Logistic Regression on DonorsChoose

In [1]:

```
%matplotlib inline
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.neighbors import KNeighborsClassifier

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

import time
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')
resources_data = pd.read_csv('./resources.csv')
print(project_data.shape)
print(project_data.columns.values)
```

```
(109248, 17)
['Unnamed: 0' 'id' 'teacher_id' 'teacher_prefix' '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']
```

In [3]:

```
# how to replace elements in list python: https://stackoverflow.com/a/2582163/4084039
cols = ['Date' if x == 'project_submitted_datetime' else x for x in list(project_data.columns)]
```

```
#sort dataframe based on time pandas python: https://stackoverflow.com/a/49702492/4084039
project_data['Date'] = pd.to_datetime(project_data['project_submitted_datetime'])
project_data.drop('project_submitted_datetime', axis=1, inplace=True)
project_data.sort_values(by=['Date'], inplace=True)

# how to reorder columns pandas python: https://stackoverflow.com/a/13148611/4084039
project_data = project_data[cols]

project_data.head(2)
```

Out[3]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	Date	project_grade_category	project_
55660	8393	p205479	2bf07ba08945e5d8b2a3f269b2b3cfe5	Mrs.	CA	2016-04-27 00:27:36	Grades PreK-2	
76127	37728	p043609	3f60494c61921b3b43ab61bdde2904df	Ms.	UT	2016-04-27 00:31:25	Grades 3-5	

In [4]:

```
print(resources_data.shape)
print(resources_data.columns.values)
```

```
(1541272, 4)
['id' 'description' 'quantity' 'price']
```

In [5]:

```
price_data = resources_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_index()
project_data = pd.merge(project_data, price_data, on='id', how='left')
```

1.2 Preprocessing of project_subject_categories

In [6]:

```
catogories = list(project_data['project_subject_categories'].values)
# remove special characters from list of strings python:
https://stackoverflow.com/a/47301924/4084039

# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from-a-string
# https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-in-python
cat_list = []
for i in catogories:
    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", "Warmth", "Care & H
unger"]
        if 'The' in j.split(): # this will split each of the catogory based on space "Math & Scienc
e"=> "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) ex:"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())

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

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

```
cat_dict = dict(my_counter)
sorted_cat_dict = dict(sorted(cat_dict.items(), key=lambda kv: kv[1]))
```

1.3 Preprocessing of project_subject_subcategories

In [7]:

```
sub_catogories = list(project_data['project_subject_subcategories'].values)
# remove special characters from list of strings python:
https://stackoverflow.com/a/47301924/4084039

# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from-a-string
# https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-in-python

sub_cat_list = []
for i in sub_catogories:
    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", "Warmth", "Care & H
unger"]
        if 'The' in j.split(): # this will split each of the catogory based on space "Math & Scienc
e"=> "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) ex:"Math &
Science"=>"Math&Science"
        temp +=j.strip()+" "#" abc ".strip() will return "abc", remove the trailing spaces
        temp = temp.replace('&','_')
    sub_cat_list.append(temp.strip())

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

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

sub_cat_dict = dict(my_counter)
sorted_sub_cat_dict = dict(sorted(sub_cat_dict.items(), key=lambda kv: kv[1]))
```

1.4 Text Preprocessing of essays

In [8]:

```
# merge two column text dataframe:
project_data["essays"] = 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)
project_data['essays'][2000]
```

Out[8]:

```
'\\"Creativity is intelligence having fun.\\" --Albert Einstein. Our elementary library at
Greenville Elementary is anything but a quiet, hushed space. It\'s a place for collaboration and r
esearch. It\'s a place for incorporating technology. It\'s a place for innovation. And it\'s a pla
ce for creating.Our school serves 350 third and fourth graders who primarily live in rural and pov
erty-stricken areas in our community. Being a Title I school, approximately 85% of them receive
free or reduced lunch. But they are inquisitive, creative, and eager to learn. They love visiting
the library to check out books, hear \\r\\nstories, create digital stories, and use the computer l
ab for learning and fun. We want to build our library\'s Makerspace with activities revolving arou
nd art and literacy to provide more engaging, hands-on activities.We want to begin \\"Makerspace F
ridays!\\" Our school recently received a $1000 grant for books for our arts-integrated
Makerspace. We have received titles such as \\"Origami for Everyone,\\" \\"How to Make Stuff with
Ducktape,\\" and \\"Cool Engineering Activities for Girls.\\"  We now need supplies to correlate w
ith these new informational texts. By adding these art and craft supplies, students will be able t
o design and create masterpieces related to their coursework. \\r\\n\\r\\nFor example, while
studying Native Americans, students can use the looms and yarn to recreate Navajo and/or Pueblo we
aving. Weaving can also be integrated with literacy through Greek mythology and the story of
```

```
Arachne.\\r\\n\\r\\nCreating art with perler beads has many possibilities! Students can design the
ir own animals after studying their characteristics. They can use symmetry and patterning to creat
e one-of-a-kind originals. \\r\\n\\r\\nOrigami reinforces geometry, thinking skills, fractions, pr
oblem-solving, and just fun science!Our students need to be able to apply what they read and learn
. If they read a how-to book, they will apply that reading through a hands-on art activity and act
ually create a product. This is a crucial skill in the real world. By creating and designing their
own masterpieces, they are using many critical thinking skills. Students will become more
analytical thinkers.'
```

In [9]:

```python
# https://stackoverflow.com/questions/19790188/expanding-english-language-contractions-in-python/4
7091490#47091490

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 [10]:

```python
# https://gist.github.com/sebleier/554280

stopwords= set(['br', 'the', 'i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', "y
ou're", "you've",\
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him', 'his',
'himself', \
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 'they', 'them',
'their',\
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "that'll",
'these', 'those', \
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'had', 'having',
'do', 'does', \
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as', 'until', '
while', 'of', \
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through', 'during',
'before', 'after',\
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'over', 'under'
, 'again', 'further',\
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'any', 'both', 'e
ach', 'few', 'more',\
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too', 'very', \
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'now', 'd', 'll'
, 'm', 'o', 're', \
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't", 'doesn', "do
esn't", 'hadn',\
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'mightn',
"mightn't", 'mustn',\
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'wasn',
"wasn't", 'weren', "weren't", \
            'won', "won't", 'wouldn', "wouldn't"])
```

In [11]:

```python
# https://stackoverflow.com/questions/5843518/remove-all-special-characters-punctuation-and-spaces
-from-string/5843547#5843547

from bs4 import BeautifulSoup
from tqdm import tqdm

preprocessed_essays = [];
```

```
for sentence in tqdm(project_data['essays'].values):
    sentence = re.sub(r"http\S+", '',sentence)
    sentence = BeautifulSoup(sentence, 'lxml').get_text()
    sentence = decontracted(sentence)
    sentence = re.sub("\S*\d\S*", '', sentence).strip()
    sentence = re.sub('[^A-Za-z0-9]+',' ', sentence)
    sentence = ' '.join(e.lower() for e in sentence.split() if e.lower() not in stopwords)
    preprocessed_essays.append(sentence)
```

```
100%|██████████| 109248/109248 [01:12<00:00, 1504.71it/s]
```

