))
    print("Kappa Score : {} ".format(test_kappa))
    print("Recall score: {}".format(test_recall))
    print("Precision score : {}".format(test_precision))

    print("-"*80)
    print()

def classifier_comparator(X_train,y_train,X_val,y_val,X_test,y_test,classifier=zipped_clf):
    result = []
    for n,c in classifier:
        checker_pipeline = Pipeline([('Classifier', c)])
        print("------------------------------Fitting {} on input_data--------------------------------
".format(n))
        classifier_summary(checker_pipeline,X_train, y_train, X_val, y_val,X_test,y_test)
```

In [37]:

```
classifier_comparator(train_features,y_train,val_features,y_val,test_features,y_test,classifier=zipped_
clf)
```

```
------------------------------Fitting K Nearest Neighbour Classifier on input_data-----------------
---------------

------------------------ Train Set Metrics-----------------------

Accuracy core : 60.01%
------------------------ Validation Set Metrics-----------------------

Accuracy score : 43.95%
------------------------ Test Set Metrics-----------------------
Accuracy score : 39.39%

Accuracy score : 39.39%
F1_score : 0.34
Kappa Score : -0.06
Recall score: 0.39
Precision score : 0.31
--------------------------------------------------------------------------------

------------------------------Fitting SVM on input_data--------------------------------
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

```
----------------------- Train Set Metrics-----------------------

Accuracy core : 48.22%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 52.410000000000004%
----------------------- Test Set Metrics-----------------------
Accuracy score : 50.3%

Accuracy score : 50.3%
F1_score : 0.34
Kappa Score : 0.0
Recall score: 0.5
Precision score : 0.25
--------------------------------------------------------------------------------

------------------------------Fitting Random Forest Classifier on input_data-----------------------
---------

----------------------- Train Set Metrics-----------------------

Accuracy core : 71.44%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 52.019999999999996%
----------------------- Test Set Metrics-----------------------
Accuracy score : 53.64%

Accuracy score : 53.64%
F1_score : 0.47
Kappa Score : 0.16
Recall score: 0.54
Precision score : 0.47
--------------------------------------------------------------------------------

------------------------------Fitting AdaBoost Classifier on input_data---------------------------
----

----------------------- Train Set Metrics-----------------------

Accuracy core : 51.23%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 52.54%
----------------------- Test Set Metrics-----------------------
Accuracy score : 49.7%

Accuracy score : 49.7%
F1_score : 0.43
Kappa Score : 0.09
Recall score: 0.5
Precision score : 0.38
--------------------------------------------------------------------------------

------------------------------Fitting XGB Classifier on input_data--------------------------------
```

```
[16:40:24] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.

/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


------------------------ Train Set Metrics-----------------------

Accuracy core : 97.54%
------------------------ Validation Set Metrics-----------------------

Accuracy score : 49.41%
------------------------ Test Set Metrics-----------------------
Accuracy score : 50.61%

Accuracy score : 50.61%
F1_score : 0.47
Kappa Score : 0.16
Recall score: 0.51
Precision score : 0.45
--------------------------------------------------------------------------------
```

In [38]:

```
train_y=to_categorical(y_train,5)
val_y=to_categorical(y_val,5)
test_y=to_categorical(y_test,5)
dnn_model.compile(optimizer='adam',loss='categorical_crossentropy', metrics=['accuracy'])
history = dnn_model.fit(train_features, train_y,validation_data=(val_features,val_y), epochs=10)
loss_value , accuracy = dnn_model.evaluate(train_features, train_y)
print('Train_accuracy is:' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(val_features, val_y)
print('Validation_accuracy is := ' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(test_features, test_y)
print('test_accuracy is : = ' + str(accuracy))
```

```
Epoch 1/10
81/81 [==============================] - 1s 6ms/step - loss: 1.4441 - accuracy: 0.4611 - val_loss:
1.2739 - val_accuracy: 0.5241
Epoch 2/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2840 - accuracy: 0.4943 - val_loss:
1.2685 - val_accuracy: 0.5241
Epoch 3/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3229 - accuracy: 0.4724 - val_loss:
1.2823 - val_accuracy: 0.5241
Epoch 4/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3057 - accuracy: 0.4717 - val_loss:
1.2747 - val_accuracy: 0.5241
Epoch 5/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2678 - accuracy: 0.5024 - val_loss:
1.2695 - val_accuracy: 0.5241
Epoch 6/10
81/81 [==============================] - 0s 4ms/step - loss: 1.2830 - accuracy: 0.4879 - val_loss:
1.2646 - val_accuracy: 0.5241
Epoch 7/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2749 - accuracy: 0.4940 - val_loss:
1.2609 - val_accuracy: 0.5241
Epoch 8/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2910 - accuracy: 0.4946 - val_loss:
1.2682 - val_accuracy: 0.5241
Epoch 9/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2729 - accuracy: 0.5027 - val_loss:
1.2555 - val_accuracy: 0.5241
Epoch 10/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3026 - accuracy: 0.4821 - val_loss:
1.2510 - val_accuracy: 0.5241
81/81 [==============================] - 0s 2ms/step - loss: 1.2814 - accuracy: 0.4822
Train_accuracy is:0.48224735260009766
25/25 [==============================] - 0s 2ms/step - loss: 1.2510 - accuracy: 0.5241
Validation_accuracy is := 0.5240572094917297
11/11 [==============================] - 0s 2ms/step - loss: 1.2436 - accuracy: 0.5030
test_accuracy is : = 0.5030303001403809
```

In [39]:

```
print("Performance Report:")
y_pred10=dnn_model.predict_classes(test_features)
y_test10=[np.argmax(x) for x in test_y]
y_pred_prb10=dnn_model.predict_proba(test_features)
target=['0','1','2','3','4']
from sklearn import metrics
print('Accuracy score is :', np.round(metrics.accuracy_score(y_test10, y_pred10),4))
print('Precision score is :', np.round(metrics.precision_score(y_test10, y_pred10, average='weighted'),
4))
print('Recall score is :', np.round(metrics.recall_score(y_test10,y_pred10, average='weighted'),4))
print('F1 Score is :', np.round(metrics.f1_score(y_test10, y_pred10, average='weighted'),4))
print('Cohen Kappa Score:', np.round(metrics.cohen_kappa_score(y_test10, y_pred10),4))
print('\t\tClassification Report:\n', metrics.classification_report(y_test10, y_pred10,target_names=tar
get))
```

```
Performance Report:
Accuracy score is : 0.503
Precision score is : 0.253
Recall score is : 0.503
F1 Score is : 0.3367
Cohen Kappa Score: 0.0
                Classification Report:
               precision    recall  f1-score   support

           0       0.50      1.00      0.67       166
           1       0.00      0.00      0.00        30
           2       0.00      0.00      0.00        96
           3       0.00      0.00      0.00        15
           4       0.00      0.00      0.00        23

    accuracy                           0.50       330
   macro avg       0.10      0.20      0.13       330
weighted avg       0.25      0.50      0.34       330



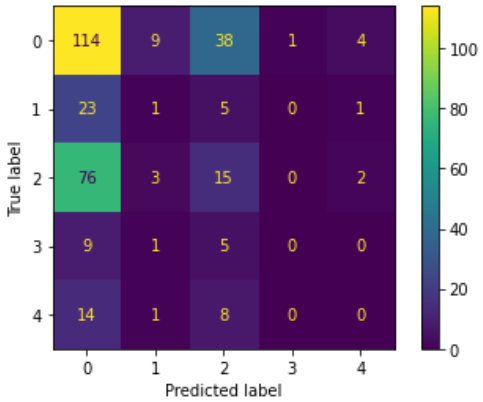
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:450: UserWarnin
g: `model.predict_classes()` is deprecated and will be removed after 2021-01-01. Please use instea
d:* `np.argmax(model.predict(x), axis=-1)`,   if your model does multi-class classification   (e.g.
if it uses a `softmax` last-layer activation).* `(model.predict(x) > 0.5).astype("int32")`,   if yo
ur model does binary classification   (e.g. if it uses a `sigmoid` last-layer activation).
  warnings.warn('`model.predict_classes()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:425: UserWarnin
g: `model.predict_proba()` is deprecated and will be removed after 2021-01-01. Please use `model.pr
edict()` instead.
  warnings.warn('`model.predict_proba()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [40]:

```python
knn = KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30)
knn.fit(train_features, y_train)
plot_confusion_matrix(knn, test_features, y_test)
```

Out[40]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e4258284450>
```

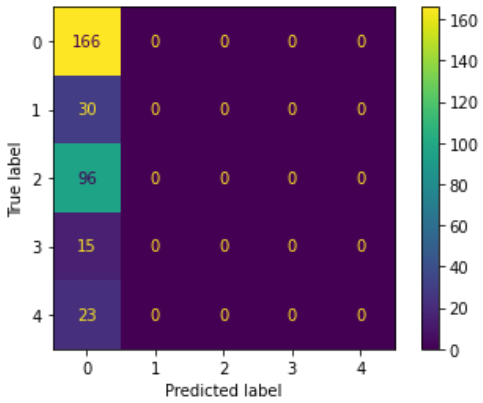


In [42]:

```
svc = SVC()
svc.fit(train_features, y_train)
plot_confusion_matrix(svc, test_features, y_test)
```

Out[42]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e425803da90>
```

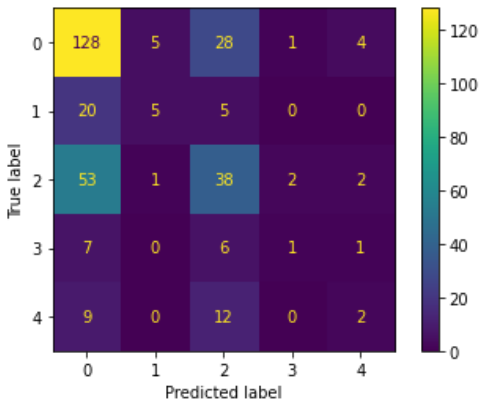


In [43]:

```
rf = RandomForestClassifier()
rf.fit(train_features, y_train)
plot_confusion_matrix(rf, test_features, y_test)
```

Out[43]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42346cc0d0>
```

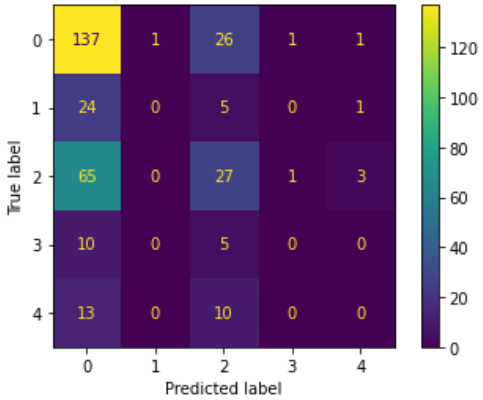


In [44]:

```
ada = AdaBoostClassifier()
ada.fit(train_features, y_train)
plot_confusion_matrix(ada, test_features, y_test)
```

Out[44]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42344deb10>
```



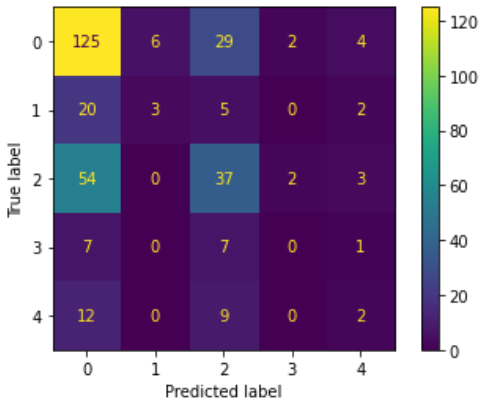
In [45]:

```
xgbc = XGBClassifier()
xgbc.fit(train_features, y_train)
plot_confusion_matrix(xgbc, test_features, y_test)
```

```
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


[16:41:02] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
```

Out[45]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42346f9310>
```



VGG-16

In [46]:

```
base_model= VGG16(input_shape=(224,224,3), weights='imagenet', include_top=False)
x = base_model.output
# x = Dropout(0.5)(x)
x = Flatten()(x)
# x = BatchNormalization()(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(256,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
predictions = Dense(5, activation='softmax')(x)

model_feat = Model(inputs=base_model.input,outputs=predictions)

train_features = model_feat.predict(x_train)
val_features=model_feat.predict(x_val)
test_features=model_feat.predict(x_test)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/vgg16/vgg16_weig
hts_tf_dim_ordering_tf_kernels_notop.h5
58892288/58889256 [==============================] - 2s 0us/step
```

In [47]:

```
from sklearn.pipeline import make_pipeline
from sklearn.pipeline import Pipeline
names = [
        "K Nearest Neighbour Classifier",
        'SVM',
        "Random Forest Classifier",
        "AdaBoost Classifier",
        "XGB Classifier"
         ]
classifiers = [
    KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30),
    SVC(),
    RandomForestClassifier(max_depth=9,criterion = 'entropy'),
    AdaBoostClassifier(),
    XGBClassifier()
        ]
zipped_clf = zip(names,classifiers)
def classifier_summary(pipeline, X_train, y_train, X_val, y_val,X_test,y_test):
    sentiment_fit = pipeline.fit(X_train, y_train)

    y_pred_train= sentiment_fit.predict(X_train)
    y_pred_val = sentiment_fit.predict(X_val)
    y_pred_test = sentiment_fit.predict(X_test)

    train_accuracy = np.round(accuracy_score(y_train, y_pred_train),4)*100
    train_precision = np.round(precision_score(y_train, y_pred_train, average='weighted'),4)
    train_recall = np.round(recall_score(y_train, y_pred_train, average='weighted'),4)
    train_F1 = np.round(f1_score(y_train, y_pred_train, average='weighted'),4)
    train_kappa =  np.round(cohen_kappa_score(y_train, y_pred_train),4)


    val_accuracy = np.round(accuracy_score(y_val, y_pred_val),4)*100
    val_precision = np.round(precision_score(y_val, y_pred_val, average='weighted'),4)
    val_recall = np.round(recall_score(y_val, y_pred_val, average='weighted'),4)
    val_F1 = np.round(f1_score(y_val, y_pred_val, average='weighted'),4)
    val_kappa =  np.round(cohen_kappa_score(y_val, y_pred_val),4)


    test_accuracy = np.round(accuracy_score(y_test, y_pred_test),4)*100
    test_precision = np.round(precision_score(y_test, y_pred_test, average='weighted'),2)
    test_recall = np.round(recall_score(y_test, y_pred_test, average='weighted'),2)
    test_F1 = np.round(f1_score(y_test, y_pred_test, average='weighted'),2)
    test_kappa =  np.round(cohen_kappa_score(y_test, y_pred_test),2)



    print()
    print('----------------------- Train Set Metrics-----------------------')
    print()
    print("Accuracy core : {}%".format(train_accuracy))

    print('----------------------- Validation Set Metrics-----------------------')
    print()
    print("Accuracy score : {}%".format(val_accuracy))
    print('----------------------- Test Set Metrics-----------------------')
```

```
    print()
    print("Accuracy score : {}%".format(test_accuracy))
    print("F1_score : {}".format(test_F1))
    print("Kappa Score : {} ".format(test_kappa))
    print("Recall score: {}".format(test_recall))
    print("Precision score : {}".format(test_precision))

    print("-"*80)
    print()

def classifier_comparator(X_train,y_train,X_val,y_val,X_test,y_test,classifier=zipped_clf):
    result = []
    for n,c in classifier:
        checker_pipeline = Pipeline([('Classifier', c)])
        print("------------------------------Fitting {} on input_data--------------------------------
".format(n))
        #print(c)
        classifier_summary(checker_pipeline,X_train, y_train, X_val, y_val,X_test,y_test)
```

In [48]:

```
classifier_comparator(train_features,y_train,val_features,y_val,test_features,y_test,classifier=zipped_
clf)
```

```
------------------------------Fitting K Nearest Neighbour Classifier on input_data-----------------
---------------

----------------------- Train Set Metrics-----------------------

Accuracy core : 60.629999999999995%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 47.33%
----------------------- Test Set Metrics-----------------------

Accuracy score : 49.09%
F1_score : 0.44
Kappa Score : 0.12
Recall score: 0.49
Precision score : 0.41
--------------------------------------------------------------------------------

------------------------------Fitting SVM on input_data--------------------------------
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))


------------------------ Train Set Metrics------------------------

Accuracy core : 48.22%
------------------------ Validation Set Metrics------------------------

Accuracy score : 52.410000000000004%
------------------------ Test Set Metrics------------------------

Accuracy score : 50.3%
F1_score : 0.34
Kappa Score : 0.0
Recall score: 0.5
Precision score : 0.25
--------------------------------------------------------------------------------

------------------------------Fitting Random Forest Classifier on input_data-----------------------
---------


/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))


------------------------ Train Set Metrics------------------------

Accuracy core : 70.23%
------------------------ Validation Set Metrics------------------------

Accuracy score : 53.449999999999996%
------------------------ Test Set Metrics------------------------

Accuracy score : 56.36%
F1_score : 0.5
Kappa Score : 0.24
Recall score: 0.56
Precision score : 0.45
--------------------------------------------------------------------------------

------------------------------Fitting AdaBoost Classifier on input_data----------------------------
----
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


----------------------- Train Set Metrics-----------------------

Accuracy core : 53.300000000000004%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 50.33%
----------------------- Test Set Metrics-----------------------

Accuracy score : 54.55%
F1_score : 0.49
Kappa Score : 0.23
Recall score: 0.55
Precision score : 0.45
--------------------------------------------------------------------------------

------------------------------Fitting XGB Classifier on input_data--------------------------------
[16:41:31] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.

----------------------- Train Set Metrics-----------------------

Accuracy core : 98.48%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 53.190000000000005%
----------------------- Test Set Metrics-----------------------

Accuracy score : 55.45%
F1_score : 0.52
Kappa Score : 0.24
Recall score: 0.55
Precision score : 0.51
--------------------------------------------------------------------------------
```

In [49]:

```
train_y=to_categorical(y_train,5)
val_y=to_categorical(y_val,5)
test_y=to_categorical(y_test,5)
dnn_model.compile(optimizer='sgd',loss='categorical_crossentropy', metrics=['accuracy'],)
history = dnn_model.fit(train_features, train_y,validation_data=(val_features,val_y), epochs=10)
loss_value , accuracy = dnn_model.evaluate(train_features, train_y)
print('Train_accuracy is:' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(val_features, val_y)
print('Validation_accuracy is := ' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(test_features, test_y)
print('test_accuracy is : = ' + str(accuracy))
```

```
Epoch 1/10
81/81 [==============================] - 1s 5ms/step - loss: 1.3992 - accuracy: 0.4892 - val_loss:
1.2882 - val_accuracy: 0.5241
Epoch 2/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2922 - accuracy: 0.4933 - val_loss:
1.2623 - val_accuracy: 0.5241
Epoch 3/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2735 - accuracy: 0.4915 - val_loss:
1.2568 - val_accuracy: 0.5241
Epoch 4/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2860 - accuracy: 0.4894 - val_loss:
1.2471 - val_accuracy: 0.5241
Epoch 5/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2965 - accuracy: 0.4700 - val_loss:
1.2445 - val_accuracy: 0.5241
Epoch 6/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2922 - accuracy: 0.4800 - val_loss:
1.2378 - val_accuracy: 0.5241
Epoch 7/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2802 - accuracy: 0.4829 - val_loss:
1.2375 - val_accuracy: 0.5241
Epoch 8/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2667 - accuracy: 0.4926 - val_loss:
1.2364 - val_accuracy: 0.5241
Epoch 9/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2743 - accuracy: 0.4737 - val_loss:
1.2362 - val_accuracy: 0.5241
Epoch 10/10
81/81 [==============================] - 0s 5ms/step - loss: 1.2723 - accuracy: 0.4863 - val_loss:
1.2319 - val_accuracy: 0.5241
81/81 [==============================] - 0s 2ms/step - loss: 1.2741 - accuracy: 0.4822
Train_accuracy is:0.48224735260009766
25/25 [==============================] - 0s 3ms/step - loss: 1.2319 - accuracy: 0.5241
Validation_accuracy is := 0.5240572094917297
11/11 [==============================] - 0s 3ms/step - loss: 1.2218 - accuracy: 0.5030
test_accuracy is : = 0.5030303001403809
```

