In [1]:

```
import warnings
warnings.filterwarnings("ignore")
import sqlite3
import pandas as pd
import numpy as np
import nltk
import string
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.feature_extraction.text import TfidfTransformer
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics import confusion_matrix
from sklearn import metrics
from sklearn.metrics import roc_curve, auc
from nltk.stem.porter import PorterStemmer
import re  # Tutorial about Python regular expressions: https://pymotw.com/2/re/
import string
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer
from nltk.stem.wordnet import WordNetLemmatizer
from gensim.models import Word2Vec
from gensim.models import KeyedVectors
import pickle
from tqdm import tqdm
import os
from plotly import plotly
import plotly.offline as offline
import plotly.graph_objs as go
offline.init_notebook_mode()
from collections import Counter
```

1.1 Reading Data

In [2]:

```
project_data = pd.read_csv('train_data.csv')
resource_data = pd.read_csv('resources.csv')
```

In [3]:

```
print("Number of data points in train data", project_data.shape)
print('-'*50)
print("The attributes of train data :", project_data.columns.values)
print('-'*50)
print("Number of data points in resource data", resource_data.shape)
print("The attributes of resource data :",resource_data.columns.values)
project_data.head(3)
#resource_data.head(3)
```

```
Number of data points in train data (109248, 17)
--------------------------------------------------
The attributes of train data : ['Unnamed: 0' 'id' 'teacher_id' 'teacher_pr
efix' 'school_state'
 'project_submitted_datetime' 'project_grade_category'
 'project_subject_categories' 'project_subject_subcategories'
 'project_title' 'project_essay_1' 'project_essay_2' 'project_essay_3'
 'project_essay_4' 'project_resource_summary'
 'teacher_number_of_previously_posted_projects' 'project_is_approved']
--------------------------------------------------
Number of data points in resource data (1541272, 4)
The attributes of resource data : ['id' 'description' 'quantity' 'price']
```

Out[3]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_s
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL
2	21895	p182444	3465aaf82da834c0582ebd0ef8040ca0	Ms.	AZ

1.2 Data Analysis

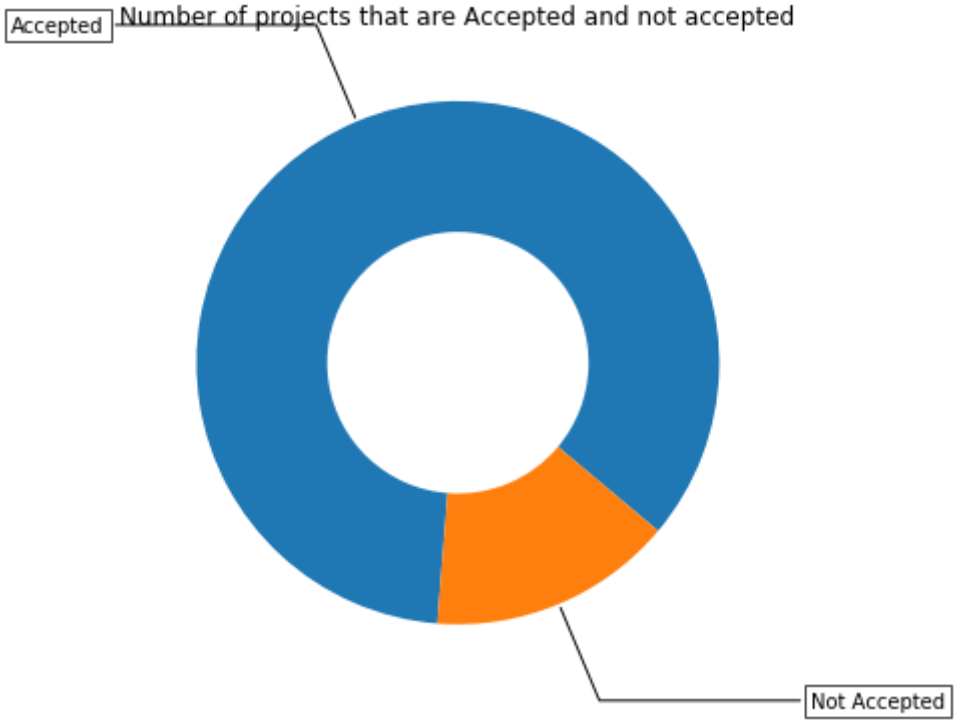
In [4]:

```
y_value_counts = project_data['project_is_approved'].value_counts()
print("Number of projects that are approved for funding are", y_value_counts[1],"which
 is:",(y_value_counts[1]/(y_value_counts[1]+y_value_counts[0]))*100,"%")
print("Number of projects that are not approved for funding are", y_value_counts[0],"wh
ich is:",(y_value_counts[0]/(y_value_counts[1]+y_value_counts[0]))*100,"%")
```

```
Number of projects that are approved for funding are 92706 which is: 84.85
830404217927 %
Number of projects that are not approved for funding are 16542 which is: 1
5.141695957820739 %
```

In [5]:

```
# PROVIDE CITATIONS TO YOUR CODE IF YOU TAKE IT FROM ANOTHER WEBSITE#pie-chart for the
 above calculation. It is not mandatory. Refer to the link.
# https://matplotlib.org/gallery/pie_and_polar_charts/pie_and_donut_labels.html

fig,ax = plt.subplots(figsize=(6, 6), subplot_kw=dict(aspect="equal"))
recipe = ["Accepted","Not Accepted"]
data = [y_value_counts[1], y_value_counts[0]]
wedges, texts = ax.pie(data, wedgeprops=dict(width=0.5), startangle=-40)
bbox_props = dict(boxstyle="square,pad=0.3", fc="w", ec="k", lw=0.72)
kw = dict(xycoords='data', textcoords='data', arrowprops=dict(arrowstyle="-"),bbox=bbox
_props, zorder=0, va="center")
for i, p in enumerate(wedges):
    ang = (p.theta2 - p.theta1)/2. + p.theta1
    y = np.sin(np.deg2rad(ang))
    x = np.cos(np.deg2rad(ang))
    horizontalalignment = {-1: "right", 1: "left"}[int(np.sign(x))]
    connectionstyle = "angle,angleA=0,angleB={}".format(ang)
    kw["arrowprops"].update({"connectionstyle": connectionstyle})
    ax.annotate(recipe[i], xy=(x, y), xytext=(1.35*np.sign(x), 1.4*y),horizontalalignme
nt=horizontalalignment, **kw)
ax.set_title("Number of projects that are Accepted and not accepted")
plt.show()
```



1.2.1 Univariate analysis-School State

In [6]:

```
# Pandas dataframe groupby count, mean: https://stackoverflow.com/a/19385591/4084039
temp = pd.DataFrame(project_data.groupby("school_state")["project_is_approved"].apply(n
p.mean)).reset_index()
temp.columns = ['state_code', 'num_proposals']
# https://www.csi.cuny.edu/sites/default/files/pdf/administration/ops/2letterstabbrev.p
df
temp.sort_values(by=['num_proposals'], inplace=True)
print("States with lowest % approvals")
print(temp.head(5))
print('='*50)
print("States with highest % approvals")
print(temp.tail(5))
```

```
States with lowest % approvals
   state_code  num_proposals
46         VT       0.800000
7          DC       0.802326
43         TX       0.813142
26         MT       0.816327
18         LA       0.831245
==================================================
States with highest % approvals
   state_code  num_proposals
30         NH       0.873563
35         OH       0.875152
47         WA       0.876178
28         ND       0.888112
8          DE       0.897959
```

From the above table we can observe that state Vermont (VT) has the least proposal acceptance rate & Delaware (DE) has the max acceptance rate.

In [7]:

```
# How to plot US state heatmap: https://datascience.stackexchange.com/a/9620- ignore fo
r the moment
```

In [8]:

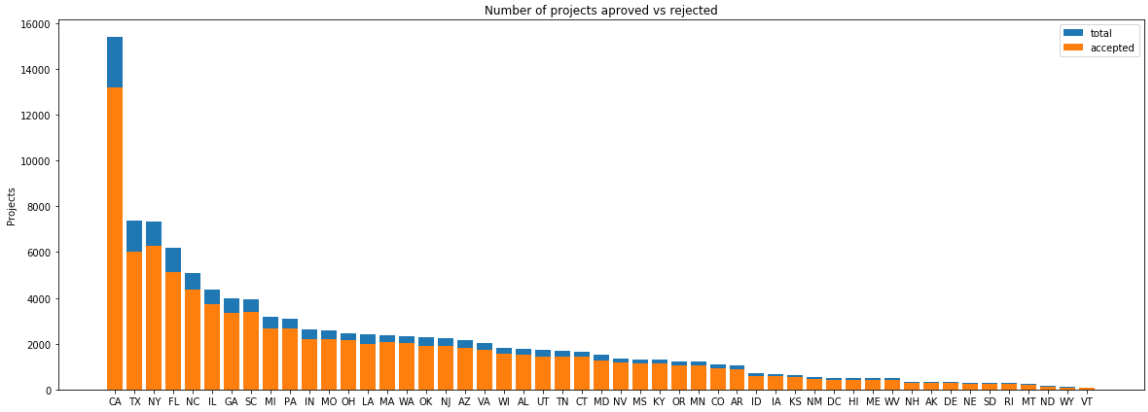
```
#stacked bar plots matplotlib: https://matplotlib.org/gallery/lines_bars_and_markers/ba
r_stacked.html
def stack_plot(data, xtick, col2='project_is_approved', col3='total'):
    ind = np.arange(data.shape[0])
    plt.figure(figsize=(20,7))
    p1 = plt.bar(ind, data[col3].values)
    p2 = plt.bar(ind, data[col2].values)
    plt.ylabel('Projects')
    plt.title('Number of projects aproved vs rejected')
    plt.xticks(ind, list(data[xtick].values))
    plt.legend((p1[0], p2[0]), ('total', 'accepted'))
    plt.show()
```

In [9]:

```
def univariate_barplots(data, col1, col2='project_is_approved', top=False):
    # Count number of zeros in dataframe python: https://stackoverflow.com/a/51540521/4084039
    temp = pd.DataFrame(project_data.groupby(col1)[col2].agg(lambda x: x.eq(1).sum())).reset_index()
    # Pandas dataframe grouby count: https://stackoverflow.com/a/19385591/4084039
    temp['total'] = pd.DataFrame(project_data.groupby(col1)[col2].agg({'total':'count'})).reset_index()['total']
    temp['Avg'] = pd.DataFrame(project_data.groupby(col1)[col2].agg({'Avg':'mean'})).reset_index()['Avg']
    temp.sort_values(by=['total'],inplace=True, ascending=False)
    if top:
        temp = temp[0:top]
    stack_plot(temp, xtick=col1, col2=col2, col3='total')
    print(temp.head(5))
    print("="*50)
    print(temp.tail(5))
```

In [10]:

```
univariate_barplots(project_data, 'school_state', 'project_is_approved', False)
```



	school_state	project_is_approved	total	Avg
4	CA	13205	15388	0.858136
43	TX	6014	7396	0.813142
34	NY	6291	7318	0.859661
9	FL	5144	6185	0.831690
27	NC	4353	5091	0.855038

==========

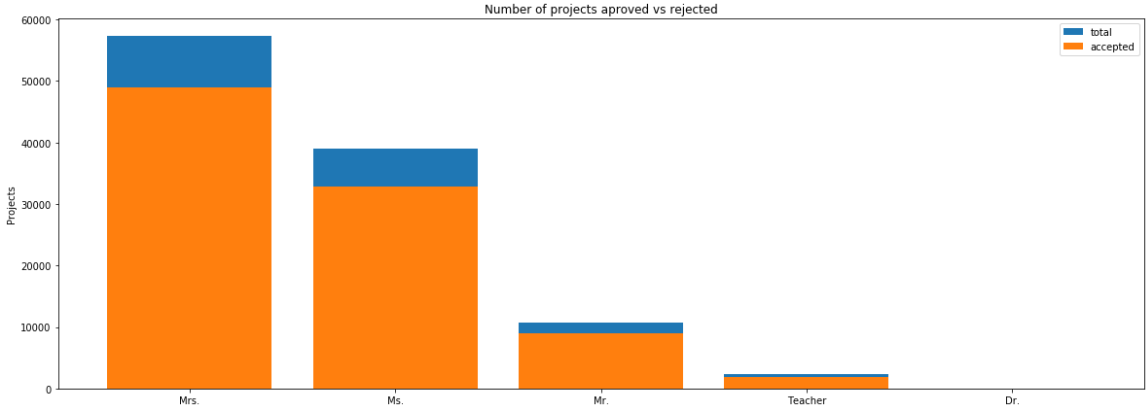
	school_state	project_is_approved	total	Avg
39	RI	243	285	0.852632
26	MT	200	245	0.816327
28	ND	127	143	0.888112
50	WY	82	98	0.836735
46	VT	64	80	0.800000

SUMMARY: Every state has greater than 80% success rate in approval.

1.2.2 Univariate Analysis: teacher_prefix

In [11]:

```
univariate_barplots(project_data, 'teacher_prefix', 'project_is_approved', False)
```



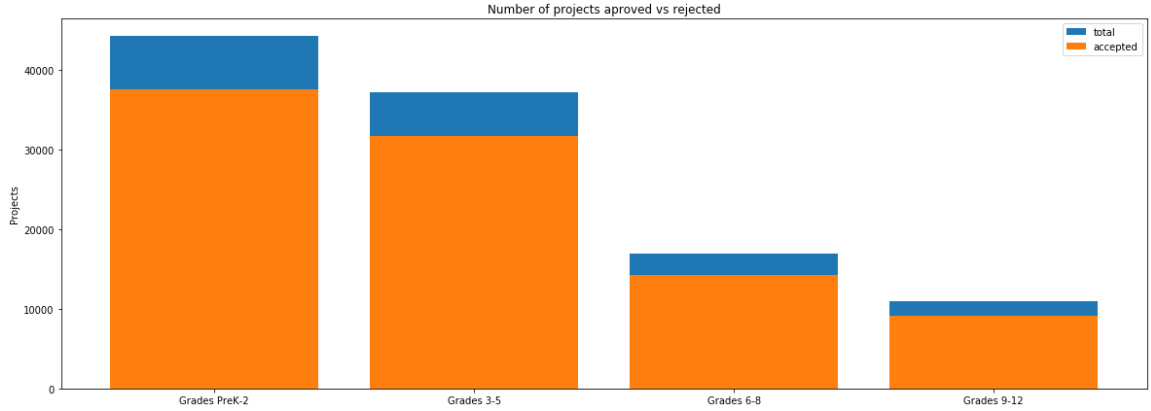

```
  teacher_prefix  project_is_approved  total       Avg
2           Mrs.                48997  57269  0.855559
3            Ms.                32860  38955  0.843537
1            Mr.                 8960  10648  0.841473
4        Teacher                 1877   2360  0.795339
0            Dr.                    9     13  0.692308
==================================================
  teacher_prefix  project_is_approved  total       Avg
2           Mrs.                48997  57269  0.855559
3            Ms.                32860  38955  0.843537
1            Mr.                 8960  10648  0.841473
4        Teacher                 1877   2360  0.795339
0            Dr.                    9     13  0.692308
```

SUMMARY: The accepetance rate of prjects for Dr. was found to be the least & the most for Mrs. This can change if the # of doctors pitch in with more proposals across all the states.

1.2.3 Univariate Analysis: project_grade_category

In [12]:

```
univariate_barplots(project_data, 'project_grade_category', 'project_is_approved', False)
```




```
  project_grade_category  project_is_approved  total       Avg
3          Grades PreK-2                37536  44225  0.848751
0             Grades 3-5                31729  37137  0.854377
1             Grades 6-8                14258  16923  0.842522
2            Grades 9-12                 9183  10963  0.837636
==================================================
  project_grade_category  project_is_approved  total       Avg
3          Grades PreK-2                37536  44225  0.848751
0             Grades 3-5                31729  37137  0.854377
1             Grades 6-8                14258  16923  0.842522
2            Grades 9-12                 9183  10963  0.837636
```

SUMMARY: We can observe that the acceptance rates for all the prject grade categories are close enough without much of a difference but the only take away from this part of analysis is that the total number of projects submitted for Grades PreK-2 is more compared to other grades & Grades 9-12 being the least.

1.2.4 Univariate Analysis: project_subject_categories

In [13]:

```
categories = list(project_data['project_subject_categories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47
301924/4084039
# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from-a-stri
ng
# https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-in-pyth
on
cat_list = []
for i in categories:
    temp =""
    # consider we have text like this Math & Science, Warmth, Care & Hunger
    for j in i.split(','):   # it will split it in three parts ["Math & Science", "Warm
th", "Care & Hunger"]
        if 'The' in j.split(): # this will split each of the catogory based on space Ma
th & Science"=> "Math","&","Science"
            j=j.replace('The','') # if we have the words "The" we are going to replace
 it with ''(i.e removing 'The')
        j = j.replace(' ','')  # we are placeing all the ' '(space) with ''(empty) e
x:"Math & Science"=>"Math&Science"
        temp+=j.strip()+" "    #" abc ".strip() will return "abc" , remove the trailing
spaces
        temp = temp.replace('&','_') # we are replacing the & value into "_"
    cat_list.append(temp.strip())
```

In [14]:

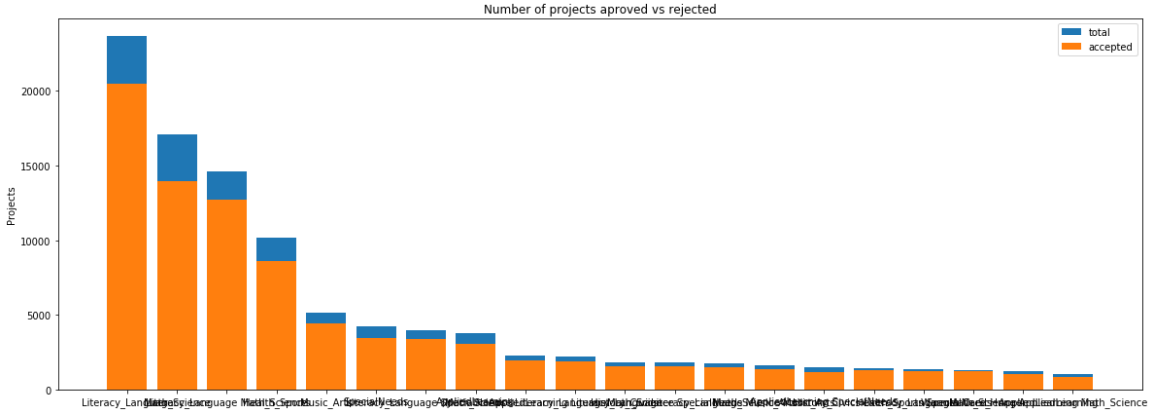
```
project_data['clean_categories'] = cat_list
project_data.drop(['project_subject_categories'], axis=1, inplace=True)
project_data.head(2)
```

Out[14]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_s
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL

In [15]:

```
univariate_barplots(project_data, 'clean_categories', 'project_is_approved', top=20)
```



	clean_categories	project_is_approved	total	Avg
24	Literacy_Language	20520	23655	0.867470
32	Math_Science	13991	17072	0.819529
28	Literacy_Language Math_Science	12725	14636	0.869432
8	Health_Sports	8640	10177	0.848973
40	Music_Arts	4429	5180	0.855019

==========

	clean_categories	project_is_approved	total	Avg
19	History_Civics Literacy_Language	1271	1421	0.894441
14	Health_Sports SpecialNeeds	1215	1391	0.873472
50	Warmth Care_Hunger	1212	1309	0.925898
33	Math_Science AppliedLearning	1019	1220	0.835246
4	AppliedLearning Math_Science	855	1052	0.812738

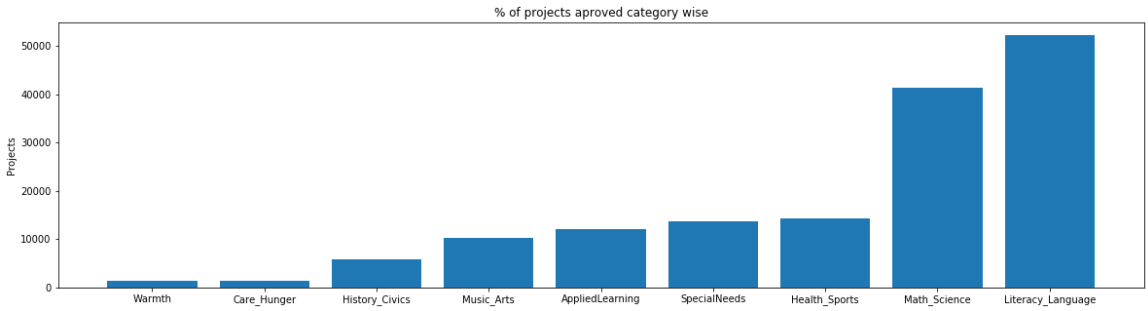
SUMMARY: It is seen that projects concerning Warmth care & hunger had the highest approval rate inspite of the total # of projects submitted were less compared to others.