1.5 Text Preprocessing of project_title

In [12]:

```
preprocessed_titles = [];
for sentence in tqdm(project_data['project_title'].values):
    sentence = re.sub(r"http\S+", '',sentence)
    sentence = BeautifulSoup(sentence, 'lxml').get_text()
    sentence = decontracted(sentence)
    sentence = re.sub("\S*\d\S*", '', sentence).strip()
    sentence = re.sub('[^A-Za-z0-9]+',' ', sentence)
    sentence = ' '.join(e.lower() for e in sentence.split() if e.lower() not in stopwords)
    preprocessed_titles.append(sentence)
```

```
100%|██████████| 109248/109248 [00:29<00:00, 3761.00it/s]
```

In [13]:

```
project_data['clean_essays'] = preprocessed_essays
project_data.drop(['project_essay_1'], axis=1, inplace=True)
project_data.drop(['project_essay_2'], axis=1, inplace=True)
project_data.drop(['project_essay_3'], axis=1, inplace=True)
project_data.drop(['project_essay_4'], axis=1, inplace=True)
```

In [14]:

```
project_data['clean_titles'] = preprocessed_titles

#https://stackoverflow.com/questions/42224700/attributeerror-float-object-has-no-attribute-split
project_data['teacher_prefix'] = project_data['teacher_prefix'].fillna('null')
```

1.6 Preprocessing of Teacher Prefix

In [15]:

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

Out[15]:

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

1.7 Computing Sentiment Scores

In [16]:

```
import nltk
from nltk.sentiment.vader import SentimentIntensityAnalyzer

sid = SentimentIntensityAnalyzer()
sentiment_scores = []

for essay in project_data['clean_essays']:
    ss = sid.polarity_scores(essay)
    sentiment_scores.append(ss)
    sentiment_scores.append(ss)

neg_sentiment_score = []
neu_sentiment_score = []
pos_sentiment_score = []
comp_sentiment_score = []

for item in sentiment_scores:
    neg_sentiment_score.append(item['neg'])
    neu_sentiment_score.append(item['neu'])
    pos_sentiment_score.append(item['pos'])
    comp_sentiment_score.append(item['compound'])
```

In [17]:

```
project_data['essays_neg_score'] = neg_sentiment_score
project_data['essays_neu_score'] = neu_sentiment_score
project_data['essays_pos_score'] = pos_sentiment_score
project_data['essays_comp_score'] = comp_sentiment_score
```

1.8 Computing number of words in essays and titles

In [18]:

```
essay_word_count = project_data['clean_essays'].str.split().apply(len)
title_word_count = project_data['clean_titles'].str.split().apply(len)
project_data['clean_essays_word_count'] = essay_word_count
project_data['clean_titles_word_count'] = title_word_count
```

2. Splitting the data

In [19]:

```
y = project_data['project_is_approved'].values
project_data.drop(['project_is_approved'], axis=1, inplace=True)
x = project_data
```

In [20]:

```
# https://scikit-learn.org/stable/modules/generated/sklearn.model_selection.train_test_split.html
from sklearn.model_selection import train_test_split

x_train, x_test, y_train, y_test = train_test_split(x,y,test_size=0.33,stratify=y)

print(x_train.shape, y_train.shape)
print(x_test.shape, y_test.shape)
```

```
(73196, 23) (73196,)
(36052, 23) (36052,)
```

3. Preparing data for model

In [21]:

```
project_data.columns
```

Out[21]:

```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
       'Date', 'project_grade_category', 'project_title',
       'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'quantity', 'price',
       'clean_categories', 'clean_subcategories', 'essays', 'clean_essays',
       'clean_titles', 'essays_neg_score', 'essays_neu_score',
       'essays_pos_score', 'essays_comp_score', 'clean_essays_word_count',
       'clean_titles_word_count'],
      dtype='object')
```

We are going to consider only the following features :-

1. Categorical Data
    - teacher_prefix
    - school_state
    - project_grade_category
    - clean_categories
    - cleaned_subcategories

1. Text Data
    - project_title
    - Essays
    - project_resources

1. Numerical Data
    - price
    - quantity
    - teacher_number_of_previously_posted_projects
    - resource_summary_contains_number
    - clean_essays_word_count
    - clean_titles_word_count
    - essays_neg_score
    - essays_neu_score
    - essays_pos_score
    - essays_comp_score

3.1 Vectorizing Categorical Data

1. Clean Categories

In [22]:

```
proj_cat_vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict.keys()), lowercase=False, binary=True)
x_train_categories_one_hot = proj_cat_vectorizer.fit_transform(x_train['clean_categories'].values)
# x_cv_categories_one_hot = proj_cat_vectorizer.fit_transform(x_cv['clean_categories'].values)
x_test_categories_one_hot = proj_cat_vectorizer.fit_transform(x_test['clean_categories'].values)
print(x_train_categories_one_hot.shape)
# print(x_cv_categories_one_hot.shape)
print(x_test_categories_one_hot.shape)
```

```
(73196, 9)
(36052, 9)
```

2. Clean Subcategories

In [23]:

```
proj_subcat_vectorizer = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=False, binary=True)
x_train_subcategories_one_hot = proj_subcat_vectorizer.fit_transform(x_train['clean_categories'].values)
# x_cv_subcategories_one_hot = proj_subcat_vectorizer.fit_transform(x_cv['clean_categories'].values)
x_test_subcategories_one_hot = proj_subcat_vectorizer.fit_transform(x_test['clean_categories'].values)
print(x_train_subcategories_one_hot.shape)
# print(x_cv_subcategories_one_hot.shape)
print(x_test_subcategories_one_hot.shape)
```

```
(73196, 30)
(36052, 30)
```

3. Project Grade Category

In [24]:

```
my_counter = Counter()
for word in project_data['project_grade_category'].values:
    my_counter.update(word.split())
project_grade_cat_dict = dict(my_counter)
```

In [25]:

```
# https://stackoverflow.com/questions/4406501/change-the-name-of-a-key-in-dictionary

project_grade_cat_dict['Grades PreK-2'] = project_grade_cat_dict['PreK-2']
project_grade_cat_dict['Grades 6-8'] = project_grade_cat_dict['6-8']
project_grade_cat_dict['Grades 3-5'] = project_grade_cat_dict['3-5']
project_grade_cat_dict['Grades 9-12'] = project_grade_cat_dict['9-12']
del project_grade_cat_dict['Grades']
del project_grade_cat_dict['PreK-2']
del project_grade_cat_dict['6-8']
del project_grade_cat_dict['3-5']
del project_grade_cat_dict['9-12']
project_grade_cat_dict_sort = dict(sorted(project_grade_cat_dict.items(), key = lambda kv: kv[1]))
```

In [26]:

```
project_grade_vectorizer = CountVectorizer(vocabulary=list(project_grade_cat_dict_sort.keys()), lo
wercase=False, binary=True)

x_train_project_grade_categories_one_hot =
project_grade_vectorizer.fit_transform(x_train['project_grade_category'].values)
# x_cv_project_grade_categories_one_hot =
project_grade_vectorizer.fit_transform(x_cv['project_grade_category'].values)
x_test_project_grade_categories_one_hot =
project_grade_vectorizer.fit_transform(x_test['project_grade_category'].values)
print(x_train_project_grade_categories_one_hot.shape)
# print(x_cv_project_grade_categories_one_hot.shape)
print(x_test_project_grade_categories_one_hot.shape)
```

```
(73196, 4)
(36052, 4)
```