In [50]:

```
print("Performance Report:")
y_pred2=dnn_model.predict_classes(test_features)
y_test2=[np.argmax(x) for x in test_y]
y_pred_prb2=dnn_model.predict_proba(test_features)
target=['0','1','2','3','4']
from sklearn import metrics
print('Accuracy score is :', np.round(metrics.accuracy_score(y_test2, y_pred2),4))
print('Precision score is :', np.round(metrics.precision_score(y_test2, y_pred2, average='weighted'),
4))
print('Recall score is :', np.round(metrics.recall_score(y_test2,y_pred2, average='weighted'),4))
print('F1 Score is :', np.round(metrics.f1_score(y_test2, y_pred2, average='weighted'),4))
print('Cohen Kappa Score:', np.round(metrics.cohen_kappa_score(y_test2, y_pred2),4))
print('\t\tClassification Report:\n', metrics.classification_report(y_test2, y_pred2,target_names=targe
t))
```

```
Performance Report:
Accuracy score is : 0.503
Precision score is : 0.253
Recall score is : 0.503
F1 Score is : 0.3367
Cohen Kappa Score: 0.0
                Classification Report:
               precision    recall  f1-score   support

           0       0.50      1.00      0.67       166
           1       0.00      0.00      0.00        30
           2       0.00      0.00      0.00        96
           3       0.00      0.00      0.00        15
           4       0.00      0.00      0.00        23

    accuracy                           0.50       330
   macro avg       0.10      0.20      0.13       330
weighted avg       0.25      0.50      0.34       330
```

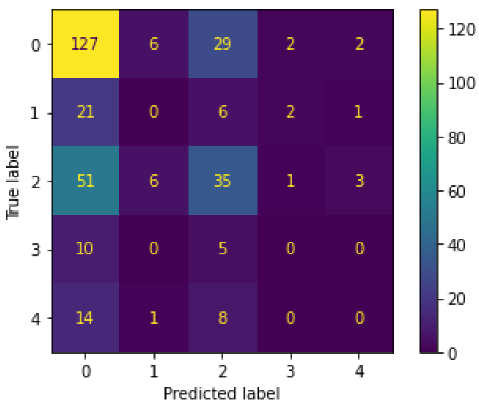
```
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:450: UserWarnin
g: `model.predict_classes()` is deprecated and will be removed after 2021-01-01. Please use instea
d:* `np.argmax(model.predict(x), axis=-1)`,   if your model does multi-class classification   (e.g.
if it uses a `softmax` last-layer activation).* `(model.predict(x) > 0.5).astype("int32")`,   if yo
ur model does binary classification   (e.g. if it uses a `sigmoid` last-layer activation).
  warnings.warn('`model.predict_classes()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:425: UserWarnin
g: `model.predict_proba()` is deprecated and will be removed after 2021-01-01. Please use `model.pr
edict()` instead.
  warnings.warn('`model.predict_proba()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [51]:

```python
knn = KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30)
knn.fit(train_features, y_train)
plot_confusion_matrix(knn, test_features, y_test)
```

Out[51]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e4230447390>
```

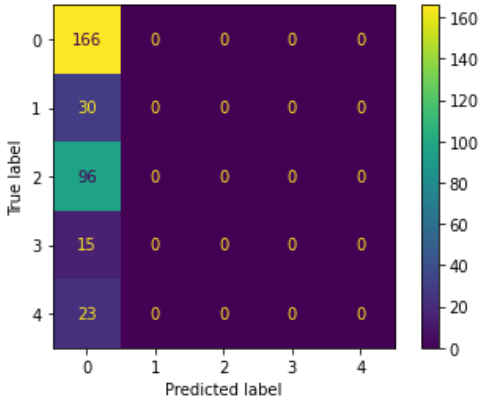


In [52]:

```python
svc = SVC()
svc.fit(train_features, y_train)
plot_confusion_matrix(svc, test_features, y_test)
```

Out[52]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42303c63d0>
```

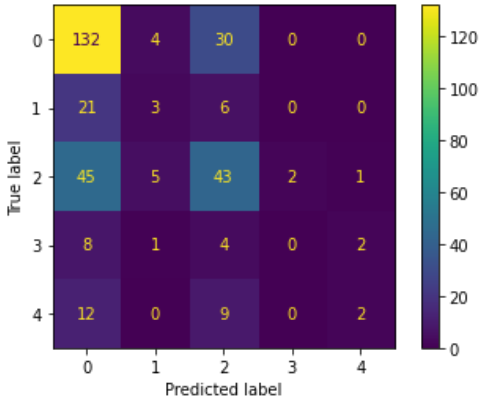


In [53]:

```
rf = RandomForestClassifier()
rf.fit(train_features, y_train)
plot_confusion_matrix(rf, test_features, y_test)
```

Out[53]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42346ed210>
```

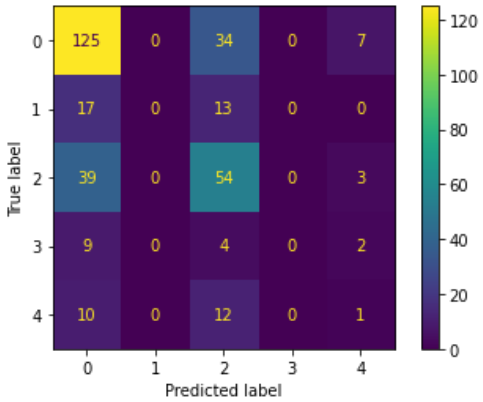


In [54]:

```
ada = AdaBoostClassifier()
ada.fit(train_features, y_train)
plot_confusion_matrix(ada, test_features, y_test)
```

Out[54]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e4258061e90>
```



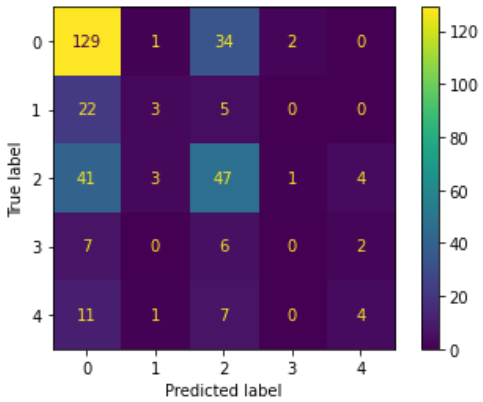
In [55]:

```
xgbc = XGBClassifier()
xgbc.fit(train_features, y_train)
plot_confusion_matrix(xgbc, test_features, y_test)
```

```
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


[16:41:52] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
```

Out[55]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42582b0b10>
```



VGG-19

In [56]:

```
base_model= VGG19(input_shape=(224,224,3), weights='imagenet', include_top=False)
x = base_model.output
# x = Dropout(0.5)(x)
x = Flatten()(x)
# x = BatchNormalization()(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(256,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
predictions = Dense(5, activation='softmax')(x)

model_feat = Model(inputs=base_model.input,outputs=predictions)

train_features = model_feat.predict(x_train)
val_features=model_feat.predict(x_val)
test_features=model_feat.predict(x_test)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/vgg19/vgg19_weig
hts_tf_dim_ordering_tf_kernels_notop.h5
80142336/80134624 [==============================] - 2s 0us/step
```

In [57]:

```
from sklearn.pipeline import make_pipeline
from sklearn.pipeline import Pipeline
names = [
        "K Nearest Neighbour Classifier",
        'SVM',
        "Random Forest Classifier",
        "AdaBoost Classifier",
        "XGB Classifier"
         ]
classifiers = [
    KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30),
    SVC(),
    RandomForestClassifier(max_depth=9,criterion = 'entropy'),
    AdaBoostClassifier(),
    XGBClassifier()
        ]
zipped_clf = zip(names,classifiers)
def classifier_summary(pipeline, X_train, y_train, X_val, y_val,X_test,y_test):
    sentiment_fit = pipeline.fit(X_train, y_train)

    y_pred_train= sentiment_fit.predict(X_train)
    y_pred_val = sentiment_fit.predict(X_val)
    y_pred_test = sentiment_fit.predict(X_test)

    train_accuracy = np.round(accuracy_score(y_train, y_pred_train),4)*100
    train_precision = np.round(precision_score(y_train, y_pred_train, average='weighted'),4)
    train_recall = np.round(recall_score(y_train, y_pred_train, average='weighted'),4)
    train_F1 = np.round(f1_score(y_train, y_pred_train, average='weighted'),4)
    train_kappa =  np.round(cohen_kappa_score(y_train, y_pred_train),4)


    val_accuracy = np.round(accuracy_score(y_val, y_pred_val),4)*100
    val_precision = np.round(precision_score(y_val, y_pred_val, average='weighted'),4)
    val_recall = np.round(recall_score(y_val, y_pred_val, average='weighted'),4)
    val_F1 = np.round(f1_score(y_val, y_pred_val, average='weighted'),4)
    val_kappa =  np.round(cohen_kappa_score(y_val, y_pred_val),4)


    test_accuracy = np.round(accuracy_score(y_test, y_pred_test),4)*100
    test_precision = np.round(precision_score(y_test, y_pred_test, average='weighted'),2)
    test_recall = np.round(recall_score(y_test, y_pred_test, average='weighted'),2)
    test_F1 = np.round(f1_score(y_test, y_pred_test, average='weighted'),2)
    test_kappa =  np.round(cohen_kappa_score(y_test, y_pred_test),2)



    print()
    print('----------------------- Train Set Metrics-----------------------')
    print()
    print("Accuracy core : {}%".format(train_accuracy))

    print('----------------------- Validation Set Metrics-----------------------')
    print()
    print("Accuracy score : {}%".format(val_accuracy))
    print('----------------------- Test Set Metrics-----------------------')
```

```
    print()
    print("Accuracy score : {}%".format(test_accuracy))
    print("F1_score : {}".format(test_F1))
    print("Kappa Score : {} ".format(test_kappa))
    print("Recall score: {}".format(test_recall))
    print("Precision score : {}".format(test_precision))

    print("-"*80)
    print()

def classifier_comparator(X_train,y_train,X_val,y_val,X_test,y_test,classifier=zipped_clf):
    result = []
    for n,c in classifier:
        checker_pipeline = Pipeline([('Classifier', c)])
        print("------------------------------Fitting {} on input_data--------------------------------
".format(n))
        #print(c)
        classifier_summary(checker_pipeline,X_train, y_train, X_val, y_val,X_test,y_test)
```

In [58]:

```
classifier_comparator(train_features,y_train,val_features,y_val,test_features,y_test,classifier=zipped_
clf)
```

```
------------------------------Fitting K Nearest Neighbour Classifier on input_data-----------------
---------------

----------------------- Train Set Metrics-----------------------

Accuracy core : 57.67%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 47.46%
----------------------- Test Set Metrics-----------------------

Accuracy score : 43.94%
F1_score : 0.39
Kappa Score : 0.02
Recall score: 0.44
Precision score : 0.37
--------------------------------------------------------------------------------

------------------------------Fitting SVM on input_data--------------------------------
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))


------------------------ Train Set Metrics------------------------

Accuracy core : 48.22%
------------------------ Validation Set Metrics------------------------

Accuracy score : 52.410000000000004%
------------------------ Test Set Metrics------------------------

Accuracy score : 50.3%
F1_score : 0.34
Kappa Score : 0.0
Recall score: 0.5
Precision score : 0.25
--------------------------------------------------------------------------------

------------------------------Fitting Random Forest Classifier on input_data-----------------------
---------

/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

```
------------------------ Train Set Metrics------------------------

Accuracy core : 60.550000000000004%
------------------------ Validation Set Metrics------------------------

Accuracy score : 49.93%
------------------------ Test Set Metrics------------------------

Accuracy score : 50.3%
F1_score : 0.39
Kappa Score : 0.04
Recall score: 0.5
Precision score : 0.37
--------------------------------------------------------------------------------

------------------------------Fitting AdaBoost Classifier on input_data-----------------------------
----

/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)
```

```
----------------------- Train Set Metrics-----------------------

Accuracy core : 48.38%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 49.93%
----------------------- Test Set Metrics-----------------------

Accuracy score : 48.79%
F1_score : 0.35
Kappa Score : -0.0
Recall score: 0.49
Precision score : 0.32
--------------------------------------------------------------------------------

------------------------------Fitting XGB Classifier on input_data--------------------------------
[16:42:07] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.

----------------------- Train Set Metrics-----------------------

Accuracy core : 97.74000000000001%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 45.25%
----------------------- Test Set Metrics-----------------------

Accuracy score : 50.91%
F1_score : 0.47
Kappa Score : 0.15
Recall score: 0.51
Precision score : 0.46
--------------------------------------------------------------------------------
```

In [59]:

```
train_y=to_categorical(y_train,5)
val_y=to_categorical(y_val,5)
test_y=to_categorical(y_test,5)
dnn_model.compile(optimizer='adam',loss='categorical_crossentropy', metrics=['accuracy'])
history = dnn_model.fit(train_features, train_y,validation_data=(val_features,val_y), epochs=10)
loss_value , accuracy = dnn_model.evaluate(train_features, train_y)
print('Train_accuracy is:' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(val_features, val_y)
print('Validation_accuracy is := ' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(test_features, test_y)
print('test_accuracy is : = ' + str(accuracy))
```

```
Epoch 1/10
81/81 [==============================] - 1s 8ms/step - loss: 1.3118 - accuracy: 0.4817 - val_loss:
1.2729 - val_accuracy: 0.5241
Epoch 2/10
81/81 [==============================] - 0s 5ms/step - loss: 1.3045 - accuracy: 0.4872 - val_loss:
1.2767 - val_accuracy: 0.5241
Epoch 3/10
81/81 [==============================] - 0s 4ms/step - loss: 1.3037 - accuracy: 0.4719 - val_loss:
1.2747 - val_accuracy: 0.5241
Epoch 4/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2932 - accuracy: 0.4863 - val_loss:
1.2738 - val_accuracy: 0.5241
Epoch 5/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2928 - accuracy: 0.4858 - val_loss:
1.2818 - val_accuracy: 0.5241
Epoch 6/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3017 - accuracy: 0.4818 - val_loss:
1.2787 - val_accuracy: 0.5241
Epoch 7/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2932 - accuracy: 0.5001 - val_loss:
1.2828 - val_accuracy: 0.5241
Epoch 8/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3107 - accuracy: 0.4699 - val_loss:
1.2724 - val_accuracy: 0.5241
Epoch 9/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2973 - accuracy: 0.4850 - val_loss:
1.2736 - val_accuracy: 0.5241
Epoch 10/10
81/81 [==============================] - 0s 4ms/step - loss: 1.3049 - accuracy: 0.4858 - val_loss:
1.2835 - val_accuracy: 0.5241
81/81 [==============================] - 0s 2ms/step - loss: 1.3063 - accuracy: 0.4822
Train_accuracy is:0.48224735260009766
25/25 [==============================] - 0s 2ms/step - loss: 1.2835 - accuracy: 0.5241
Validation_accuracy is := 0.5240572094917297
11/11 [==============================] - 0s 2ms/step - loss: 1.2595 - accuracy: 0.5030
test_accuracy is : = 0.5030303001403809
```

In [60]:

```
print("Performance Report:")
y_pred1=dnn_model.predict_classes(test_features)
y_test1=[np.argmax(x) for x in test_y]
y_pred_prb1=dnn_model.predict_proba(test_features)
target=['0','1','2','3','4']
from sklearn import metrics
print('Accuracy score is :', np.round(metrics.accuracy_score(y_test1, y_pred1),4))
print('Precision score is :', np.round(metrics.precision_score(y_test1, y_pred1, average='weighted'),
4))
print('Recall score is :', np.round(metrics.recall_score(y_test1,y_pred1, average='weighted'),4))
print('F1 Score is :', np.round(metrics.f1_score(y_test1, y_pred1, average='weighted'),4))
print('Cohen Kappa Score:', np.round(metrics.cohen_kappa_score(y_test1, y_pred1),4))
print('\t\tClassification Report:\n', metrics.classification_report(y_test1, y_pred1,target_names=targe
t))
```

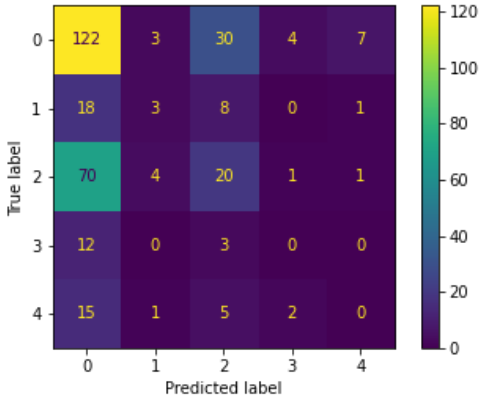
```
Performance Report:
Accuracy score is : 0.503
Precision score is : 0.253
Recall score is : 0.503
F1 Score is : 0.3367
Cohen Kappa Score: 0.0
                Classification Report:
               precision    recall  f1-score   support

           0       0.50      1.00      0.67       166
           1       0.00      0.00      0.00        30
           2       0.00      0.00      0.00        96
           3       0.00      0.00      0.00        15
           4       0.00      0.00      0.00        23

    accuracy                           0.50       330
   macro avg       0.10      0.20      0.13       330
weighted avg       0.25      0.50      0.34       330



/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:450: UserWarnin
g: `model.predict_classes()` is deprecated and will be removed after 2021-01-01. Please use instea
d:* `np.argmax(model.predict(x), axis=-1)`,   if your model does multi-class classification   (e.g.
if it uses a `softmax` last-layer activation).* `(model.predict(x) > 0.5).astype("int32")`,   if yo
ur model does binary classification   (e.g. if it uses a `sigmoid` last-layer activation).
  warnings.warn('`model.predict_classes()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:425: UserWarnin
g: `model.predict_proba()` is deprecated and will be removed after 2021-01-01. Please use `model.pr
edict()` instead.
  warnings.warn('`model.predict_proba()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [61]:

```
knn = KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30)
knn.fit(train_features, y_train)
plot_confusion_matrix(knn, test_features, y_test)
```

Out[61]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42304fc350>
```

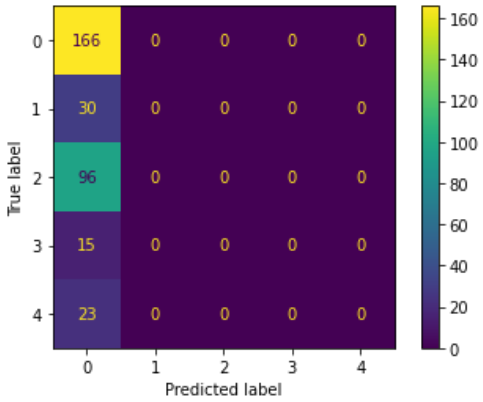


In [62]:

```
svc = SVC()
svc.fit(train_features, y_train)
plot_confusion_matrix(svc, test_features, y_test)
```

Out[62]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e4230193710>
```

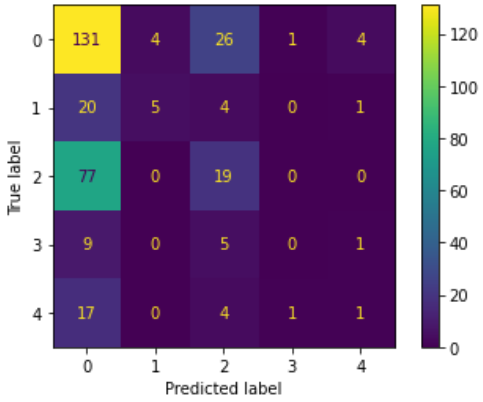


In [63]:

```
rf = RandomForestClassifier()
rf.fit(train_features, y_train)
plot_confusion_matrix(rf, test_features, y_test)
```