In [16]:

```
# count of all the words in corpus python: https://stackoverflow.com/a/22898595/4084039
from collections import Counter
my_counter = Counter()
for word in project_data['clean_categories'].values:
    my_counter.update(word.split())
```

In [17]:

```
# dict sort by value python: https://stackoverflow.com/a/613218/4084039
cat_dict = dict(my_counter)
sorted_cat_dict = dict(sorted(cat_dict.items(), key=lambda kv: kv[1]))
ind = np.arange(len(sorted_cat_dict))
plt.figure(figsize=(20,5))
p1 = plt.bar(ind, list(sorted_cat_dict.values()))
plt.ylabel('Projects')
plt.title('% of projects aproved category wise')
plt.xticks(ind, list(sorted_cat_dict.keys()))
plt.show()
```



In [18]:

```
for i, j in sorted_cat_dict.items():
    print("{:20} :{:10}".format(i,j))
    #print(i,":",j)
```

```
Warmth               :      1388
Care_Hunger          :      1388
History_Civics       :      5914
Music_Arts           :     10293
AppliedLearning      :     12135
SpecialNeeds         :     13642
Health_Sports        :     14223
Math_Science         :     41421
Literacy_Language    :     52239
```

SUMMARY: It can be observed that projects submitted in Literacy_Language(accounting for 50% of total) category was the highest & warmth,care_hunger being the lowest.

1.2.5 Univariate Analysis: project_subject_subcategories

In [19]:

```
sub_categories = list(project_data['project_subject_subcategories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47
301924/4084039
# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from-a-stri
ng
# https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-in-pyth
on
sub_cat_list = []
for i in sub_categories:
    temp =""
    # consider we have text like this Math & Science, Warmth, Care & Hunger
    for j in i.split(','):   # it will split it in three parts ["Math & Science", "Warm
th", "Care & Hunger"]
        if 'The' in j.split(): # this will split each of the catogory based on space Ma
th & Science"=> "Math","&","Science"
            j=j.replace('The','') # if we have the words "The" we are going to replace
 it with ''(i.e removing 'The')
        j = j.replace(' ','')  # we are placeing all the ' '(space) with ''(empty) e
x:"Math & Science"=>"Math&Science"
        temp+=j.strip()+" "    #" abc ".strip() will return "abc" , remove the trailing
spaces
        temp = temp.replace('&','_') # we are replacing the & value into "_"
    sub_cat_list.append(temp.strip())
```

In [20]:

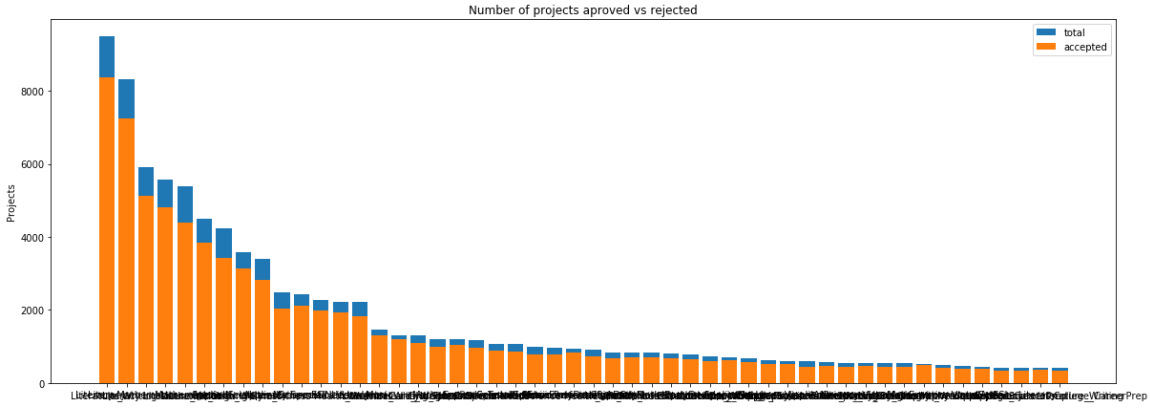
```
project_data['clean_subcategories'] = sub_cat_list
project_data.drop(['project_subject_subcategories'], axis=1, inplace=True)
project_data.head(2)
```

Out[20]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_s
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL

In [21]:

```
univariate_barplots(project_data, 'clean_subcategories', 'project_is_approved', top=50)
```




```
              clean_subcategories  project_is_approved  total       Avg
317                       Literacy                 8371   9486  0.882458
319           Literacy Mathematics                 7260   8325  0.872072
331  Literature_Writing Mathematics                 5140   5923  0.867803
318     Literacy Literature_Writing                 4823   5571  0.865733
342                    Mathematics                 4385   5379  0.815207
==================================================
                  clean_subcategories  project_is_approved  total
Avg
196       EnvironmentalScience Literacy                  389    444  0.876
126
127                                ESL                  349    421  0.828
979
79                  College_CareerPrep                  343    421  0.814
727
17   AppliedSciences Literature_Writing                 361    420  0.859
524
3    AppliedSciences College_CareerPrep                 330    405  0.814
815
```

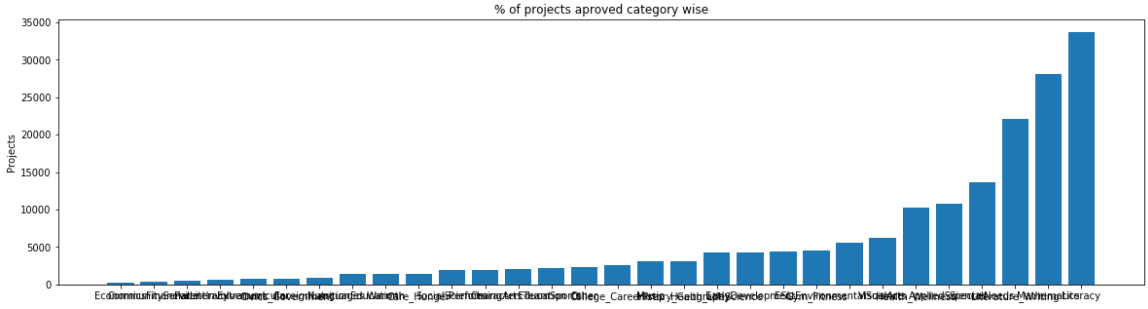
SUMMARY: It can be observed that total # of projects submitted & the acceptance rate was highest for Literacy subcategory compared to other sub-categories.

In [22]:

```
# count of all the words in corpus python: https://stackoverflow.com/a/22898595/4084039
from collections import Counter
my_counter = Counter()
for word in project_data['clean_subcategories'].values:
    my_counter.update(word.split())
```

In [23]:

```
# dict sort by value python: https://stackoverflow.com/a/613218/4084039
sub_cat_dict = dict(my_counter)
sorted_sub_cat_dict = dict(sorted(sub_cat_dict.items(), key=lambda kv: kv[1]))
ind = np.arange(len(sorted_sub_cat_dict))
plt.figure(figsize=(20,5))
p1 = plt.bar(ind, list(sorted_sub_cat_dict.values()))
plt.ylabel('Projects')
plt.title('% of projects aproved category wise')
plt.xticks(ind, list(sorted_sub_cat_dict.keys()))
plt.show()
```



In [24]:

```
for i, j in sorted_sub_cat_dict.items():
    print("{:20} :{:10}".format(i,j))
```

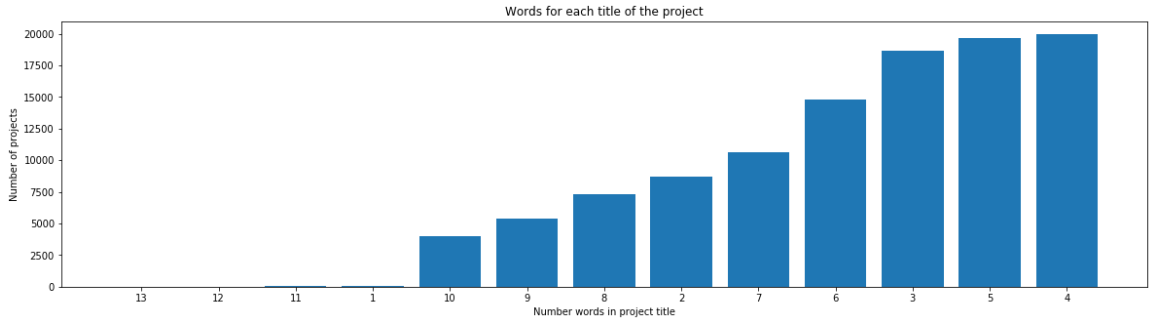
```
Economics            :       269
CommunityService     :       441
FinancialLiteracy    :       568
ParentInvolvement    :       677
Extracurricular      :       810
Civics_Government    :       815
ForeignLanguages     :       890
NutritionEducation   :      1355
Warmth               :      1388
Care_Hunger          :      1388
SocialSciences       :      1920
PerformingArts       :      1961
CharacterEducation   :      2065
TeamSports           :      2192
Other                :      2372
College_CareerPrep   :      2568
Music                :      3145
History_Geography    :      3171
Health_LifeScience   :      4235
EarlyDevelopment     :      4254
ESL                  :      4367
Gym_Fitness          :      4509
EnvironmentalScience :      5591
VisualArts           :      6278
Health_Wellness      :     10234
AppliedSciences      :     10816
SpecialNeeds         :     13642
Literature_Writing   :     22179
Mathematics          :     28074
Literacy             :     33700
```

SUMMARY: It can be observed that the number of projects with Literacy as sub-category was the highest & Economics was the lowest in terms of count.

1.2.6 Univariate Analysis: Text features (Title)

In [25]:

```
#How to calculate number of words in a string in DataFrame: https://stackoverflow.com/a/37483537/4084039
word_count = project_data['project_title'].str.split().apply(len).value_counts()
word_dict = dict(word_count)
word_dict = dict(sorted(word_dict.items(), key=lambda kv: kv[1]))
ind = np.arange(len(word_dict))
plt.figure(figsize=(20,5))
p1 = plt.bar(ind, list(word_dict.values()))
plt.ylabel('Number of projects')
plt.xlabel('Number words in project title')
plt.title('Words for each title of the project')
plt.xticks(ind, list(word_dict.keys()))
plt.show()
```

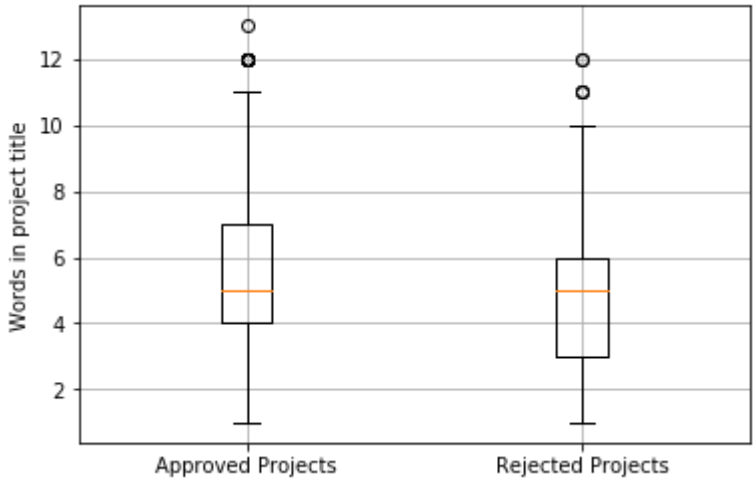


In [26]:

```
approved_title_word_count = project_data[project_data['project_is_approved']==1]['project_title'].str.split().apply(len)
approved_title_word_count = approved_title_word_count.values
rejected_title_word_count = project_data[project_data['project_is_approved']==0]['project_title'].str.split().apply(len)
rejected_title_word_count = rejected_title_word_count.values
```

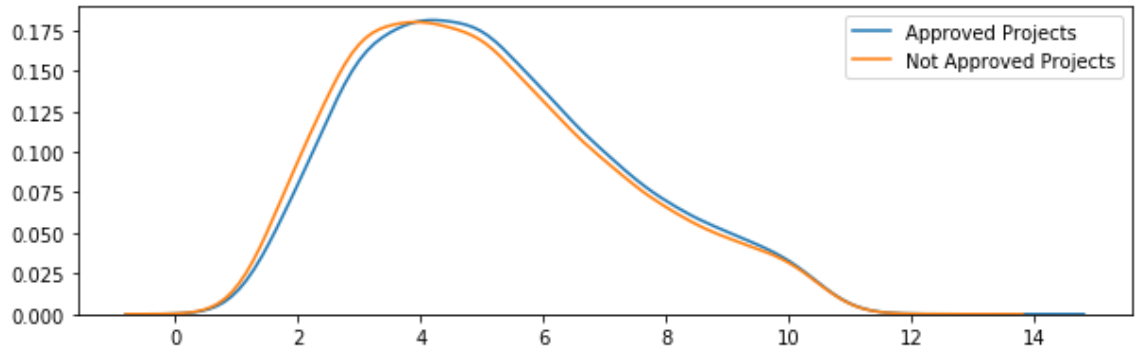
In [27]:

```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.html
plt.boxplot([approved_title_word_count, rejected_title_word_count])
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Words in project title')
plt.grid()
plt.show()
```



In [28]:

```
#pdf
plt.figure(figsize=(10,3))
sns.kdeplot(approved_title_word_count,label="Approved Projects", bw=0.6)
sns.kdeplot(rejected_title_word_count,label="Not Approved Projects", bw=0.6)
plt.legend()
plt.show()
```



SUMMARY: The box plot & the pdf implies that the distribution of Approved projects > rejected projects. Hence we can say that approved projects have more words than rejected projects.

1.2.7 Univariate Analysis: Text features (Project Essay's)

In [29]:

```
# merge two column text dataframe:
#https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.Series.map.html
#https://www.geeksforgeeks.org/python-pandas-map/
project_data["essay"] = project_data["project_essay_1"].map(str) + \
project_data["project_essay_2"].map(str) + \
project_data["project_essay_3"].map(str) + \
project_data["project_essay_4"].map(str)
#print(project_data["essay"][1])
```

In [30]:

```
project_data.head(3)
```

Out[30]:

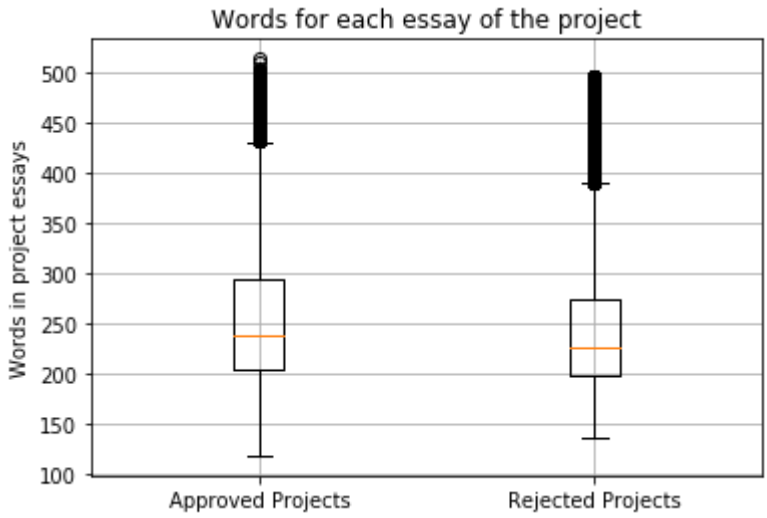
	Unnamed: 0	id	teacher_id	teacher_prefix	school_s
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL
2	21895	p182444	3465aaf82da834c0582ebd0ef8040ca0	Ms.	AZ

In [31]:

```
approved_word_count = project_data[project_data['project_is_approved']==1]['essay'].str
.split().apply(len)
approved_word_count = approved_word_count.values
rejected_word_count = project_data[project_data['project_is_approved']==0]['essay'].str
.split().apply(len)
rejected_word_count = rejected_word_count.values
```

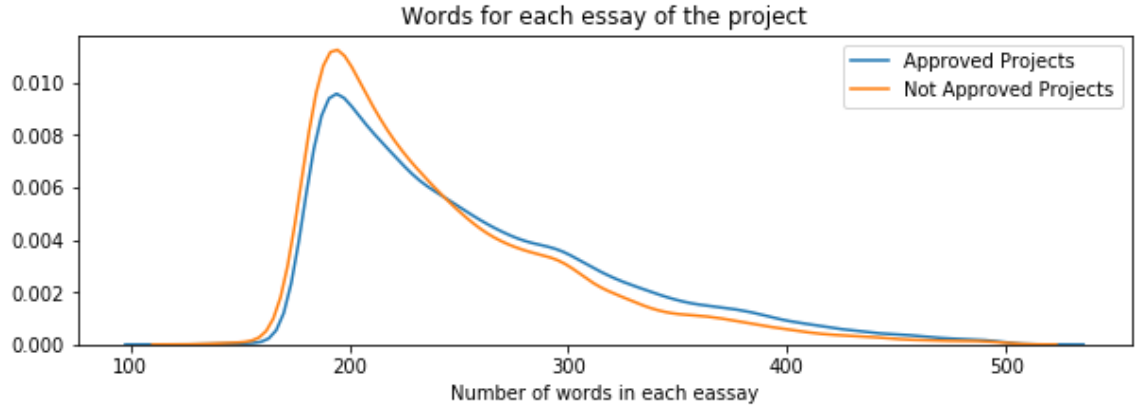
In [32]:

```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.html
plt.boxplot([approved_word_count, rejected_word_count])
plt.title('Words for each essay of the project')
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Words in project essays')
plt.grid()
plt.show()
```



In [33]:

```
plt.figure(figsize=(10,3))
sns.distplot(approved_word_count, hist=False, label="Approved Projects")
sns.distplot(rejected_word_count, hist=False, label="Not Approved Projects")
plt.title('Words for each essay of the project')
plt.xlabel('Number of words in each eassay')
plt.legend()
plt.show()
```



SUMMARY: It can be observed from the boxplots that although the medians for approved & rejected projects are almost equal, the distribution of approved projects is larger and greater than rejected projects. Hence approved projects have more words in essays than rejected projects.

1.2.8 Univariate Analysis: Cost per project

In [34]:

```
# we get the cost of the project using resource.csv file
resource_data.head(2)
```

Out[34]:

	id	description	quantity	price
0	p233245	LC652 - Lakeshore Double-Space Mobile Drying Rack	1	149.00
1	p069063	Bouncy Bands for Desks (Blue support pipes)	3	14.95

In [35]:

```
#https://stackoverflow.com/questions/22407798/how-to-reset-a-dataframes-indexes-for-all-groups-in-one-step
#https://stackoverflow.com/questions/19384532/get-statistics-for-each-group-such-as-count-mean-etc-using-pandas-groupby/19385591#19385591
price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_index()
price_data.head(2)
```

Out[35]:

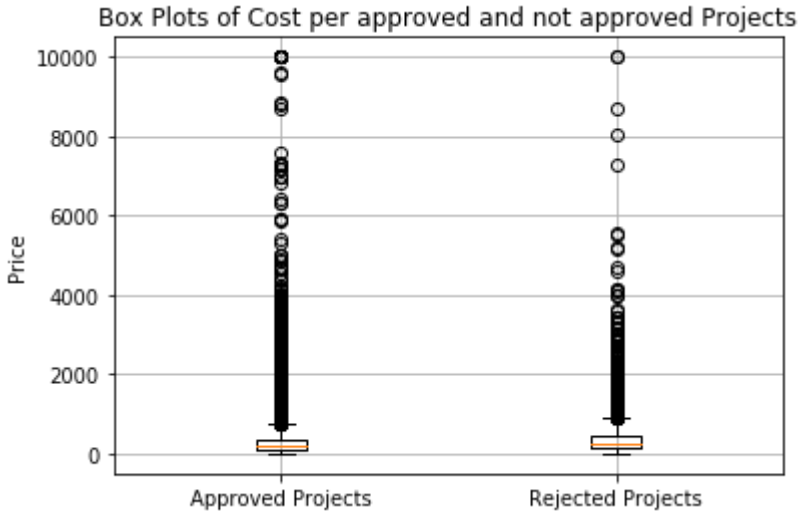
	id	price	quantity
0	p000001	459.56	7
1	p000002	515.89	21

In [36]:

```
# join two dataframes in python:
project_data = pd.merge(project_data, price_data, on='id', how='left')
approved_price = project_data[project_data['project_is_approved']==1]['price'].values
rejected_price = project_data[project_data['project_is_approved']==0]['price'].values
```

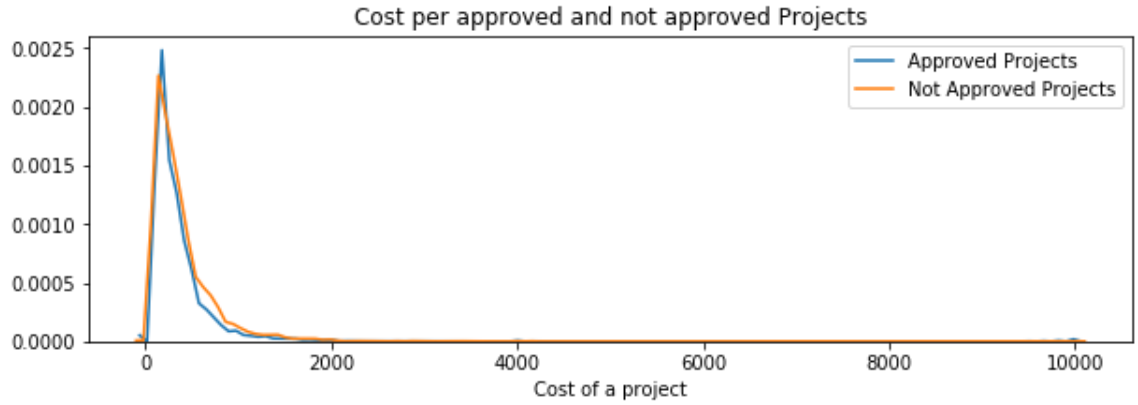
In [37]:

```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.html
plt.boxplot([approved_price, rejected_price])
plt.title('Box Plots of Cost per approved and not approved Projects')
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Price')
plt.grid()
plt.show()
```



In [38]:

```
#pdf
plt.figure(figsize=(10,3))
sns.distplot(approved_price, hist=False, label="Approved Projects")
sns.distplot(rejected_price, hist=False, label="Not Approved Projects")
plt.title('Cost per approved and not approved Projects')
plt.xlabel('Cost of a project')
plt.legend()
plt.show()
```



SUMMARY:It can be seen from the pdf that cost for rejected projects was slighlty higher than approved projects but this is not convincing, so we move ahead and use percentile as a parameter to clearly justify the cost.