4. Teacher Prefix

In [27]:

```
my_counter = Counter()
for word in project_data['teacher_prefix'].values:
    if str(word) != 'null':
        my_counter.update(str(word).split())
teacher_prefix_dict = dict(my_counter)
teacher_prefix_dict_sort = dict(sorted(teacher_prefix_dict.items(), key = lambda kv: kv[1]))
teacher_prefix_dict_sort.items()
```

Out[27]:

```
dict_items([('Mrs.', 57269), ('Ms.', 38955), ('Dr.', 13), ('Teacher', 2360), ('Mr.', 10648)])
```

In [28]:

```
#https://stackoverflow.com/questions/39303912/tfidfvectorizer-in-scikit-learn-valueerror-np-nan-is
-an-invalid-document

teacher_prefix_vectorizer = CountVectorizer(vocabulary=list(teacher_prefix_dict_sort.keys()), lowe
rcase=False, binary=True)
x_train_teacher_prefix_one_hot = teacher_prefix_vectorizer.fit_transform(x_train['teacher_prefix']
.values.astype('U'))
# x_cv_teacher_prefix_one_hot =
teacher_prefix_vectorizer.fit_transform(x_cv['teacher_prefix'].values.astype('U'))
x_test_teacher_prefix_one_hot =
teacher_prefix_vectorizer.fit_transform(x_test['teacher_prefix'].values.astype('U'))
print(x_train_teacher_prefix_one_hot.shape)
# print(x_cv_teacher_prefix_one_hot.shape)
print(x_test_teacher_prefix_one_hot.shape)
```

```
(73196, 5)
(36052, 5)
```

5. School State

In [29]:

```
my_counter = Counter()
for word in project_data['school_state'].values:
    my_counter.update(word.split())
school_state_dict = dict(my_counter)
school_state_dict_sort = dict(sorted(school_state_dict.items(), key = lambda kv: kv[1]))
```

In [30]:

```
school_state_vectorizer = CountVectorizer(vocabulary=list(school_state_dict_sort.keys()),
lowercase=False, binary=True)
x_train_school_state_one_hot =
school_state_vectorizer.fit_transform(x_train['school_state'].values.astype('U'))
# x_cv_school_state_one_hot =
school_state_vectorizer.fit_transform(x_cv['school_state'].values.astype('U'))
x_test_school_state_one_hot = school_state_vectorizer.fit_transform(x_test['school_state'].values.a
stype('U'))
print(x_train_school_state_one_hot.shape)
# print(x_cv_school_state_one_hot.shape)
print(x_test_school_state_one_hot.shape)
```

```
(73196, 51)
(36052, 51)
```

3.2 Vectorizing Text Data

1. Essays

Bag of Words (BoW)

In [31]:

```
bow_vectorizer_essays = CountVectorizer(min_df = 10, ngram_range=(1,2), max_features=5000)

x_train_essays_bow = bow_vectorizer_essays.fit_transform(x_train['clean_essays'])
# x_cv_essays_bow = bow_vectorizer_essays.transform(x_cv['clean_essays'])
x_test_essays_bow = bow_vectorizer_essays.transform(x_test['clean_essays'])
print(x_train_essays_bow.shape)
# print(x_cv_essays_bow.shape)
print(x_test_essays_bow.shape)
```

```
(73196, 5000)
(36052, 5000)
```

TFIDF Vectorizer

In [32]:

```
tfidf_vectorizer_essays = TfidfVectorizer(min_df = 10, ngram_range=(1,2), max_features=5000)

x_train_essays_tfidf = tfidf_vectorizer_essays.fit_transform(x_train['clean_essays'])
# x_cv_essays_tfidf = tfidf_vectorizer_essays.transform(x_cv['clean_essays'])
x_test_essays_tfidf = tfidf_vectorizer_essays.transform(x_test['clean_essays'])
print(x_train_essays_tfidf.shape)
```

```
# print(x_cv_essays_tfidf.shape)
print(x_test_essays_tfidf.shape)
```

```
(73196, 5000)
(36052, 5000)
```

Average Word2Vector (AVG W2V)

In [33]:

```
# Taking referrence from Amazon Fine Food Reviews

# essays_sentences = []
# for sentence in x_train['clean_essays']:
#     essays_sentences.append(sentence)
```

In [34]:

```
# essays_w2v_model = Word2Vec(essays_sentences, min_count=5, size=300, workers=5)
# essays_w2v_words = essays_w2v_model.wv.vocab
# essays_w2v_words
```

In [35]:

```
# x_train_essays_w2v_vectors = []

# for sent in tqdm(x_train['clean_essays']):
#     sent_vec= np.zeros(300)
#     count=0
#     for word in sent:
#         if word in essays_w2v_words:
#             vec = essays_w2v_model.wv[word]
#             sent_vec += vec
#             count += 1
#     if count != 0:
#         sent_vec /= count
#         x_train_essays_w2v_vectors.append(sent_vec)

# print(len(x_train_essays_w2v_vectors))
# print(len(x_train_essays_w2v_vectors[0]))

# # x_cv_essays_w2v_vectors = []

# # for sent in tqdm(x_cv['clean_essays']):
# #     sent_vec= np.zeros(300)
# #     count=0
# #     for word in sent:
# #         if word in essays_w2v_words:
# #             vec = essays_w2v_model.wv[word]
# #             sent_vec += vec
# #             count += 1
# #     if count != 0:
# #         sent_vec /= count
# #         x_cv_essays_w2v_vectors.append(sent_vec)

# # print(len(x_cv_essays_w2v_vectors))
# # print(len(x_cv_essays_w2v_vectors[0]))

# x_test_essays_w2v_vectors = []

# for sent in tqdm(x_test['clean_essays']):
#     sent_vec= np.zeros(300)
#     count=0
#     for word in sent:
#         if word in essays_w2v_words:
#             vec = essays_w2v_model.wv[word]
#             sent_vec += vec
#             count += 1
#     if count != 0:
#         sent_vec /= count
#         x_test_essays_w2v_vectors.append(sent_vec)
# print(len(x_test_essays_w2v_vectors))
# print(len(x_test_essays_w2v_vectors[0]))
```

TFIDF weighted W2V

In [36]:

```
# # Taking referrence from Amazon Fine Food Reviews

# model = TfidfVectorizer()
# model.fit(x_train['clean_essays'])
# essays_tfidf_dictionary = dict(zip(model.get_feature_names(), list(model.idf_)))
```

In [37]:

```
# essays_tfidf_words = set(model.get_feature_names())
# x_train_essays_tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this
list
# for sentence in tqdm(x_train['clean_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 essays_w2v_words) and (word in essays_tfidf_words):
#             vec = w2v_model.wv[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 = essays_tfidf_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
#     x_train_essays_tfidf_w2v_vectors.append(vector)

# print(len(x_train_essays_tfidf_w2v_vectors))
# print(len(x_train_essays_tfidf_w2v_vectors[0]))

# x_cv_essays_tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this lis
t
# for sentence in tqdm(x_cv['clean_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 essays_w2v_words) and (word in essays_tfidf_words):
#             vec = w2v_model.wv[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 = essays_tfidf_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
#     x_cv_essays_tfidf_w2v_vectors.append(vector)

# print(len(x_cv_essays_tfidf_w2v_vectors))
# print(len(x_cv_essays_tfidf_w2v_vectors[0]))

# x_test_essays_tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this l
ist
# for sentence in tqdm(x_test['clean_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 essays_w2v_words) and (word in essays_tfidf_words):
#             vec = w2v_model.wv[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 = essays_tfidf_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
#     x_test_essays_tfidf_w2v_vectors.append(vector)

# print(len(x_test_essays_tfidf_w2v_vectors))
# print(len(x_test_essays_tfidf_w2v_vectors[0]))
```