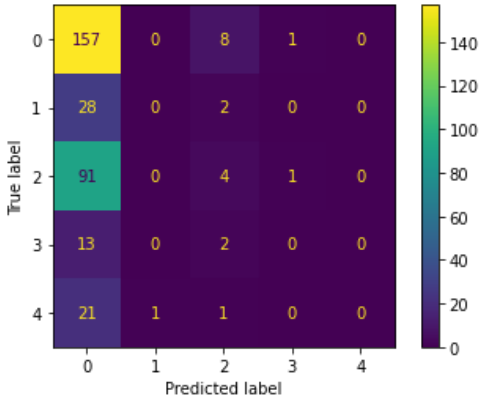
Out[63]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42345e8850>
```



In [64]:
```
ada = AdaBoostClassifier()
ada.fit(train_features, y_train)
plot_confusion_matrix(ada, test_features, y_test)
```

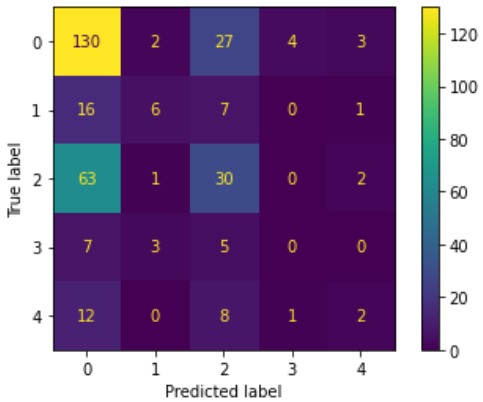
Out[64]:
```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e423020f650>
```



In [65]:
```
xgbc = XGBClassifier()
xgbc.fit(train_features, y_train)
plot_confusion_matrix(xgbc, test_features, y_test)
```

```
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


[16:42:15] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
```

Out[65]:
```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42346f9c10>
```



ResNet101

In [66]:

```
base_model= ResNet101(input_shape=(224,224,3), weights='imagenet', include_top=False)
x = base_model.output
# x = Dropout(0.5)(x)
x = Flatten()(x)
# x = BatchNormalization()(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(256,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
predictions = Dense(5, activation='softmax')(x)

model_feat = Model(inputs=base_model.input,outputs=predictions)

train_features = model_feat.predict(x_train)
val_features=model_feat.predict(x_val)
test_features=model_feat.predict(x_test)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/resnet/resnet101
_weights_tf_dim_ordering_tf_kernels_notop.h5
171450368/171446536 [==============================] - 6s 0us/step
```

In [67]:

```
from sklearn.pipeline import make_pipeline
from sklearn.pipeline import Pipeline
names = [
        "K Nearest Neighbour Classifier",
        'SVM',
        "Random Forest Classifier",
        "AdaBoost Classifier",
        "XGB Classifier"
         ]
classifiers = [
    KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30),
    SVC(),
    RandomForestClassifier(max_depth=9,criterion = 'entropy'),
    AdaBoostClassifier(),
    XGBClassifier()
        ]
zipped_clf = zip(names,classifiers)
def classifier_summary(pipeline, X_train, y_train, X_val, y_val,X_test,y_test):
    sentiment_fit = pipeline.fit(X_train, y_train)

    y_pred_train= sentiment_fit.predict(X_train)
    y_pred_val = sentiment_fit.predict(X_val)
    y_pred_test = sentiment_fit.predict(X_test)

    train_accuracy = np.round(accuracy_score(y_train, y_pred_train),4)*100
    train_precision = np.round(precision_score(y_train, y_pred_train, average='weighted'),4)
    train_recall = np.round(recall_score(y_train, y_pred_train, average='weighted'),4)
    train_F1 = np.round(f1_score(y_train, y_pred_train, average='weighted'),4)
    train_kappa =  np.round(cohen_kappa_score(y_train, y_pred_train),4)


    val_accuracy = np.round(accuracy_score(y_val, y_pred_val),4)*100
    val_precision = np.round(precision_score(y_val, y_pred_val, average='weighted'),4)
    val_recall = np.round(recall_score(y_val, y_pred_val, average='weighted'),4)
    val_F1 = np.round(f1_score(y_val, y_pred_val, average='weighted'),4)
    val_kappa =  np.round(cohen_kappa_score(y_val, y_pred_val),4)


    test_accuracy = np.round(accuracy_score(y_test, y_pred_test),4)*100
    test_precision = np.round(precision_score(y_test, y_pred_test, average='weighted'),2)
    test_recall = np.round(recall_score(y_test, y_pred_test, average='weighted'),2)
    test_F1 = np.round(f1_score(y_test, y_pred_test, average='weighted'),2)
    test_kappa =  np.round(cohen_kappa_score(y_test, y_pred_test),2)



    print()
    print('----------------------- Train Set Metrics-----------------------')
    print()
    print("Accuracy core : {}%".format(train_accuracy))

    print('----------------------- Validation Set Metrics-----------------------')
    print()
    print("Accuracy score : {}%".format(val_accuracy))
    print('----------------------- Test Set Metrics-----------------------')
```

```
    print()
    print("Accuracy score : {}%".format(test_accuracy))
    print("F1_score : {}".format(test_F1))
    print("Kappa Score : {} ".format(test_kappa))
    print("Recall score: {}".format(test_recall))
    print("Precision score : {}".format(test_precision))

    print("-"*80)
    print()

def classifier_comparator(X_train,y_train,X_val,y_val,X_test,y_test,classifier=zipped_clf):
    result = []
    for n,c in classifier:
        checker_pipeline = Pipeline([('Classifier', c)])
        print("------------------------------Fitting {} on input_data--------------------------------
".format(n))
        #print(c)
        classifier_summary(checker_pipeline,X_train, y_train, X_val, y_val,X_test,y_test)
```

In [68]:

```
classifier_comparator(train_features,y_train,val_features,y_val,test_features,y_test,classifier=zipped_
clf)
```

```
------------------------------Fitting K Nearest Neighbour Classifier on input_data-----------------
---------------

----------------------- Train Set Metrics-----------------------

Accuracy core : 62.86000000000001%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 54.36%
----------------------- Test Set Metrics-----------------------

Accuracy score : 55.45%
F1_score : 0.51
Kappa Score : 0.23
Recall score: 0.55
Precision score : 0.52
--------------------------------------------------------------------------------

------------------------------Fitting SVM on input_data--------------------------------
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))


------------------------ Train Set Metrics------------------------

Accuracy core : 54.31%
------------------------ Validation Set Metrics------------------------

Accuracy score : 57.220000000000006%
------------------------ Test Set Metrics------------------------

Accuracy score : 57.58%
F1_score : 0.5
Kappa Score : 0.24
Recall score: 0.58
Precision score : 0.45
--------------------------------------------------------------------------------

------------------------------Fitting Random Forest Classifier on input_data-----------------------
---------


/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))


------------------------ Train Set Metrics------------------------

Accuracy core : 75.69%
------------------------ Validation Set Metrics------------------------

Accuracy score : 60.209999999999994%
------------------------ Test Set Metrics------------------------

Accuracy score : 60.0%
F1_score : 0.54
Kappa Score : 0.31
Recall score: 0.6
Precision score : 0.54
--------------------------------------------------------------------------------

------------------------------Fitting AdaBoost Classifier on input_data----------------------------
----
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


------------------------ Train Set Metrics------------------------

Accuracy core : 58.64%
------------------------ Validation Set Metrics------------------------

Accuracy score : 57.74%
------------------------ Test Set Metrics------------------------

Accuracy score : 59.089999999999996%
F1_score : 0.53
Kappa Score : 0.28
Recall score: 0.59
Precision score : 0.49
--------------------------------------------------------------------------------

------------------------------Fitting XGB Classifier on input_data--------------------------------
[16:42:39] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.

------------------------ Train Set Metrics------------------------

Accuracy core : 98.28%
------------------------ Validation Set Metrics------------------------

Accuracy score : 58.91%
------------------------ Test Set Metrics------------------------

Accuracy score : 62.12%
F1_score : 0.59
Kappa Score : 0.37
Recall score: 0.62
Precision score : 0.58
--------------------------------------------------------------------------------
```

In [69]:

```
train_y=to_categorical(y_train,5)
val_y=to_categorical(y_val,5)
test_y=to_categorical(y_test,5)
dnn_model.compile(optimizer='adam',loss='categorical_crossentropy', metrics=['accuracy'])
history = dnn_model.fit(train_features, train_y,validation_data=(val_features,val_y), epochs=10)
loss_value , accuracy = dnn_model.evaluate(train_features, train_y)
print('Train_accuracy is:' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(val_features, val_y)
print('Validation_accuracy is := ' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(test_features, test_y)
print('test_accuracy is : = ' + str(accuracy))
```

```
Epoch 1/10
81/81 [==============================] - 1s 8ms/step - loss: 1.2824 - accuracy: 0.4823 - val_loss:
1.1654 - val_accuracy: 0.5605
Epoch 2/10
81/81 [==============================] - 0s 5ms/step - loss: 1.2109 - accuracy: 0.5415 - val_loss:
1.1424 - val_accuracy: 0.5735
Epoch 3/10
81/81 [==============================] - 0s 5ms/step - loss: 1.2270 - accuracy: 0.5273 - val_loss:
1.1708 - val_accuracy: 0.5553
Epoch 4/10
81/81 [==============================] - 0s 4ms/step - loss: 1.2201 - accuracy: 0.5250 - val_loss:
1.1288 - val_accuracy: 0.5813
Epoch 5/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2174 - accuracy: 0.5332 - val_loss:
1.1647 - val_accuracy: 0.5657
Epoch 6/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2030 - accuracy: 0.5377 - val_loss:
1.1208 - val_accuracy: 0.5865
Epoch 7/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1868 - accuracy: 0.5525 - val_loss:
1.1184 - val_accuracy: 0.5774
Epoch 8/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1764 - accuracy: 0.5598 - val_loss:
1.1302 - val_accuracy: 0.5813
Epoch 9/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1783 - accuracy: 0.5632 - val_loss:
1.1232 - val_accuracy: 0.5839
Epoch 10/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1786 - accuracy: 0.5477 - val_loss:
1.1316 - val_accuracy: 0.5930
81/81 [==============================] - 0s 2ms/step - loss: 1.1705 - accuracy: 0.5587
Train_accuracy is:0.5587202310562134
25/25 [==============================] - 0s 2ms/step - loss: 1.1316 - accuracy: 0.5930
Validation_accuracy is := 0.5929778814315796
11/11 [==============================] - 0s 2ms/step - loss: 1.1335 - accuracy: 0.5758
test_accuracy is : = 0.5757575631141663
```

In [70]:

```
print("Performance Report:")
y_pred3=dnn_model.predict_classes(test_features)
y_test3=[np.argmax(x) for x in test_y]
y_pred_prb3=dnn_model.predict_proba(test_features)
target=['0','1','2','3','4']
from sklearn import metrics
print('Accuracy score is :', np.round(metrics.accuracy_score(y_test3, y_pred3),4))
print('Precision score is :', np.round(metrics.precision_score(y_test3, y_pred3, average='weighted'),
4))
print('Recall score is :', np.round(metrics.recall_score(y_test3,y_pred3, average='weighted'),4))
print('F1 Score is :', np.round(metrics.f1_score(y_test3, y_pred3, average='weighted'),4))
print('Cohen Kappa Score:', np.round(metrics.cohen_kappa_score(y_test3, y_pred3),4))
print('\t\tClassification Report:\n', metrics.classification_report(y_test3, y_pred3,target_names=targe
t))
```

```
Performance Report:
Accuracy score is : 0.5758
Precision score is : 0.4655
Recall score is : 0.5758
F1 Score is : 0.514
Cohen Kappa Score: 0.2732
                Classification Report:
               precision    recall  f1-score   support

           0       0.68      0.80      0.73       166
           1       0.00      0.00      0.00        30
           2       0.43      0.60      0.50        96
           3       0.00      0.00      0.00        15
           4       0.00      0.00      0.00        23

    accuracy                           0.58       330
   macro avg       0.22      0.28      0.25       330
weighted avg       0.47      0.58      0.51       330
```

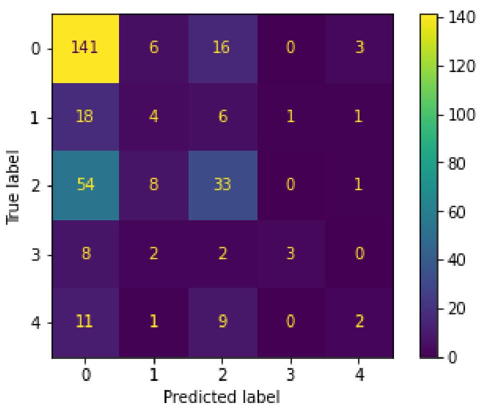
```
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:450: UserWarnin
g: `model.predict_classes()` is deprecated and will be removed after 2021-01-01. Please use instea
d:* `np.argmax(model.predict(x), axis=-1)`,   if your model does multi-class classification   (e.g.
if it uses a `softmax` last-layer activation).* `(model.predict(x) > 0.5).astype("int32")`,   if yo
ur model does binary classification   (e.g. if it uses a `sigmoid` last-layer activation).
  warnings.warn('`model.predict_classes()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:425: UserWarnin
g: `model.predict_proba()` is deprecated and will be removed after 2021-01-01. Please use `model.pr
edict()` instead.
  warnings.warn('`model.predict_proba()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [71]:

```
knn = KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30)
knn.fit(train_features, y_train)
plot_confusion_matrix(knn, test_features, y_test)
```

Out[71]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e4278245a50>
```

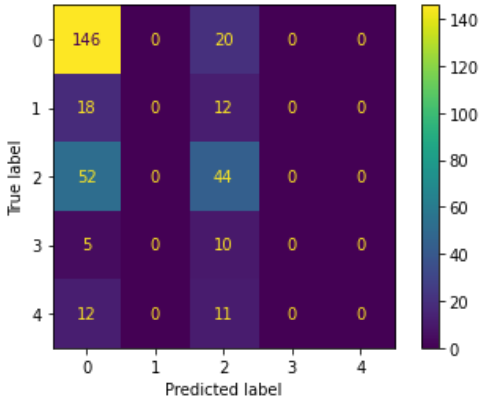


In [72]:

```
svc = SVC()
svc.fit(train_features, y_train)
plot_confusion_matrix(svc, test_features, y_test)
```

Out[72]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e54f18890>
```

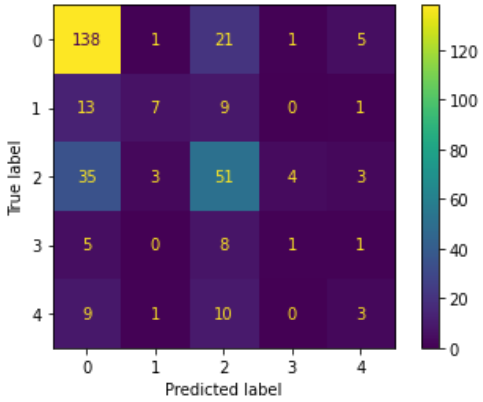


In [73]:

```
rf = RandomForestClassifier()
rf.fit(train_features, y_train)
plot_confusion_matrix(rf, test_features, y_test)
```

Out[73]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e423045db50>
```

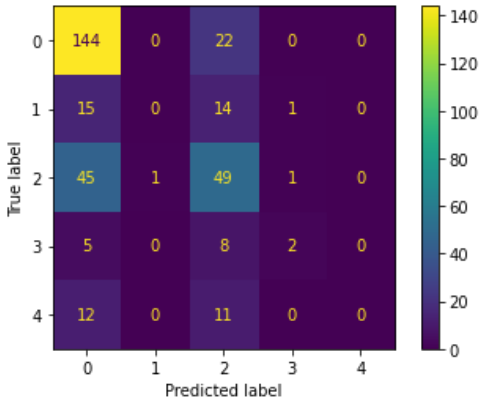


In [74]:

```
ada = AdaBoostClassifier()
ada.fit(train_features, y_train)
plot_confusion_matrix(ada, test_features, y_test)
```

Out[74]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42207b1cd0>
```



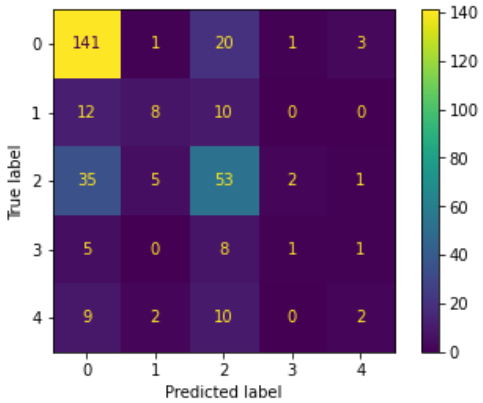
In [75]:

```
xgbc = XGBClassifier()
xgbc.fit(train_features, y_train)
plot_confusion_matrix(xgbc, test_features, y_test)
```

```
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


[16:42:47] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
```

Out[75]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e4220642410>
```



MobileNetV2

In [76]:

```
base_model= MobileNetV2(input_shape=(224,224,3), weights='imagenet', include_top=False)
x = base_model.output
# x = Dropout(0.5)(x)
x = Flatten()(x)
# x = BatchNormalization()(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(256,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
predictions = Dense(5, activation='softmax')(x)

model_feat = Model(inputs=base_model.input,outputs=predictions)

train_features = model_feat.predict(x_train)
val_features=model_feat.predict(x_val)
test_features=model_feat.predict(x_test)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/mobilenet_v2/mob
ilenet_v2_weights_tf_dim_ordering_tf_kernels_1.0_224_no_top.h5
9412608/9406464 [==============================] - 1s 0us/step
```

In [77]:

```
from sklearn.pipeline import make_pipeline
from sklearn.pipeline import Pipeline
names = [
        "K Nearest Neighbour Classifier",
        'SVM',
        "Random Forest Classifier",
        "AdaBoost Classifier",
        "XGB Classifier"
         ]
classifiers = [
    KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30),
    SVC(),
    RandomForestClassifier(max_depth=9,criterion = 'entropy'),
    AdaBoostClassifier(),
    XGBClassifier()
        ]
zipped_clf = zip(names,classifiers)
def classifier_summary(pipeline, X_train, y_train, X_val, y_val,X_test,y_test):
    sentiment_fit = pipeline.fit(X_train, y_train)

    y_pred_train= sentiment_fit.predict(X_train)
    y_pred_val = sentiment_fit.predict(X_val)
    y_pred_test = sentiment_fit.predict(X_test)

    train_accuracy = np.round(accuracy_score(y_train, y_pred_train),4)*100
    train_precision = np.round(precision_score(y_train, y_pred_train, average='weighted'),4)
    train_recall = np.round(recall_score(y_train, y_pred_train, average='weighted'),4)
    train_F1 = np.round(f1_score(y_train, y_pred_train, average='weighted'),4)
    train_kappa =  np.round(cohen_kappa_score(y_train, y_pred_train),4)


    val_accuracy = np.round(accuracy_score(y_val, y_pred_val),4)*100
    val_precision = np.round(precision_score(y_val, y_pred_val, average='weighted'),4)
    val_recall = np.round(recall_score(y_val, y_pred_val, average='weighted'),4)
    val_F1 = np.round(f1_score(y_val, y_pred_val, average='weighted'),4)
    val_kappa =  np.round(cohen_kappa_score(y_val, y_pred_val),4)


    test_accuracy = np.round(accuracy_score(y_test, y_pred_test),4)*100
    test_precision = np.round(precision_score(y_test, y_pred_test, average='weighted'),2)
    test_recall = np.round(recall_score(y_test, y_pred_test, average='weighted'),2)
    test_F1 = np.round(f1_score(y_test, y_pred_test, average='weighted'),2)
    test_kappa =  np.round(cohen_kappa_score(y_test, y_pred_test),2)



    print()
    print('----------------------- Train Set Metrics-----------------------')
    print()
    print("Accuracy core : {}%".format(train_accuracy))

    print('----------------------- Validation Set Metrics-----------------------')
    print()
    print("Accuracy score : {}%".format(val_accuracy))
    print('----------------------- Test Set Metrics-----------------------')
```

```
    print()
    print("Accuracy score : {}%".format(test_accuracy))
    print("F1_score : {}".format(test_F1))
    print("Kappa Score : {} ".format(test_kappa))
    print("Recall score: {}".format(test_recall))
    print("Precision score : {}".format(test_precision))

    print("-"*80)
    print()

def classifier_comparator(X_train,y_train,X_val,y_val,X_test,y_test,classifier=zipped_clf):
    result = []
    for n,c in classifier:
        checker_pipeline = Pipeline([('Classifier', c)])
        print("-----------------------------Fitting {} on input_data-------------------------------
".format(n))
        #print(c)
        classifier_summary(checker_pipeline,X_train, y_train, X_val, y_val,X_test,y_test)
```

In [78]:

```
classifier_comparator(train_features,y_train,val_features,y_val,test_features,y_test,classifier=zipped_
clf)
```

```
------------------------------Fitting K Nearest Neighbour Classifier on input_data-----------------
---------------

----------------------- Train Set Metrics-----------------------

Accuracy core : 65.47%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 52.54%
----------------------- Test Set Metrics-----------------------

Accuracy score : 55.15%
F1_score : 0.51
Kappa Score : 0.25
Recall score: 0.55
Precision score : 0.48
--------------------------------------------------------------------------------

------------------------------Fitting SVM on input_data--------------------------------
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))


------------------------ Train Set Metrics------------------------

Accuracy core : 57.38999999999999%
------------------------ Validation Set Metrics------------------------

Accuracy score : 57.48%
------------------------ Test Set Metrics------------------------

Accuracy score : 57.269999999999996%
F1_score : 0.52
Kappa Score : 0.29
Recall score: 0.57
Precision score : 0.49
--------------------------------------------------------------------------------

------------------------------Fitting Random Forest Classifier on input_data-----------------------
---------


/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

```
------------------------ Train Set Metrics------------------------

Accuracy core : 71.56%
------------------------ Validation Set Metrics------------------------

Accuracy score : 56.57%
------------------------ Test Set Metrics------------------------

Accuracy score : 59.089999999999996%
F1_score : 0.54
Kappa Score : 0.32
Recall score: 0.59
Precision score : 0.56
--------------------------------------------------------------------------------

------------------------------Fitting AdaBoost Classifier on input_data-----------------------------
----


/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)
```

```
----------------------- Train Set Metrics-----------------------

Accuracy core : 54.86%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 53.449999999999996%
----------------------- Test Set Metrics-----------------------

Accuracy score : 51.82%
F1_score : 0.47
Kappa Score : 0.19
Recall score: 0.52
Precision score : 0.46
--------------------------------------------------------------------------------

------------------------------Fitting XGB Classifier on input_data--------------------------------
[16:42:58] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.

----------------------- Train Set Metrics-----------------------

Accuracy core : 98.91%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 54.49%
----------------------- Test Set Metrics-----------------------

Accuracy score : 54.55%
F1_score : 0.52
Kappa Score : 0.26
Recall score: 0.55
Precision score : 0.53
--------------------------------------------------------------------------------
```

In [79]:

```
train_y=to_categorical(y_train,5)
val_y=to_categorical(y_val,5)
test_y=to_categorical(y_test,5)
dnn_model.compile(optimizer='adam',loss='categorical_crossentropy', metrics=['accuracy'])
history = dnn_model.fit(train_features, train_y,validation_data=(val_features,val_y), epochs=10)
loss_value , accuracy = dnn_model.evaluate(train_features, train_y)
print('Train_accuracy is:' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(val_features, val_y)
print('Validation_accuracy is := ' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(test_features, test_y)
print('test_accuracy is : = ' + str(accuracy))
```

```
Epoch 1/10
81/81 [==============================] - 1s 5ms/step - loss: 1.2965 - accuracy: 0.4853 - val_loss:
1.1739 - val_accuracy: 0.5566
Epoch 2/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1809 - accuracy: 0.5383 - val_loss:
1.1747 - val_accuracy: 0.5501
Epoch 3/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1844 - accuracy: 0.5241 - val_loss:
1.1403 - val_accuracy: 0.5618
Epoch 4/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1708 - accuracy: 0.5418 - val_loss:
1.1337 - val_accuracy: 0.5605
Epoch 5/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1564 - accuracy: 0.5283 - val_loss:
1.1402 - val_accuracy: 0.5540
Epoch 6/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1335 - accuracy: 0.5526 - val_loss:
1.1244 - val_accuracy: 0.5605
Epoch 7/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1147 - accuracy: 0.5710 - val_loss:
1.1262 - val_accuracy: 0.5657
Epoch 8/10
81/81 [==============================] - 0s 4ms/step - loss: 1.1221 - accuracy: 0.5594 - val_loss:
1.1335 - val_accuracy: 0.5618
Epoch 9/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1196 - accuracy: 0.5535 - val_loss:
1.1260 - val_accuracy: 0.5605
Epoch 10/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1122 - accuracy: 0.5717 - val_loss:
1.1282 - val_accuracy: 0.5605
81/81 [==============================] - 0s 2ms/step - loss: 1.1269 - accuracy: 0.5568
Train_accuracy is:0.5567694306373596
25/25 [==============================] - 0s 2ms/step - loss: 1.1282 - accuracy: 0.5605
Validation_accuracy is := 0.5604681372642517
11/11 [==============================] - 0s 2ms/step - loss: 1.1036 - accuracy: 0.5667
test_accuracy is : = 0.5666666626930237
```

In [80]:

```
print("Performance Report:")
y_pred4=dnn_model.predict_classes(test_features)
y_test4=[np.argmax(x) for x in test_y]
y_pred_prb4=dnn_model.predict_proba(test_features)
target=['0','1','2','3','4']
from sklearn import metrics
print('Accuracy score is :', np.round(metrics.accuracy_score(y_test4, y_pred4),4))
print('Precision score is :', np.round(metrics.precision_score(y_test4, y_pred4, average='weighted'),
4))
print('Recall score is :', np.round(metrics.recall_score(y_test4,y_pred4, average='weighted'),4))
print('F1 Score is :', np.round(metrics.f1_score(y_test4, y_pred4, average='weighted'),4))
print('Cohen Kappa Score:', np.round(metrics.cohen_kappa_score(y_test4, y_pred4),4))
print('\t\tClassification Report:\n', metrics.classification_report(y_test4, y_pred4,target_names=targe
t))
```

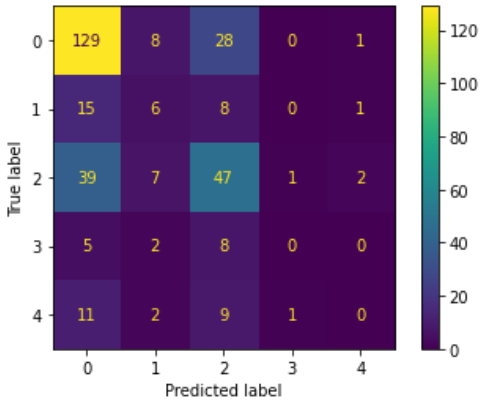
```
Performance Report:
Accuracy score is : 0.5667
Precision score is : 0.4988
Recall score is : 0.5667
F1 Score is : 0.5147
Cohen Kappa Score: 0.2942
                Classification Report:
               precision    recall  f1-score   support

           0       0.75      0.67      0.71       166
           1       0.00      0.00      0.00        30
           2       0.42      0.79      0.55        96
           3       0.00      0.00      0.00        15
           4       0.00      0.00      0.00        23

    accuracy                           0.57       330
   macro avg       0.23      0.29      0.25       330
weighted avg       0.50      0.57      0.51       330



/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:450: UserWarnin
g: `model.predict_classes()` is deprecated and will be removed after 2021-01-01. Please use instea
d:* `np.argmax(model.predict(x), axis=-1)`,   if your model does multi-class classification   (e.g.
if it uses a `softmax` last-layer activation).* `(model.predict(x) > 0.5).astype("int32")`,   if yo
ur model does binary classification   (e.g. if it uses a `sigmoid` last-layer activation).
  warnings.warn('`model.predict_classes()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:425: UserWarnin
g: `model.predict_proba()` is deprecated and will be removed after 2021-01-01. Please use `model.pr
edict()` instead.
  warnings.warn('`model.predict_proba()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [81]:

```
knn = KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30)
knn.fit(train_features, y_train)
plot_confusion_matrix(knn, test_features, y_test)
```

Out[81]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e55398690>
```

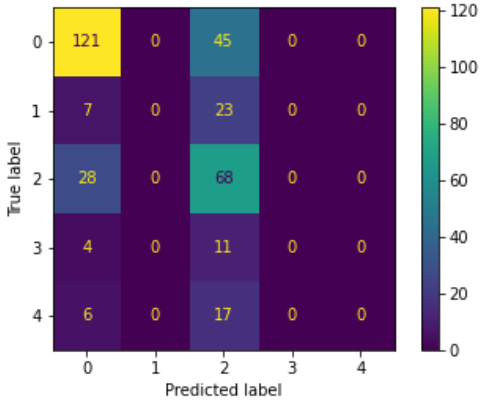


In [82]:

```
svc = SVC()
svc.fit(train_features, y_train)
plot_confusion_matrix(svc, test_features, y_test)
```

Out[82]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e4230534390>
```

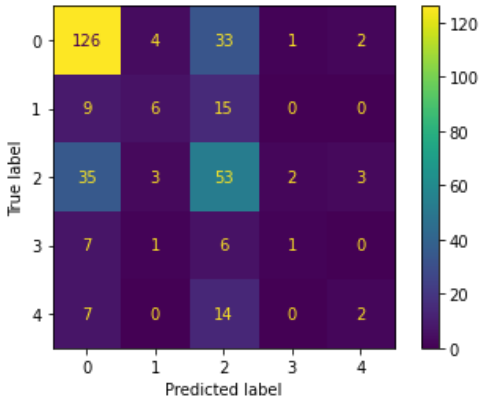


In [83]:

```
rf = RandomForestClassifier()
rf.fit(train_features, y_train)
plot_confusion_matrix(rf, test_features, y_test)
```

Out[83]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42ac1c6c50>
```

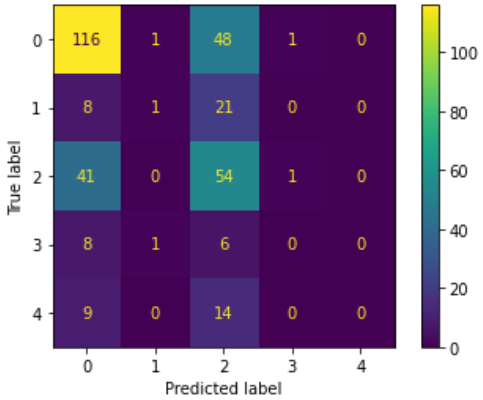


In [84]:

```
ada = AdaBoostClassifier()
ada.fit(train_features, y_train)
plot_confusion_matrix(ada, test_features, y_test)
```

Out[84]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42ac053710>
```



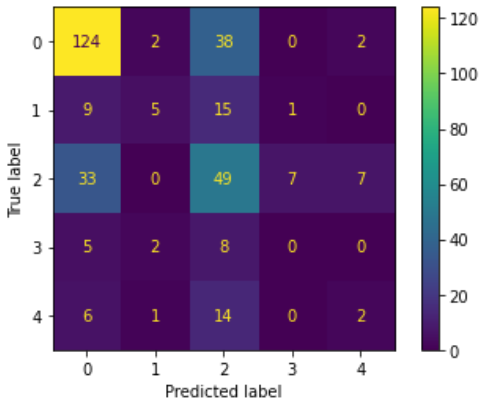
In [85]:

```
xgbc = XGBClassifier()
xgbc.fit(train_features, y_train)
plot_confusion_matrix(xgbc, test_features, y_test)
```

```
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


[16:43:06] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
```

Out[85]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42ac1b2710>
```



MobileNet

In [86]:

```
base_model= MobileNet(input_shape=(224,224,3), weights='imagenet', include_top=False)
x = base_model.output
# x = Dropout(0.5)(x)
x = Flatten()(x)
# x = BatchNormalization()(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(256,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
predictions = Dense(5, activation='softmax')(x)

model_feat = Model(inputs=base_model.input,outputs=predictions)

train_features = model_feat.predict(x_train)
val_features=model_feat.predict(x_val)
test_features=model_feat.predict(x_test)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/mobilenet/mobile
net_1_0_224_tf_no_top.h5
17227776/17225924 [==============================] - 1s 0us/step
```

In [87]:

```
from sklearn.pipeline import make_pipeline
from sklearn.pipeline import Pipeline
names = [
        "K Nearest Neighbour Classifier",
        'SVM',
        "Random Forest Classifier",
        "AdaBoost Classifier",
        "XGB Classifier"
         ]
classifiers = [
    KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30),
    SVC(),
    RandomForestClassifier(max_depth=9,criterion = 'entropy'),
    AdaBoostClassifier(),
    XGBClassifier()
        ]
zipped_clf = zip(names,classifiers)
def classifier_summary(pipeline, X_train, y_train, X_val, y_val,X_test,y_test):
    sentiment_fit = pipeline.fit(X_train, y_train)

    y_pred_train= sentiment_fit.predict(X_train)
    y_pred_val = sentiment_fit.predict(X_val)
    y_pred_test = sentiment_fit.predict(X_test)

    train_accuracy = np.round(accuracy_score(y_train, y_pred_train),4)*100
    train_precision = np.round(precision_score(y_train, y_pred_train, average='weighted'),4)
    train_recall = np.round(recall_score(y_train, y_pred_train, average='weighted'),4)
    train_F1 = np.round(f1_score(y_train, y_pred_train, average='weighted'),4)
    train_kappa =  np.round(cohen_kappa_score(y_train, y_pred_train),4)


    val_accuracy = np.round(accuracy_score(y_val, y_pred_val),4)*100
    val_precision = np.round(precision_score(y_val, y_pred_val, average='weighted'),4)
    val_recall = np.round(recall_score(y_val, y_pred_val, average='weighted'),4)
    val_F1 = np.round(f1_score(y_val, y_pred_val, average='weighted'),4)
    val_kappa =  np.round(cohen_kappa_score(y_val, y_pred_val),4)


    test_accuracy = np.round(accuracy_score(y_test, y_pred_test),4)*100
    test_precision = np.round(precision_score(y_test, y_pred_test, average='weighted'),2)
    test_recall = np.round(recall_score(y_test, y_pred_test, average='weighted'),2)
    test_F1 = np.round(f1_score(y_test, y_pred_test, average='weighted'),2)
    test_kappa =  np.round(cohen_kappa_score(y_test, y_pred_test),2)



    print()
    print('----------------------- Train Set Metrics-----------------------')
    print()
    print("Accuracy core : {}%".format(train_accuracy))

    print('----------------------- Validation Set Metrics-----------------------')
    print()
    print("Accuracy score : {}%".format(val_accuracy))
    print('----------------------- Test Set Metrics-----------------------')
```

```
    print()
    print("Accuracy score : {}%".format(test_accuracy))
    print("F1_score : {}".format(test_F1))
    print("Kappa Score : {} ".format(test_kappa))
    print("Recall score: {}".format(test_recall))
    print("Precision score : {}".format(test_precision))

    print("-"*80)
    print()

def classifier_comparator(X_train,y_train,X_val,y_val,X_test,y_test,classifier=zipped_clf):
    result = []
    for n,c in classifier:
        checker_pipeline = Pipeline([('Classifier', c)])
        print("------------------------------Fitting {} on input_data--------------------------------
".format(n))
        #print(c)
        classifier_summary(checker_pipeline,X_train, y_train, X_val, y_val,X_test,y_test)
```

In [88]:

```
classifier_comparator(train_features,y_train,val_features,y_val,test_features,y_test,classifier=zipped_
clf)
```

```
------------------------------Fitting K Nearest Neighbour Classifier on input_data-----------------
---------------

----------------------- Train Set Metrics-----------------------

Accuracy core : 63.29%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 50.72%
----------------------- Test Set Metrics-----------------------

Accuracy score : 50.91%
F1_score : 0.47
Kappa Score : 0.18
Recall score: 0.51
Precision score : 0.46
--------------------------------------------------------------------------------

------------------------------Fitting SVM on input_data--------------------------------
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))


------------------------ Train Set Metrics------------------------

Accuracy core : 49.2%
------------------------ Validation Set Metrics------------------------

Accuracy score : 53.32%
------------------------ Test Set Metrics------------------------

Accuracy score : 50.61%
F1_score : 0.36
Kappa Score : 0.02
Recall score: 0.51
Precision score : 0.35
--------------------------------------------------------------------------------

------------------------------Fitting Random Forest Classifier on input_data-----------------------
---------


/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))


------------------------ Train Set Metrics------------------------

Accuracy core : 69.41000000000001%
------------------------ Validation Set Metrics------------------------

Accuracy score : 54.620000000000005%
------------------------ Test Set Metrics------------------------

Accuracy score : 53.03%
F1_score : 0.47
Kappa Score : 0.17
Recall score: 0.53
Precision score : 0.42
--------------------------------------------------------------------------------

------------------------------Fitting AdaBoost Classifier on input_data----------------------------
----
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


------------------------ Train Set Metrics------------------------

Accuracy core : 51.78%
------------------------ Validation Set Metrics------------------------

Accuracy score : 51.11%
------------------------ Test Set Metrics------------------------

Accuracy score : 51.519999999999996%
F1_score : 0.47
Kappa Score : 0.16
Recall score: 0.52
Precision score : 0.44
--------------------------------------------------------------------------------

------------------------------Fitting XGB Classifier on input_data--------------------------------
[16:43:15] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.

------------------------ Train Set Metrics------------------------

Accuracy core : 98.79%
------------------------ Validation Set Metrics------------------------

Accuracy score : 54.1%
------------------------ Test Set Metrics------------------------

Accuracy score : 55.15%
F1_score : 0.53
Kappa Score : 0.26
Recall score: 0.55
Precision score : 0.51
--------------------------------------------------------------------------------
```

In [89]:

```
train_y=to_categorical(y_train,5)
val_y=to_categorical(y_val,5)
test_y=to_categorical(y_test,5)
dnn_model.compile(optimizer='adam',loss='categorical_crossentropy', metrics=['accuracy'])
history = dnn_model.fit(train_features, train_y,validation_data=(val_features,val_y), epochs=10)
loss_value , accuracy = dnn_model.evaluate(train_features, train_y)
print('Train_accuracy is:' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(val_features, val_y)
print('Validation_accuracy is := ' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(test_features, test_y)
print('test_accuracy is : = ' + str(accuracy))
```

```
Epoch 1/10
81/81 [==============================] - 1s 5ms/step - loss: 1.7029 - accuracy: 0.4594 - val_loss:
1.2200 - val_accuracy: 0.4707
Epoch 2/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2127 - accuracy: 0.4825 - val_loss:
1.1848 - val_accuracy: 0.5241
Epoch 3/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1953 - accuracy: 0.5211 - val_loss:
1.1800 - val_accuracy: 0.5358
Epoch 4/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2127 - accuracy: 0.4949 - val_loss:
1.2342 - val_accuracy: 0.4551
Epoch 5/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2027 - accuracy: 0.4995 - val_loss:
1.1722 - val_accuracy: 0.5449
Epoch 6/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1837 - accuracy: 0.5111 - val_loss:
1.1715 - val_accuracy: 0.5488
Epoch 7/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1899 - accuracy: 0.5120 - val_loss:
1.1788 - val_accuracy: 0.5319
Epoch 8/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1965 - accuracy: 0.5131 - val_loss:
1.1722 - val_accuracy: 0.5462
Epoch 9/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1848 - accuracy: 0.5181 - val_loss:
1.1740 - val_accuracy: 0.5371
Epoch 10/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1802 - accuracy: 0.5265 - val_loss:
1.1893 - val_accuracy: 0.5410
81/81 [==============================] - 0s 2ms/step - loss: 1.2102 - accuracy: 0.4990
Train_accuracy is:0.49902456998825073
25/25 [==============================] - 0s 2ms/step - loss: 1.1893 - accuracy: 0.5410
Validation_accuracy is := 0.540962278842926
11/11 [==============================] - 0s 2ms/step - loss: 1.1868 - accuracy: 0.5212
test_accuracy is : = 0.521212100982666
```