In [39]:

```
#percentile
# http://zetcode.com/python/prettytable/
from prettytable import PrettyTable
x = PrettyTable()
x.field_names = ["Percentile", "Approved Projects", "Not Approved Projects"]
for i in range(0,101,5):
    x.add_row([i,np.round(np.percentile(approved_price,i), 3), np.round(np.percentile(r
ejected_price,i), 3)])
print(x)
```

```
+------------+------------------+----------------------+
| Percentile | Approved Projects | Not Approved Projects |
+------------+------------------+----------------------+
|     0      |        0.66       |          1.97        |
|     5      |       13.59       |          41.9        |
|     10     |       33.88       |         73.67        |
|     15     |        58.0       |         99.109       |
|     20     |       77.38       |         118.56       |
|     25     |       99.95       |        140.892       |
|     30     |       116.68      |         162.23       |
|     35     |      137.232      |        184.014       |
|     40     |       157.0       |        208.632       |
|     45     |      178.265      |        235.106       |
|     50     |       198.99      |        263.145       |
|     55     |       223.99      |         292.61       |
|     60     |       255.63      |        325.144       |
|     65     |      285.412      |         362.39       |
|     70     |      321.225      |         399.99       |
|     75     |      366.075      |        449.945       |
|     80     |       411.67      |        519.282       |
|     85     |       479.0       |        618.276       |
|     90     |       593.11      |        739.356       |
|     95     |      801.598      |        992.486       |
|    100     |       9999.0      |         9999.0       |
+------------+------------------+----------------------+
```

SUMMARY OF THE PERCENTILE TABLE:As seen from the above percentile table, the rejected project cost for every 5th percentile is greater than approved projects cost.

1.2.9 Univariate Analysis: teacher_number_of_previously_posted_projects

In [40]:

```
#previously posted projects according to teacher prefix
prefix_projects = project_data.groupby('teacher_prefix').agg({'teacher_number_of_previo
usly_posted_projects':'sum'}).reset_index()
prefix_projects
```

Out[40]:

	teacher_prefix	teacher_number_of_previously_posted_projects
0	Dr.	53
1	Mr.	129559
2	Mrs.	639594
3	Ms.	441583
4	Teacher	7671

In [41]:

```
#previously posted projects according to state
state_projects = project_data.groupby('school_state').agg({'teacher_number_of_previousl
y_posted_projects':'sum'}).reset_index()
state_projects.sort_values(by=['teacher_number_of_previously_posted_projects'],inplace=
True, ascending=False)
state_projects
```

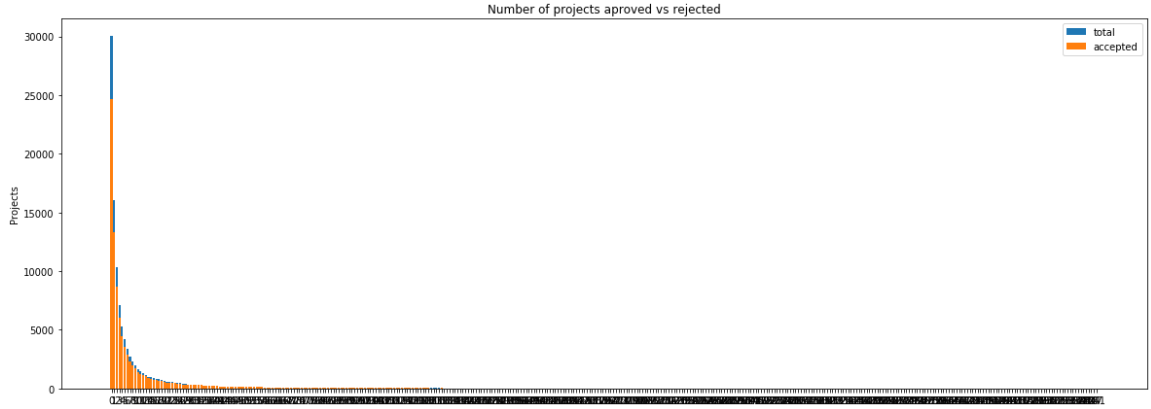
Out[41]:

	school_state	teacher_number_of_previously_posted_projects
4	CA	251179
34	NY	160338
27	NC	80616
38	PA	55980
9	FL	50089
14	IL	47271
43	TX	46933
40	SC	34401
22	MI	29884
10	GA	29825
15	IN	29416
47	WA	23179
24	MO	22261
6	CT	22107
35	OH	21664
31	NJ	21562
17	KY	18859
19	MA	18810
48	WI	18791
33	NV	18015
36	OK	16042
42	TN	15852
3	AZ	15177
45	VA	14191
1	AL	13341
18	LA	12207
37	OR	11265
2	AR	10997
20	MD	10502
23	MN	10303
25	MS	9835
44	UT	8781
5	CO	7936

	school_state	teacher_number_of_previously_posted_projects
13	ID	7790
0	AK	7162
8	DE	5984
7	DC	5515
32	NM	4899
11	HI	4625
49	WV	3811
16	KS	3263
12	IA	3053
21	ME	2949
39	RI	2307
29	NE	2225
30	NH	2141
26	MT	1665
41	SD	1347
28	ND	1088
46	VT	554
50	WY	474

In [42]:

```
univariate_barplots(project_data, 'teacher_number_of_previously_posted_projects', 'proj
ect_is_approved', False)
```



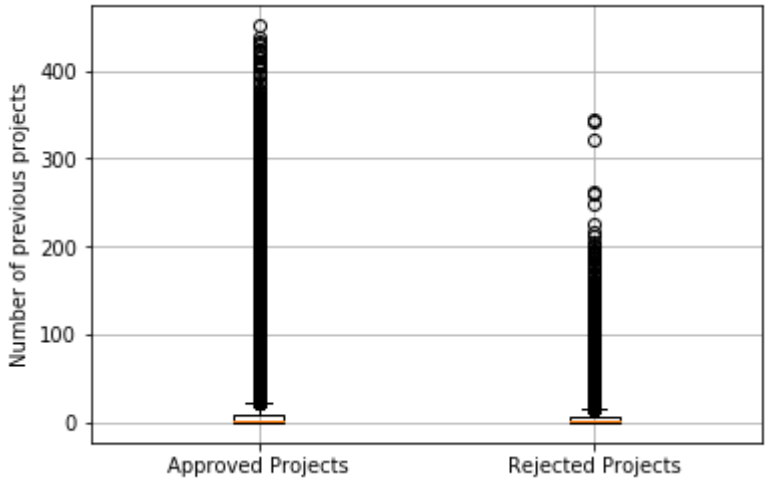

```
   teacher_number_of_previously_posted_projects  project_is_approved  tota
l  \
0                                             0                24652  3001
4
1                                             1                13329  1605
8
2                                             2                 8705  1035
0
3                                             3                 5997   711
0
4                                             4                 4452   526
6

        Avg
0  0.821350
1  0.830054
2  0.841063
3  0.843460
4  0.845423
==================================================
     teacher_number_of_previously_posted_projects  project_is_approved  to
tal  \
242                                           242                   1
1
268                                           270                   1
1
234                                           234                   1
1
335                                           347                   1
1
373                                           451                   1
1

     Avg
242  1.0
268  1.0
234  1.0
335  1.0
373  1.0
```

In [43]:

```
approved = project_data[project_data['project_is_approved']==1]['teacher_number_of_prev
iously_posted_projects']
approved = approved.values
rejected = project_data[project_data['project_is_approved']==0]['teacher_number_of_prev
iously_posted_projects']
rejected = rejected.values
```

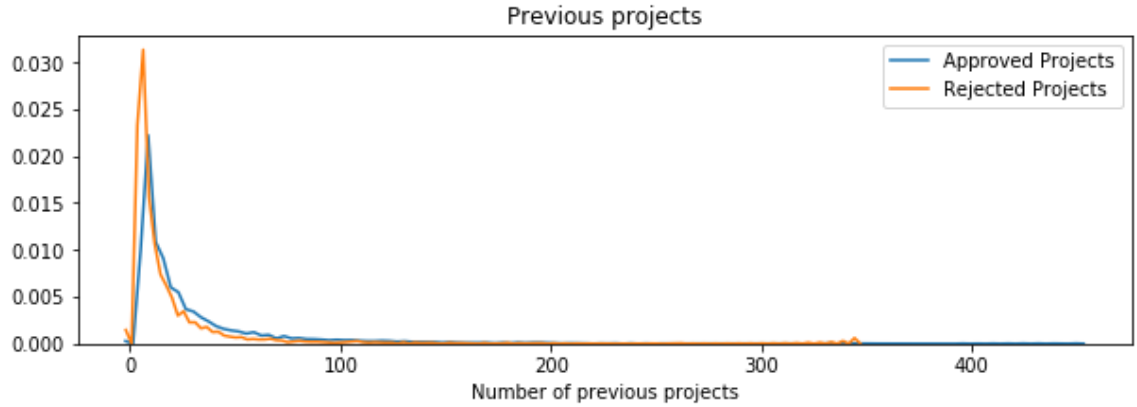
In [44]:

```
plt.boxplot([approved, rejected])
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Number of previous projects')
plt.grid()
plt.show()
```



In [45]:

```
#pdf
plt.figure(figsize=(10,3))
sns.distplot(approved, hist=False, label="Approved Projects")
sns.distplot(rejected, hist=False, label="Rejected Projects")
plt.title('Previous projects')
plt.xlabel('Number of previous projects')
plt.legend()
plt.show()
```



SUMMARY:

1. It can be observed that across USA a maximum of 639.5K projects were posted alone by Mrs. & 53 being the least number posted by Dr's.
2. It is observed that projects posting by teachers were highest in CA(California) with a staggering number of 251K & least being 474 in WA(Washington)
3. Finally, it can be observed that more the number of projects submitted previously, the higher is the chance of that project being approved by the committee. Hence experience of teachers in project submission plays a vital role in the acceptance of the project.

1.2.10 Univariate Analysis: project_resource_summary

In [46]:

```
#https://stackoverflow.com/questions/19859282/check-if-a-string-contains-a-number
def check(data):
    return any(char.isdigit() for char in data)

resource_summary=project_data['project_resource_summary']
values=resource_summary.map(check)
project_data['Numerical digits in summary']=values
#https://stackoverflow.com/questions/39698672/pandas-replace-boolean-value-with-string-or-integer
project_data['Numerical digits in summary'] = np.where(project_data['Numerical digits in summary'], 1, 0)
project_data.head(5)
```

Out[46]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_s
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL
2	21895	p182444	3465aaf82da834c0582ebd0ef8040ca0	Ms.	AZ
3	45	p246581	f3cb9bffbba169bef1a77b243e620b60	Mrs.	KY
4	172407	p104768	be1f7507a41f8479dc06f047086a39ec	Mrs.	TX

5 rows × 21 columns

In [47]:

```
#Numbers used by teachers according to teacher prefix in order to quantify claim in the
summary
prefix_summary_count = project_data.groupby('Numerical digits in summary').agg({'teache
r_prefix':'count'}).reset_index()
prefix_summary_count
```

Out[47]:

	Numerical digits in summary	teacher_prefix
0	0	93490
1	1	15755

In [48]:

```
project_data_1=project_data[project_data['Numerical digits in summary']==1]
prefix_summary_individuals = project_data_1.groupby('teacher_prefix').agg({'Numerical d
igits in summary':'count'}).reset_index()
prefix_summary_individuals
```

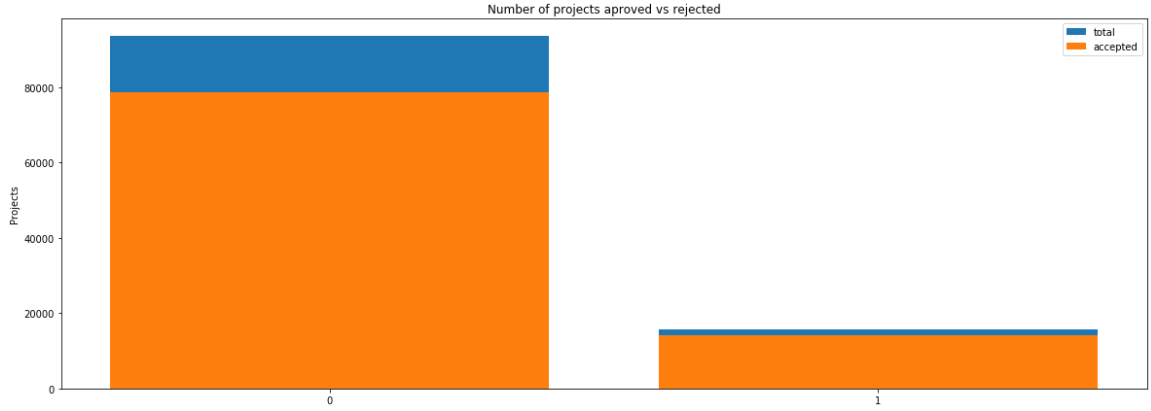
Out[48]:

	teacher_prefix	Numerical digits in summary
0	Dr.	1
1	Mr.	1933
2	Mrs.	8284
3	Ms.	5204
4	Teacher	333

SUMMARY: As seen from the summary tables above, there were just around 15.7K out of 100K teachers who used numerics in the summary and there were many projects(i.e.8284) submitted by teachers with prefix Mrs. who used numerics quite often than others.

In [49]:

```
univariate_barplots(project_data, 'Numerical digits in summary', 'project_is_approved',
False)
```




```
   Numerical digits in summary  project_is_approved  total       Avg
0                            0                78616  93492  0.840885
1                            1                14090  15756  0.894263
==================================================
   Numerical digits in summary  project_is_approved  total       Avg
0                            0                78616  93492  0.840885
1                            1                14090  15756  0.894263
```

SUMMARY:

1. It can be observed that the acceptance rate for projects having numbers in the summary were marginally higher than the ones without any numbers in the summary.
2. I would conclude that this parameter/ feature of Numerical digits in summary has less impact on the project acceptance as there is a marginal difference in acceptance with or without numbers in the summary.

1.3 Text preprocessing

1.3.1 Essay Text

In [50]:

```
project_data.head(2)
```

Out[50]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_s
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL

2 rows × 21 columns

In [51]:

```
# printing some random essays
print(project_data['essay'].values[20000])
print("="*50)
print(project_data['essay'].values[99999])
print("="*50)
```

```
My kindergarten students have varied disabilities ranging from speech and
language delays, cognitive delays, gross/fine motor delays, to autism. The
y are eager beavers and always strive to work their hardest working past t
heir limitations. \r\n\r\nThe materials we have are the ones I seek out fo
r my students. I teach in a Title I school where most of the students rece
ive free or reduced price lunch.  Despite their disabilities and limitatio
ns, my students love coming to school and come eager to learn and explore.
Have you ever felt like you had ants in your pants and you needed to groov
e and move as you were in a meeting? This is how my kids feel all the tim
e. The want to be able to move as they learn or so they say.Wobble chairs
are the answer and I love then because they develop their core, which enha
nces gross motor and in Turn fine motor skills. \r\nThey also want to lear
n through games, my kids don't want to sit and do worksheets. They want to
learn to count by jumping and playing. Physical engagement is the key to o
ur success. The number toss and color and shape mats can make that happen.
My students will forget they are doing work and just have the fun a 6 year
old deserves.nannan
==================================================
The mediocre teacher tells. The good teacher explains. The superior teache
r demonstrates. The great teacher inspires. -William A. Ward\r\n\r\nMy sch
ool has 803 students which is makeup is 97.6% African-American, making up
the largest segment of the student body. A typical school in Dallas is mad
e up of 23.2% African-American students. Most of the students are on free
or reduced lunch. We aren't receiving doctors, lawyers, or engineers child
ren from rich backgrounds or neighborhoods. As an educator I am inspiring
minds of young children and we focus not only on academics but one smart,
effective, efficient, and disciplined students with good character.In our
classroom we can utilize the Bluetooth for swift transitions during class.
I use a speaker which doesn't amplify the sound enough to receive the mess
age. Due to the volume of my speaker my students can't hear videos or book
s clearly and it isn't making the lessons as meaningful. But with the blue
tooth speaker my students will be able to hear and I can stop, pause and r
eplay it at any time.\r\nThe cart will allow me to have more room for stor
age of things that are needed for the day and has an extra part to it I ca
n use.  The table top chart has all of the letter, words and pictures for
students to learn about different letters and it is more accessible.nannan
==================================================
```

In [52]:

```
# https://stackoverflow.com/a/47091490/4084039
import re
def decontracted(phrase):# specific
    phrase = re.sub(r"won\'t", "will not", phrase)
    phrase = re.sub(r"can\'t", "can not", phrase)
    # general
    phrase = re.sub(r"n\'t", " not", phrase)
    phrase = re.sub(r"\'re", " are", phrase)
    phrase = re.sub(r"\'s", " is", phrase)
    phrase = re.sub(r"\'d", " would", phrase)
    phrase = re.sub(r"\'ll", " will", phrase)
    phrase = re.sub(r"\'t", " not", phrase)
    phrase = re.sub(r"\'ve", " have", phrase)
    phrase = re.sub(r"\'m", " am", phrase)
    return phrase
```

In [53]:

```
sent = decontracted(project_data['essay'].values[20000])
print(sent)
print("="*50)
```

```
My kindergarten students have varied disabilities ranging from speech and
language delays, cognitive delays, gross/fine motor delays, to autism. The
y are eager beavers and always strive to work their hardest working past t
heir limitations. \r\n\r\nThe materials we have are the ones I seek out fo
r my students. I teach in a Title I school where most of the students rece
ive free or reduced price lunch.  Despite their disabilities and limitatio
ns, my students love coming to school and come eager to learn and explore.
Have you ever felt like you had ants in your pants and you needed to groov
e and move as you were in a meeting? This is how my kids feel all the tim
e. The want to be able to move as they learn or so they say.Wobble chairs
are the answer and I love then because they develop their core, which enha
nces gross motor and in Turn fine motor skills. \r\nThey also want to lear
n through games, my kids do not want to sit and do worksheets. They want t
o learn to count by jumping and playing. Physical engagement is the key to
our success. The number toss and color and shape mats can make that happe
n. My students will forget they are doing work and just have the fun a 6 y
ear old deserves.nannan
==================================================
```