2. Title

Bag of Words (Bow)

In [38]:

```
bow_vectorizer_title = CountVectorizer(min_df = 10)

x_train_titles_bow = bow_vectorizer_title.fit_transform(x_train['clean_titles'])
# x_cv_titles_bow = bow_vectorizer_title.transform(x_cv['clean_titles'])
x_test_titles_bow = bow_vectorizer_title.transform(x_test['clean_titles'])
print(x_train_titles_bow.shape)
# print(x_cv_titles_bow.shape)
print(x_test_titles_bow.shape)
```

```
(73196, 2523)
(36052, 2523)
```

TFIDF Vectorizer

In [39]:

```
tfidf_vectorizer_title = TfidfVectorizer(min_df = 10)

x_train_titles_tfidf = tfidf_vectorizer_title.fit_transform(x_train['clean_titles'])
# x_cv_titles_tfidf = tfidf_vectorizer_title.transform(x_cv['clean_titles'])
x_test_titles_tfidf = tfidf_vectorizer_title.transform(x_test['clean_titles'])
print(x_train_titles_tfidf.shape)
# print(x_cv_titles_tfidf.shape)
print(x_test_titles_tfidf.shape)
```

```
(73196, 2523)
(36052, 2523)
```

Average Word2Vector (W2V)

In [40]:

```
# # Taking referrence from Amazon Fine Food Reviews

# titles_sentences = []
# for sentence in x_train['clean_titles']:
#     titles_sentences.append(sentence)
```

In [41]:

```
# titles_w2v_model = Word2Vec(titles_sentences, min_count=1, size=300, workers=5)
# titles_w2v_words = titles_w2v_model.wv.vocab
```

In [42]:

```
# x_train_titles_w2v_vectors = []

# for sent in tqdm(x_train['clean_titles']):
#     sent_vec= np.zeros(300)
#     count=0
#     for word in sent:
#         if word in titles_w2v_words:
#             vec = titles_w2v_model.wv[word]
#             sent_vec += vec
#             count += 1
#     if count != 0:
#         sent_vec /= count
#         x_train_titles_w2v_vectors.append(sent_vec)

# print(len(x_train_titles_w2v_vectors))
# print(len(x_train_titles_w2v_vectors[0]))

# x_cv_titles_w2v_vectors = []

# for sent in tqdm(x_cv['clean_titles']):
#     sent_vec= np.zeros(300)
#     count=0
#     for word in sent:
#         if word in titles_w2v_words:
#             vec = titles_w2v_model.wv[word]
#             sent_vec += vec
#             count += 1
#     if count != 0:
#         sent_vec /= count
#         x_cv_titles_w2v_vectors.append(sent_vec)

# print(len(x_cv_titles_w2v_vectors))
# print(len(x_cv_titles_w2v_vectors[0]))

# x_test_titles_w2v_vectors = []

# for sent in tqdm(x_test['clean_titles']):
#     sent_vec= np.zeros(300)
#     count=0
#     for word in sent:
#         if word in titles_w2v_words:
#             vec = titles_w2v_model.wv[word]
#             sent_vec += vec
#             count += 1
#     if count != 0:
#         sent_vec /= count
#         x_test_titles_w2v_vectors.append(sent_vec)

# print(len(x_test_titles_w2v_vectors))
# print(len(x_test_titles_w2v_vectors[0]))
```

TFIDF weighted W2V

In [43]:

```
# # Taking referrence from Amazon Fine Food Reviews

# model = TfidfVectorizer()
# model.fit(x_train['clean_titles'])
# titles_tfidf_dictionary = dict(zip(model.get_feature_names(), list(model.idf_)))
```

In [44]:

```
# titles_tfidf_words = set(model.get_feature_names())
# x_train_titles_tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this
list
# for sentence in tqdm(x_train['clean_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 titles_w2v_words) and (word in titles_tfidf_words):
#             vec = w2v_model.wv[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 = titles_tfidf_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
#     x_train_titles_tfidf_w2v_vectors.append(vector)

# print(len(x_train_titles_tfidf_w2v_vectors))
# print(len(x_train_titles_tfidf_w2v_vectors[0]))
# print(len(x_train_titles_tfidf_w2v_vectors[0]))

# x_cv_titles_tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this lis
t
# for sentence in tqdm(x_cv['clean_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 titles_w2v_words) and (word in titles_tfidf_words):
#             vec = w2v_model.wv[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 = titles_tfidf_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
#     x_cv_titles_tfidf_w2v_vectors.append(vector)

# print(len(x_cv_titles_tfidf_w2v_vectors))
# print(len(x_cv_titles_tfidf_w2v_vectors[0]))

# x_test_titles_tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this l
ist
# for sentence in tqdm(x_test['clean_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 titles_w2v_words) and (word in titles_tfidf_words):
#             vec = w2v_model.wv[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 = titles_tfidf_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
#     x_test_titles_tfidf_w2v_vectors.append(vector)

# print(len(x_test_titles_tfidf_w2v_vectors))
# print(len(x_test_titles_tfidf_w2v_vectors[0]))
```

3.3 Standardizing Numerical Data

1. Price

In [45]:

```
# https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html

from sklearn.preprocessing import StandardScaler

price_scalar = StandardScaler()
x_train_price_standardized = price_scalar.fit_transform(x_train['price'].values.reshape(-1,1))
# x_cv_price_standardized = price_scalar.transform(x_cv['price'].values.reshape(-1,1))
x_test_price_standardized = price_scalar.transform(x_test['price'].values.reshape(-1,1))
print(x_train_price_standardized.shape)
# print(x_cv_price_standardized.shape)
print(x_test_price_standardized.shape)
```

```
(73196, 1)
(36052, 1)
```

In [46]:

```
from sklearn.preprocessing import Normalizer

price_normalizer = Normalizer()

x_train_price_normalized = price_normalizer.fit_transform(x_train['price'].values.reshape(-1,1))
# x_cv_price_normalized = price_normalizer.transform(x_cv['price'].values.reshape(-1,1))
# x_cv_price_normalized = price_normalizer.transform(x_cv['price'].values.reshape(-1,1))
x_test_price_normalized = price_normalizer.transform(x_test['price'].values.reshape(-1,1))

print(x_train_price_normalized)
# print(x_cv_price_normalized)
print(x_test_price_normalized)
```

```
[[1.]
 [1.]
 [1.]
 ...
 [1.]
 [1.]
 [1.]]
[[1.]
 [1.]
 [1.]
 ...
 [1.]
 [1.]
 [1.]]
```