In [90]:

```
print("Performance Report:")
y_pred5=dnn_model.predict_classes(test_features)
y_test5=[np.argmax(x) for x in test_y]
y_pred_prb5=dnn_model.predict_proba(test_features)
target=['0','1','2','3','4']
from sklearn import metrics
print('Accuracy score is :', np.round(metrics.accuracy_score(y_test5, y_pred5),4))
print('Precision score is :', np.round(metrics.precision_score(y_test5, y_pred5, average='weighted'),
4))
print('Recall score is :', np.round(metrics.recall_score(y_test5,y_pred5, average='weighted'),4))
print('F1 Score is :', np.round(metrics.f1_score(y_test5, y_pred5, average='weighted'),4))
print('Cohen Kappa Score:', np.round(metrics.cohen_kappa_score(y_test5, y_pred5),4))
print('\t\tClassification Report:\n', metrics.classification_report(y_test5, y_pred5,target_names=targe
t))
```

```
Performance Report:
Accuracy score is : 0.5212
Precision score is : 0.4023
Recall score is : 0.5212
F1 Score is : 0.3928
Cohen Kappa Score: 0.0621
                Classification Report:
               precision    recall  f1-score   support

           0       0.52      0.98      0.68       166
           1       0.00      0.00      0.00        30
           2       0.48      0.10      0.17        96
           3       0.00      0.00      0.00        15
           4       0.00      0.00      0.00        23

    accuracy                           0.52       330
   macro avg       0.20      0.22      0.17       330
weighted avg       0.40      0.52      0.39       330
```

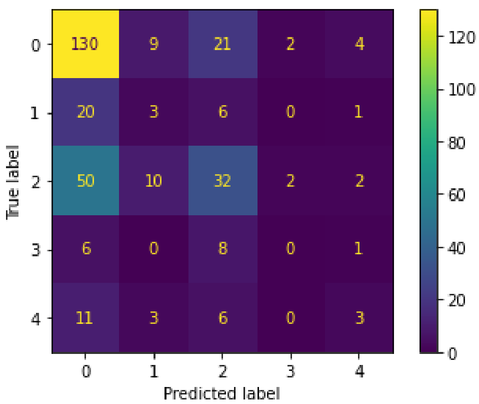
```
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:450: UserWarnin
g: `model.predict_classes()` is deprecated and will be removed after 2021-01-01. Please use instea
d:* `np.argmax(model.predict(x), axis=-1)`,   if your model does multi-class classification   (e.g.
if it uses a `softmax` last-layer activation).* `(model.predict(x) > 0.5).astype("int32")`,   if yo
ur model does binary classification   (e.g. if it uses a `sigmoid` last-layer activation).
  warnings.warn('`model.predict_classes()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:425: UserWarnin
g: `model.predict_proba()` is deprecated and will be removed after 2021-01-01. Please use `model.pr
edict()` instead.
  warnings.warn('`model.predict_proba()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [91]:

```python
knn = KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30)
knn.fit(train_features, y_train)
plot_confusion_matrix(knn, test_features, y_test)
```

Out[91]:

```
&lt;sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e405af110&gt;
```

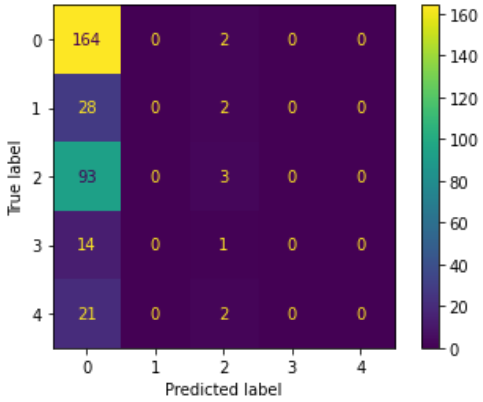


In [92]:

```python
svc = SVC()
svc.fit(train_features, y_train)
plot_confusion_matrix(svc, test_features, y_test)
```

Out[92]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e403adbd0>
```

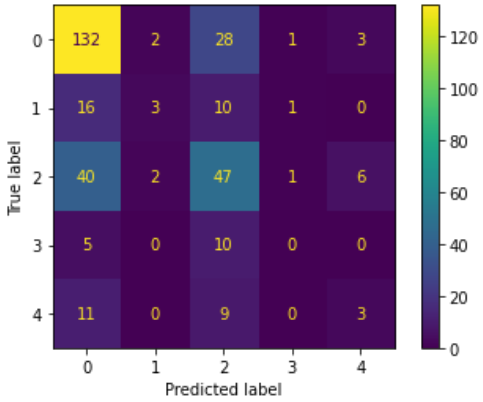


In [93]:

```
rf = RandomForestClassifier()
rf.fit(train_features, y_train)
plot_confusion_matrix(rf, test_features, y_test)
```

Out[93]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e54436690>
```

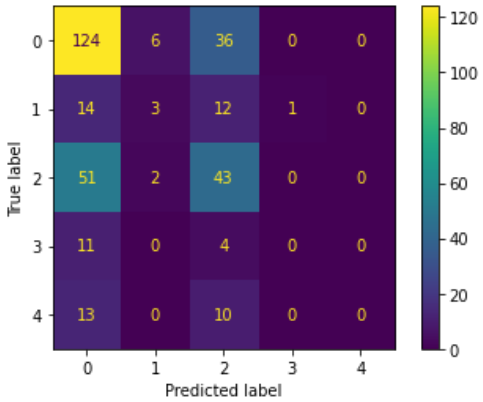


In [94]:

```
ada = AdaBoostClassifier()
ada.fit(train_features, y_train)
plot_confusion_matrix(ada, test_features, y_test)
```

Out[94]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42ac187050>
```



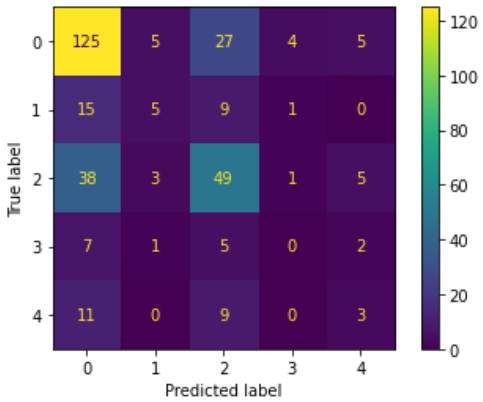
In [95]:

```
xgbc = XGBClassifier()
xgbc.fit(train_features, y_train)
plot_confusion_matrix(xgbc, test_features, y_test)
```

```
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


[16:43:23] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
```

Out[95]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e4230175f10>
```



InceptionV3

In [96]:

```
base_model= MobileNet(input_shape=(224,224,3), weights='imagenet', include_top=False)
x = base_model.output
# x = Dropout(0.5)(x)
x = Flatten()(x)
# x = BatchNormalization()(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(256,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
predictions = Dense(5, activation='softmax')(x)

model_feat = Model(inputs=base_model.input,outputs=predictions)

train_features = model_feat.predict(x_train)
val_features=model_feat.predict(x_val)
test_features=model_feat.predict(x_test)
```

In [97]:

```
from sklearn.pipeline import make_pipeline
from sklearn.pipeline import Pipeline
names = [
        "K Nearest Neighbour Classifier",
        'SVM',
        "Random Forest Classifier",
        "AdaBoost Classifier",
        "XGB Classifier"
         ]
classifiers = [
    KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30),
    SVC(),
    RandomForestClassifier(max_depth=9,criterion = 'entropy'),
    AdaBoostClassifier(),
    XGBClassifier()
        ]
zipped_clf = zip(names,classifiers)
def classifier_summary(pipeline, X_train, y_train, X_val, y_val,X_test,y_test):
    sentiment_fit = pipeline.fit(X_train, y_train)

    y_pred_train= sentiment_fit.predict(X_train)
    y_pred_val = sentiment_fit.predict(X_val)
    y_pred_test = sentiment_fit.predict(X_test)

    train_accuracy = np.round(accuracy_score(y_train, y_pred_train),4)*100
    train_precision = np.round(precision_score(y_train, y_pred_train, average='weighted'),4)
    train_recall = np.round(recall_score(y_train, y_pred_train, average='weighted'),4)
    train_F1 = np.round(f1_score(y_train, y_pred_train, average='weighted'),4)
    train_kappa =  np.round(cohen_kappa_score(y_train, y_pred_train),4)


    val_accuracy = np.round(accuracy_score(y_val, y_pred_val),4)*100
    val_precision = np.round(precision_score(y_val, y_pred_val, average='weighted'),4)
    val_recall = np.round(recall_score(y_val, y_pred_val, average='weighted'),4)
    val_F1 = np.round(f1_score(y_val, y_pred_val, average='weighted'),4)
    val_kappa =  np.round(cohen_kappa_score(y_val, y_pred_val),4)


    test_accuracy = np.round(accuracy_score(y_test, y_pred_test),4)*100
    test_precision = np.round(precision_score(y_test, y_pred_test, average='weighted'),2)
    test_recall = np.round(recall_score(y_test, y_pred_test, average='weighted'),2)
    test_F1 = np.round(f1_score(y_test, y_pred_test, average='weighted'),2)
    test_kappa =  np.round(cohen_kappa_score(y_test, y_pred_test),2)



    print()
    print('----------------------- Train Set Metrics-----------------------')
    print()
    print("Accuracy core : {}%".format(train_accuracy))

    print('----------------------- Validation Set Metrics-----------------------')
    print()
    print("Accuracy score : {}%".format(val_accuracy))
    print('----------------------- Test Set Metrics-----------------------')
```

```
    print()
    print("Accuracy score : {}%".format(test_accuracy))
    print("F1_score : {}".format(test_F1))
    print("Kappa Score : {} ".format(test_kappa))
    print("Recall score: {}".format(test_recall))
    print("Precision score : {}".format(test_precision))

    print("-"*80)
    print()

def classifier_comparator(X_train,y_train,X_val,y_val,X_test,y_test,classifier=zipped_clf):
    result = []
    for n,c in classifier:
        checker_pipeline = Pipeline([('Classifier', c)])
        print("------------------------------Fitting {} on input_data--------------------------------
".format(n))
        #print(c)
        classifier_summary(checker_pipeline,X_train, y_train, X_val, y_val,X_test,y_test)
```

In [98]:

```
classifier_comparator(train_features,y_train,val_features,y_val,test_features,y_test,classifier=zipped_
clf)
```

```
------------------------------Fitting K Nearest Neighbour Classifier on input_data-----------------
---------------

----------------------- Train Set Metrics-----------------------

Accuracy core : 66.84%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 56.830000000000005%
----------------------- Test Set Metrics-----------------------

Accuracy score : 56.06%
F1_score : 0.54
Kappa Score : 0.3
Recall score: 0.56
Precision score : 0.53
--------------------------------------------------------------------------------

------------------------------Fitting SVM on input_data--------------------------------
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))

------------------------ Train Set Metrics------------------------

Accuracy core : 59.19%
------------------------ Validation Set Metrics------------------------

Accuracy score : 62.68%
------------------------ Test Set Metrics------------------------

Accuracy score : 61.519999999999996%
F1_score : 0.54
Kappa Score : 0.32
Recall score: 0.62
Precision score : 0.48
--------------------------------------------------------------------------------

------------------------------Fitting Random Forest Classifier on input_data-----------------------
---------

/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))

------------------------ Train Set Metrics------------------------

Accuracy core : 78.66%
------------------------ Validation Set Metrics------------------------

Accuracy score : 63.849999999999994%
------------------------ Test Set Metrics------------------------

Accuracy score : 63.94%
F1_score : 0.59
Kappa Score : 0.39
Recall score: 0.64
Precision score : 0.56
--------------------------------------------------------------------------------

------------------------------Fitting AdaBoost Classifier on input_data----------------------------
----
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


----------------------- Train Set Metrics-----------------------

Accuracy core : 60.709999999999994%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 62.029999999999994%
----------------------- Test Set Metrics-----------------------

Accuracy score : 60.91%
F1_score : 0.56
Kappa Score : 0.34
Recall score: 0.61
Precision score : 0.54
--------------------------------------------------------------------------------

------------------------------Fitting XGB Classifier on input_data--------------------------------
[16:43:31] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.

----------------------- Train Set Metrics-----------------------

Accuracy core : 99.1%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 60.6%
----------------------- Test Set Metrics-----------------------

Accuracy score : 64.85%
F1_score : 0.62
Kappa Score : 0.44
Recall score: 0.65
Precision score : 0.61
--------------------------------------------------------------------------------
```

In [99]:

```
train_y=to_categorical(y_train,5)
val_y=to_categorical(y_val,5)
test_y=to_categorical(y_test,5)
dnn_model.compile(optimizer='adam',loss='categorical_crossentropy', metrics=['accuracy'])
history = dnn_model.fit(train_features, train_y,validation_data=(val_features,val_y), epochs=10)
loss_value , accuracy = dnn_model.evaluate(train_features, train_y)
print('Train_accuracy is:' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(val_features, val_y)
print('Validation_accuracy is := ' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(test_features, test_y)
print('test_accuracy is : = ' + str(accuracy))
```

```
Epoch 1/10
81/81 [==============================] - 1s 5ms/step - loss: 1.6981 - accuracy: 0.4296 - val_loss:
1.2808 - val_accuracy: 0.5228
Epoch 2/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3100 - accuracy: 0.4583 - val_loss:
1.2538 - val_accuracy: 0.5254
Epoch 3/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2740 - accuracy: 0.4976 - val_loss:
1.2633 - val_accuracy: 0.5176
Epoch 4/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2551 - accuracy: 0.4871 - val_loss:
1.1861 - val_accuracy: 0.5319
Epoch 5/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2296 - accuracy: 0.5175 - val_loss:
1.1251 - val_accuracy: 0.5982
Epoch 6/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1756 - accuracy: 0.5623 - val_loss:
1.1728 - val_accuracy: 0.5722
Epoch 7/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1705 - accuracy: 0.5549 - val_loss:
1.0796 - val_accuracy: 0.6112
Epoch 8/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1303 - accuracy: 0.5923 - val_loss:
1.1234 - val_accuracy: 0.5995
Epoch 9/10
81/81 [==============================] - 0s 3ms/step - loss: 1.1224 - accuracy: 0.5989 - val_loss:
1.0728 - val_accuracy: 0.6203
Epoch 10/10
81/81 [==============================] - 0s 3ms/step - loss: 1.0962 - accuracy: 0.6033 - val_loss:
1.1013 - val_accuracy: 0.6073
81/81 [==============================] - 0s 2ms/step - loss: 1.1197 - accuracy: 0.6009
Train_accuracy is:0.6008583903312683
25/25 [==============================] - 0s 2ms/step - loss: 1.1013 - accuracy: 0.6073
Validation_accuracy is := 0.6072821617126465
11/11 [==============================] - 0s 2ms/step - loss: 1.0718 - accuracy: 0.6000
test_accuracy is : = 0.6000000238418579
```

In [100]:

```
print("Performance Report:")
y_pred6=dnn_model.predict_classes(test_features)
y_test6=[np.argmax(x) for x in test_y]
y_pred_prb6=dnn_model.predict_proba(test_features)
target=['0','1','2','3','4']
from sklearn import metrics
print('Accuracy score is :', np.round(metrics.accuracy_score(y_test6, y_pred6),4))
print('Precision score is :', np.round(metrics.precision_score(y_test6, y_pred6, average='weighted'),
4))
print('Recall score is :', np.round(metrics.recall_score(y_test6,y_pred6, average='weighted'),4))
print('F1 Score is :', np.round(metrics.f1_score(y_test6, y_pred6, average='weighted'),4))
print('Cohen Kappa Score:', np.round(metrics.cohen_kappa_score(y_test6, y_pred6),4))
print('\t\tClassification Report:\n', metrics.classification_report(y_test6, y_pred6,target_names=targe
t))
```

```
Performance Report:
Accuracy score is : 0.6
Precision score is : 0.5179
Recall score is : 0.6
F1 Score is : 0.5454
Cohen Kappa Score: 0.3402
                Classification Report:
               precision    recall  f1-score   support

           0       0.78      0.75      0.77       166
           1       0.00      0.00      0.00        30
           2       0.43      0.76      0.55        96
           3       0.00      0.00      0.00        15
           4       0.00      0.00      0.00        23

    accuracy                           0.60       330
   macro avg       0.24      0.30      0.26       330
weighted avg       0.52      0.60      0.55       330
```

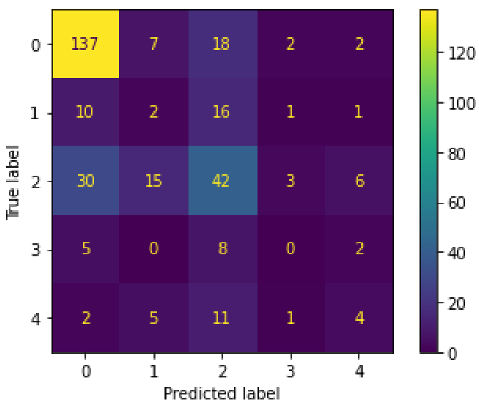
```
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:450: UserWarnin
g: `model.predict_classes()` is deprecated and will be removed after 2021-01-01. Please use instea
d:* `np.argmax(model.predict(x), axis=-1)`,   if your model does multi-class classification   (e.g.
if it uses a `softmax` last-layer activation).* `(model.predict(x) > 0.5).astype("int32")`,   if yo
ur model does binary classification   (e.g. if it uses a `sigmoid` last-layer activation).
  warnings.warn('`model.predict_classes()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:425: UserWarnin
g: `model.predict_proba()` is deprecated and will be removed after 2021-01-01. Please use `model.pr
edict()` instead.
  warnings.warn('`model.predict_proba()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [101]:

```
knn = KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30)
knn.fit(train_features, y_train)
plot_confusion_matrix(knn, test_features, y_test)
```

Out[101]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e5541b950>
```

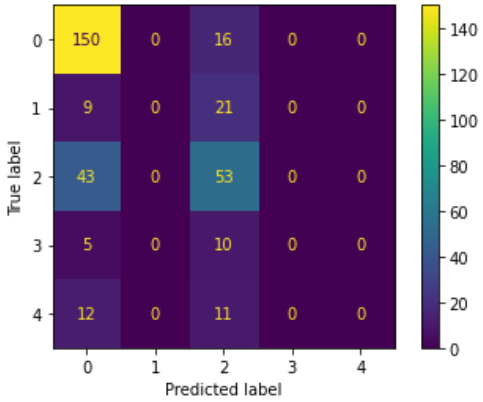


In [102]:

```
svc = SVC()
svc.fit(train_features, y_train)
plot_confusion_matrix(svc, test_features, y_test)
```

Out[102]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e55467490>
```

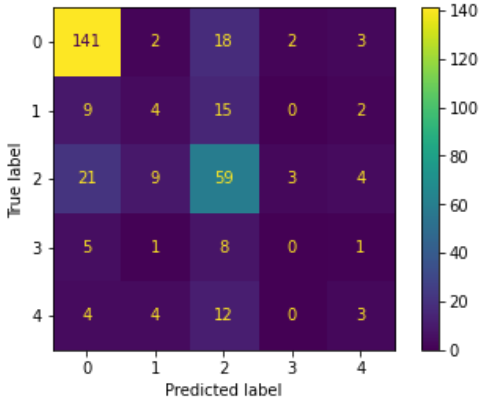


In [103]:

```
rf = RandomForestClassifier()
rf.fit(train_features, y_train)
plot_confusion_matrix(rf, test_features, y_test)
```

Out[103]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e4021ef90>
```

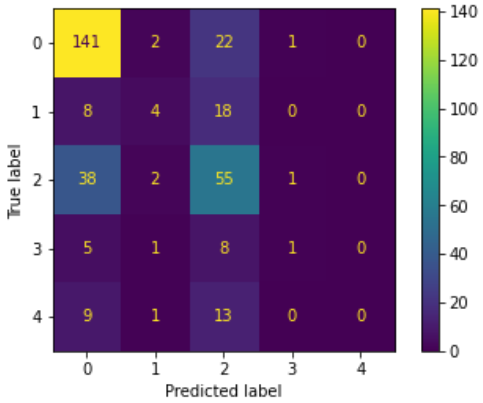


In [104]:

```
ada = AdaBoostClassifier()
ada.fit(train_features, y_train)
plot_confusion_matrix(ada, test_features, y_test)
```

Out[104]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e401011d0>
```



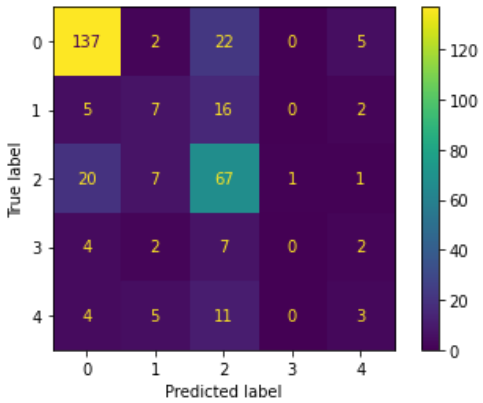
In [105]:

```
xgbc = XGBClassifier()
xgbc.fit(train_features, y_train)
plot_confusion_matrix(xgbc, test_features, y_test)
```

```
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


[16:43:38] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
```