In [54]:

```
# \\r \\n \\t remove from string python: http://texthandler.com/info/remove-line-breaks
-python/
sent = sent.replace('\\r', ' ')
sent = sent.replace('\\', ' ')
sent = sent.replace('\\n', ' ')
print(sent)
```

```
My kindergarten students have varied disabilities ranging from speech and
language delays, cognitive delays, gross/fine motor delays, to autism. The
y are eager beavers and always strive to work their hardest working past t
heir limitations.   n  nThe materials we have are the ones I seek out for
my students. I teach in a Title I school where most of the students receiv
e free or reduced price lunch.  Despite their disabilities and limitation
s, my students love coming to school and come eager to learn and explore.H
ave you ever felt like you had ants in your pants and you needed to groove
and move as you were in a meeting? This is how my kids feel all the time.
The want to be able to move as they learn or so they say.Wobble chairs are
the answer and I love then because they develop their core, which enhances
gross motor and in Turn fine motor skills.   nThey also want to learn thro
ugh games, my kids do not want to sit and do worksheets. They want to lear
n to count by jumping and playing. Physical engagement is the key to our s
uccess. The number toss and color and shape mats can make that happen. My
students will forget they are doing work and just have the fun a 6 year ol
d deserves.nannan
```

In [55]:

```
#remove spacial character: https://stackoverflow.com/a/5843547/4084039
sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
print(sent)
```

```
My kindergarten students have varied disabilities ranging from speech and
language delays cognitive delays gross fine motor delays to autism They ar
e eager beavers and always strive to work their hardest working past their
limitations n nThe materials we have are the ones I seek out for my studen
ts I teach in a Title I school where most of the students receive free or
reduced price lunch Despite their disabilities and limitations my students
love coming to school and come eager to learn and explore Have you ever fe
lt like you had ants in your pants and you needed to groove and move as yo
u were in a meeting This is how my kids feel all the time The want to be a
ble to move as they learn or so they say Wobble chairs are the answer and
I love then because they develop their core which enhances gross motor and
in Turn fine motor skills nThey also want to learn through games my kids d
o not want to sit and do worksheets They want to learn to count by jumping
and playing Physical engagement is the key to our success The number toss
and color and shape mats can make that happen My students will forget they
are doing work and just have the fun a 6 year old deserves nannan
```

In [57]:

```
# Combining all the above statemennts
from tqdm import tqdm # tqdm is for printing the status bar
preprocessed_essays = []
for sentance in tqdm(project_data['essay'].values):
    sent = decontracted(sentance)
    sent = sent.replace('\\r', ' ')
    sent = sent.replace('\\"', ' ')
    sent = sent.replace('\\n', ' ')
    sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
    # https://gist.github.com/sebleier/554280
    sent = ' '.join(e for e in sent.split() if e not in stopwords.words('english'))
    #sent = [snow.stem(word) for word in sent.split() if word not in stopwords.words('e
nglish')]
    #temp.append(words)
    preprocessed_essays.append(sent.lower().strip())
```

```
100%|████████████████████████████████████████████████████████████
████████████████████████████████████████| 109248/109248 [39:00:10<
00:00,  9.61it/s]
```

In [59]:

```
# after preprocesing
preprocessed_essays[20000]
```

Out[59]:

```
'my kindergarten students varied disabilities ranging speech language dela
ys cognitive delays gross fine motor delays autism they eager beavers alwa
ys strive work hardest working past limitations the materials ones i seek
students i teach title i school students receive free reduced price lunch
despite disabilities limitations students love coming school come eager le
arn explore have ever felt like ants pants needed groove move meeting this
kids feel time the want able move learn say wobble chairs answer i love de
velop core enhances gross motor turn fine motor skills they also want lear
n games kids want sit worksheets they want learn count jumping playing phy
sical engagement key success the number toss color shape mats make happen
my students forget work fun 6 year old deserves nannan'
```

1.3.2 Project title Text

In [56]:

```
# printing some random titles
print(project_data['project_title'].values[20000])
print("="*50)
print(project_data['project_title'].values[99999])
print("="*50)
```

```
We Need To Move It While We Input It!
==================================================
Inspiring Minds by Enhancing the Educational Experience
==================================================
```

In [57]:

```
#decontraction
import re
def decontracted(phrase):# specific
    phrase = re.sub(r"won\'t", "will not", phrase)
    phrase = re.sub(r"can\'t", "can not", phrase)
    # general
    phrase = re.sub(r"n\'t", " not", phrase)
    phrase = re.sub(r"\'re", " are", phrase)
    phrase = re.sub(r"\'s", " is", phrase)
    phrase = re.sub(r"\'d", " would", phrase)
    phrase = re.sub(r"\'ll", " will", phrase)
    phrase = re.sub(r"\'t", " not", phrase)
    phrase = re.sub(r"\'ve", " have", phrase)
    phrase = re.sub(r"\'m", " am", phrase)
    return phrase
```

In [58]:

```
sent = decontracted(project_data['project_title'].values[20000])
print(sent)
print("="*50)
```

```
We Need To Move It While We Input It!
==================================================
```

In [59]:

```
# \\r \\n \\t remove from string python: http://texthandler.com/info/remove-line-breaks
-python/
sent = sent.replace('\\r', ' ')
sent = sent.replace('\\', ' ')
sent = sent.replace('\\n', ' ')
print(sent)
```

```
We Need To Move It While We Input It!
```

In [60]:

```
#remove spacial character: https://stackoverflow.com/a/5843547/4084039
sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
print(sent)
```

```
We Need To Move It While We Input It
```

In [61]:

```
# Combining all the above statemennts
from tqdm import tqdm # tqdm is for printing the status bar
preprocessed_titles = []
for sentance in tqdm(project_data['project_title'].values):
    sent = decontracted(sentance)
    sent = sent.replace('\\r', ' ')
    sent = sent.replace('\\"', ' ')
    sent = sent.replace('\\n', ' ')
    sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
    # https://gist.github.com/sebleier/554280
    sent = ' '.join(e for e in sent.split() if e not in stopwords.words('english'))
    #sent = [snow.stem(word) for word in sent.split() if word not in stopwords.words('e
nglish')]
    #temp.append(words)
    preprocessed_titles.append(sent.lower().strip())
```

```
100%|████████████████████████████████████████████████████████████████
████████████████████████████████████████████| 109248/109248 [04:30<0
0:00, 403.78it/s]
```

In [62]:

```
# after preprocesing
preprocessed_titles[20000]
```

Out[62]:

```
'we need to move it while we input it'
```

In [63]:

```
project_data.head(2)
```

Out[63]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_s
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL

2 rows × 21 columns

In [64]:

```
project_data['preprocessed_titles']=preprocessed_titles
project_data.head(2)
title_column=project_data[['id','preprocessed_titles']]
#title_column.shape
title_column.head(2)
```

Out[64]:

	id	preprocessed_titles
0	p253737	educational support english learners home
1	p258326	wanted projector hungry learners

1. 4 Preparing data for models

Features in our project_data can be roughly classified into 3 categories:

1. Categorical data like school_state,clean_categories,clean_subcategories,project_grade_category,teacher_prefix. Convert to one-hot encoding variations
2. Text data like project_title, essay, project_resource_summary- Apply featurization techniques like BOW,TFIDF,W2V etc
3. Numerical data like quantity,teacher_number_of_previously_posted_projects,price- Apply standardization

1.4.1 Vectorizing Categorical data

https://www.appliedaicourse.com/course/applied-ai-course-online/lessons/handling-categorical-and-numerical-features (https://www.appliedaicourse.com/course/applied-ai-course-online/lessons/handling-categorical-and-numerical-features)

In [65]:

```
project_data.columns
```

Out[65]:

```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
       'project_submitted_datetime', 'project_grade_category', 'project_ti
tle',
       'project_essay_1', 'project_essay_2', 'project_essay_3',
       'project_essay_4', 'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_approve
d',
       'clean_categories', 'clean_subcategories', 'essay', 'price', 'quant
ity',
       'Numerical digits in summary', 'preprocessed_titles'],
      dtype='object')
```

In [66]:

```
# we use count vectorizer to convert the values into one hot encoded features
#one-hot encoding for clean_categories
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict.keys()), lowercase=False,
binary=True)
vectorizer.fit(project_data['clean_categories'].values)
print(vectorizer.get_feature_names())
categories_one_hot = vectorizer.transform(project_data['clean_categories'].values)
print("Shape of matrix after one hot encodig",categories_one_hot.shape)
```

```
['Warmth', 'Care_Hunger', 'History_Civics', 'Music_Arts', 'AppliedLearnin
g', 'SpecialNeeds', 'Health_Sports', 'Math_Science', 'Literacy_Language']
Shape of matrix after one hot encodig (109248, 9)
```

In [67]:

```
#one-hot encoding for clean_sub_categories
vectorizer = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=Fal
se, binary=True)
vectorizer.fit(project_data['clean_subcategories'].values)
print(vectorizer.get_feature_names())
sub_categories_one_hot = vectorizer.transform(project_data['clean_subcategories'].value
s)
print("Shape of matrix after one hot encodig",sub_categories_one_hot.shape)
```

```
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolvemen
t', 'Extracurricular', 'Civics_Government', 'ForeignLanguages', 'Nutrition
Education', 'Warmth', 'Care_Hunger', 'SocialSciences', 'PerformingArts',
'CharacterEducation', 'TeamSports', 'Other', 'College_CareerPrep', 'Musi
c', 'History_Geography', 'Health_LifeScience', 'EarlyDevelopment', 'ESL',
'Gym_Fitness', 'EnvironmentalScience', 'VisualArts', 'Health_Wellness', 'A
ppliedSciences', 'SpecialNeeds', 'Literature_Writing', 'Mathematics', 'Lit
eracy']
Shape of matrix after one hot encodig (109248, 30)
```

In [68]:

```
#one-hot encoding for school_state
#https://machinelearningmastery.com/prepare-text-data-machine-learning-scikit-learn/
ss_values = list(project_data['school_state'].values)
vectorizer = CountVectorizer()
vectorizer.fit(ss_values)
print(vectorizer.get_feature_names())
school_state_one_hot = vectorizer.transform(ss_values)
print("Shape of matrix after one hot encodig",school_state_one_hot.shape)
```

```
['ak', 'al', 'ar', 'az', 'ca', 'co', 'ct', 'dc', 'de', 'fl', 'ga', 'hi',
'ia', 'id', 'il', 'in', 'ks', 'ky', 'la', 'ma', 'md', 'me', 'mi', 'mn', 'm
o', 'ms', 'mt', 'nc', 'nd', 'ne', 'nh', 'nj', 'nm', 'nv', 'ny', 'oh', 'o
k', 'or', 'pa', 'ri', 'sc', 'sd', 'tn', 'tx', 'ut', 'va', 'vt', 'wa', 'w
i', 'wv', 'wy']
Shape of matrix after one hot encodig (109248, 51)
```

In [69]:

```
#one-hot encoding for project_grade_category
project_grade_category = list(project_data['project_grade_category'].values)
vectorizer = CountVectorizer(ngram_range=(1,2),max_features=4)
vectorizer.fit(project_grade_category)
print(vectorizer.get_feature_names())
project_grade_category_one_hot = vectorizer.transform(project_grade_category)
print("Shape of matrix after one hot encoding",project_grade_category_one_hot.shape)
```

```
['12', 'grades', 'grades prek', 'prek']
Shape of matrix after one hot encoding (109248, 4)
```

In [70]:

```
#checking for NaN values in the column
teacher_prefix = list(project_data['teacher_prefix'].values)
teacher_prefix
print("Number of Nan values in teacher_prefix column:",project_data['teacher_prefix'].i
snull().values.sum())
```

```
Number of Nan values in teacher_prefix column: 3
```

In [71]:

```
#one-hot encoding for teacher_prefix
#https://www.geeksforgeeks.org/python-pandas-dataframe-fillna-to-replace-null-values-in
-dataframe/
project_data['teacher_prefix'].fillna('none',inplace = True) #NaN values have been repl
aced with none
teacher_prefix = list(project_data['teacher_prefix'].values)
vectorizer = CountVectorizer()
vectorizer.fit(teacher_prefix)
print(vectorizer.get_feature_names())
teacher_prefix_one_hot = vectorizer.transform(teacher_prefix)
print("Shape of matrix after one hot encodig",teacher_prefix_one_hot.shape)
```

```
['dr', 'mr', 'mrs', 'ms', 'none', 'teacher']
Shape of matrix after one hot encodig (109248, 6)
```

1.4.2 Vectorizing Text data

1.4.2.1 Bag of words

We are considering only the words which appeared in at least 10 documents(rows or projects).

BOW for preprocessed_essays

vectorizer = CountVectorizer(min_df=10) text_bow = vectorizer.fit_transform(preprocessed_essays)
print("Shape of matrix after applying BOW",text_bow.shape)

In [72]:

```
#BOW for preprocessed_titles
vectorizer = CountVectorizer(min_df=10)
title_bow = vectorizer.fit_transform(preprocessed_titles)
print("Shape of matrix after applying BOW",title_bow.shape)
```

```
Shape of matrix after applying BOW (109248, 3329)
```

In [73]:

```
# https://stackoverflow.com/questions/35874744/python-how-to-check-if-matrix-is-sparse-or-not
from scipy import sparse
sparse.issparse(title_bow)
```

Out[73]:

True

1.4.2.3 TFIDF vectorizer

In [77]:

```
#TFIDF for preprocessed_essays
from sklearn.feature_extraction.text import TfidfVectorizer
vectorizer = TfidfVectorizer(min_df=10)
essay_tfidf = vectorizer.fit_transform(preprocessed_essays)
print("Shape of matrix after applying TFIDF",essay_tfidf.shape)
```

Shape of matrix after applying TFIDF (109248, 16623)

In [73]:

```
#TFIDF for preprocessed_titless
vectorizer = TfidfVectorizer(min_df=10)
title_tfidf = vectorizer.fit_transform(preprocessed_titles)
print("Shape of matrix after applying TFIDF",title_tfidf.shape)
```

Shape of matrix after applying TFIDF (109248, 3329)

1.4.2.5 Using Pretrained Models: Avg W2V

loading glove vectors contaning W2V for all the documents in the corpus

Reading glove vectors in python: https://stackoverflow.com/a/38230349/4084039 (https://stackoverflow.com/a/38230349/4084039)

def loadGloveModel(gloveFile): print ("Loading Glove Model") f = open(gloveFile,'r', encoding="utf8") model = {} for line in tqdm(f): splitLine = line.split() word = splitLine[0] embedding = np.array([float(val) for val in splitLine[1:]]) model[word] = embedding print ("Done.",len(model)," words loaded!") return model model = loadGloveModel('glove_vectors')

In [74]:

```
# stronging variables into pickle files python: http://www.jessicayung.com/how-to-use-p
ickle-to-save-and-load-variables-in-python/
# make sure you have the glove_vectors file
with open('glove_vectors', 'rb') as f:
    model = pickle.load(f)
    glove_words =  set(model.keys())
print ("Done.",len(model)," words loaded!")
```

```
Done. 51510  words loaded!
```

In [80]:

```
# average Word2Vec
# compute average word2vec for each review.
avg_w2v_vectors = []   # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(preprocessed_essays):   # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0 # num of words with a valid vector in the sentence/review
    for word in sentence.split():  # for each word in a review/sentence
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors.append(vector)
print(len(avg_w2v_vectors))
print(len(avg_w2v_vectors[0]))
```

```
100%|██████████████████████████████████████████████████████████████
██████████████████████████████████████████| 109248/109248 [00:52<0
0:00, 2093.27it/s]

109248
300
```

1.4.2.6 Using Pretrained Models: AVG W2V on project_title

In [75]:

```
avg_w2v_vectors_title = []
for sentence in tqdm(preprocessed_titles):
    vector = np.zeros(300)
    cnt_words =0
    for word in sentence.split():
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_title.append(vector)
print(len(avg_w2v_vectors_title))
print(len(avg_w2v_vectors_title[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████████████| 109248/109248 [00:02<00:00, 44417.33it/s]

109248
300
```

1.4.2.7 Using Pretrained Models: TFIDF weighted W2V

S = ["abc def pqr", "def def def abc", "pqr pqr def"]

tfidf_model = TfidfVectorizer() tfidf_model.fit(preprocessed_essays)

we are converting a dictionary with word as a key, and the idf as a value

dictionary = dict(zip(tfidf_model.get_feature_names(), list(tfidf*model.idf*))) tfidf_words = set(tfidf_model.get_feature_names())

1.4.2.8 Using Pretrained Models: TFIDF weighted W2V on preprocessed_essays

In [86]:

```
# average Word2Vec
# compute average word2vec for each review.
tfidf_w2v_vectors = [] # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(preprocessed_essays): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word]  # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sen
tence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # ge
tting the tfidf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
        tfidf_w2v_vectors.append(vector)
print(len(tfidf_w2v_vectors))
print(len(tfidf_w2v_vectors[0]))
```

```
100%|████████████████████████████████████████████████████████████
████████████████████████████████████████| 109248/109248 [06:04<0
0:00, 299.93it/s]

109248
300
```

1.4.2.9 Using Pretrained Models: TFIDF weighted W2V on project_title

tfidf_w2v_vectors = [] # the avg-w2v for each sentence/review is stored in this list for sentence in tqdm(preprocessed_titles): # for each review/sentence vector = np.zeros(300) # as word vectors are of zero length tf_idf_weight =0; # num of words with a valid vector in the sentence/review for word in sentence.split(): # for each word in a review/sentence if (word in glove_words) and (word in tfidf_words): vec = model[word] # getting the vector for each word

```
            # here we are multiplying idf value(dictionary[word]) and the tf value
    ((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) #
    getting the tfidf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
        tfidf_w2v_vectors.append(vector)
```

print(len(tfidf_w2v_vectors)) print(len(tfidf_w2v_vectors[0]))

1.4.3 Vectorizing Numerical features

In [77]:

```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s
# standardization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html
from sklearn.preprocessing import StandardScaler
# price_standardized = standardScalar.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329.   ...
 399.   287.73   5.5 ]
# Reshape your data either using array.reshape(-1, 1)
#numerical features for price
price_scalar = StandardScaler()
price_scalar.fit(project_data['price'].values.reshape(-1,1))
# finding the mean and standard deviation of this data
print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_
[0])}")
# Now standardize the data with above mean and variance.
price_standardized = price_scalar.transform(project_data['price'].values.reshape(-1, 1
))
```

```
Mean : 298.1193425966608, Standard deviation : 367.49634838483496
```

In [78]:

```
price_standardized
```

Out[78]:

```
array([[-0.3905327 ],
       [ 0.00239637],
       [ 0.59519138],
       ...,
       [-0.15825829],
       [-0.61243967],
       [-0.51216657]])
```

In [79]:

```
#numerical features for quantity
import warnings
warnings.filterwarnings("ignore")
quantity_scalar = StandardScaler()
quantity_scalar.fit(project_data['quantity'].values.reshape(-1,1))
print(f"Mean : {quantity_scalar.mean_[0]}, Standard deviation : {np.sqrt(quantity_scala
r.var_[0])}")
quantity_standardized = quantity_scalar.transform(project_data['quantity'].values.resha
pe(-1, 1))
```

```
Mean : 16.965610354422964, Standard deviation : 26.182821919093175
```

In [80]:

```
quantity_standardized
```

Out[80]:

```
array([[ 0.23047132],
       [-0.60977424],
       [ 0.19227834],
       ...,
       [-0.4951953 ],
       [-0.03687954],
       [-0.45700232]])
```

In [81]:

```
#numerical features for teacher_number_of_previously_posted_projects
previousprojects_scalar = StandardScaler()
previousprojects_scalar.fit(project_data['teacher_number_of_previously_posted_projects'
].values.reshape(-1,1))
print(f"Mean : {previousprojects_scalar.mean_[0]}, Standard deviation : {np.sqrt(previo
usprojects_scalar.var_[0])}")
previousprojects_standardized = previousprojects_scalar.transform(project_data['teacher
_number_of_previously_posted_projects'].values.reshape(-1, 1))
```

```
Mean : 11.153165275336848, Standard deviation : 27.77702641477403
```

In [82]:

```
previousprojects_standardized
```

Out[82]:

```
array([[-0.40152481],
       [-0.14951799],
       [-0.36552384],
       ...,
       [-0.29352189],
       [-0.40152481],
       [-0.40152481]])
```

In [86]:

```
from scipy import sparse
sparse.issparse(previousprojects_standardized)
```

Out[86]:

```
False
```

1.4.4 Merging all the above features

- we need to merge all the numerical vectors i.e catogorical, text, numerical vectors

print(categories_one_hot.shape) print(sub_categories_one_hot.shape) print(text_bow.shape) print(price_standardized.shape)

In [118]:

```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack
# with the same hstack function we are concatinating a sparse matrix and a dense matirx
:
X = hstack((categories_one_hot, sub_categories_one_hot, text_bow, price_standardized))
X.shape
#X.dtype
```

Out[118]:

```
(109248, 16663)
```

Assignment 2: Apply TSNE

1. In the above cells we have plotted and analyzed many features. Please observe the plots and write the observations in markdown cells below every plot.
2. EDA: Please complete the analysis of the feature: teacher_number_of_previously_posted_projects
3. Build the data matrix using these features
   - school_state : categorical data (one hot encoding)
   - clean_categories : categorical data (one hot encoding)
   - clean_subcategories : categorical data (one hot encoding)
   - teacher_prefix : categorical data (one hot encoding)
   - project_grade_category : categorical data (one hot encoding)
   - project_title : text data (BOW, TFIDF, AVG W2V, TFIDF W2V)
   - price : numerical
   - teacher_number_of_previously_posted_projects : numerical
4. Now, plot FOUR t-SNE plots with each of these feature sets.
   - A.categorical, numerical features + project_title(BOW)
   - B.categorical, numerical features + project_title(TFIDF)
   - C.categorical, numerical features + project_title(AVG W2V)
   - D.categorical, numerical features + project_title(TFIDF W2V)
5. Concatenate all the features and Apply TNSE on the final data matrix
6. Note 1: The TSNE accepts only dense matrices
7. Note 2: Consider only 5k to 6k data points to avoid memory issues. If you run into memory error issues, reduce the number of data points but clearly state the number of datat-points you are using

I'm considering 5K data points for this analysis.