2. Teacher Number of Previously Posted Projects

In [47]:

```
# https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html

from sklearn.preprocessing import StandardScaler

teacher_number_of_previously_posted_projects_scalar = StandardScaler()
x_train_teacher_number_of_previously_posted_projects_standardized =
teacher_number_of_previously_posted_projects_scalar.fit_transform(x_train['teacher_number_of_previo
usly_posted_projects'].values.reshape(-1,1))
# x_cv_teacher_number_of_previously_posted_projects_standardized =
teacher_number_of_previously_posted_projects_scalar.transform(x_cv['teacher_number_of_previously_po
_projects'].values.reshape(-1,1))
x_test_teacher_number_of_previously_posted_projects_standardized =
teacher_number_of_previously_posted_projects_scalar.transform(x_test['teacher_number_of_previously_
osted_projects'].values.reshape(-1,1))
print(x_train_teacher_number_of_previously_posted_projects_standardized.shape)
# print(x_cv_teacher_number_of_previously_posted_projects_standardized.shape)
print(x_test_teacher_number_of_previously_posted_projects_standardized.shape)
```

```
(73196, 1)
(36052, 1)
```

3. Clean Essays Word Count

In [48]:

```
# https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html

from sklearn.preprocessing import StandardScaler

clean_essays_word_count_scalar = StandardScaler()
x_train_clean_essays_word_count_standardized =
clean_essays_word_count_scalar.fit_transform(x_train['clean_essays_word_count'].values.reshape(-1,
1))
# x_cv_clean_essays_word_count_standardized =
clean_essays_word_count_scalar.transform(x_cv['clean_essays_word_count'].values.reshape(-1,1))
x_test_clean_essays_word_count_standardized = clean_essays_word_count_scalar.transform(x_test['cle
an_essays_word_count'].values.reshape(-1,1))
print(x_train_clean_essays_word_count_standardized.shape)
# print(x_cv_clean_essays_word_count_standardized.shape)
print(x_test_clean_essays_word_count_standardized.shape)
```

```
(73196, 1)
(36052, 1)
```

4. Clean Titles Word Count

In [49]:

```
# https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html

from sklearn.preprocessing import StandardScaler

clean_titles_word_count_scalar = StandardScaler()
x_train_clean_titles_word_count_standardized = clean_titles_word_count_scalar.fit_transform(x_train['clean_titles_word_count'].values.reshape(-1,1))
# x_cv_clean_titles_word_count_standardized = clean_titles_word_count_scalar.transform(x_cv['clean_titles_word_count'].values.reshape(-1,1))
x_test_clean_titles_word_count_standardized = clean_titles_word_count_scalar.transform(x_test['clean_titles_word_count'].values.reshape(-1,1))
print(x_train_clean_titles_word_count_standardized.shape)
# print(x_cv_clean_titles_word_count_standardized.shape)
print(x_test_clean_titles_word_count_standardized.shape)
```

```
(73196, 1)
(36052, 1)
```

5. Essay Sentiment Scores

In [50]:

```
from sklearn.preprocessing import StandardScaler

essays_comp_score_scalar = StandardScaler()
x_train_essays_comp_score_standardized = essays_comp_score_scalar.fit_transform(x_train['essays_comp_score'].values.reshape(-1,1))
# x_cv_essays_comp_score_standardized = essays_comp_score_scalar.transform(x_cv['essays_comp_score'].values.reshape(-1,1))
x_test_essays_comp_score_standardized = essays_comp_score_scalar.transform(x_test['essays_comp_score'].values.reshape(-1,1))
print(x_train_essays_comp_score_standardized.shape)
# print(x_cv_essays_comp_score_standardized.shape)
print(x_test_essays_comp_score_standardized.shape)
```

```
(73196, 1)
(36052, 1)
```

In [51]:

```
from sklearn.preprocessing import StandardScaler

essays_pos_score_scalar = StandardScaler()
x_train_essays_pos_score_standardized = essays_pos_score_scalar.fit_transform(x_train['essays_pos_score'].values.reshape(-1,1))
# x_cv_essays_pos_score_standardized = essays_pos_score_scalar.transform(x_cv['essays_pos_score'].values.reshape(-1,1))
x_test_essays_pos_score_standardized = essays_pos_score_scalar.transform(x_test['essays_pos_score'].values.reshape(-1,1))
print(x_train_essays_pos_score_standardized.shape)
# print(x_cv_essays_pos_score_standardized.shape)
print(x_test_essays_pos_score_standardized.shape)
```

```
(73196, 1)
(36052, 1)
```

In [52]:

```
from sklearn.preprocessing import StandardScaler

essays_neu_score_scalar = StandardScaler()
x_train_essays_neu_score_standardized = essays_neu_score_scalar.fit_transform(x_train['essays_neu_score'].values.reshape(-1,1))
# x_cv_essays_neu_score_standardized = essays_neu_score_scalar.transform(x_cv['essays_neu_score'].values.reshape(-1,1))
```

```
x_test_essays_neu_score_standardized = essays_neu_score_scalar.transform(x_test['essays_neu_score'
].values.reshape(-1,1))
print(x_train_essays_neu_score_standardized.shape)
# print(x_cv_essays_neu_score_standardized.shape)
print(x_test_essays_neu_score_standardized.shape)
```

```
(73196, 1)
(36052, 1)
```

In [53]:

```
from sklearn.preprocessing import StandardScaler

essays_neg_score_scalar = StandardScaler()
x_train_essays_neg_score_standardized =
essays_neg_score_scalar.fit_transform(x_train['essays_neg_score'].values.reshape(-1,1))
# x_cv_essays_neg_score_standardized =
essays_neg_score_scalar.transform(x_cv['essays_neg_score'].values.reshape(-1,1))
x_test_essays_neg_score_standardized = essays_neg_score_scalar.transform(x_test['essays_neg_score'
].values.reshape(-1,1))
print(x_train_essays_neg_score_standardized.shape)
# print(x_cv_essays_neg_score_standardized.shape)
print(x_test_essays_neg_score_standardized.shape)
```

```
(73196, 1)
(36052, 1)
```

Merging all Features to preapre the Data for Modelling

In [54]:

```
from scipy.sparse import hstack

x_tr = hstack((x_train_categories_one_hot,x_train_subcategories_one_hot,
               x_train_project_grade_categories_one_hot,x_train_teacher_prefix_one_hot,
               x_train_school_state_one_hot,x_train_price_standardized,
               x_train_essays_bow,x_train_titles_bow)).tocsr()

# x_cv =
hstack((x_cv_categories_one_hot,x_cv_subcategories_one_hot,x_cv_project_grade_categories_one_hot,
#
x_cv_teacher_prefix_one_hot,x_cv_school_state_one_hot,x_cv_price_standardized,x_cv_essays_bow,
#                x_cv_titles_bow)).tocsr()

x_te =
hstack((x_test_categories_one_hot,x_test_subcategories_one_hot,x_test_project_grade_categories_one_
ot,
               x_test_teacher_prefix_one_hot,x_test_school_state_one_hot,x_test_price_standardized,
x_test_essays_bow,
               x_test_titles_bow)).tocsr()


print("Final Data matrix")
print(x_tr.shape, y_train.shape)
# print(x_cv.shape, y_cv.shape)
print(x_te.shape, y_test.shape)
```

```
Final Data matrix
(73196, 7623) (73196,)
(36052, 7623) (36052,)
```

Dimensionality Reduction on the selected features

In [55]:

```
from sklearn.feature_selection import SelectKBest, f_classif
t = SelectKBest(f_classif,k=5000).fit(x_tr, y_train)
x_tr = t.transform(x_tr)
x_te = t.transform(x_te)
x_te = t.transform(x_te)

print("Final Data matrix on TFIDF")
print(x_tr.shape, y_train.shape)

print(x_te.shape, y_test.shape)
print("="*100)
```

```
Final Data matrix on TFIDF
(73196, 5000) (73196,)
(36052, 5000) (36052,)
====================================================================================================
```