Out[105]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e4006f250>
```



InceptionResNetV2

In [106]:

```
base_model= InceptionResNetV2(input_shape=(224,224,3), weights='imagenet', include_top=False)
x = base_model.output
# x = Dropout(0.5)(x)
x = Flatten()(x)
# x = BatchNormalization()(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(256,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
predictions = Dense(5, activation='softmax')(x)

model_feat = Model(inputs=base_model.input,outputs=predictions)

train_features = model_feat.predict(x_train)
val_features=model_feat.predict(x_val)
test_features=model_feat.predict(x_test)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/inception_resnet
_v2/inception_resnet_v2_weights_tf_dim_ordering_tf_kernels_notop.h5
219062272/219055592 [==============================] - 7s 0us/step
```

In [107]:

```
from sklearn.pipeline import make_pipeline
from sklearn.pipeline import Pipeline
names = [
        "K Nearest Neighbour Classifier",
        'SVM',
        "Random Forest Classifier",
        "AdaBoost Classifier",
        "XGB Classifier"
         ]
classifiers = [
    KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30),
    SVC(),
    RandomForestClassifier(max_depth=9,criterion = 'entropy'),
    AdaBoostClassifier(),
    XGBClassifier()
        ]
zipped_clf = zip(names,classifiers)
def classifier_summary(pipeline, X_train, y_train, X_val, y_val,X_test,y_test):
    sentiment_fit = pipeline.fit(X_train, y_train)

    y_pred_train= sentiment_fit.predict(X_train)
    y_pred_val = sentiment_fit.predict(X_val)
    y_pred_test = sentiment_fit.predict(X_test)

    train_accuracy = np.round(accuracy_score(y_train, y_pred_train),4)*100
    train_precision = np.round(precision_score(y_train, y_pred_train, average='weighted'),4)
    train_recall = np.round(recall_score(y_train, y_pred_train, average='weighted'),4)
    train_F1 = np.round(f1_score(y_train, y_pred_train, average='weighted'),4)
    train_kappa =  np.round(cohen_kappa_score(y_train, y_pred_train),4)


    val_accuracy = np.round(accuracy_score(y_val, y_pred_val),4)*100
    val_precision = np.round(precision_score(y_val, y_pred_val, average='weighted'),4)
    val_recall = np.round(recall_score(y_val, y_pred_val, average='weighted'),4)
    val_F1 = np.round(f1_score(y_val, y_pred_val, average='weighted'),4)
    val_kappa =  np.round(cohen_kappa_score(y_val, y_pred_val),4)


    test_accuracy = np.round(accuracy_score(y_test, y_pred_test),4)*100
    test_precision = np.round(precision_score(y_test, y_pred_test, average='weighted'),2)
    test_recall = np.round(recall_score(y_test, y_pred_test, average='weighted'),2)
    test_F1 = np.round(f1_score(y_test, y_pred_test, average='weighted'),2)
    test_kappa =  np.round(cohen_kappa_score(y_test, y_pred_test),2)



    print()
    print('----------------------- Train Set Metrics-----------------------')
    print()
    print("Accuracy core : {}%".format(train_accuracy))

    print('----------------------- Validation Set Metrics-----------------------')
    print()
    print("Accuracy score : {}%".format(val_accuracy))
    print('----------------------- Test Set Metrics-----------------------')
```

```
    print()
    print("Accuracy score : {}%".format(test_accuracy))
    print("F1_score : {}".format(test_F1))
    print("Kappa Score : {} ".format(test_kappa))
    print("Recall score: {}".format(test_recall))
    print("Precision score : {}".format(test_precision))

    print("-"*80)
    print()

def classifier_comparator(X_train,y_train,X_val,y_val,X_test,y_test,classifier=zipped_clf):
    result = []
    for n,c in classifier:
        checker_pipeline = Pipeline([('Classifier', c)])
        print("-----------------------------Fitting {} on input_data--------------------------------
".format(n))
        #print(c)
        classifier_summary(checker_pipeline,X_train, y_train, X_val, y_val,X_test,y_test)
```

In [108]:

```
classifier_comparator(train_features,y_train,val_features,y_val,test_features,y_test,classifier=zipped_
clf)
```

```
------------------------------Fitting K Nearest Neighbour Classifier on input_data-----------------
---------------


/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

```
------------------------ Train Set Metrics------------------------

Accuracy core : 30.080000000000002%
------------------------ Validation Set Metrics------------------------

Accuracy score : 26.009999999999998%
------------------------ Test Set Metrics------------------------

Accuracy score : 32.12%
F1_score : 0.2
Kappa Score : 0.03
Recall score: 0.32
Precision score : 0.46
--------------------------------------------------------------------------------

------------------------------Fitting SVM on input_data--------------------------------


/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))


------------------------ Train Set Metrics------------------------

Accuracy core : 48.22%
------------------------ Validation Set Metrics------------------------

Accuracy score : 52.410000000000004%
------------------------ Test Set Metrics------------------------

Accuracy score : 50.3%
F1_score : 0.34
Kappa Score : 0.0
Recall score: 0.5
Precision score : 0.25
--------------------------------------------------------------------------------

------------------------------Fitting Random Forest Classifier on input_data-----------------------
---------
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

```
------------------------ Train Set Metrics------------------------

Accuracy core : 48.26%
------------------------ Validation Set Metrics------------------------

Accuracy score : 52.410000000000004%
------------------------ Test Set Metrics------------------------

Accuracy score : 50.3%
F1_score : 0.34
Kappa Score : 0.0
Recall score: 0.5
Precision score : 0.25
--------------------------------------------------------------------------------

------------------------------Fitting AdaBoost Classifier on input_data-----------------------------
----

------------------------ Train Set Metrics------------------------

Accuracy core : 48.26%
------------------------ Validation Set Metrics------------------------

Accuracy score : 52.410000000000004%
------------------------ Test Set Metrics------------------------

Accuracy score : 50.3%
F1_score : 0.34
Kappa Score : 0.0
Recall score: 0.5
Precision score : 0.25
--------------------------------------------------------------------------------

------------------------------Fitting XGB Classifier on input_data--------------------------------
[16:44:08] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.


/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)
```

```
------------------------ Train Set Metrics-----------------------

Accuracy core : 49.120000000000005%
------------------------ Validation Set Metrics-----------------------

Accuracy score : 52.15%
------------------------ Test Set Metrics-----------------------

Accuracy score : 50.0%
F1_score : 0.34
Kappa Score : -0.0
Recall score: 0.5
Precision score : 0.25
--------------------------------------------------------------------------------
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [109]:

```
train_y=to_categorical(y_train,5)
val_y=to_categorical(y_val,5)
test_y=to_categorical(y_test,5)
dnn_model.compile(optimizer='adam',loss='categorical_crossentropy', metrics=['accuracy'])
history = dnn_model.fit(train_features, train_y,validation_data=(val_features,val_y), epochs=10)
loss_value , accuracy = dnn_model.evaluate(train_features, train_y)
print('Train_accuracy is:' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(val_features, val_y)
print('Validation_accuracy is := ' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(test_features, test_y)
print('test_accuracy is : = ' + str(accuracy))
```

```
Epoch 1/10
81/81 [==============================] - 1s 5ms/step - loss: 2.2411 - accuracy: 0.4642 - val_loss:
1.2745 - val_accuracy: 0.5241
Epoch 2/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3123 - accuracy: 0.4696 - val_loss:
1.2716 - val_accuracy: 0.5241
Epoch 3/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2951 - accuracy: 0.4856 - val_loss:
1.2733 - val_accuracy: 0.5241
Epoch 4/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3062 - accuracy: 0.4782 - val_loss:
1.2732 - val_accuracy: 0.5241
Epoch 5/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2940 - accuracy: 0.4983 - val_loss:
1.2783 - val_accuracy: 0.5241
Epoch 6/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2973 - accuracy: 0.4932 - val_loss:
1.2725 - val_accuracy: 0.5241
Epoch 7/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3314 - accuracy: 0.4664 - val_loss:
1.2851 - val_accuracy: 0.5241
Epoch 8/10
81/81 [==============================] - 0s 4ms/step - loss: 1.3453 - accuracy: 0.4593 - val_loss:
1.2717 - val_accuracy: 0.5241
Epoch 9/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3317 - accuracy: 0.4756 - val_loss:
1.2817 - val_accuracy: 0.5241
Epoch 10/10
81/81 [==============================] - 0s 4ms/step - loss: 1.2941 - accuracy: 0.4909 - val_loss:
1.2845 - val_accuracy: 0.5241
81/81 [==============================] - 0s 2ms/step - loss: 1.3095 - accuracy: 0.4822
Train_accuracy is:0.48224735260009766
25/25 [==============================] - 0s 2ms/step - loss: 1.2845 - accuracy: 0.5241
Validation_accuracy is := 0.5240572094917297
11/11 [==============================] - 0s 2ms/step - loss: 1.2644 - accuracy: 0.5030
test_accuracy is : = 0.5030303001403809
```

In [110]:

```
print("Performance Report:")
y_pred7=dnn_model.predict_classes(test_features)
y_test7=[np.argmax(x) for x in test_y]
y_pred_prb7=dnn_model.predict_proba(test_features)
target=['0','1','2','3','4']
from sklearn import metrics
print('Accuracy score is :', np.round(metrics.accuracy_score(y_test7, y_pred7),4))
print('Precision score is :', np.round(metrics.precision_score(y_test7, y_pred7, average='weighted'),
4))
print('Recall score is :', np.round(metrics.recall_score(y_test7,y_pred7, average='weighted'),4))
print('F1 Score is :', np.round(metrics.f1_score(y_test7, y_pred7, average='weighted'),4))
print('Cohen Kappa Score:', np.round(metrics.cohen_kappa_score(y_test7, y_pred7),4))
print('\t\tClassification Report:\n', metrics.classification_report(y_test7, y_pred7,target_names=targe
t))
```

```
Performance Report:
Accuracy score is : 0.503
Precision score is : 0.253
Recall score is : 0.503
F1 Score is : 0.3367
Cohen Kappa Score: 0.0
                Classification Report:
               precision    recall  f1-score   support

           0       0.50      1.00      0.67       166
           1       0.00      0.00      0.00        30
           2       0.00      0.00      0.00        96
           3       0.00      0.00      0.00        15
           4       0.00      0.00      0.00        23

    accuracy                           0.50       330
   macro avg       0.10      0.20      0.13       330
weighted avg       0.25      0.50      0.34       330
```

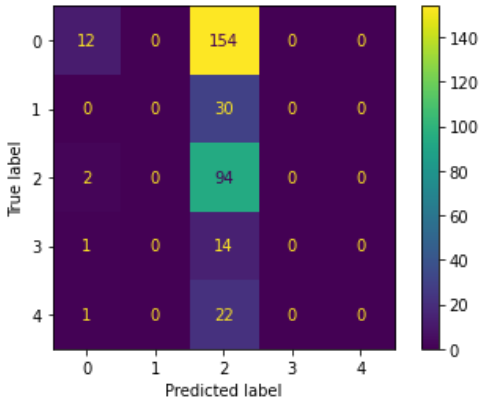
```
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:450: UserWarnin
g: `model.predict_classes()` is deprecated and will be removed after 2021-01-01. Please use instea
d:* `np.argmax(model.predict(x), axis=-1)`,   if your model does multi-class classification   (e.g.
if it uses a `softmax` last-layer activation).* `(model.predict(x) > 0.5).astype("int32")`,   if yo
ur model does binary classification   (e.g. if it uses a `sigmoid` last-layer activation).
  warnings.warn('`model.predict_classes()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:425: UserWarnin
g: `model.predict_proba()` is deprecated and will be removed after 2021-01-01. Please use `model.pr
edict()` instead.
  warnings.warn('`model.predict_proba()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [111]:

```
knn = KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30)
knn.fit(train_features, y_train)
plot_confusion_matrix(knn, test_features, y_test)
```

Out[111]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e318f44d0>
```

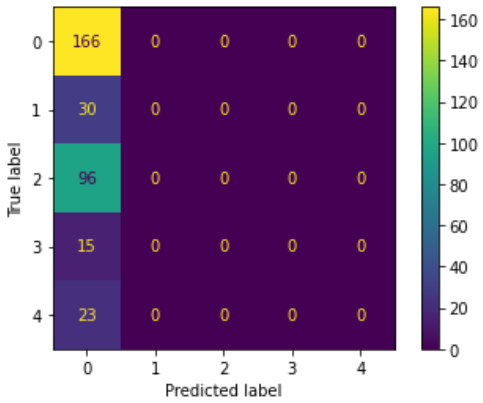


In [112]:

```
svc = SVC()
svc.fit(train_features, y_train)
plot_confusion_matrix(svc, test_features, y_test)
```

Out[112]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e380f12d0>
```

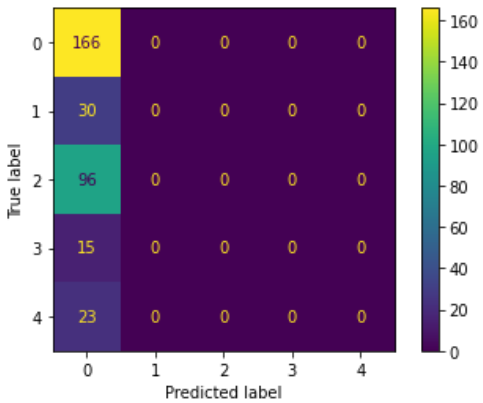


In [113]:

```
rf = RandomForestClassifier()
rf.fit(train_features, y_train)
plot_confusion_matrix(rf, test_features, y_test)
```

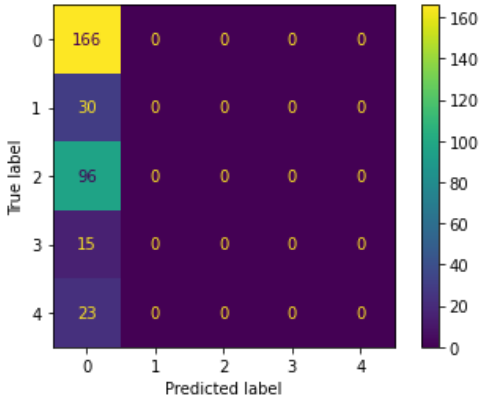
Out[113]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e5c2bb250>
```



In [114]:
```
ada = AdaBoostClassifier()
ada.fit(train_features, y_train)
plot_confusion_matrix(ada, test_features, y_test)
```

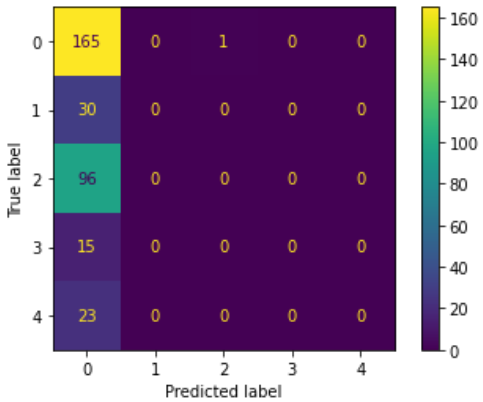
Out[114]:
```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e42ac03f410>
```



In [115]:
```
xgbc = XGBClassifier()
xgbc.fit(train_features, y_train)
plot_confusion_matrix(xgbc, test_features, y_test)
```

```
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


[16:44:15] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
```

Out[115]:
```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e5c394cd0>
```



DenseNet169

In [116]:

```
base_model= InceptionResNetV2(input_shape=(224,224,3), weights='imagenet', include_top=False)
x = base_model.output
# x = Dropout(0.5)(x)
x = Flatten()(x)
# x = BatchNormalization()(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(256,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
predictions = Dense(5, activation='softmax')(x)

model_feat = Model(inputs=base_model.input,outputs=predictions)

train_features = model_feat.predict(x_train)
val_features=model_feat.predict(x_val)
test_features=model_feat.predict(x_test)
```

In [117]:

```
from sklearn.pipeline import make_pipeline
from sklearn.pipeline import Pipeline
names = [
        "K Nearest Neighbour Classifier",
        'SVM',
        "Random Forest Classifier",
        "AdaBoost Classifier",
        "XGB Classifier"
         ]
classifiers = [
    KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30),
    SVC(),
    RandomForestClassifier(max_depth=9,criterion = 'entropy'),
    AdaBoostClassifier(),
    XGBClassifier()
        ]
zipped_clf = zip(names,classifiers)
def classifier_summary(pipeline, X_train, y_train, X_val, y_val,X_test,y_test):
    sentiment_fit = pipeline.fit(X_train, y_train)

    y_pred_train= sentiment_fit.predict(X_train)
    y_pred_val = sentiment_fit.predict(X_val)
    y_pred_test = sentiment_fit.predict(X_test)

    train_accuracy = np.round(accuracy_score(y_train, y_pred_train),4)*100
    train_precision = np.round(precision_score(y_train, y_pred_train, average='weighted'),4)
    train_recall = np.round(recall_score(y_train, y_pred_train, average='weighted'),4)
    train_F1 = np.round(f1_score(y_train, y_pred_train, average='weighted'),4)
    train_kappa =  np.round(cohen_kappa_score(y_train, y_pred_train),4)


    val_accuracy = np.round(accuracy_score(y_val, y_pred_val),4)*100
    val_precision = np.round(precision_score(y_val, y_pred_val, average='weighted'),4)
    val_recall = np.round(recall_score(y_val, y_pred_val, average='weighted'),4)
    val_F1 = np.round(f1_score(y_val, y_pred_val, average='weighted'),4)
    val_kappa =  np.round(cohen_kappa_score(y_val, y_pred_val),4)


    test_accuracy = np.round(accuracy_score(y_test, y_pred_test),4)*100
    test_precision = np.round(precision_score(y_test, y_pred_test, average='weighted'),2)
    test_recall = np.round(recall_score(y_test, y_pred_test, average='weighted'),2)
    test_F1 = np.round(f1_score(y_test, y_pred_test, average='weighted'),2)
    test_kappa =  np.round(cohen_kappa_score(y_test, y_pred_test),2)



    print()
    print('----------------------- Train Set Metrics-----------------------')
    print()
    print("Accuracy core : {}%".format(train_accuracy))

    print('----------------------- Validation Set Metrics-----------------------')
    print()
    print("Accuracy score : {}%".format(val_accuracy))
    print('----------------------- Test Set Metrics-----------------------')
```

```
    print()
    print("Accuracy score : {}%".format(test_accuracy))
    print("F1_score : {}".format(test_F1))
    print("Kappa Score : {} ".format(test_kappa))
    print("Recall score: {}".format(test_recall))
    print("Precision score : {}".format(test_precision))

    print("-"*80)
    print()

def classifier_comparator(X_train,y_train,X_val,y_val,X_test,y_test,classifier=zipped_clf):
    result = []
    for n,c in classifier:
        checker_pipeline = Pipeline([('Classifier', c)])
        print("------------------------------Fitting {} on input_data--------------------------------
".format(n))
        #print(c)
        classifier_summary(checker_pipeline,X_train, y_train, X_val, y_val,X_test,y_test)
```