2.1 Data preparation

Selecting 5000 data points (with equal approval & rejected datapoints i.e. 2.5K) from project_data for t-NSE analysis purpose.

In [83]:

```
approved=project_data[project_data['project_is_approved']==1]
rejected=project_data[project_data['project_is_approved']==0]
approved.head(5)
approved_top=approved[0:2500]
approved_top.head(5)
rejected_top=rejected[0:2500]
rejected_top.head(10)
data_5K=pd.concat([approved_top,rejected_top], axis=0,ignore_index=True)
data_5K.head(2)
```

Out[83]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_s
0	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL
1	45	p246581	f3cb9bffbba169bef1a77b243e620b60	Mrs.	KY

2 rows × 22 columns

In [84]:

```
#counts of approved & rejected projects in the 5K data set.
data_5K['project_is_approved'].value_counts()
```

Out[84]:

```
1    2500
0    2500
Name: project_is_approved, dtype: int64
```

2.2 Preparing Data Matrices for Categorical,numerical & text features for 5K points

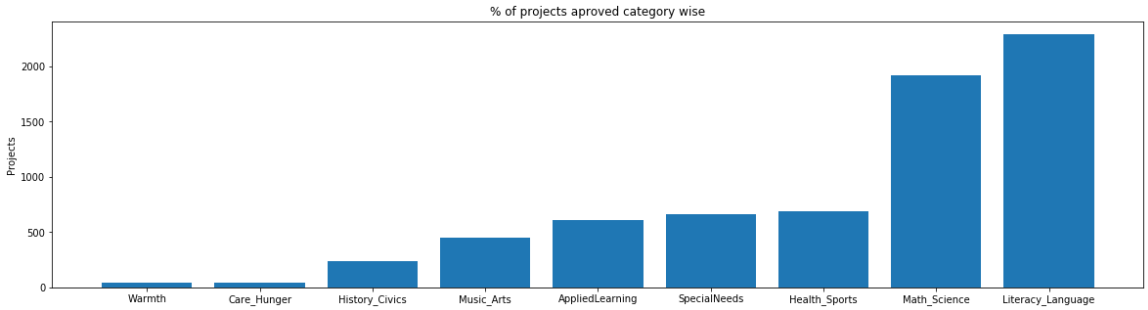
Categorical Features:

In [85]:

```
# count of all the words in corpus python: https://stackoverflow.com/a/22898595/4084039
from collections import Counter
my_counter = Counter()
for word in data_5K['clean_categories'].values:
    my_counter.update(word.split())
```

In [86]:

```
# dict sort by value python: https://stackoverflow.com/a/613218/4084039
cat_dict = dict(my_counter)
sorted_cat_dict = dict(sorted(cat_dict.items(), key=lambda kv: kv[1]))
ind = np.arange(len(sorted_cat_dict))
plt.figure(figsize=(20,5))
p1 = plt.bar(ind, list(sorted_cat_dict.values()))
plt.ylabel('Projects')
plt.title('% of projects aproved category wise')
plt.xticks(ind, list(sorted_cat_dict.keys()))
plt.show()
```



In [87]:

```
for i, j in sorted_cat_dict.items():
    print("{:20} :{:10}".format(i,j))
```

```
Warmth               :        45
Care_Hunger          :        45
History_Civics       :       241
Music_Arts           :       455
AppliedLearning      :       614
SpecialNeeds         :       662
Health_Sports        :       688
Math_Science         :      1918
Literacy_Language    :      2292
```

SUMMARY: It can be observed that projects submitted in Literacy_Language(accounting for 50% of total) category was the highest & warmth,care_hunger being the lowest.

In [88]:

```
# we use count vectorizer to convert the values into one hot encoded features
#one-hot encoding for clean_categories
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict.keys()), lowercase=False,
binary=True)
vectorizer.fit(data_5K['clean_categories'].values)
print(vectorizer.get_feature_names())
categories_one_hot = vectorizer.transform(data_5K['clean_categories'].values)
print("Shape of matrix after one hot encoding",categories_one_hot.shape)
```

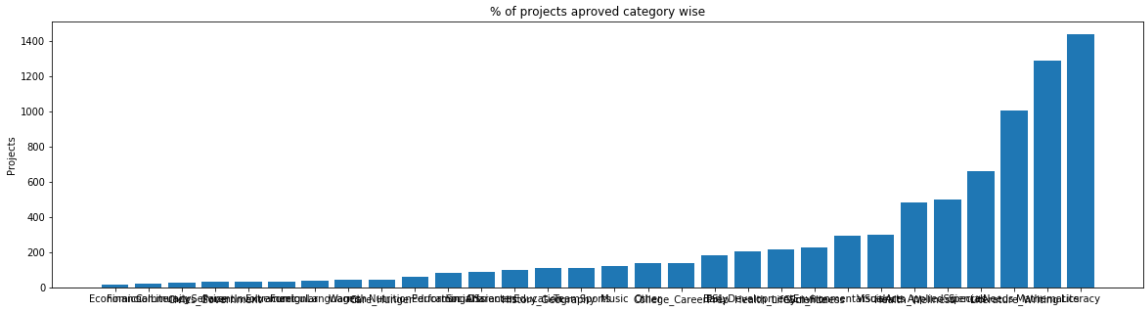
```
['Warmth', 'Care_Hunger', 'History_Civics', 'Music_Arts', 'AppliedLearnin
g', 'SpecialNeeds', 'Health_Sports', 'Math_Science', 'Literacy_Language']
Shape of matrix after one hot encoding (5000, 9)
```

In [89]:

```
from collections import Counter
my_counter = Counter()
for word in data_5K['clean_subcategories'].values:
    my_counter.update(word.split())
```

In [90]:

```
# dict sort by value python: https://stackoverflow.com/a/613218/4084039
sub_cat_dict = dict(my_counter)
sorted_sub_cat_dict = dict(sorted(sub_cat_dict.items(), key=lambda kv: kv[1]))
ind = np.arange(len(sorted_sub_cat_dict))
plt.figure(figsize=(20,5))
p1 = plt.bar(ind, list(sorted_sub_cat_dict.values()))
plt.ylabel('Projects')
plt.title('% of projects aproved category wise')
plt.xticks(ind, list(sorted_sub_cat_dict.keys()))
plt.show()
```



In [91]:

```
for i, j in sorted_sub_cat_dict.items():
    print("{:20} :{:10}".format(i,j))
```

```
Economics            :        14
FinancialLiteracy    :        24
CommunityService     :        29
Civics_Government    :        32
ParentInvolvement    :        33
Extracurricular      :        35
ForeignLanguages     :        36
Warmth               :        45
Care_Hunger          :        45
NutritionEducation   :        63
PerformingArts       :        82
SocialSciences       :        88
CharacterEducation   :       102
History_Geography    :       110
TeamSports           :       112
Music                :       122
Other                :       136
College_CareerPrep   :       136
ESL                  :       182
EarlyDevelopment     :       205
Health_LifeScience   :       215
Gym_Fitness          :       226
EnvironmentalScience :       294
VisualArts           :       297
Health_Wellness      :       483
AppliedSciences      :       501
SpecialNeeds         :       662
Literature_Writing   :      1006
Mathematics          :      1289
Literacy             :      1436
```

In [92]:

```
#one-hot encoding for clean_sub_categories
vectorizer = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=Fal
se, binary=True)
vectorizer.fit(data_5K['clean_subcategories'].values)
print(vectorizer.get_feature_names())
sub_categories_one_hot = vectorizer.transform(data_5K['clean_subcategories'].values)
print("Shape of matrix after one hot encodig",sub_categories_one_hot.shape)
```

```
['Economics', 'FinancialLiteracy', 'CommunityService', 'Civics_Governmen
t', 'ParentInvolvement', 'Extracurricular', 'ForeignLanguages', 'Warmth',
'Care_Hunger', 'NutritionEducation', 'PerformingArts', 'SocialSciences',
'CharacterEducation', 'History_Geography', 'TeamSports', 'Music', 'Other',
'College_CareerPrep', 'ESL', 'EarlyDevelopment', 'Health_LifeScience', 'Gy
m_Fitness', 'EnvironmentalScience', 'VisualArts', 'Health_Wellness', 'Appl
iedSciences', 'SpecialNeeds', 'Literature_Writing', 'Mathematics', 'Litera
cy']
Shape of matrix after one hot encodig (5000, 30)
```

In [93]:

```
#one-hot encoding for school_state
#https://machinelearningmastery.com/prepare-text-data-machine-learning-scikit-learn/
ss_values = list(data_5K['school_state'].values)
vectorizer = CountVectorizer()
vectorizer.fit(ss_values)
print(vectorizer.get_feature_names())
school_state_one_hot = vectorizer.transform(ss_values)
print("Shape of matrix after one hot encoding",school_state_one_hot.shape)
```

```
['ak', 'al', 'ar', 'az', 'ca', 'co', 'ct', 'dc', 'de', 'fl', 'ga', 'hi',
'ia', 'id', 'il', 'in', 'ks', 'ky', 'la', 'ma', 'md', 'me', 'mi', 'mn', 'm
o', 'ms', 'mt', 'nc', 'nd', 'ne', 'nh', 'nj', 'nm', 'nv', 'ny', 'oh', 'o
k', 'or', 'pa', 'ri', 'sc', 'sd', 'tn', 'tx', 'ut', 'va', 'vt', 'wa', 'w
i', 'wv', 'wy']
Shape of matrix after one hot encoding (5000, 51)
```

In [94]:

```
#one-hot encoding for project_grade_category
project_grade_category = list(data_5K['project_grade_category'].values)
vectorizer = CountVectorizer(ngram_range=(1,2),max_features=4)
vectorizer.fit(project_grade_category)
print(vectorizer.get_feature_names())
project_grade_category_one_hot = vectorizer.transform(project_grade_category)
print("Shape of matrix after one hot encodig",project_grade_category_one_hot.shape)
```

```
['12', 'grades', 'grades prek', 'prek']
Shape of matrix after one hot encodig (5000, 4)
```

In [95]:

```
#checking for NaN values in the column
#https://www.geeksforgeeks.org/python-pandas-dataframe-fillna-to-replace-null-values-in
-dataframe/
teacher_prefix = list(data_5K['teacher_prefix'].values)
teacher_prefix
print("Number of Nan values in teacher_prefix column:",data_5K['teacher_prefix'].isnull
().values.sum())
```

```
Number of Nan values in teacher_prefix column: 0
```

In [98]:

```
data_5K['teacher_prefix'].unique()
```

Out[98]:

```
array(['Mr.', 'Mrs.', 'Ms.', 'Teacher'], dtype=object)
```

In [99]:

```
#one-hot encoding for teacher_prefix
#https://www.geeksforgeeks.org/python-pandas-dataframe-fillna-to-replace-null-values-in-dataframe/
#project_data['teacher_prefix'].fillna('none',inplace = True) #NaN values have been replaced with none
teacher_prefix = list(data_5K['teacher_prefix'].values)
vectorizer = CountVectorizer()
vectorizer.fit(teacher_prefix)
print(vectorizer.get_feature_names())
teacher_prefix_one_hot = vectorizer.transform(teacher_prefix)
print("Shape of matrix after one hot encodig",teacher_prefix_one_hot.shape)
```

```
['mr', 'mrs', 'ms', 'teacher']
Shape of matrix after one hot encodig (5000, 4)
```

Text Features: BOW, TFIDF, AVG W2V, TFIDF W2V on Project_title

1. BOW

In [100]:

```
#BOW for preprocessed_titles
vectorizer = CountVectorizer(min_df=10)
title_bow = vectorizer.fit_transform(data_5K['preprocessed_titles'])
print("Shape of matrix after applying BOW",title_bow.shape)
```

```
Shape of matrix after applying BOW (5000, 369)
```

In [101]:

```
# https://stackoverflow.com/questions/35874744/python-how-to-check-if-matrix-is-sparse-or-not
from scipy import sparse
sparse.issparse(title_bow)
```

Out[101]:

```
True
```

2. TFIDF vectorizer

In [102]:

```
#TFIDF for preprocessed_titles
vectorizer = TfidfVectorizer(min_df=10)
title_tfidf = vectorizer.fit_transform(data_5K['preprocessed_titles'])
print("Shape of matrix after applying TFIDF",title_tfidf.shape)
```

```
Shape of matrix after applying TFIDF (5000, 369)
```

3. AVG W2V on project_title

In [103]:

```
#Train your own Word2Vec model using your own text corpus
w2v_data = data_5K['preprocessed_titles']
split=[]
for row in w2v_data:
    split.append([word for word in row.split()])     #splitting words
#split[100]
#train your W2v
train_w2v = Word2Vec(split,min_count=1,size=50, workers=4)
word_vectors = train_w2v.wv
w2v_words =list(word_vectors.vocab)
print(len(w2v_words ))
```

```
3933
```

In [104]:

```
# compute average word2vec for each title.
sent_vectors = [] # the avg-w2v for each title is stored in this list
for sent in tqdm(split):   # for each title
    sent_vec = np.zeros(50)  # as word vectors are of zero length 50
    cnt_words =0   # num of words with a valid vector in the title
    for word in sent:   # for each word in a title
        if word in w2v_words:
            vec = word_vectors[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
        sent_vectors.append(sent_vec)
print(len(sent_vectors))
print(len(sent_vectors[3]))
from scipy.sparse import coo_matrix
a=coo_matrix(sent_vectors) #https://docs.scipy.org/doc/scipy/reference/generated/scipy.sparse.coo_matrix.html
a.shape
```

```
100%|████████████████████████████████████████████████████████████████████
████████████████████████████████████████████████| 5000/5000 [00:00<0
0:00, 7804.76it/s]

5000
50

Out[104]:

(5000, 50)
```

4. TFIDF weighted W2V on project_title

In [105]:

```
model = TfidfVectorizer()
model.fit(data_5K['preprocessed_titles'])
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(model.get_feature_names(), list(model.idf_)))
# TF-IDF weighted Word2Vec
tfidf_feat = model.get_feature_names()
# tfidf words/col-names
# final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf
tfidf_sent_vectors = [] # the tfidf-w2v for each sentence/review is stored in this list
row=0
for sent in tqdm(split): # for each review/sentence
    sent_vec = np.zeros(50)  # as word vectors are of zero length
    weight_sum =0  # num of words with a valid vector in the sentence/review\
    for word in sent:  # for each word in a review/sentence
        if word in w2v_words and word in tfidf_feat:
            vec = word_vectors[word]
            #tf_idf = tf_idf_matrix[row, tfidf_feat.index(word)]
            # to reduce the computation we are using dictionary[word] = idf value of wo
rd in whole courpus
            # & sent.count(word) = tf valeus of word in this review
            tf_idf = dictionary[word]*(sent.count(word)/len(sent))
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
    if weight_sum != 0:
        sent_vec /= weight_sum
        tfidf_sent_vectors.append(sent_vec)
        row += 1
print(len(tfidf_sent_vectors))
print(len(tfidf_sent_vectors[2]))
b=coo_matrix(tfidf_sent_vectors) #https://docs.scipy.org/doc/scipy/reference/generated/
scipy.sparse.coo_matrix.html
b.shape
```

```
100%|████████████████████████████████████████████████████████████
████████████████████████████████████████| 5000/5000 [00:01<0
0:00, 2659.68it/s]

5000
50

Out[105]:

(5000, 50)
```

Numerical Features: Standardization on Price & teacher_number_of_previously_posted_projects

In [106]:

```
from sklearn.preprocessing import StandardScaler
price_scalar = StandardScaler()
price_scalar.fit(data_5K['price'].values.reshape(-1,1))
# finding the mean and standard deviation of this data
print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_
[0])}")
# Now standardize the data with above mean and variance.
price_standardized = price_scalar.transform(data_5K['price'].values.reshape(-1, 1))
```

```
Mean : 325.74432800000005, Standard deviation : 384.0878237218519
```

In [107]:

```
#numerical features for teacher_number_of_previously_posted_projects
import warnings
warnings.filterwarnings("ignore")
previousprojects_scalar = StandardScaler()
previousprojects_scalar.fit(data_5K['teacher_number_of_previously_posted_projects'].val
ues.reshape(-1,1))
print(f"Mean : {previousprojects_scalar.mean_[0]}, Standard deviation : {np.sqrt(previo
usprojects_scalar.var_[0])}")
previousprojects_standardized = previousprojects_scalar.transform(data_5K['teacher_numb
er_of_previously_posted_projects'].values.reshape(-1, 1))
```

```
Mean : 9.2148, Standard deviation : 23.00654387255939
```

3.1 TSNE with BOW encoding of project_title feature

3.1.1 Merging features i.e all catogorical, numerical & BOW vectors.

In [108]:

```
print(categories_one_hot.shape)
print(sub_categories_one_hot.shape)
print(school_state_one_hot.shape)
print(project_grade_category_one_hot.shape)
print(teacher_prefix_one_hot.shape)
print(title_bow.shape)
print(price_standardized.shape)
print(previousprojects_standardized.shape)
```

```
(5000, 9)
(5000, 30)
(5000, 51)
(5000, 4)
(5000, 4)
(5000, 369)
(5000, 1)
(5000, 1)
```

In [109]:

```
from scipy.sparse import hstack
X1 = hstack((categories_one_hot, sub_categories_one_hot,school_state_one_hot,project_grade_category_one_hot,teacher_prefix_one_hot, title_bow,price_standardized,previousprojects_standardized))
X1.shape
```

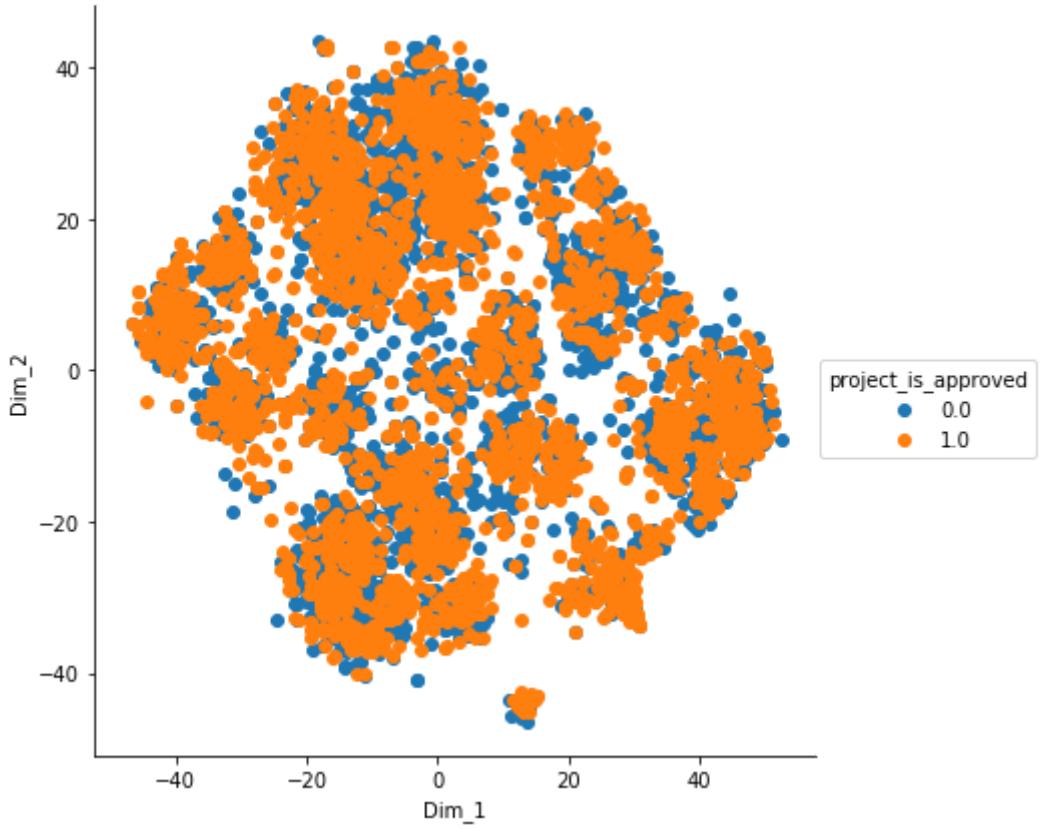
Out[109]:

(5000, 469)

3.1.2 T-SNE plots for various values of perplexity & iterations .

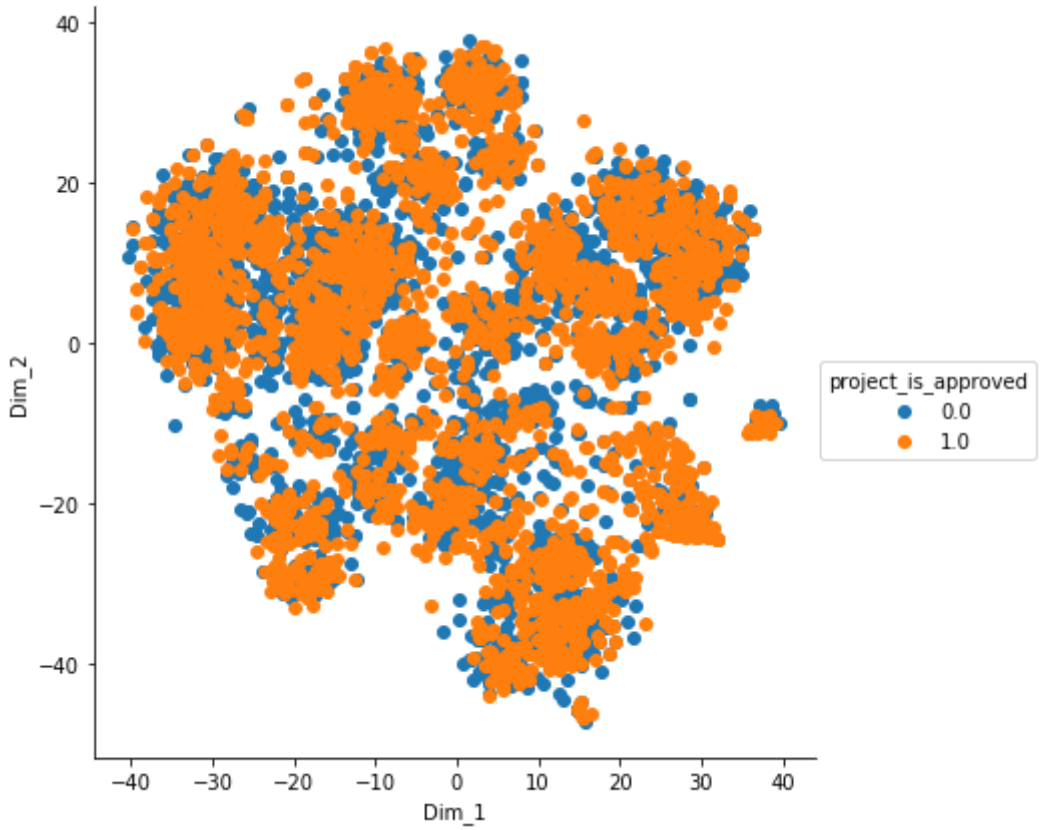
In [112]:

```
#t-SNE
#perplexity=50 & step=1000
from sklearn.manifold import TSNE
import seaborn as sns
model = TSNE(n_components=2, random_state=0, perplexity=50, n_iter=1000)
tsne_data = model.fit_transform(X1.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Dim_2').add_legend()
plt.show()
```



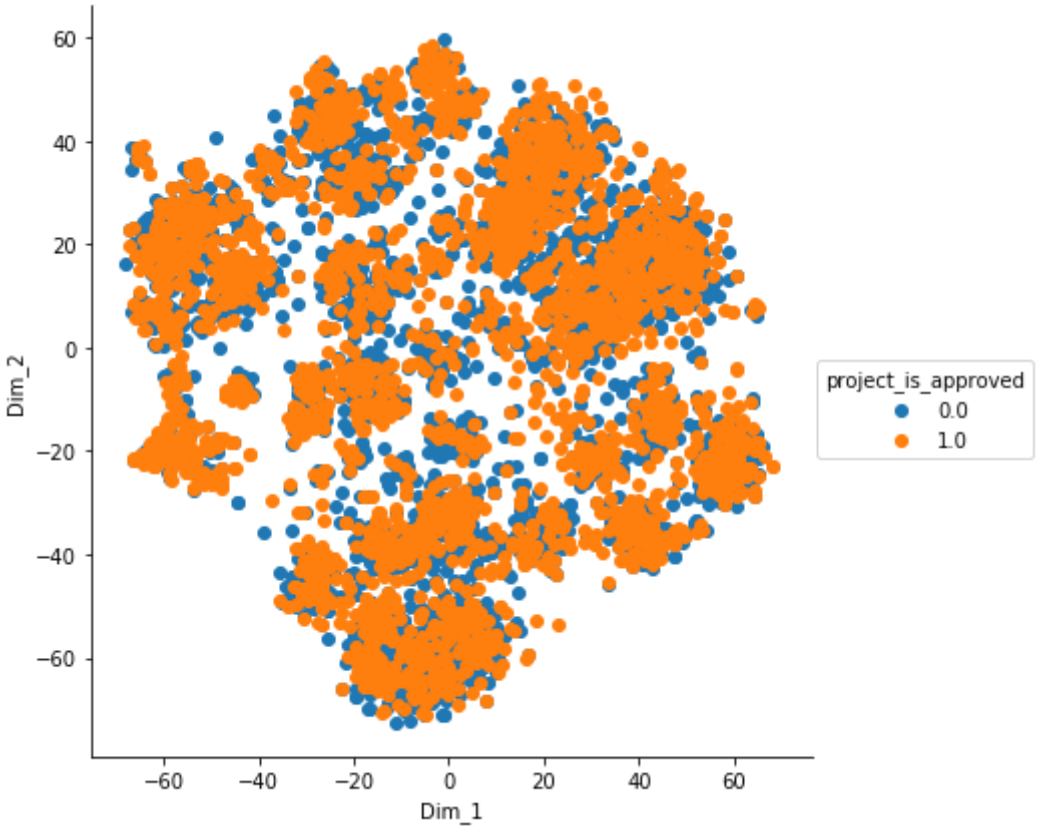
In [292]:

```
#perplexity=70 & step=1500
from sklearn.manifold import TSNE
import seaborn as sns
model = TSNE(n_components=2, random_state=0, perplexity=70, n_iter=1500)
tsne_data = model.fit_transform(X1.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



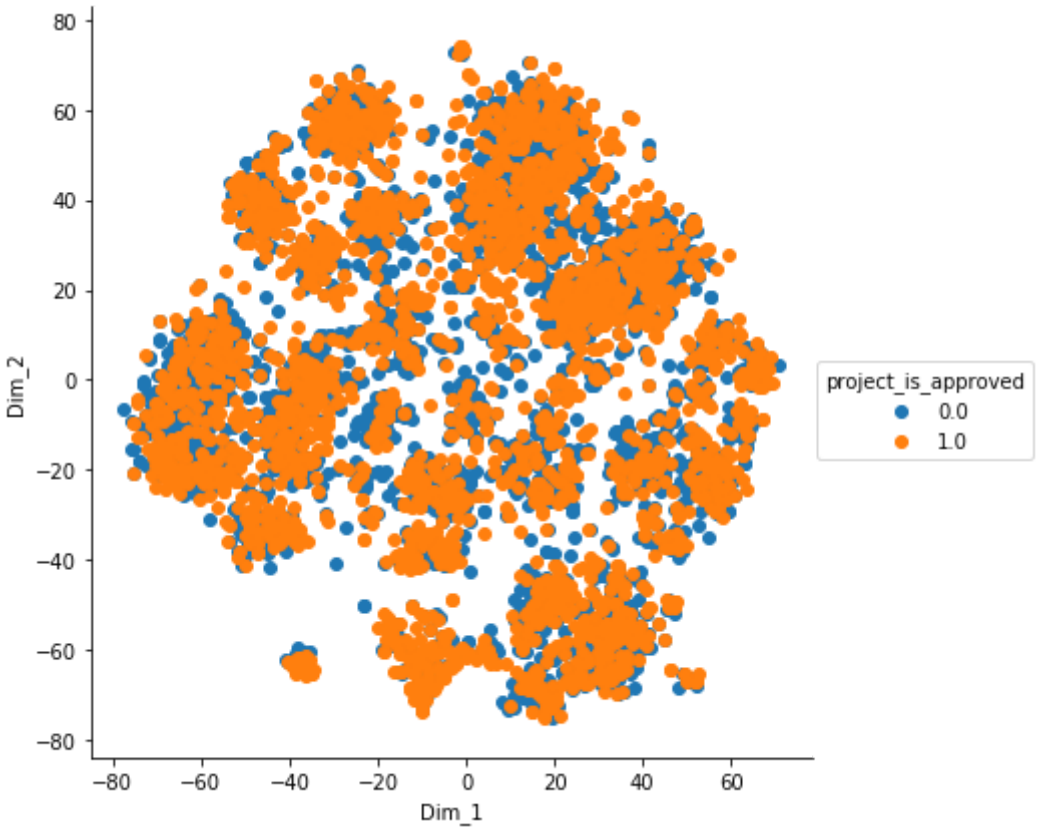
In [293]:

```
#perplexity=30 & step=2000
from sklearn.manifold import TSNE
import seaborn as sns
model = TSNE(n_components=2, random_state=0, perplexity=30, n_iter=2000)
tsne_data = model.fit_transform(X1.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



In [113]:

```
#perplexity=20 & step=1500
model = TSNE(n_components=2, random_state=0, perplexity=20, n_iter=1500)
tsne_data = model.fit_transform(X1.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



3.2 TSNE with TFIDF encoding of project_title feature

3.2.1 Merging features i.e all catogorical, numerical & TFIDF vectors.

In [110]:

```
print(categories_one_hot.shape)
print(sub_categories_one_hot.shape)
print(school_state_one_hot.shape)
print(project_grade_category_one_hot.shape)
print(teacher_prefix_one_hot.shape)
print(title_tfidf.shape)
print(price_standardized.shape)
print(previousprojects_standardized.shape)
```

```
(5000, 9)
(5000, 30)
(5000, 51)
(5000, 4)
(5000, 4)
(5000, 369)
(5000, 1)
(5000, 1)
```

In [111]:

```
from scipy.sparse import hstack
X2 = hstack((categories_one_hot, sub_categories_one_hot,school_state_one_hot,project_gr
ade_category_one_hot,teacher_prefix_one_hot, title_tfidf,price_standardized,previouspro
jects_standardized))
X2.shape
```

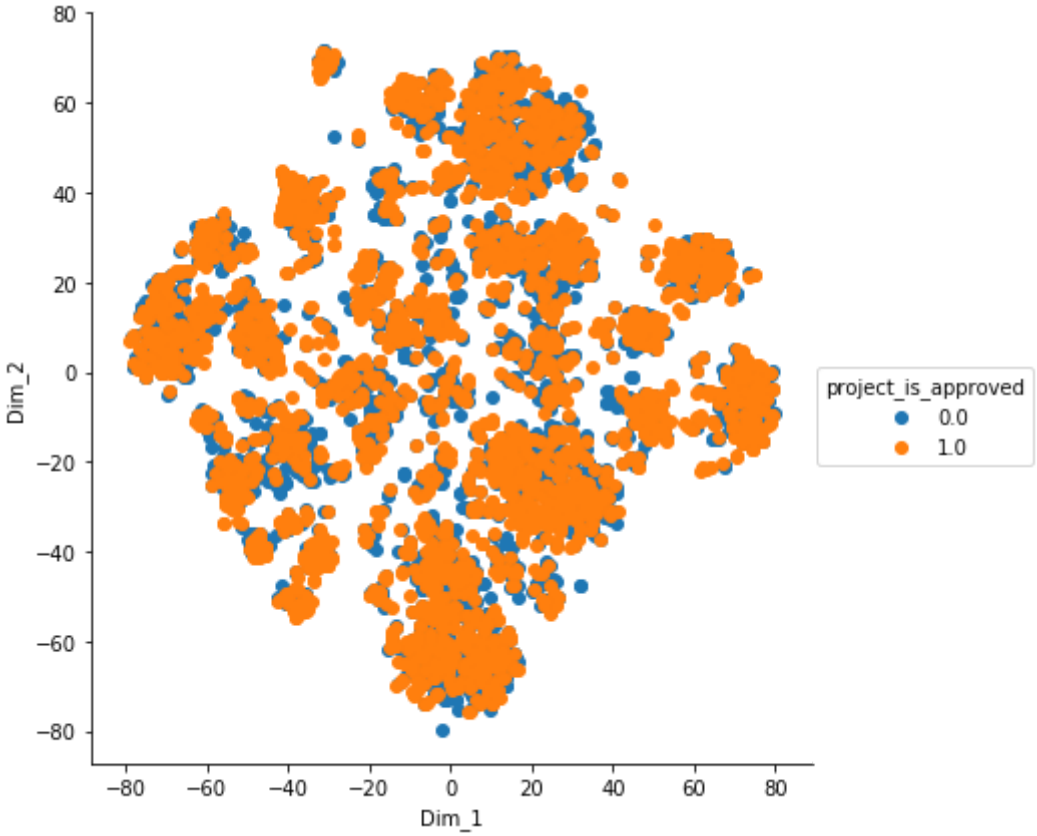
Out[111]:

```
(5000, 469)
```

3.2.2 T-SNE plots for various values of perplexity & iterations .

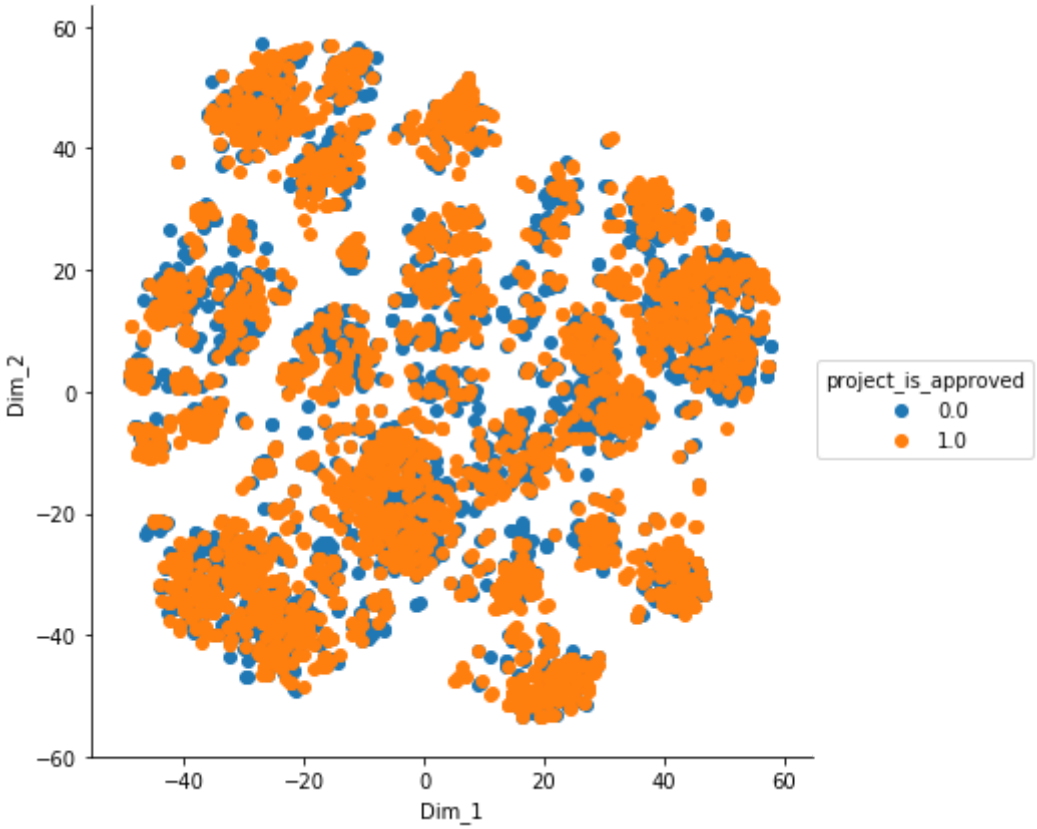
In [116]:

```
#t-SNE
#perplexity=30 & step=1000
from sklearn.manifold import TSNE
import seaborn as sns
model = TSNE(n_components=2, random_state=0, perplexity=30, n_iter=1000)
tsne_data = model.fit_transform(X2.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



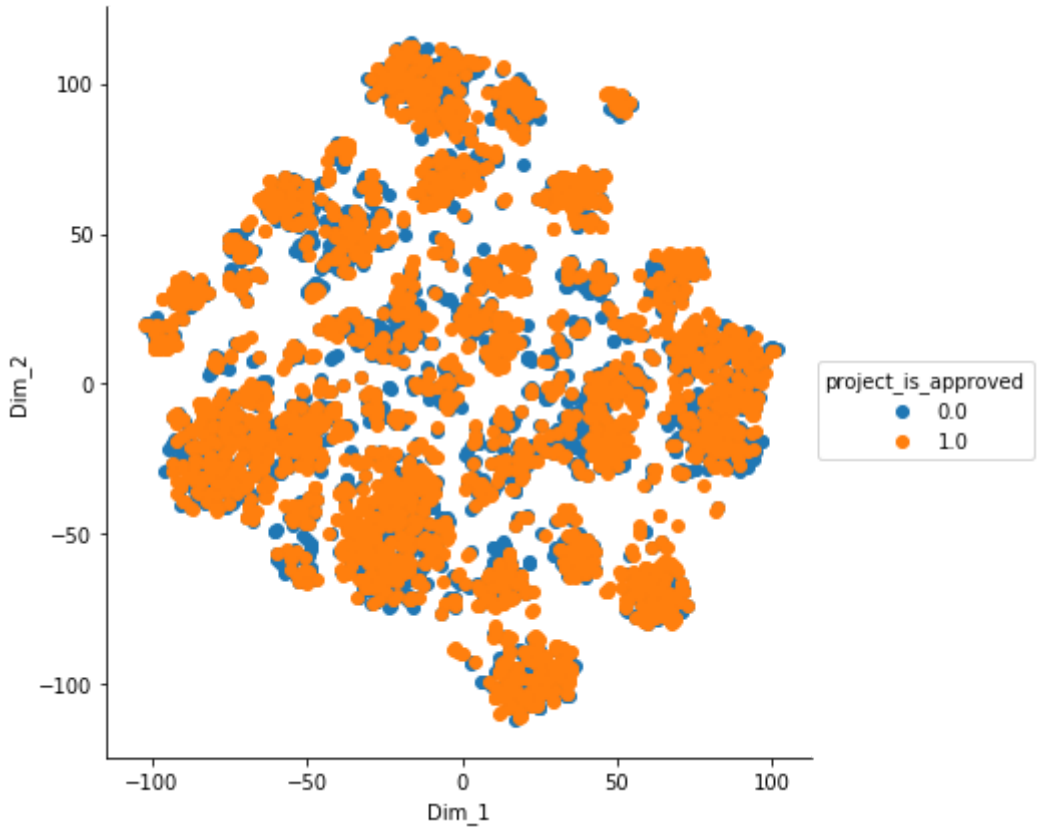
In [117]:

```
#perplexity=50 & step=1000
model = TSNE(n_components=2, random_state=0, perplexity=50, n_iter=1000)
tsne_data = model.fit_transform(X2.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



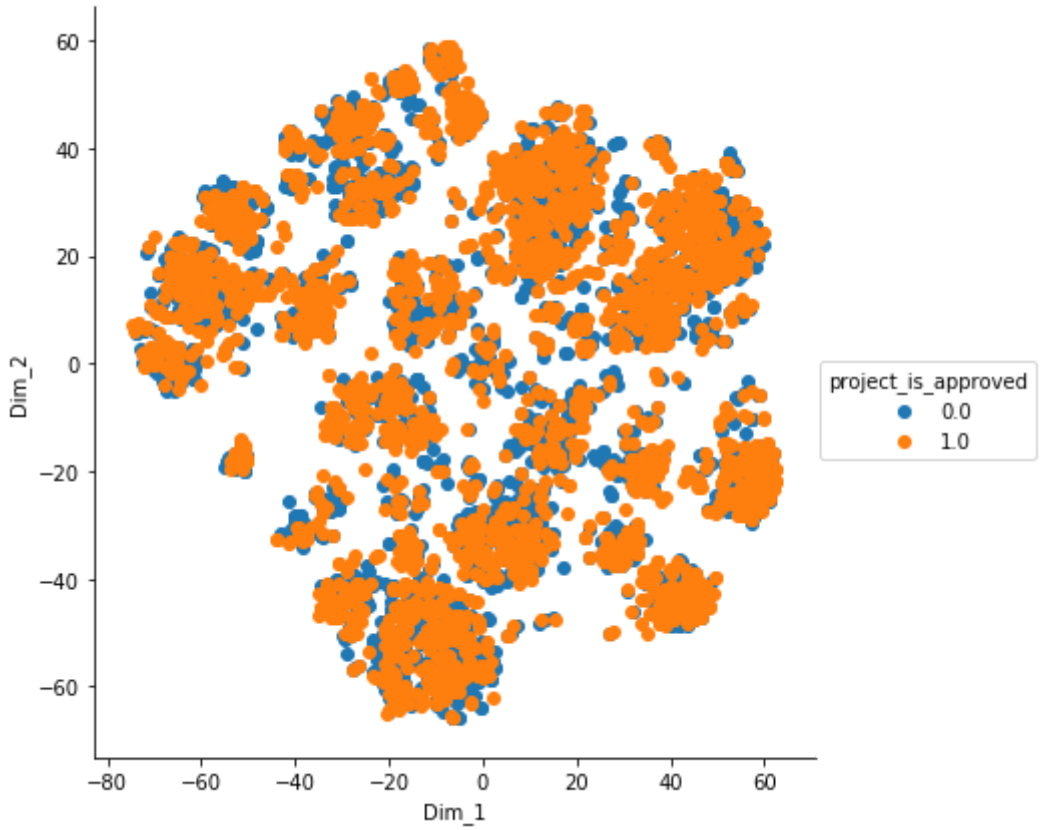
In [118]:

```
#perplexity=20 & step=2000
model = TSNE(n_components=2, random_state=0, perplexity=20, n_iter=2000)
tsne_data = model.fit_transform(X2.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



In [191]:

```
#perplexity=70 & step=3000
model = TSNE(n_components=2, random_state=0, perplexity=70, n_iter=3000)
tsne_data = model.fit_transform(X2.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



3.3 TSNE with Avg W2V encoding of project_title feature

3.3.1 Merging features i.e all catogorical, numerical & Avg W2V vectors.

In [112]:

```
print(categories_one_hot.shape)
print(sub_categories_one_hot.shape)
print(school_state_one_hot.shape)
print(project_grade_category_one_hot.shape)
print(teacher_prefix_one_hot.shape)
print(a.shape)
print(price_standardized.shape)
print(previousprojects_standardized.shape)
```

```
(5000, 9)
(5000, 30)
(5000, 51)
(5000, 4)
(5000, 4)
(5000, 50)
(5000, 1)
(5000, 1)
```

In [113]:

```
from scipy.sparse import hstack
from scipy.sparse import coo_matrix, vstack
import numpy as np

X2 = hstack((categories_one_hot, sub_categories_one_hot,school_state_one_hot,project_gr
ade_category_one_hot,teacher_prefix_one_hot,a,price_standardized,previousprojects_stand
ardized))
X2.shape
```

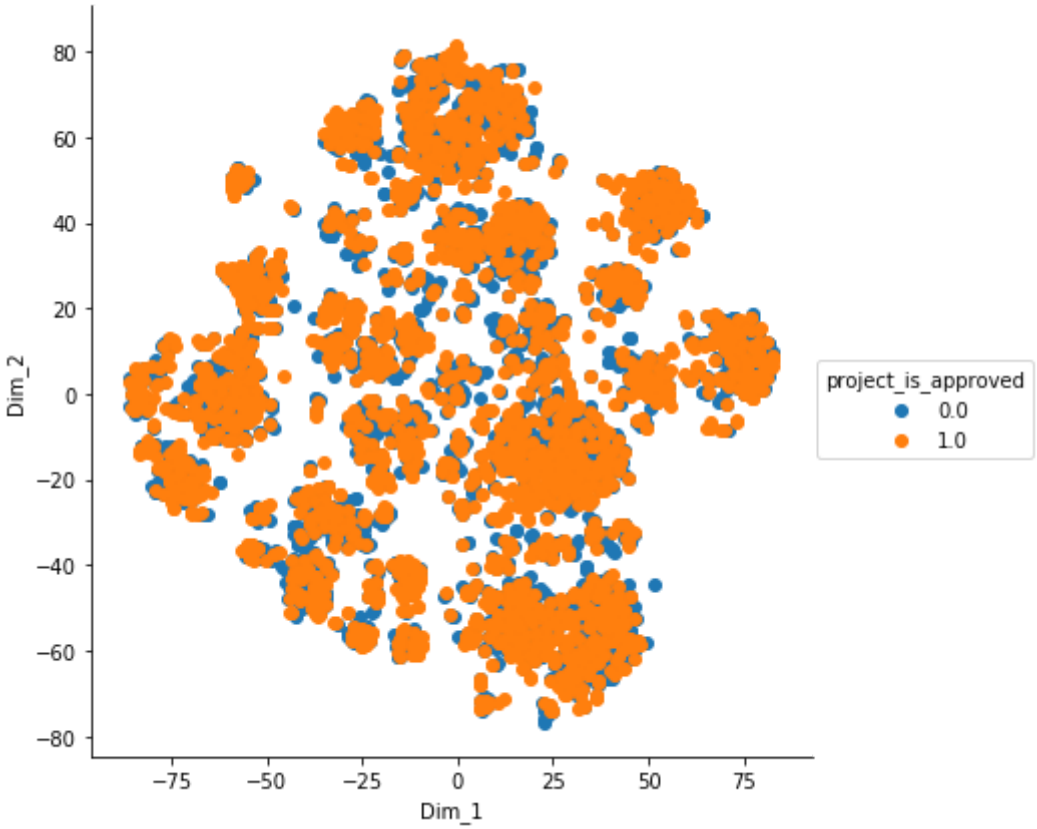
Out[113]:

```
(5000, 150)
```

3.3.2 T-SNE plots for various values of perplexity & iterations .

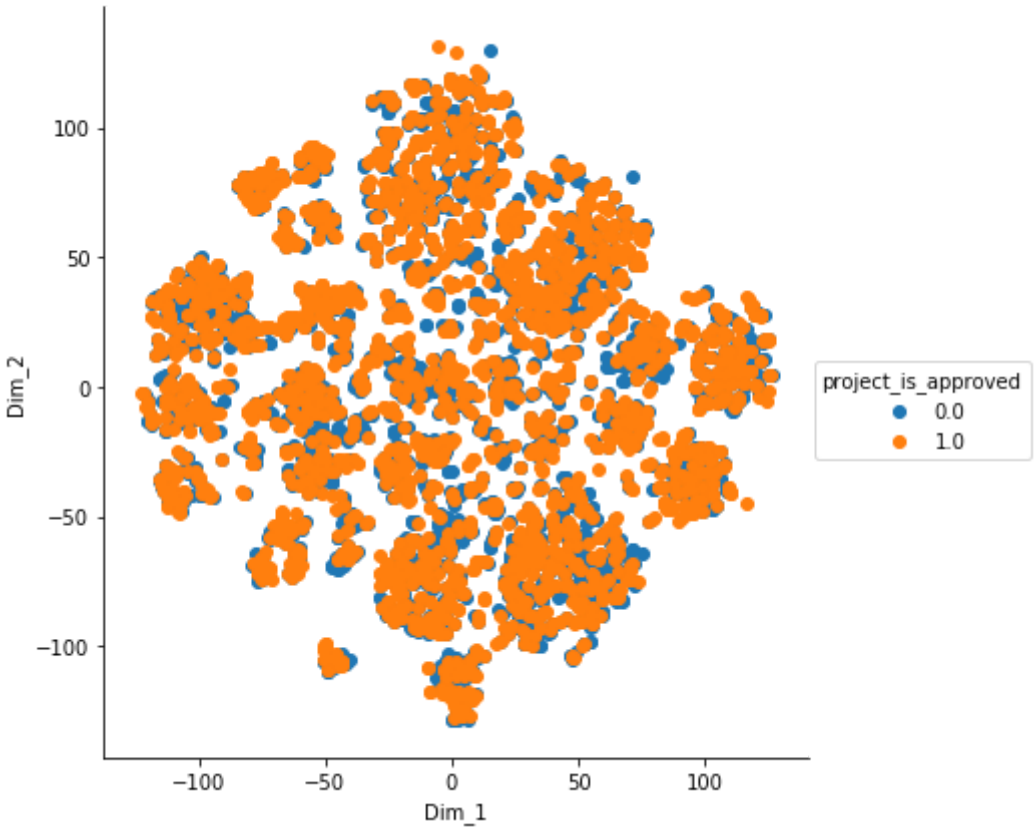
In [179]:

```
#t-SNE
#perplexity=30 & step=1000
from sklearn.manifold import TSNE
import seaborn as sns
model = TSNE(n_components=2, random_state=0, perplexity=30, n_iter=1000)
tsne_data = model.fit_transform(X2.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



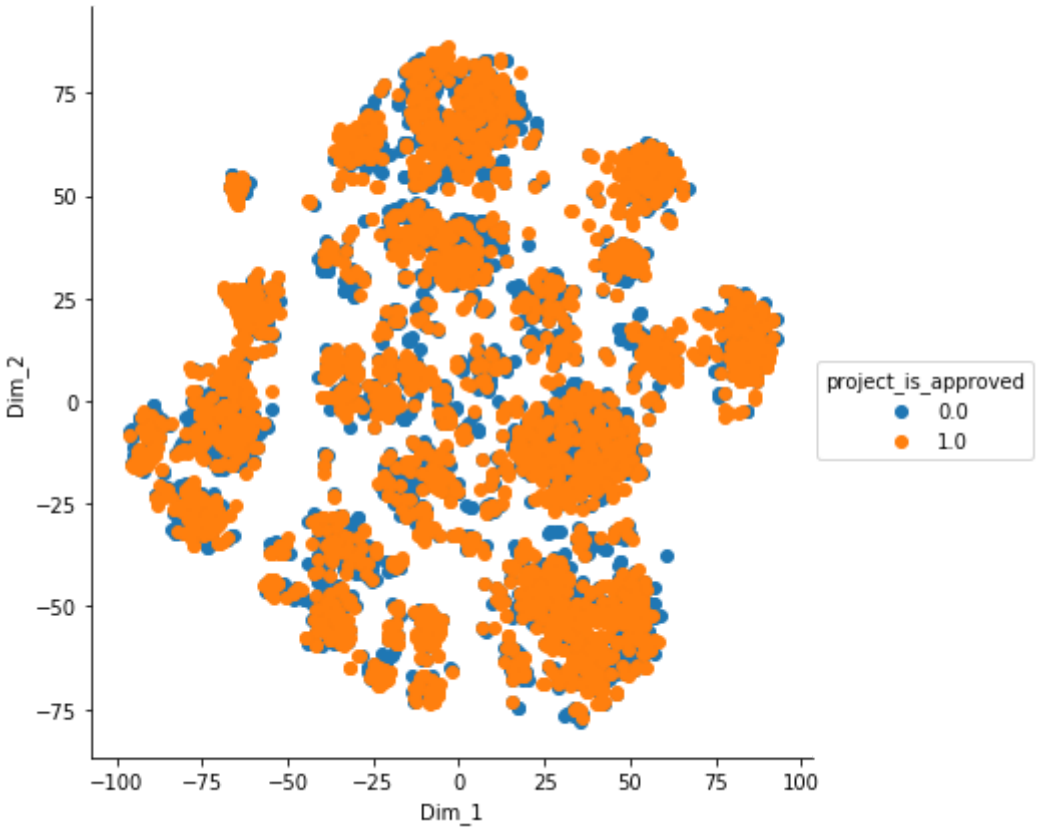
In [180]:

```
#perplexity=10 & step=1500
model = TSNE(n_components=2, random_state=0, perplexity=10, n_iter=1500)
tsne_data = model.fit_transform(X2.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



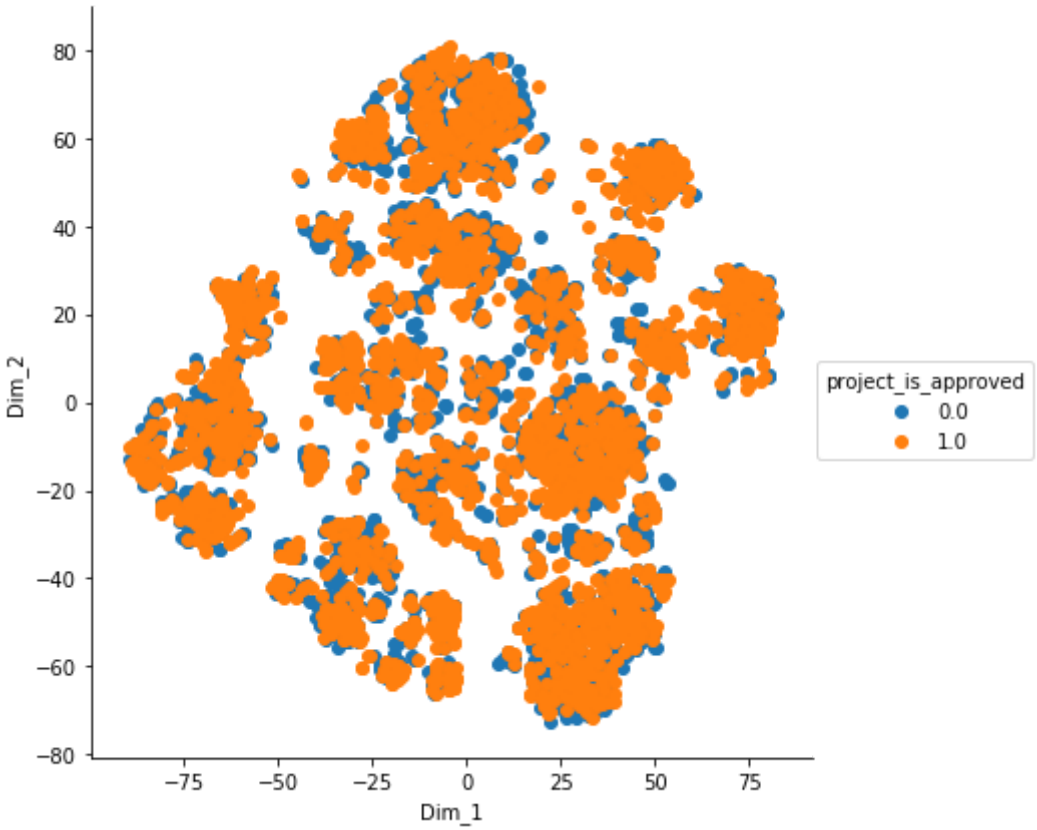
In [181]:

```
#perplexity=40 & step=2000
model = TSNE(n_components=2, random_state=0, perplexity=40, n_iter=2000)
tsne_data = model.fit_transform(X2.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



In [182]:

```
#perplexity=50 & step=2500
model = TSNE(n_components=2, random_state=0, perplexity=50, n_iter=2500)
tsne_data = model.fit_transform(X2.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



3.4 TSNE with TFIDF Weighted W2V encoding of project_title feature

3.4.1 Merging features i.e all catogorical, numerical & TFIDF W2V vectors.

In [114]:

```
print(categories_one_hot.shape)
print(sub_categories_one_hot.shape)
print(school_state_one_hot.shape)
print(project_grade_category_one_hot.shape)
print(teacher_prefix_one_hot.shape)
print(b.shape)
print(price_standardized.shape)
print(previousprojects_standardized.shape)
```

```
(5000, 9)
(5000, 30)
(5000, 51)
(5000, 4)
(5000, 4)
(5000, 50)
(5000, 1)
(5000, 1)
```

In [115]:

```
from scipy.sparse import hstack
from scipy.sparse import coo_matrix, vstack
import numpy as np

X3 = hstack((categories_one_hot, sub_categories_one_hot,school_state_one_hot,project_gr
ade_category_one_hot,teacher_prefix_one_hot,b,price_standardized,previousprojects_stand
ardized))
X3.shape
```

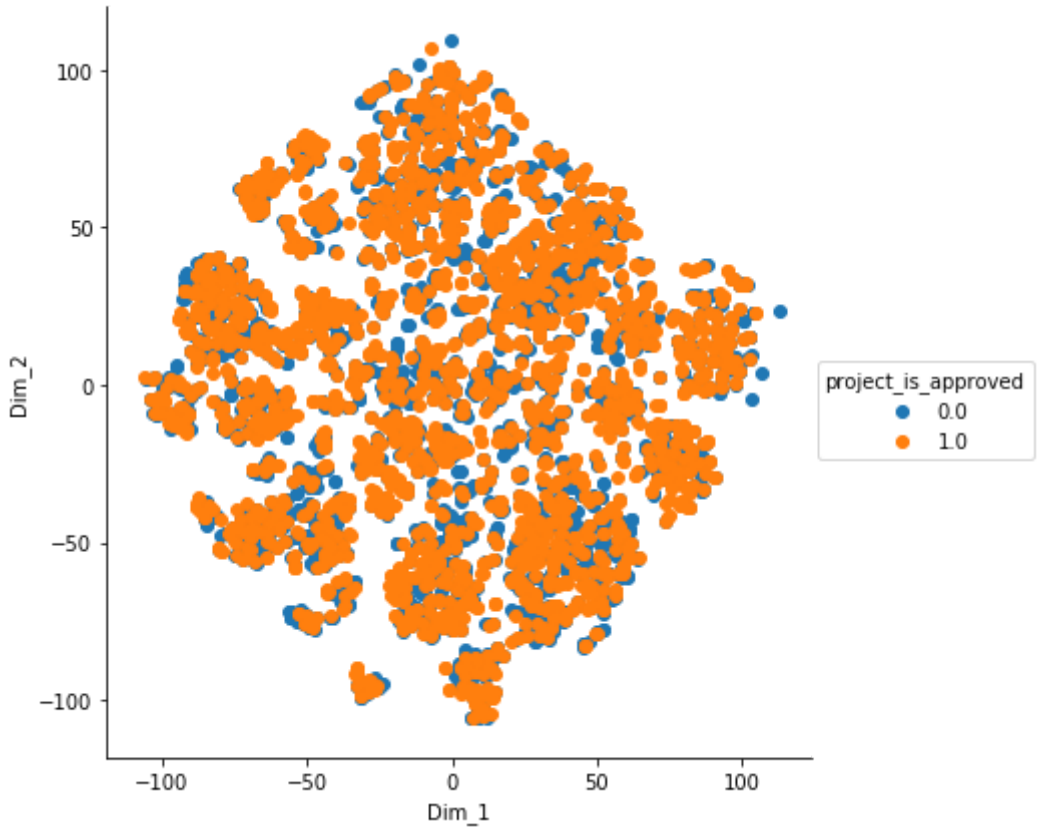
Out[115]:

```
(5000, 150)
```

3.4.2 T-SNE plots for various values of perplexity & iterations .

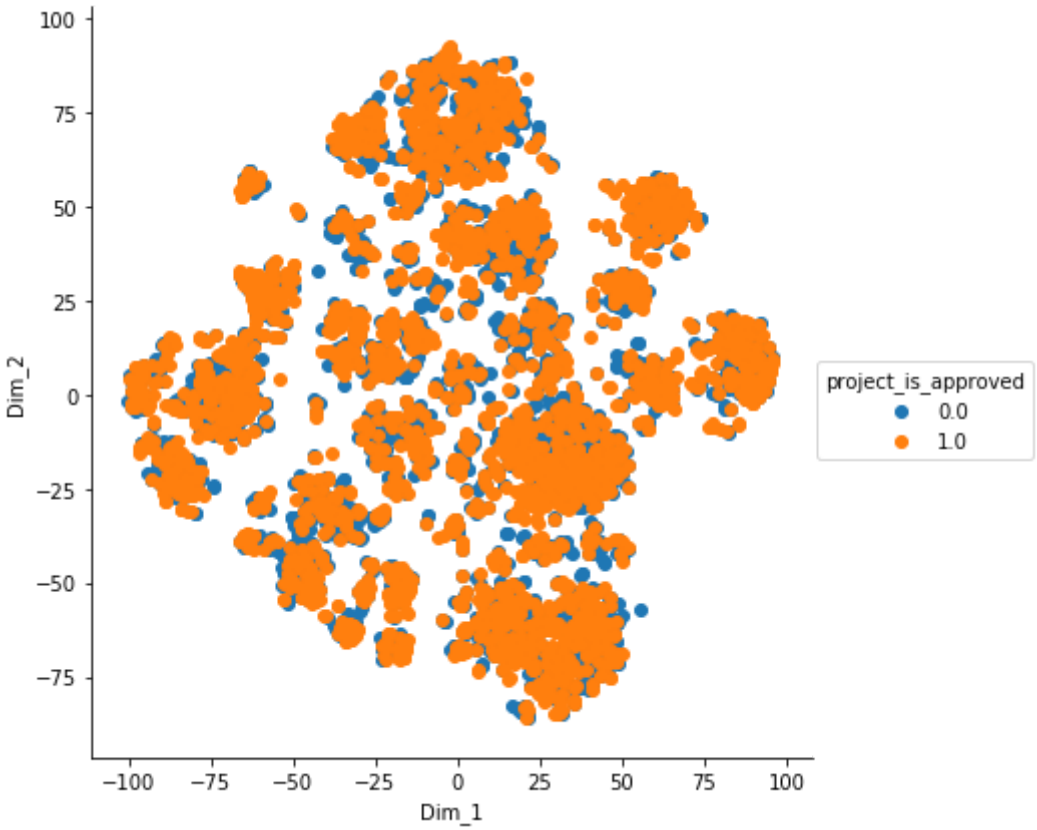
In [187]:

```
#perplexity=10 & step=1000
model = TSNE(n_components=2, random_state=0, perplexity=10, n_iter=1000)
tsne_data = model.fit_transform(X3.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



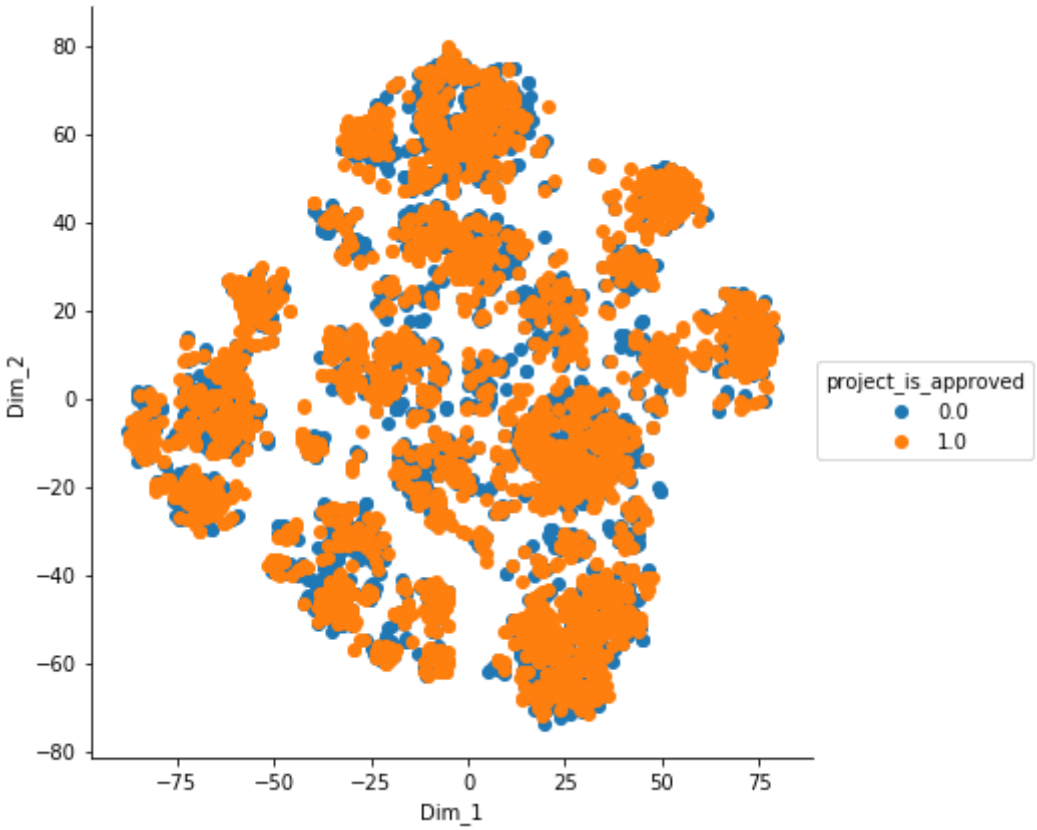
In [188]:

```
#perplexity=30 & step=1500
model = TSNE(n_components=2, random_state=0, perplexity=30, n_iter=1500)
tsne_data = model.fit_transform(X3.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



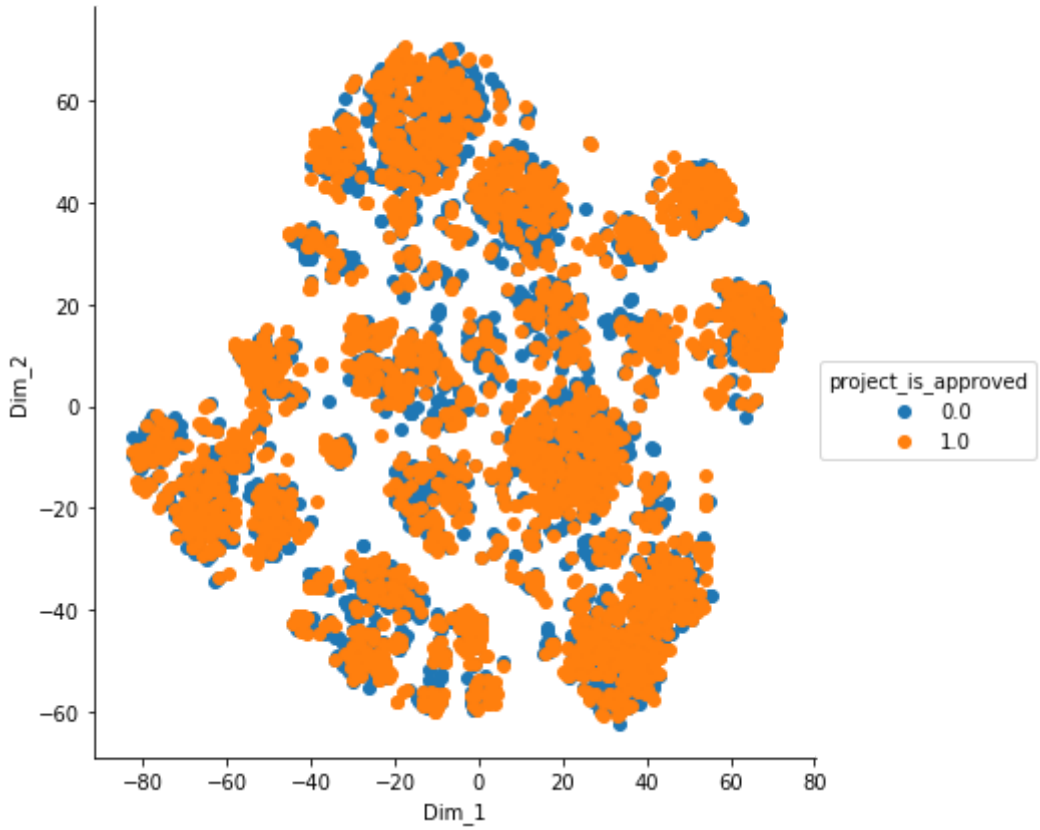
In [189]:

```
#perplexity=50 & step=2000
model = TSNE(n_components=2, random_state=0, perplexity=50, n_iter=2000)
tsne_data = model.fit_transform(X3.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



In [190]:

```
#perplexity=60 & step=2500
model = TSNE(n_components=2, random_state=0, perplexity=60, n_iter=2500)
tsne_data = model.fit_transform(X3.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



3.5 TSNE on all categorical, numerical & text features (project_title)

3.5.1 Final data matrix:

In [116]:

```
from scipy.sparse import hstack

final = hstack((categories_one_hot, sub_categories_one_hot,school_state_one_hot,project
_grade_category_one_hot,teacher_prefix_one_hot,title_bow,title_tfidf,a,b,price_standard
ized,previousprojects_standardized))
final.shape
```

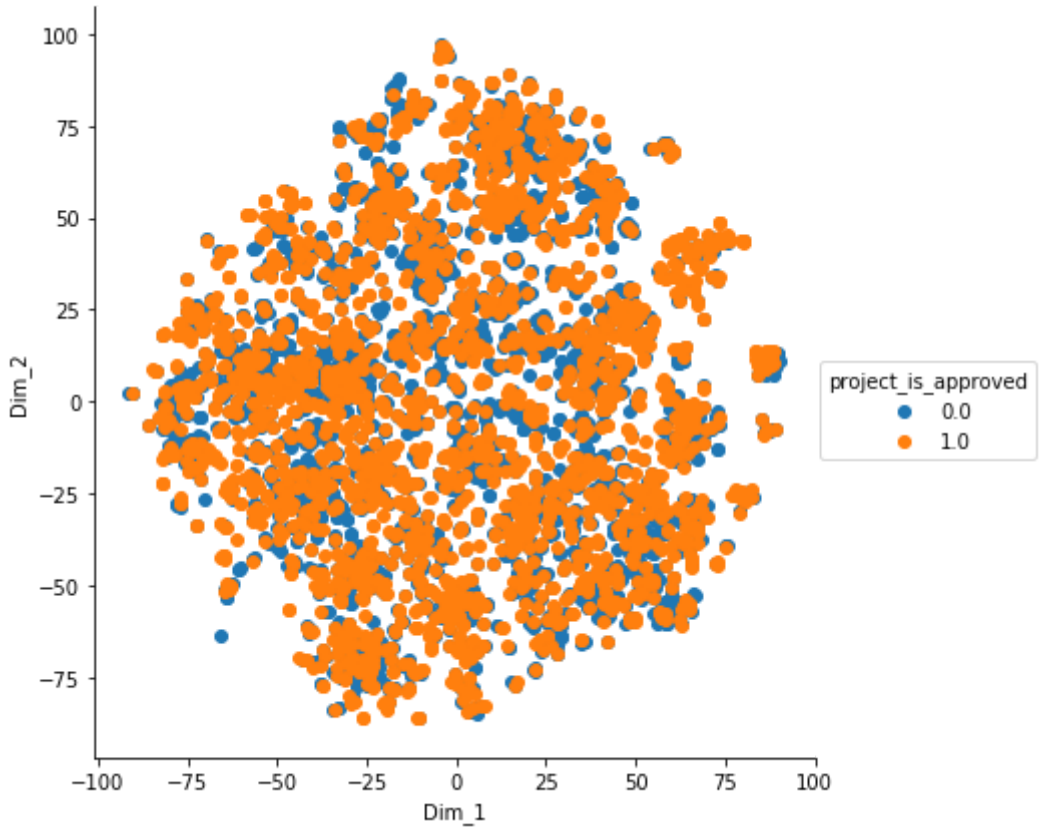
Out[116]:

```
(5000, 938)
```

3.5.2 T-SNE plots for various values of perplexity & iterations.

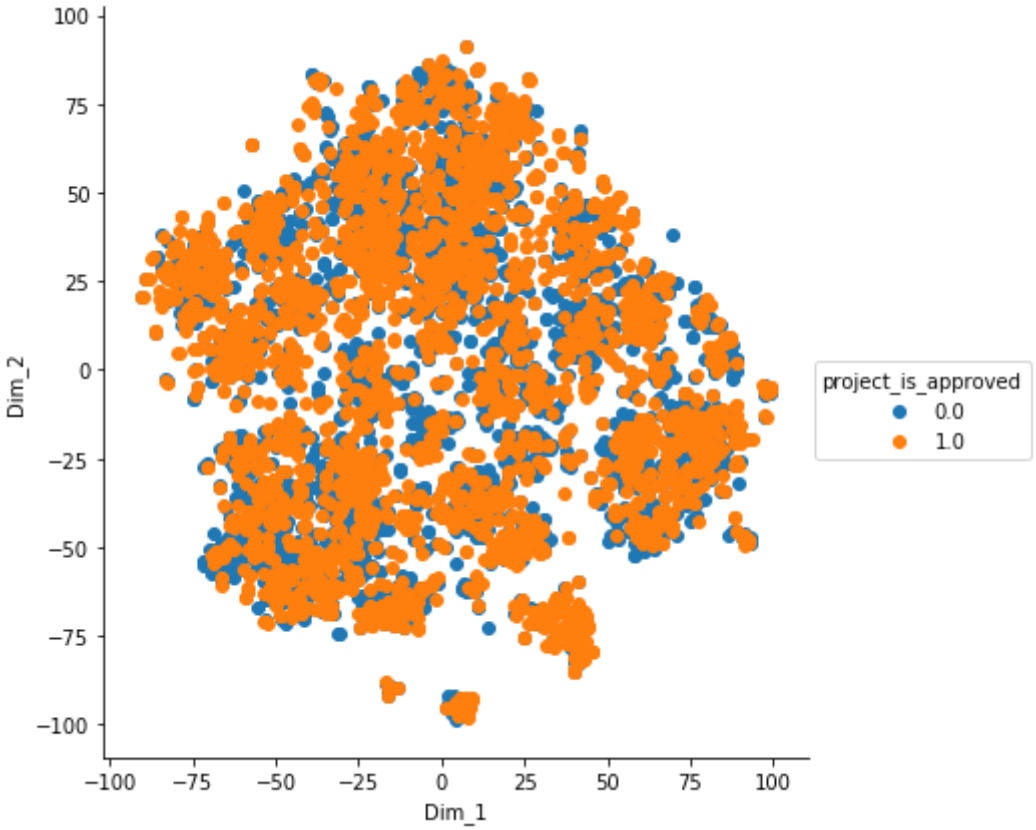
In [194]:

```
#perplexity=5 & step=1000
model = TSNE(n_components=2, random_state=0, perplexity=5, n_iter=1000)
tsne_data = model.fit_transform(final.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



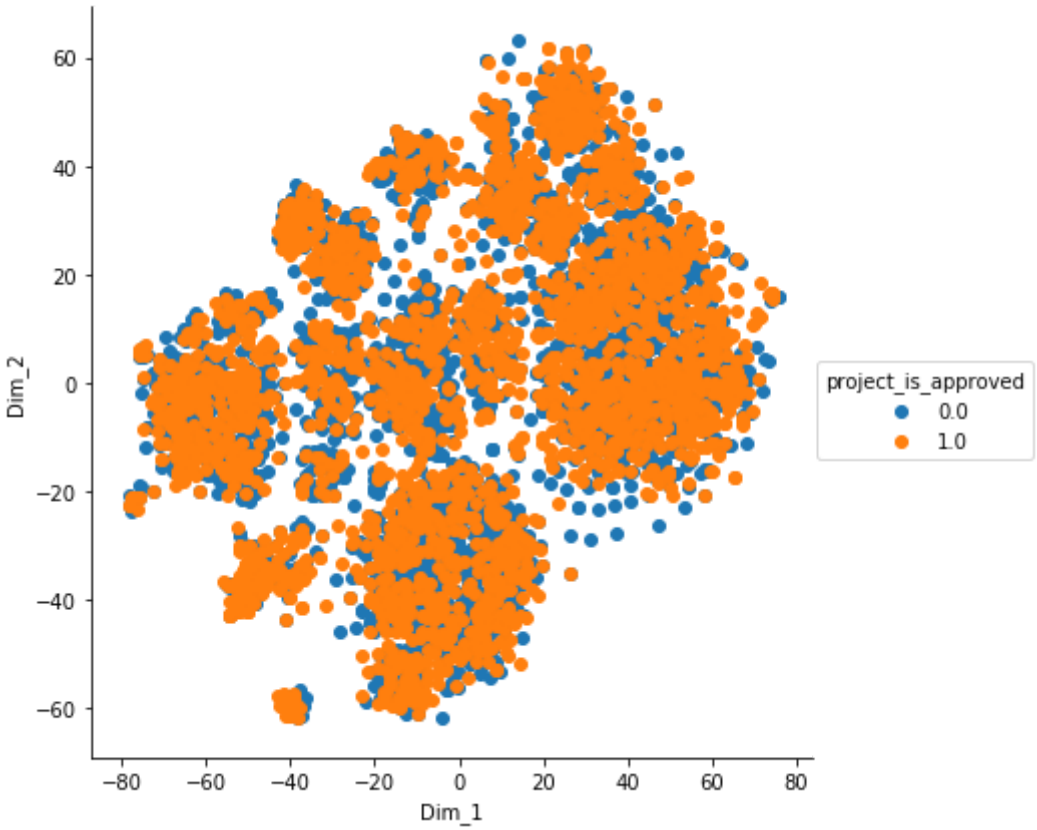
In [195]:

```
#perplexity=10 & step=1500
model = TSNE(n_components=2, random_state=0, perplexity=10, n_iter=1500)
tsne_data = model.fit_transform(final.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



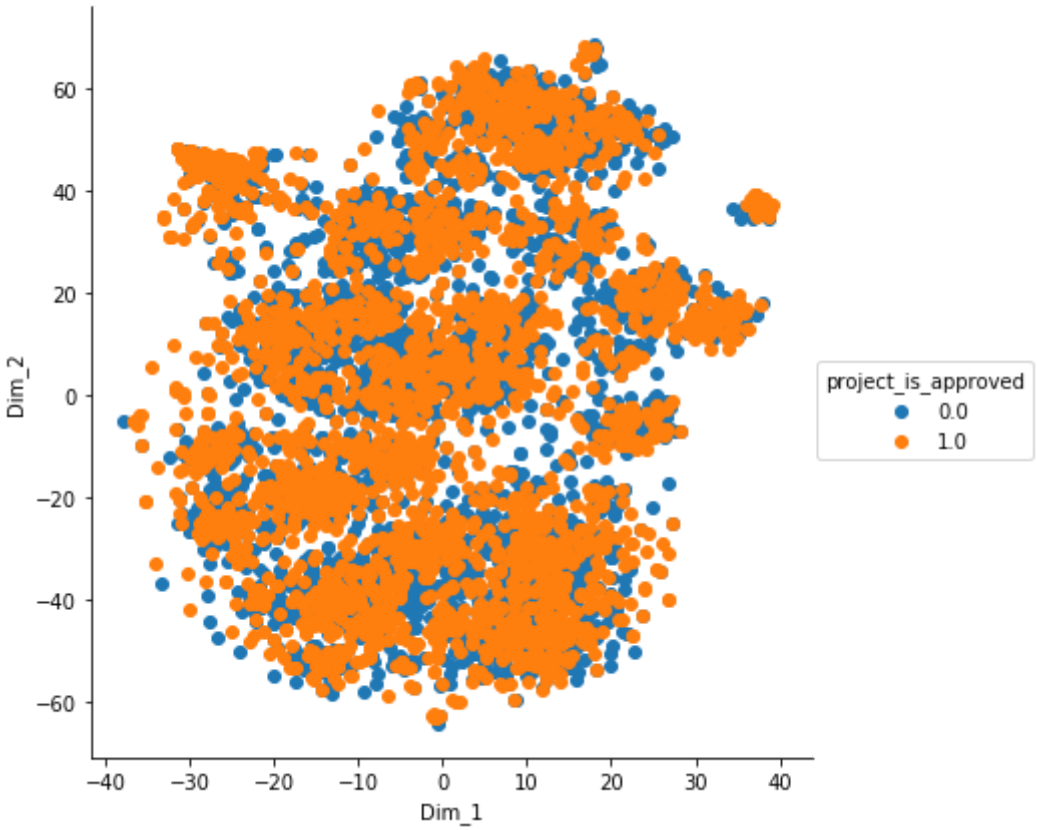
In [196]:

```
#perplexity=30 & step=2000
model = TSNE(n_components=2, random_state=0, perplexity=30, n_iter=2000)
tsne_data = model.fit_transform(final.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



In [197]:

```
#perplexity=50 & step=2500
model = TSNE(n_components=2, random_state=0, perplexity=50, n_iter=2500)
tsne_data = model.fit_transform(final.toarray())
tsne_data = np.vstack((tsne_data.T, data_5K['project_is_approved'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2","project_is_approved"
))
sns.FacetGrid(tsne_df, hue="project_is_approved", size=6).map(plt.scatter, 'Dim_1', 'Di
m_2').add_legend()
plt.show()
```



3.6 SUMMARY:

1. T-SNE plots: From all the 5 t-SNE plots with variety in perplexity & iterations, it can be concluded that a clear separation (i.e. by drawing a linear plane) of approved & not approved projects could not be obtained using all the featurizations. Hence a classification model for 5K train examples cannot be built using the visual results of t-SNE. Maybe, applying t-SNE on top of essays and with more train examples can result in clustering of the 2 groups.
2. Key takeaways from the data set in sum:
    - Any project submitted from state Delaware(DE),the likelihood of the project being approved is high
    - Projects submitted by Married women teachers (Mrs) had a higher chance of getting approved
    - Any project related to Warmth Care & Hunger had the highest acceptance rate although the total number of projects in this category was the least.
    - More the words in project titles & essays, greater was the acceptance rate of the projects.
    - More the number of projects submitted previously by teachers, the higher is the chance of that project being approved.