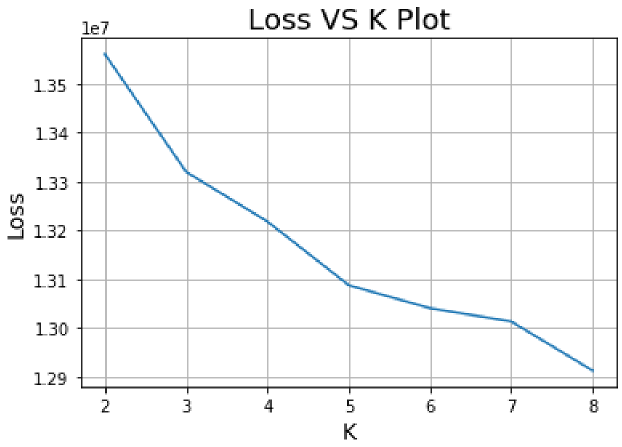
Apply K-Means

In [62]:

```
from sklearn.cluster import KMeans, MiniBatchKMeans

k_values = [2,3,4,5,6,7,8]
loss = []
for i in k_values:
    kmeans = MiniBatchKMeans(n_clusters=i, batch_size=1000).fit(x_tr)
    loss.append(kmeans.inertia_)
```

In [63]:

```
plt.plot(k_values, loss)
plt.xlabel('K',size=14)
plt.ylabel('Loss',size=14)
plt.title('Loss VS K Plot',size=18)
plt.grid()
plt.show()
```



In [65]:

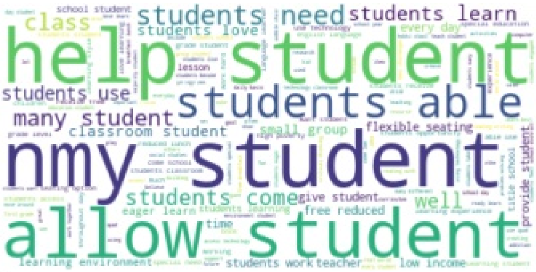
```
optimal_k = 6

kmeans = MiniBatchKMeans(n_clusters=optimal_k).fit(x_tr)
```

In [68]:

```
essays = x_train['clean_essays'].values

cluster1 = []
cluster2 = []
cluster3 = []
cluster4 = []
cluster5 = []
cluster6 = []
for i in range(kmeans.labels_.shape[0]):
    if kmeans.labels_[i] == 0:
        cluster1.append(essays[i])
    elif kmeans.labels_[i] == 1:
        cluster2.append(essays[i])
    elif kmeans.labels_[i] == 2:
        cluster3.append(essays[i])
    elif  kmeans.labels_[i] == 3:
        cluster4.append(essays[i])
    elif  kmeans.labels_[i] == 4:
        cluster5.append(essays[i])
    elif  kmeans.labels_[i] == 5:
        cluster6.append(essays[i])
```

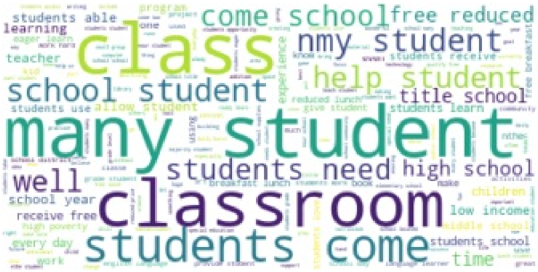
In [69]:

```
#cluster 1
words=''
for i in cluster1:
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



In [70]:

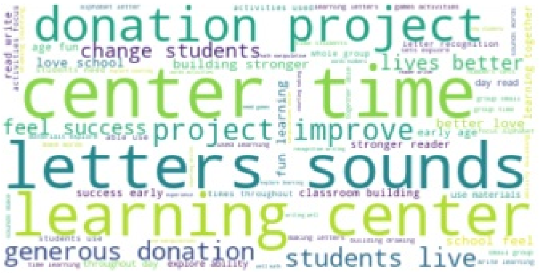
```
#cluster 2
words=''
for i in cluster2:
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



In [71]:

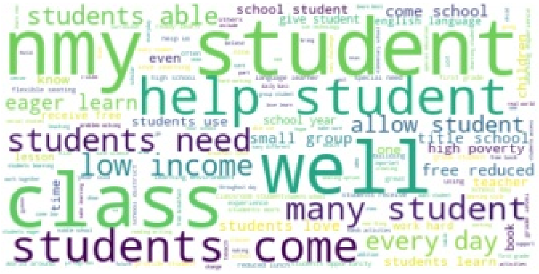
```
#cluster 3
words=''
for i in cluster3:
    words+=str(i)
from wordcloud import WordCloud
```

```
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



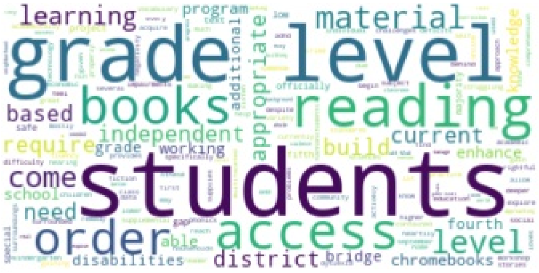
In [72]:

```
#cluster 4
words=''
for i in cluster4:
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



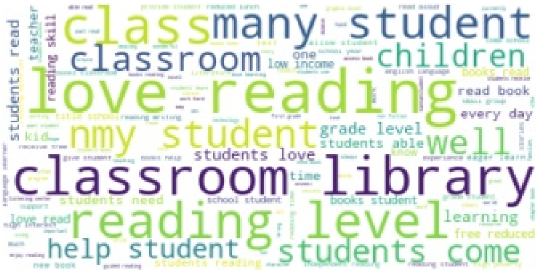
In [73]:

```
#cluster 5
words=''
for i in cluster5:
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



In [74]:

```
#cluster 6
words=''
for i in cluster6:
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



Apply AgglomerativeClustering

In [56]:

```
# As  hierarchal clustering is computationally very expensive, hence using only 1000 features

from sklearn.feature_selection import SelectKBest, f_classif
t = SelectKBest(f_classif,k=1000).fit(x_tr, y_train)
x_tr = t.transform(x_tr)
x_te = t.transform(x_te)

print("Final Data matrix on TFIDF")
print(x_tr.shape, y_train.shape)

print(x_te.shape, y_test.shape)
```

```
Final Data matrix on TFIDF
(73196, 1000) (73196,)
(36052, 1000) (36052,)
```

For K=2

In [57]:

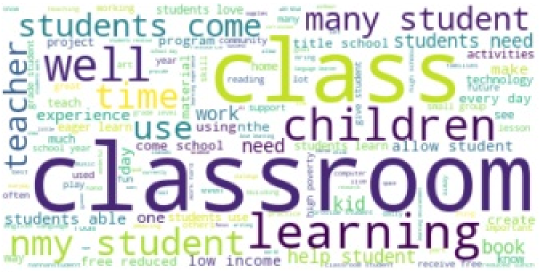
```
# As  hierarchal clustering is computationally very expensive, hence using only 10000 rows
from sklearn.cluster import AgglomerativeClustering

aggcl=AgglomerativeClustering(affinity='euclidean', compute_full_tree='auto',
                        connectivity=None, distance_threshold=None,
                        linkage='ward', memory=None, n_clusters=2).fit(x_tr[:10000].toarray())
```