In [118]:

```
classifier_comparator(train_features,y_train,val_features,y_val,test_features,y_test,classifier=zipped_
clf)
```

```
------------------------------Fitting K Nearest Neighbour Classifier on input_data-----------------
---------------

----------------------- Train Set Metrics-----------------------

Accuracy core : 53.769999999999996%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 54.230000000000004%
----------------------- Test Set Metrics-----------------------

Accuracy score : 50.91%
F1_score : 0.4
Kappa Score : 0.06
Recall score: 0.51
Precision score : 0.38
--------------------------------------------------------------------------------

------------------------------Fitting SVM on input_data--------------------------------
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))


------------------------ Train Set Metrics------------------------

Accuracy core : 50.449999999999996%
------------------------ Validation Set Metrics------------------------

Accuracy score : 52.93%
------------------------ Test Set Metrics------------------------

Accuracy score : 50.0%
F1_score : 0.4
Kappa Score : 0.05
Recall score: 0.5
Precision score : 0.36
--------------------------------------------------------------------------------

------------------------------Fitting Random Forest Classifier on input_data-----------------------
---------


/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)
```

```
------------------------ Train Set Metrics------------------------

Accuracy core : 53.1%
------------------------ Validation Set Metrics------------------------

Accuracy score : 53.059999999999995%
------------------------ Test Set Metrics------------------------

Accuracy score : 48.79%
F1_score : 0.39
Kappa Score : 0.03
Recall score: 0.49
Precision score : 0.36
--------------------------------------------------------------------------------

------------------------------Fitting AdaBoost Classifier on input_data-----------------------------
----

------------------------ Train Set Metrics------------------------

Accuracy core : 50.6%
------------------------ Validation Set Metrics------------------------

Accuracy score : 53.32%
------------------------ Test Set Metrics------------------------

Accuracy score : 50.3%
F1_score : 0.4
Kappa Score : 0.05
Recall score: 0.5
Precision score : 0.37
--------------------------------------------------------------------------------

------------------------------Fitting XGB Classifier on input_data--------------------------------
[16:44:37] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.

------------------------ Train Set Metrics------------------------

Accuracy core : 63.83%
------------------------ Validation Set Metrics------------------------

Accuracy score : 54.230000000000004%
------------------------ Test Set Metrics------------------------

Accuracy score : 49.39%
F1_score : 0.39
Kappa Score : 0.06
Recall score: 0.49
Precision score : 0.4
--------------------------------------------------------------------------------
```

In [119]:

```
train_y=to_categorical(y_train,5)
val_y=to_categorical(y_val,5)
test_y=to_categorical(y_test,5)
dnn_model.compile(optimizer='adam',loss='categorical_crossentropy', metrics=['accuracy'])
history = dnn_model.fit(train_features, train_y,validation_data=(val_features,val_y), epochs=10)
loss_value , accuracy = dnn_model.evaluate(train_features, train_y)
print('Train_accuracy is:' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(val_features, val_y)
print('Validation_accuracy is := ' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(test_features, test_y)
print('test_accuracy is : = ' + str(accuracy))
```

```
Epoch 1/10
81/81 [==============================] - 1s 5ms/step - loss: 1.3826 - accuracy: 0.4501 - val_loss:
1.2641 - val_accuracy: 0.5306
Epoch 2/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2850 - accuracy: 0.5154 - val_loss:
1.2536 - val_accuracy: 0.5306
Epoch 3/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2975 - accuracy: 0.4912 - val_loss:
1.2541 - val_accuracy: 0.5306
Epoch 4/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3044 - accuracy: 0.4878 - val_loss:
1.2556 - val_accuracy: 0.5319
Epoch 5/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2878 - accuracy: 0.5027 - val_loss:
1.2561 - val_accuracy: 0.5306
Epoch 6/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2460 - accuracy: 0.5200 - val_loss:
1.2569 - val_accuracy: 0.5319
Epoch 7/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2790 - accuracy: 0.5074 - val_loss:
1.2618 - val_accuracy: 0.5306
Epoch 8/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3013 - accuracy: 0.5020 - val_loss:
1.2563 - val_accuracy: 0.5306
Epoch 9/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3080 - accuracy: 0.4917 - val_loss:
1.2635 - val_accuracy: 0.5319
Epoch 10/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2584 - accuracy: 0.5224 - val_loss:
1.2690 - val_accuracy: 0.5306
81/81 [==============================] - 0s 2ms/step - loss: 1.2811 - accuracy: 0.5045: 0s - loss:
1.2729 - accuracy: 0.
Train_accuracy is:0.5044869184494019
25/25 [==============================] - 0s 2ms/step - loss: 1.2690 - accuracy: 0.5306
Validation_accuracy is := 0.5305591821670532
11/11 [==============================] - 0s 2ms/step - loss: 1.2463 - accuracy: 0.5030
test_accuracy is : = 0.5030303001403809
```

In [120]:

```
print("Performance Report:")
y_pred8=dnn_model.predict_classes(test_features)
y_test8=[np.argmax(x) for x in test_y]
y_pred_prb8=dnn_model.predict_proba(test_features)
target=['0','1','2','3','4']
from sklearn import metrics
print('Accuracy score is :', np.round(metrics.accuracy_score(y_test8, y_pred8),4))
print('Precision score is :', np.round(metrics.precision_score(y_test8, y_pred8, average='weighted'),
4))
print('Recall score is :', np.round(metrics.recall_score(y_test8,y_pred8, average='weighted'),4))
print('F1 Score is :', np.round(metrics.f1_score(y_test8, y_pred8, average='weighted'),4))
print('Cohen Kappa Score:', np.round(metrics.cohen_kappa_score(y_test8, y_pred8),4))
print('\t\tClassification Report:\n', metrics.classification_report(y_test8, y_pred8,target_names=targe
t))
```

```
Performance Report:
Accuracy score is : 0.503
Precision score is : 0.3682
Recall score is : 0.503
F1 Score is : 0.4006
Cohen Kappa Score: 0.055
                Classification Report:
               precision    recall  f1-score   support

           0       0.53      0.90      0.67       166
           1       0.00      0.00      0.00        30
           2       0.36      0.17      0.23        96
           3       0.00      0.00      0.00        15
           4       0.00      0.00      0.00        23

    accuracy                           0.50       330
   macro avg       0.18      0.21      0.18       330
weighted avg       0.37      0.50      0.40       330
```

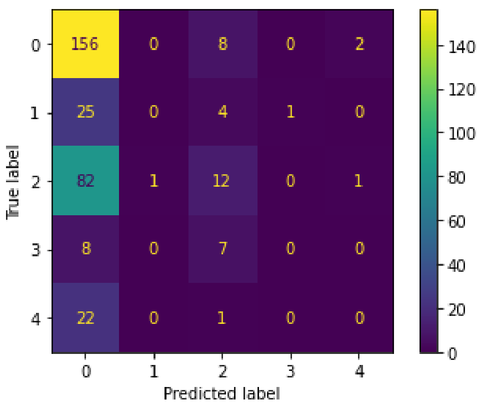
```
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:450: UserWarnin
g: `model.predict_classes()` is deprecated and will be removed after 2021-01-01. Please use instea
d:* `np.argmax(model.predict(x), axis=-1)`,   if your model does multi-class classification   (e.g.
if it uses a `softmax` last-layer activation).* `(model.predict(x) > 0.5).astype("int32")`,   if yo
ur model does binary classification   (e.g. if it uses a `sigmoid` last-layer activation).
  warnings.warn('`model.predict_classes()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:425: UserWarnin
g: `model.predict_proba()` is deprecated and will be removed after 2021-01-01. Please use `model.pr
edict()` instead.
  warnings.warn('`model.predict_proba()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [121]:

```python
knn = KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30)
knn.fit(train_features, y_train)
plot_confusion_matrix(knn, test_features, y_test)
```

Out[121]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e2e658b50>
```

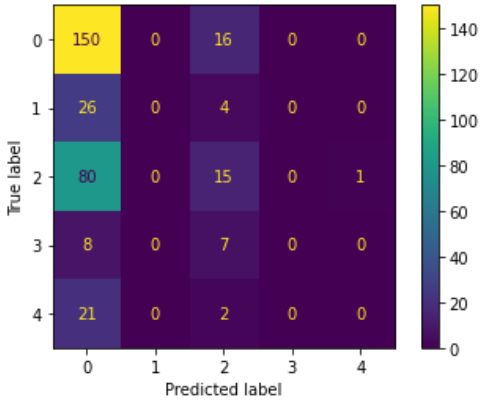


In [122]:

```python
svc = SVC()
svc.fit(train_features, y_train)
plot_confusion_matrix(svc, test_features, y_test)
```

Out[122]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e2f7321d0>
```

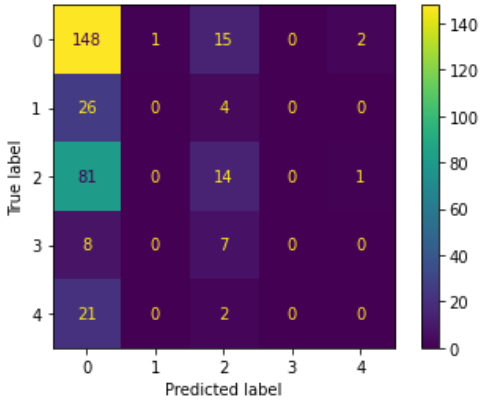


In [123]:

```
rf = RandomForestClassifier()
rf.fit(train_features, y_train)
plot_confusion_matrix(rf, test_features, y_test)
```

Out[123]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e5554d710>
```

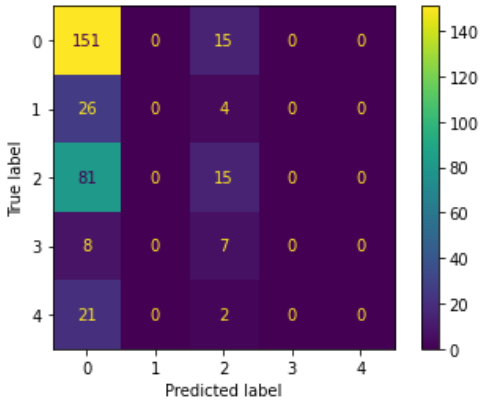


In [124]:

```
ada = AdaBoostClassifier()
ada.fit(train_features, y_train)
plot_confusion_matrix(ada, test_features, y_test)
```

Out[124]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e4053da50>
```



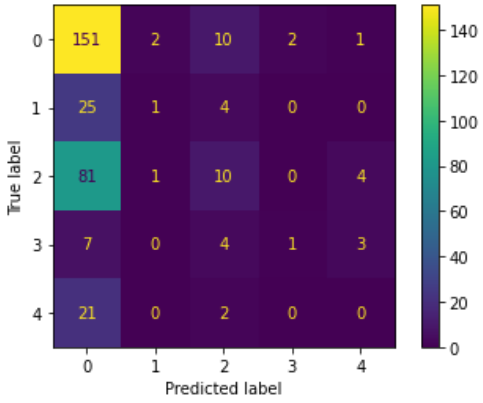
In [125]:

```
xgbc = XGBClassifier()
xgbc.fit(train_features, y_train)
plot_confusion_matrix(xgbc, test_features, y_test)
```

```
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


[16:44:43] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
```

Out[125]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e3872bdd0>
```



DenseNet121

In [126]:

```
base_model= InceptionResNetV2(input_shape=(224,224,3), weights='imagenet', include_top=False)
x = base_model.output
# x = Dropout(0.5)(x)
x = Flatten()(x)
# x = BatchNormalization()(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(256,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
predictions = Dense(5, activation='softmax')(x)

model_feat = Model(inputs=base_model.input,outputs=predictions)

train_features = model_feat.predict(x_train)
val_features=model_feat.predict(x_val)
test_features=model_feat.predict(x_test)
```

In [127]:

```
from sklearn.pipeline import make_pipeline
from sklearn.pipeline import Pipeline
names = [
        "K Nearest Neighbour Classifier",
        'SVM',
        "Random Forest Classifier",
        "AdaBoost Classifier",
        "XGB Classifier"
         ]
classifiers = [
    KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30),
    SVC(),
    RandomForestClassifier(max_depth=9,criterion = 'entropy'),
    AdaBoostClassifier(),
    XGBClassifier()
        ]
zipped_clf = zip(names,classifiers)
def classifier_summary(pipeline, X_train, y_train, X_val, y_val,X_test,y_test):
    sentiment_fit = pipeline.fit(X_train, y_train)

    y_pred_train= sentiment_fit.predict(X_train)
    y_pred_val = sentiment_fit.predict(X_val)
    y_pred_test = sentiment_fit.predict(X_test)

    train_accuracy = np.round(accuracy_score(y_train, y_pred_train),4)*100
    train_precision = np.round(precision_score(y_train, y_pred_train, average='weighted'),4)
    train_recall = np.round(recall_score(y_train, y_pred_train, average='weighted'),4)
    train_F1 = np.round(f1_score(y_train, y_pred_train, average='weighted'),4)
    train_kappa =  np.round(cohen_kappa_score(y_train, y_pred_train),4)


    val_accuracy = np.round(accuracy_score(y_val, y_pred_val),4)*100
    val_precision = np.round(precision_score(y_val, y_pred_val, average='weighted'),4)
    val_recall = np.round(recall_score(y_val, y_pred_val, average='weighted'),4)
    val_F1 = np.round(f1_score(y_val, y_pred_val, average='weighted'),4)
    val_kappa =  np.round(cohen_kappa_score(y_val, y_pred_val),4)


    test_accuracy = np.round(accuracy_score(y_test, y_pred_test),4)*100
    test_precision = np.round(precision_score(y_test, y_pred_test, average='weighted'),2)
    test_recall = np.round(recall_score(y_test, y_pred_test, average='weighted'),2)
    test_F1 = np.round(f1_score(y_test, y_pred_test, average='weighted'),2)
    test_kappa =  np.round(cohen_kappa_score(y_test, y_pred_test),2)



    print()
    print('----------------------- Train Set Metrics-----------------------')
    print()
    print("Accuracy core : {}%".format(train_accuracy))

    print('----------------------- Validation Set Metrics-----------------------')
    print()
    print("Accuracy score : {}%".format(val_accuracy))
    print('----------------------- Test Set Metrics-----------------------')
```

```python
    print()
    print("Accuracy score : {}%".format(test_accuracy))
    print("F1_score : {}".format(test_F1))
    print("Kappa Score : {} ".format(test_kappa))
    print("Recall score: {}".format(test_recall))
    print("Precision score : {}".format(test_precision))

    print("-"*80)
    print()

def classifier_comparator(X_train,y_train,X_val,y_val,X_test,y_test,classifier=zipped_clf):
    result = []
    for n,c in classifier:
        checker_pipeline = Pipeline([('Classifier', c)])
        print("------------------------------Fitting {} on input_data--------------------------------
".format(n))
        #print(c)
        classifier_summary(checker_pipeline,X_train, y_train, X_val, y_val,X_test,y_test)
```

In [128]:

```python
classifier_comparator(train_features,y_train,val_features,y_val,test_features,y_test,classifier=zipped_
clf)
```

```
------------------------------Fitting K Nearest Neighbour Classifier on input_data-----------------
---------------


/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

```
------------------------ Train Set Metrics-----------------------

Accuracy core : 10.03%
------------------------ Validation Set Metrics-----------------------

Accuracy score : 10.92%
------------------------ Test Set Metrics-----------------------

Accuracy score : 9.09%
F1_score : 0.02
Kappa Score : 0.0
Recall score: 0.09
Precision score : 0.01
--------------------------------------------------------------------------------

------------------------------Fitting SVM on input_data--------------------------------


/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))


------------------------ Train Set Metrics-----------------------

Accuracy core : 48.22%
------------------------ Validation Set Metrics-----------------------

Accuracy score : 52.410000000000004%
------------------------ Test Set Metrics-----------------------

Accuracy score : 50.3%
F1_score : 0.34
Kappa Score : 0.0
Recall score: 0.5
Precision score : 0.25
--------------------------------------------------------------------------------

------------------------------Fitting Random Forest Classifier on input_data-----------------------
---------
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

```
----------------------- Train Set Metrics-----------------------

Accuracy core : 48.22%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 52.410000000000004%
----------------------- Test Set Metrics-----------------------

Accuracy score : 50.3%
F1_score : 0.34
Kappa Score : 0.0
Recall score: 0.5
Precision score : 0.25
--------------------------------------------------------------------------------

------------------------------Fitting AdaBoost Classifier on input_data-----------------------------
----

----------------------- Train Set Metrics-----------------------

Accuracy core : 48.22%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 52.410000000000004%
----------------------- Test Set Metrics-----------------------

Accuracy score : 50.3%
F1_score : 0.34
Kappa Score : 0.0
Recall score: 0.5
Precision score : 0.25
--------------------------------------------------------------------------------

------------------------------Fitting XGB Classifier on input_data--------------------------------
[16:45:06] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.

----------------------- Train Set Metrics-----------------------

Accuracy core : 48.22%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 52.410000000000004%
----------------------- Test Set Metrics-----------------------

Accuracy score : 50.3%
F1_score : 0.34
Kappa Score : 0.0
Recall score: 0.5
Precision score : 0.25
--------------------------------------------------------------------------------
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [129]:

```
train_y=to_categorical(y_train,5)
val_y=to_categorical(y_val,5)
test_y=to_categorical(y_test,5)
dnn_model.compile(optimizer='adam',loss='categorical_crossentropy', metrics=['accuracy'])
history = dnn_model.fit(train_features, train_y,validation_data=(val_features,val_y), epochs=10)
loss_value , accuracy = dnn_model.evaluate(train_features, train_y)
print('Train_accuracy is:' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(val_features, val_y)
print('Validation_accuracy is := ' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(test_features, test_y)
print('test_accuracy is : = ' + str(accuracy))
```

```
Epoch 1/10
81/81 [==============================] - 1s 5ms/step - loss: 1.3070 - accuracy: 0.4735 - val_loss:
1.2758 - val_accuracy: 0.5241
Epoch 2/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2820 - accuracy: 0.4983 - val_loss:
1.2738 - val_accuracy: 0.5241
Epoch 3/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2973 - accuracy: 0.4872 - val_loss:
1.2806 - val_accuracy: 0.5241
Epoch 4/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3155 - accuracy: 0.4774 - val_loss:
1.2764 - val_accuracy: 0.5241
Epoch 5/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3118 - accuracy: 0.4840 - val_loss:
1.2810 - val_accuracy: 0.5241
Epoch 6/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3100 - accuracy: 0.4866 - val_loss:
1.2744 - val_accuracy: 0.5241
Epoch 7/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2993 - accuracy: 0.4793 - val_loss:
1.2754 - val_accuracy: 0.5241
Epoch 8/10
81/81 [==============================] - 0s 4ms/step - loss: 1.2982 - accuracy: 0.4863 - val_loss:
1.2785 - val_accuracy: 0.5241
Epoch 9/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2983 - accuracy: 0.5008 - val_loss:
1.2838 - val_accuracy: 0.5241
Epoch 10/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3144 - accuracy: 0.4892 - val_loss:
1.2754 - val_accuracy: 0.5241
81/81 [==============================] - 0s 2ms/step - loss: 1.3048 - accuracy: 0.4822
Train_accuracy is:0.48224735260009766
25/25 [==============================] - 0s 2ms/step - loss: 1.2754 - accuracy: 0.5241
Validation_accuracy is := 0.5240572094917297
11/11 [==============================] - 0s 2ms/step - loss: 1.2501 - accuracy: 0.5030
test_accuracy is : = 0.5030303001403809
```

In [130]:

```
print("Performance Report:")
y_pred9=dnn_model.predict_classes(test_features)
y_test9=[np.argmax(x) for x in test_y]
y_pred_prb9=dnn_model.predict_proba(test_features)
target=['0','1','2','3','4']
from sklearn import metrics
print('Accuracy score is :', np.round(metrics.accuracy_score(y_test9, y_pred9),4))
print('Precision score is :', np.round(metrics.precision_score(y_test9, y_pred9, average='weighted'),
4))
print('Recall score is :', np.round(metrics.recall_score(y_test9,y_pred9, average='weighted'),4))
print('F1 Score is :', np.round(metrics.f1_score(y_test9, y_pred9, average='weighted'),4))
print('Cohen Kappa Score:', np.round(metrics.cohen_kappa_score(y_test9, y_pred9),4))
print('\t\tClassification Report:\n', metrics.classification_report(y_test9, y_pred9,target_names=targe
t))
```

```
Performance Report:
Accuracy score is : 0.503
Precision score is : 0.253
Recall score is : 0.503
F1 Score is : 0.3367
Cohen Kappa Score: 0.0
                Classification Report:
               precision    recall  f1-score   support

           0       0.50      1.00      0.67       166
           1       0.00      0.00      0.00        30
           2       0.00      0.00      0.00        96
           3       0.00      0.00      0.00        15
           4       0.00      0.00      0.00        23

    accuracy                           0.50       330
   macro avg       0.10      0.20      0.13       330
weighted avg       0.25      0.50      0.34       330
```

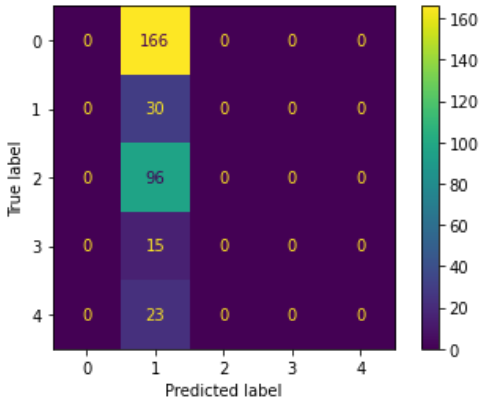
```
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:450: UserWarnin
g: `model.predict_classes()` is deprecated and will be removed after 2021-01-01. Please use instea
d:* `np.argmax(model.predict(x), axis=-1)`,   if your model does multi-class classification   (e.g.
if it uses a `softmax` last-layer activation).* `(model.predict(x) > 0.5).astype("int32")`,   if yo
ur model does binary classification   (e.g. if it uses a `sigmoid` last-layer activation).
  warnings.warn('`model.predict_classes()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:425: UserWarnin
g: `model.predict_proba()` is deprecated and will be removed after 2021-01-01. Please use `model.pr
edict()` instead.
  warnings.warn('`model.predict_proba()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [131]:

```
knn = KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30)
knn.fit(train_features, y_train)
plot_confusion_matrix(knn, test_features, y_test)
```

Out[131]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e552c4710>
```

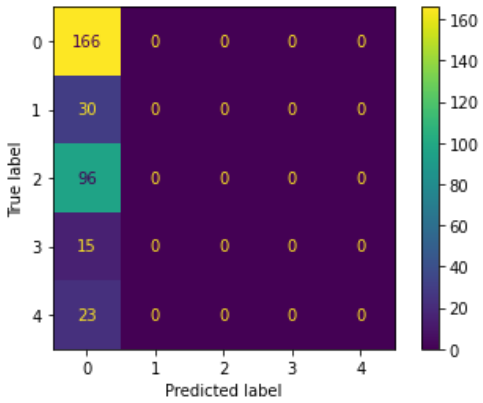


In [132]:

```
svc = SVC()
svc.fit(train_features, y_train)
plot_confusion_matrix(svc, test_features, y_test)
```

Out[132]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e5403e310>
```

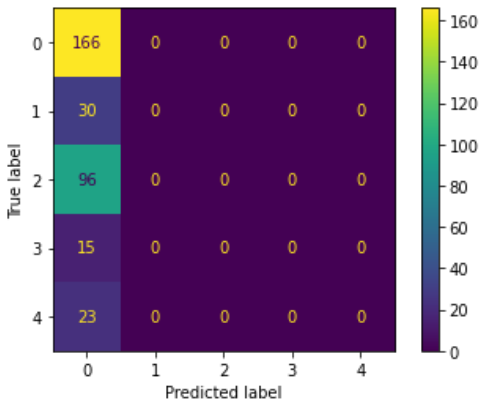


In [133]:

```
rf = RandomForestClassifier()
rf.fit(train_features, y_train)
plot_confusion_matrix(rf, test_features, y_test)
```

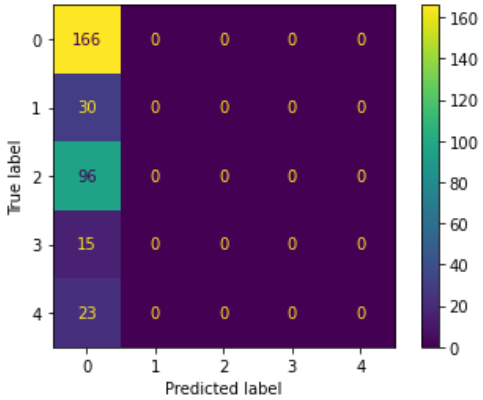
Out[133]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e4051c910>
```



In [134]:
```
ada = AdaBoostClassifier()
ada.fit(train_features, y_train)
plot_confusion_matrix(ada, test_features, y_test)
```

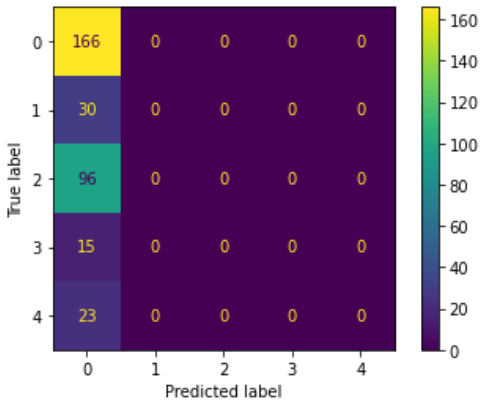
Out[134]:
```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e2e43c910>
```



In [135]:
```
xgbc = XGBClassifier()
xgbc.fit(train_features, y_train)
plot_confusion_matrix(xgbc, test_features, y_test)
```

```
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


[16:45:12] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
```

Out[135]:
```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e2e446550>
```



XceptionNet

In [136]:

```
base_model= InceptionResNetV2(input_shape=(224,224,3), weights='imagenet', include_top=False)
x = base_model.output
# x = Dropout(0.5)(x)
x = Flatten()(x)
# x = BatchNormalization()(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(256,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(128,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
x = Dense(64,kernel_initializer='he_uniform')(x)
# x = BatchNormalization()(x)
x = Activation('relu')(x)
# x = Dropout(0.5)(x)
predictions = Dense(5, activation='softmax')(x)

model_feat = Model(inputs=base_model.input,outputs=predictions)

train_features = model_feat.predict(x_train)
val_features=model_feat.predict(x_val)
test_features=model_feat.predict(x_test)
```

In [137]:

```
from sklearn.pipeline import make_pipeline
from sklearn.pipeline import Pipeline
names = [
        "K Nearest Neighbour Classifier",
        'SVM',
        "Random Forest Classifier",
        "AdaBoost Classifier",
        "XGB Classifier"
         ]
classifiers = [
    KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30),
    SVC(),
    RandomForestClassifier(max_depth=9,criterion = 'entropy'),
    AdaBoostClassifier(),
    XGBClassifier()
        ]
zipped_clf = zip(names,classifiers)
def classifier_summary(pipeline, X_train, y_train, X_val, y_val,X_test,y_test):
    sentiment_fit = pipeline.fit(X_train, y_train)

    y_pred_train= sentiment_fit.predict(X_train)
    y_pred_val = sentiment_fit.predict(X_val)
    y_pred_test = sentiment_fit.predict(X_test)

    train_accuracy = np.round(accuracy_score(y_train, y_pred_train),4)*100
    train_precision = np.round(precision_score(y_train, y_pred_train, average='weighted'),4)
    train_recall = np.round(recall_score(y_train, y_pred_train, average='weighted'),4)
    train_F1 = np.round(f1_score(y_train, y_pred_train, average='weighted'),4)
    train_kappa =  np.round(cohen_kappa_score(y_train, y_pred_train),4)


    val_accuracy = np.round(accuracy_score(y_val, y_pred_val),4)*100
    val_precision = np.round(precision_score(y_val, y_pred_val, average='weighted'),4)
    val_recall = np.round(recall_score(y_val, y_pred_val, average='weighted'),4)
    val_F1 = np.round(f1_score(y_val, y_pred_val, average='weighted'),4)
    val_kappa =  np.round(cohen_kappa_score(y_val, y_pred_val),4)


    test_accuracy = np.round(accuracy_score(y_test, y_pred_test),4)*100
    test_precision = np.round(precision_score(y_test, y_pred_test, average='weighted'),2)
    test_recall = np.round(recall_score(y_test, y_pred_test, average='weighted'),2)
    test_F1 = np.round(f1_score(y_test, y_pred_test, average='weighted'),2)
    test_kappa =  np.round(cohen_kappa_score(y_test, y_pred_test),2)



    print()
    print('----------------------- Train Set Metrics-----------------------')
    print()
    print("Accuracy core : {}%".format(train_accuracy))

    print('----------------------- Validation Set Metrics-----------------------')
    print()
    print("Accuracy score : {}%".format(val_accuracy))
    print('----------------------- Test Set Metrics-----------------------')
```

```
    print()
    print("Accuracy score : {}%".format(test_accuracy))
    print("F1_score : {}".format(test_F1))
    print("Kappa Score : {} ".format(test_kappa))
    print("Recall score: {}".format(test_recall))
    print("Precision score : {}".format(test_precision))

    print("-"*80)
    print()

def classifier_comparator(X_train,y_train,X_val,y_val,X_test,y_test,classifier=zipped_clf):
    result = []
    for n,c in classifier:
        checker_pipeline = Pipeline([('Classifier', c)])
        print("------------------------------Fitting {} on input_data--------------------------------
".format(n))
        #print(c)
        classifier_summary(checker_pipeline,X_train, y_train, X_val, y_val,X_test,y_test)
```

In [138]:

```
classifier_comparator(train_features,y_train,val_features,y_val,test_features,y_test,classifier=zipped_
clf)
```

```
------------------------------Fitting K Nearest Neighbour Classifier on input_data-----------------
---------------


/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

```
------------------------ Train Set Metrics------------------------

Accuracy core : 49.32%
------------------------ Validation Set Metrics------------------------

Accuracy score : 50.33%
------------------------ Test Set Metrics------------------------

Accuracy score : 50.3%
F1_score : 0.38
Kappa Score : 0.03
Recall score: 0.5
Precision score : 0.36
--------------------------------------------------------------------------------

------------------------------Fitting SVM on input_data--------------------------------


/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))


------------------------ Train Set Metrics------------------------

Accuracy core : 48.3%
------------------------ Validation Set Metrics------------------------

Accuracy score : 52.410000000000004%
------------------------ Test Set Metrics------------------------

Accuracy score : 50.3%
F1_score : 0.34
Kappa Score : 0.0
Recall score: 0.5
Precision score : 0.25
--------------------------------------------------------------------------------

------------------------------Fitting Random Forest Classifier on input_data-----------------------
---------
```

```
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encoder in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, do the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and 2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)
```

```
----------------------- Train Set Metrics-----------------------

Accuracy core : 49.24%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 52.15%
----------------------- Test Set Metrics-----------------------

Accuracy score : 50.0%
F1_score : 0.34
Kappa Score : -0.0
Recall score: 0.5
Precision score : 0.25
--------------------------------------------------------------------------------

------------------------------Fitting AdaBoost Classifier on input_data-----------------------------
----

----------------------- Train Set Metrics-----------------------

Accuracy core : 48.46%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 52.28%
----------------------- Test Set Metrics-----------------------

Accuracy score : 50.3%
F1_score : 0.34
Kappa Score : 0.0
Recall score: 0.5
Precision score : 0.35
--------------------------------------------------------------------------------

------------------------------Fitting XGB Classifier on input_data--------------------------------
[16:45:33] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.

----------------------- Train Set Metrics-----------------------

Accuracy core : 53.61%
----------------------- Validation Set Metrics-----------------------

Accuracy score : 51.629999999999995%
----------------------- Test Set Metrics-----------------------

Accuracy score : 50.0%
F1_score : 0.36
Kappa Score : 0.02
Recall score: 0.5
Precision score : 0.39
--------------------------------------------------------------------------------
```

In [139]:

```
train_y=to_categorical(y_train,5)
val_y=to_categorical(y_val,5)
test_y=to_categorical(y_test,5)
dnn_model.compile(optimizer='adam',loss='categorical_crossentropy', metrics=['accuracy'])
history = dnn_model.fit(train_features, train_y,validation_data=(val_features,val_y), epochs=10)
loss_value , accuracy = dnn_model.evaluate(train_features, train_y)
print('Train_accuracy is:' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(val_features, val_y)
print('Validation_accuracy is := ' + str(accuracy))
loss_value , accuracy = dnn_model.evaluate(test_features, test_y)
print('test_accuracy is : = ' + str(accuracy))
```

```
Epoch 1/10
81/81 [==============================] - 2s 5ms/step - loss: 1.3382 - accuracy: 0.4413 - val_loss:
1.2708 - val_accuracy: 0.5254
Epoch 2/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3139 - accuracy: 0.4691 - val_loss:
1.2673 - val_accuracy: 0.5254
Epoch 3/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3009 - accuracy: 0.4863 - val_loss:
1.2724 - val_accuracy: 0.5254
Epoch 4/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3139 - accuracy: 0.4785 - val_loss:
1.2740 - val_accuracy: 0.5254
Epoch 5/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3075 - accuracy: 0.4780 - val_loss:
1.2740 - val_accuracy: 0.5254
Epoch 6/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2935 - accuracy: 0.4963 - val_loss:
1.2792 - val_accuracy: 0.5241
Epoch 7/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2876 - accuracy: 0.4880 - val_loss:
1.2761 - val_accuracy: 0.5241
Epoch 8/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3115 - accuracy: 0.4801 - val_loss:
1.2664 - val_accuracy: 0.5241
Epoch 9/10
81/81 [==============================] - 0s 3ms/step - loss: 1.2890 - accuracy: 0.4827 - val_loss:
1.2732 - val_accuracy: 0.5241
Epoch 10/10
81/81 [==============================] - 0s 3ms/step - loss: 1.3060 - accuracy: 0.4870 - val_loss:
1.2767 - val_accuracy: 0.5241
81/81 [==============================] - 0s 2ms/step - loss: 1.2988 - accuracy: 0.4830
Train_accuracy is:0.48302769660949707
25/25 [==============================] - 0s 2ms/step - loss: 1.2767 - accuracy: 0.5241
Validation_accuracy is := 0.5240572094917297
11/11 [==============================] - 0s 2ms/step - loss: 1.2552 - accuracy: 0.5030
test_accuracy is : = 0.5030303001403809
```

In [140]:

```
print("Performance Report:")
y_pred9=dnn_model.predict_classes(test_features)
y_test9=[np.argmax(x) for x in test_y]
y_pred_prb9=dnn_model.predict_proba(test_features)
target=['0','1','2','3','4']
from sklearn import metrics
print('Accuracy score is :', np.round(metrics.accuracy_score(y_test9, y_pred9),4))
print('Precision score is :', np.round(metrics.precision_score(y_test9, y_pred9, average='weighted'),
4))
print('Recall score is :', np.round(metrics.recall_score(y_test9,y_pred9, average='weighted'),4))
print('F1 Score is :', np.round(metrics.f1_score(y_test9, y_pred9, average='weighted'),4))
print('Cohen Kappa Score:', np.round(metrics.cohen_kappa_score(y_test9, y_pred9),4))
print('\t\tClassification Report:\n', metrics.classification_report(y_test9, y_pred9,target_names=targe
t))
```

```
Performance Report:
Accuracy score is : 0.503
Precision score is : 0.253
Recall score is : 0.503
F1 Score is : 0.3367
Cohen Kappa Score: 0.0
                Classification Report:
               precision    recall  f1-score   support

           0       0.50      1.00      0.67       166
           1       0.00      0.00      0.00        30
           2       0.00      0.00      0.00        96
           3       0.00      0.00      0.00        15
           4       0.00      0.00      0.00        23

    accuracy                           0.50       330
   macro avg       0.10      0.20      0.13       330
weighted avg       0.25      0.50      0.34       330
```

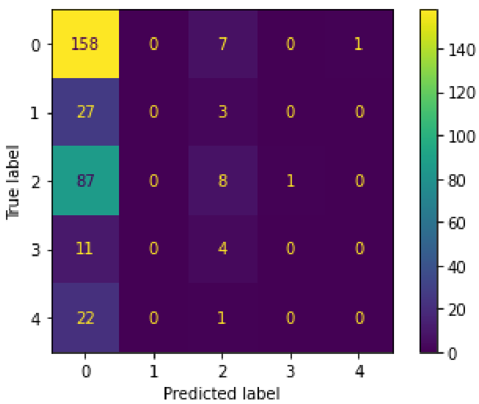
```
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:450: UserWarnin
g: `model.predict_classes()` is deprecated and will be removed after 2021-01-01. Please use instea
d:* `np.argmax(model.predict(x), axis=-1)`,   if your model does multi-class classification   (e.g.
if it uses a `softmax` last-layer activation).* `(model.predict(x) > 0.5).astype("int32")`,   if yo
ur model does binary classification   (e.g. if it uses a `sigmoid` last-layer activation).
  warnings.warn('`model.predict_classes()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:425: UserWarnin
g: `model.predict_proba()` is deprecated and will be removed after 2021-01-01. Please use `model.pr
edict()` instead.
  warnings.warn('`model.predict_proba()` is deprecated and '
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_d
ivision` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1245: UndefinedMetricWarn
ing: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted sample
s. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [141]:

```
knn = KNeighborsClassifier(n_neighbors = 5, algorithm='ball_tree', leaf_size=30)
knn.fit(train_features, y_train)
plot_confusion_matrix(knn, test_features, y_test)
```

Out[141]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e385bbd10>
```

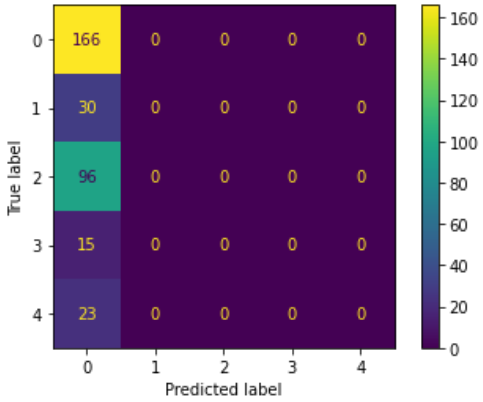


In [142]:

```
svc = SVC()
svc.fit(train_features, y_train)
plot_confusion_matrix(svc, test_features, y_test)
```

Out[142]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e4220482490>
```

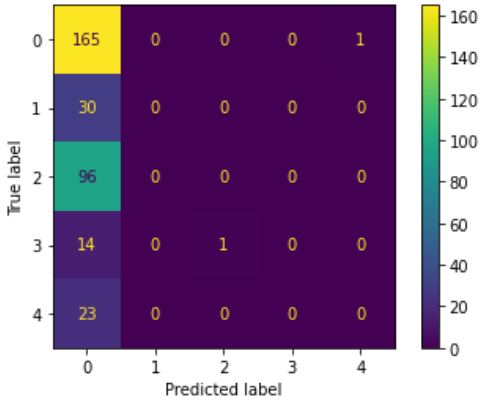


In [143]:

```
rf = RandomForestClassifier()
rf.fit(train_features, y_train)
plot_confusion_matrix(rf, test_features, y_test)
```

Out[143]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e32c0cb50>
```

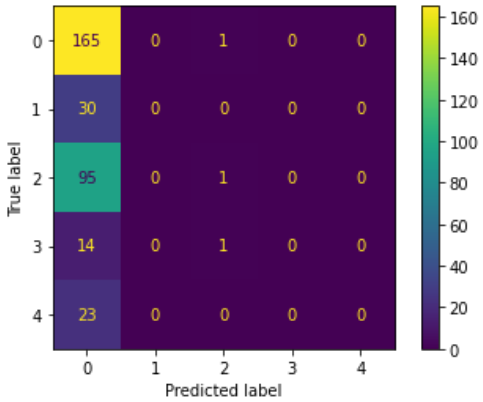


In [144]:

```
ada = AdaBoostClassifier()
ada.fit(train_features, y_train)
plot_confusion_matrix(ada, test_features, y_test)
```

Out[144]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e32bb6250>
```



In [145]:

```
xgbc = XGBClassifier()
xgbc.fit(train_features, y_train)
plot_confusion_matrix(xgbc, test_features, y_test)
```

```
/opt/conda/lib/python3.7/site-packages/xgboost/sklearn.py:888: UserWarning: The use of label encode
r in XGBClassifier is deprecated and will be removed in a future release. To remove this warning, d
o the following: 1) Pass option use_label_encoder=False when constructing XGBClassifier object; and
2) Encode your labels (y) as integers starting with 0, i.e. 0, 1, 2, ..., [num_class - 1].
  warnings.warn(label_encoder_deprecation_msg, UserWarning)


[16:45:40] WARNING: ../src/learner.cc:1061: Starting in XGBoost 1.3.0, the default evaluation metri
c used with the objective 'multi:softprob' was changed from 'merror' to 'mlogloss'. Explicitly set
eval_metric if you'd like to restore the old behavior.
```

Out[145]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7e3e2e391b90>
```