In [60]:

```
cluster1=[]
cluster2=[]
essays = x_train['clean_essays'].values
for i in range(aggcl.labels_.shape[0]):
    if aggcl.labels_[i] == 0:
        cluster1.append(essays[i])
    elif aggcl.labels_[i] == 1:
        cluster2.append(essays[i])
```

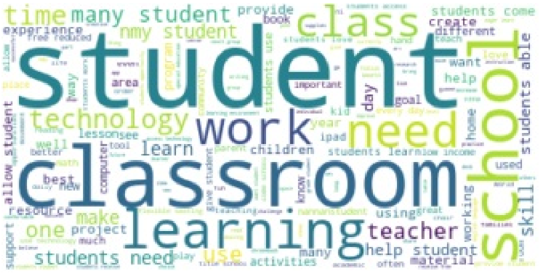
In [61]:

```
#cluster 1
words=''
for i in cluster1:
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



In [62]:

```
#cluster 2
words=''
for i in cluster2:
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



For k=5

In [56]:

```
from sklearn.cluster import AgglomerativeClustering

aggcl=AgglomerativeClustering(affinity='euclidean', compute_full_tree='auto',
                        connectivity=None, distance_threshold=None,
                        linkage='ward', memory=None, n_clusters=5).fit(x_tr[:10000].toarray())
```

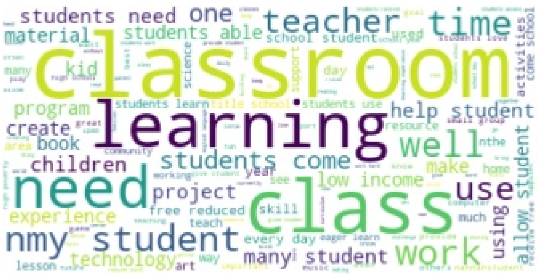
In [57]:

```
cluster1=[]
cluster2=[]
cluster3=[]
cluster4=[]
cluster5=[]
```

```
cluster5=[]
essays = x_train['clean_essays'].values
for i in range(aggcl.labels_.shape[0]):
    if aggcl.labels_[i] == 0:
        cluster1.append(essays[i])
    elif aggcl.labels_[i] == 1:
        cluster2.append(essays[i])
    elif aggcl.labels_[i] == 2:
        cluster3.append(essays[i])
    elif  aggcl.labels_[i] == 3:
        cluster4.append(essays[i])
    elif  aggcl.labels_[i] == 4:
        cluster5.append(essays[i])
```

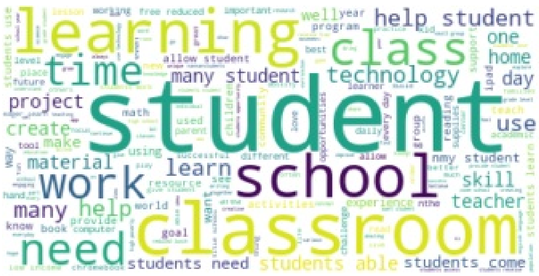
In [58]:

```
#cluster 1
words=''
for i in cluster1:
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



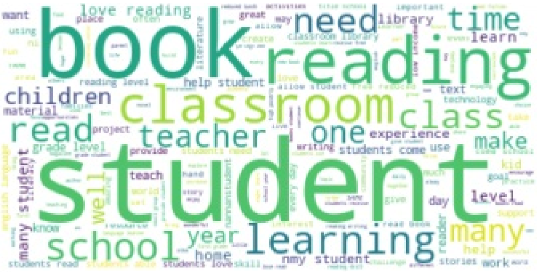
In [59]:

```
#cluster 2
words=''
for i in cluster2:
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



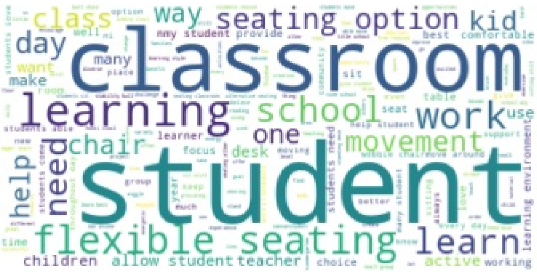
In [60]:

```
#cluster 3
words=''
for i in cluster3:
    words+=str(i)
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



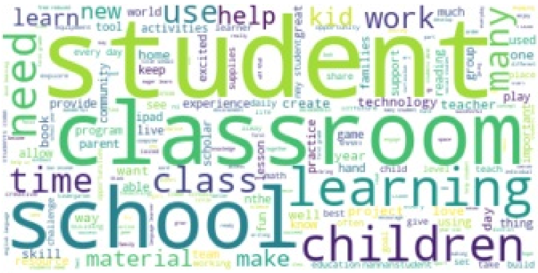
In [61]:

```
#cluster 4
words=''
for i in cluster4:
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



In [62]:

```
#cluster 5
words=''
for i in cluster5:
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```

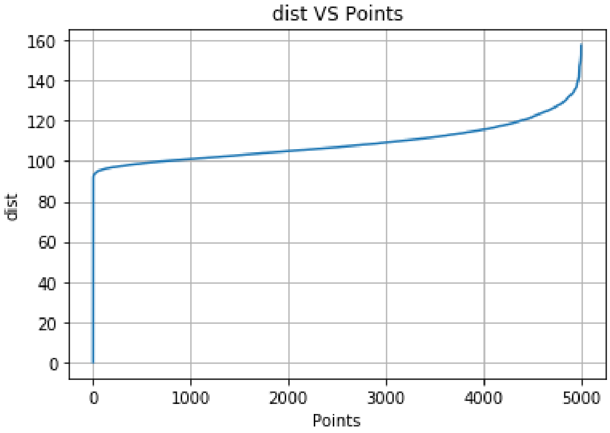


Apply DBSCAN

In [65]:

```
#https://github.com/dileepteja3/Clustering-on-Donors-choose/blob/master/dileep.teja3@gmail.com_10.ipynb

min_points = 1500
from sklearn.preprocessing import StandardScaler
from sklearn.metrics.pairwise import euclidean_distances
x_tr_std=StandardScaler().fit_transform(x_tr[:5000].toarray())

distance=[]
for point in tqdm(x_tr_std):
    temp = euclidean_distances(x_tr_std, point.reshape(1, -1))
    distance.append(temp[min_points])
sorted_distance = np.sort(np.array(distance))

sorted_dist = np.sort(sorted_distance.reshape(1,-1)[0])
points = [i for i in range(len(x_tr_std))]


# Draw distances(d_i) VS points(x_i) plot
plt.plot(points, sorted_dist)
plt.xlabel('Points')
plt.ylabel('dist')
plt.title('dist VS Points')
plt.grid()
plt.show()
```

```
100%|██████████| 5000/5000 [05:36<00:00, 14.84it/s]
```



In [67]:

```
#we can see that point of inflexion is at eps=90
from sklearn.cluster import DBSCAN
dbscan = DBSCAN(eps=90,n_jobs=-1)
dbscan.fit(x_tr_std)
print('No of clusters: ',len(set(dbscan.labels_)))
print('Cluster are including noise i.e -1: ',set(dbscan.labels_))
```

```
No of clusters:  2
Cluster are including noise i.e -1:  {0, -1}
```

In [68]:

```
#ignoring -1 as it is for noise
cluster1=[]
noisecluster1=[]
for i in range(dbscan.labels_.shape[0]):
    if dbscan.labels_[i] == 0:
        cluster1.append(essays[i])
        cluster1.append(essays[i])
    elif dbscan.labels_[i] == -1:
        noisecluster1.append(essays[i])
```

In [69]:

```
for i in range(3):
    print('%s\n'%(cluster1[i]))
```

```
students motivated become artists cultural vibrancy downtown los angeles audition free public arts
high school students enjoy rigorous art academic education students mainly low income qualifying f
ree reduced lunch making us title school enjoy local museums ride metro thrive urban environment r
n r nour school dual mission arts academic excellence students graduate ready college also study a
rts students many art classes high school well exhibitions participate national local art contests
win scholastic art awards high school western united states hardworking kids appreciate would like
love artwork mission mandate integrate arts creative ambitious certain make great use art supplies
come way project put paintbrushes hands painting ap studio art design students use paint daily bas
is classroom never ending need paintbrushes not last students learning paint exercises also workin
g artworks good brush necessary tool students learn master paint brush enough paint canvas brushes
continual challenge busy art studio r n r neach students makes least four paintings per semester a
dds paintings made spring students learning fundamentals abstract painting creating artwork style
australian aborigines also creating personal portfolios use apply college productive never seem ge
t enough paint painting canvas paper wood using acrylic paint watercolors going creative semester
painting challenges students many ways master tools materials also come visual message incredibly
engaging people keep centuries r nnannan

grade class comprised students different economic backgrounds within small town indiana many free
reduced lunch come diverse families r n r nfor school represents stability lives hardworking creat
ive kids many experience sort attention focus issue love move high energy positive hard working ki
ds reading math groups students free work around room would love flexibly seating time class set s
tability balls ensure students access alternative seating allow movement classroom also allows foc
us classroom use stability balls would cut distractions unwanted behavior students struggle attent
ion focus outlet bouncing ball sitting ball also helps balance forces students sit straight uprigh
t r n r nfunding project improve student learning opportunity flex seating not share balls already
students feel good know people world support nannan

students amazing wonderful teach first grade inclusion classroom school ask lot students asked go
beyond asked respectful responsible ready asked meet high expectations students never let always k
ind patient generous first graders incredibly hardworking happy children truly enjoy coming work e
very day requesting two osmo genius kits pair existing ipads classroom create engaging activities
variety subjects osmo gaming system unique reflector put camera ipad ipad special osmo stand game
recognizes students using cubes manipulatives game desks front r nthe osmo genius kit includes num
bers game would like introduce students numbers game played myriad ways plan students using number
s game specifically familiarize coins money counting money nannan
```

In [70]:

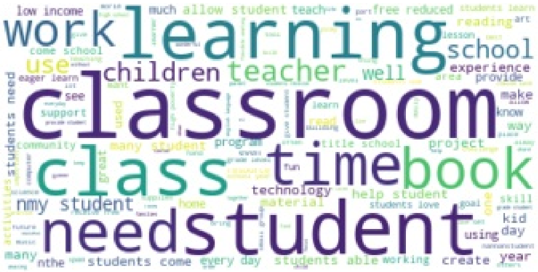
```
for i in range(3):
    print('%s\n'%(noisecluster1[i]))
```

```
students make every new day exciting fun come tight knit community share not many common values al
so great pride school community students siblings parents aunts uncles know words school alma mate
r love sing pleasure surrounded school spirit r n r nin classroom students pull together help one
another get challenges come different grade levels different cultural ethnic backgrounds different
religions yet sense ohana family shines everyday working together students need posters remind str
ive excellence always best always remind things would beneficial constant reminder around daily le
arning environment also need posters reinforce concepts learn class r n r nmy students need suppli
es allow create posters reinforce learning quadratic formula slope intercept form divide number ze
ro get real number want students supplies create reminders help peers remember answers questions a
llowing creativity personalities shine r n r nmy students also need basic health supplies like han
d sanitizer kleenex help keep healthy minimize spread germs nannan

neighborhood school busting seams students eager learners love try new things integrating technolo
gy onto classroom year need comfy areas sit pads complete projects read book r nmy students come d
ifferent educational cultural backgrounds active class likes move around want create special areas
help us relax focus learning r nour classroom small number students would love quiet comfortable a
reas sit read work pads students excited pickup book fun comfortable spot read active boys need qu
iet comfortable place settle complete work provide private area shy student wants record story not
want anyone hear want establish life long love reading making fun experience nannan

students amazing individuals come many walks life live homes stable families supportive education
others live section housing parents working multiple jobs put food table others wish someone take
care care education future lost parents cancer jail drugs r n r nevery student comes door gift con
```

```
tribute society society incomplete without teacher job gather tools teach student need share gift
society bright minds deserve opportunity success donations project give many students technology e
xperience would otherwise miss ever changing world technology schools disadvantage trying keep pac
e change r n r ni many students not access computers mobile devices internet home due financial re
straints opportunity classroom chromebooks would provide students technology opportunities may oth
erwise miss r n r nchromebooks would available students use school well academic lab homework time
hope provide students tools skills necessary make lifelong learners achieve dreams nannan
```

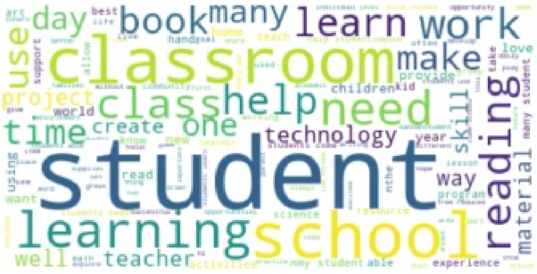
In [71]:

```python
#cluster 1
words=''
for i in cluster1:
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



In [72]:

```python
#noise cluster 1
words=''
for i in noisecluster1:
    words+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(words)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



Conclusions

K-Means

In [73]:

```python
from prettytable import PrettyTable
```

```
x = PrettyTable()
x.field_names = ["Vectorizer","Best k"]
x.add_row(['TFIDF','6'])
print(x)
```

```
+------------+--------+
| Vectorizer | Best k |
+------------+--------+
|   TFIDF    |   6    |
+------------+--------+
```

Agglomerative

In [74]:

```
from prettytable import PrettyTable
x = PrettyTable()
x.field_names = ["Vectorizer","Best k"]
x.add_row(['TFIDF','2'])
x.add_row(['TFIDF','5'])
print(x)
```

```
+------------+--------+
| Vectorizer | Best k |
+------------+--------+
|   TFIDF    |   2    |
|   TFIDF    |   5    |
+------------+--------+
```

DBSCAN

In [75]:

```
from prettytable import PrettyTable
x = PrettyTable()
x.field_names = ["Vectorizer","Best k","Eps","Number of clusters(INCLUDING NOISE)"]
x.add_row(['TFIDF','2',90,2])
print(x)
```

```
+------------+--------+-----+-------------------------------------+
| Vectorizer | Best k | Eps | Number of clusters(INCLUDING NOISE) |
+------------+--------+-----+-------------------------------------+
|   TFIDF    |   2    |  90 |                  2                  |
+------------+--------+-----+-------------------------------------+
```

In [ ]: