Objective: To train the model using clustering.

K-Means Clustering

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.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.c
om/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
```

```
C:\Users\Bhuvana Chandrahasan\Anaconda3\lib\site-packages\gensim\utils.py:1197: UserWarning: detected Windows; aliasing chunkize to chunkize_serial
  warnings.warn("detected Windows; aliasing chunkize to chunkize_serial")
```

Reading Data

In [2]:

```
project_data = pd.read_csv(r'C:\Users\Bhuvana Chandrahasan\train_data.csv')
resource_data = pd.read_csv(r'C:\Users\Bhuvana Chandrahasan\resources.csv')
```

In [3]:

```
print("Number of data points in train data", project_data.shape)
print(project_data.columns)
```

```
Number of data points in train data (109248, 1
7)
Index(['Unnamed: 0', 'id', 'teacher_id', 'teac
her_prefix', 'school_state',
       'project_submitted_datetime', 'project_
grade_category',
       'project_subject_categories', 'project_
subject_subcategories',
       'project_title', 'project_essay_1', 'pr
oject_essay_2',
       'project_essay_3', 'project_essay_4', '
project_resource_summary',
       'teacher_number_of_previously_posted_pr
ojects', 'project_is_approved'],
      dtype='object')
```

In [4]:

```
# how to replace elements in list python: https://stackoverfl
ow.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://stackove
rflow.com/a/49702492/4084039
project_data['Date'] = pd.to_datetime(project_data['project_s
ubmitted_datetime'])
project_data.drop('project_submitted_datetime', axis=1, inpla
ce=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[4]:

	Unnamed: 0	id	teacher_id	teacher_prefix	sch
55660	8393	p205479	2bf07ba08945e5d8b2a3f269b2b3cfe5	Mrs.	
76127	37728	p043609	3f60494c61921b3b43ab61bdde2904df	Ms.	

In [5]:

```
print("Number of data points in resource data", resource_data
.shape)
print("Number of data points in resource data", resource_data
.columns)
resource_data.head(2)
```

```
Number of data points in resource data (154127
2, 4)
Number of data points in resource data Index([
'id', 'description', 'quantity', 'price'], dty
pe='object')
```

Out[5]:

	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 [6]:

```
# https://stackoverflow.com/questions/22407798/how-to-reset-a-dataframes-indexes-for-all-groups-in-one-step
price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_index()
price_data.head(2)
```

Out[6]:

	id	price	quantity
0	p000001	459.56	7
1	p000002	515.89	21

In [7]:

```
# join two dataframes in python:
project_data = pd.merge(project_data, price_data, on='id', how='left')
```

In [8]:

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

Out[8]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_
0	8393	p205479	2bf07ba08945e5d8b2a3f269b2b3cfe5	Mrs.	
1	37728	p043609	3f60494c61921b3b43ab61bdde2904df	Ms.	

In [9]:

```
project_data.shape
```

Out[9]:

```
(109248, 19)
```

In [10]:

```
final_appr = project_data[project_data['project_is_approved']
 == 1]
final_appr = final_appr.sample(n=8400)
final_appr.shape
```

Out[10]:

```
(8400, 19)
```

In [11]:

```
final_rej =  project_data[project_data['project_is_approved']
 == 0]
final_rej = final_rej.sample(n=1600)
final_rej.shape
```

Out[11]:

```
(1600, 19)
```

In [12]:

```
final=pd.concat([final_appr,final_rej])
final=final.sort_values('Date', axis=0, ascending=True, inpla
ce=False, kind='quicksort', na_position='last')
final.shape
```

Out[12]:

```
(10000, 19)
```

In [13]:

```
project_data = final
```

In [14]:

```
project_data.shape
```

Out[14]:

```
(10000, 19)
```

1.1 Preprocessing of project_subject_categories

In [15]:

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

# https://www.geeksforgeeks.org/removing-stop-words-nltk-pyth
on/
# https://stackoverflow.com/questions/23669024/how-to-strip-a
-specific-word-from-a-string
# https://stackoverflow.com/questions/8270092/remove-all-whit
espace-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 & Hunger"]
        if 'The' in j.split(): # this will split each of the
catogory based on space "Math & Science"=> "Math","&", "Scien
ce"
            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 ' '(s
```

```
pace) 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, inp
lace=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]))
```

1.2 Preprocessing of project_subject_subcategories

In [16]:

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

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

```
espace-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 & Hunger"]
        if 'The' in j.split(): # this will split each of the
catogory based on space "Math & Science"=> "Math","&", "Scien
ce"
            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 ' '(s
pace) 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://stackoverf
low.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=l
ambda kv: kv[1]))
```

2.Text Preprocessing

2.1 Preprocessing of essay

In [17]:

```
# merge two column text dataframe:
project_data["essay"] = project_data["project_essay_1"].map(s
tr) +\
                        project_data["project_essay_2"].map(s
tr) + \
                        project_data["project_essay_3"].map(s
tr) + \
                        project_data["project_essay_4"].map(s
tr)
```

In [18]:

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

Out[18]:

	Unnamed: 0	id	teacher_id	teacher_prefix	schoo
10	57854	p099430	4000cfe0c8b2df75a218347c1765e283	Ms.	
49	59086	p226990	49e24758e486dabc3dbeb6e55c84532b	Mrs.	

In [19]:

```
# printing some random reviews
print(project_data['essay'].values[0])
print("="*50)
print(project_data['essay'].values[150])
print("="*50)
print(project_data['essay'].values[1000])
print("="*50)
```

```
My students yearn for a classroom environment
that matches their desire to learn. With educa
tion changing daily, we need a classroom that
can meet the needs of all of my first graders.
I have the privilege of teaching an incredible
 group of six and seven year olds who absolute
ly LOVE to learn. I am completely blown away b
y their love for learning. Each day is a new a
dventure as they enjoy learning from nonfictio
n text and hands on activities. Many of my stu
dents are very active learners who benefit fro
m kinesthetic activities. Sometimes learning,
while sitting in a seat, is difficult. I want
every child the opportunity to focus their ene
rgy in order to do their best in school!Ideall
y, I would love to delve right into \"flexible
 seating\" where students are provided many di
fferent seating options (chairs, hokki stools,
 on mats on the ground, etc.) and they have th
e freedom to choose which ever seat they feel
they need. My student would be able to choose
which seating option will best help them learn
. In addition, a pencil sharpener, mobile ease
l, magnetic strips and mounting tape will help
 make our classroom better suited for 6 and 7
year olds.This project will be so beneficial f
or my students in that they will be able to be
```

tter focus their energy. Something so small, c
hoosing their own seat, will help encourage a
positive learning environment that promotes le
arning for all students. The easel will help m
ake our classroom more mobile, because it is b
oth dry erase and on wheels. Magnetic strips,
mounting tape and a pencil sharpener will allo
w for more resources for the students during t
he school day.

==========

I work with small groups of students who are s
truggling with reading. These students work ha
rd in reading groups to improve their skills.
We work on intense remediation and everyday is
 filled with work work and more work!I work in
 predominantly Hispanic area of town. The scho
ol is also 100% on Free and Reduced lunches. T
his brings both joys and challenges. Most of m
y students work very hard to learn both a new
language and new curriculum. They are very des
erving of any and all help that I can give the
m. They have blessed me in ways I will never b
e able to repay. I am constantly amazed at how
 hard my students work.As a small group teache
r, I need supplies for center work. This will
allow students to have hands on tools. My stud
ents need to be able to touch and feel things
as well as read them. Curriculum is not provid
ed and this will really help students that com
e to my group feel valued and give them that e
xtra incentive to excel.Learning to read is a
skill that many people take for granted, but i
s essential to success. Helping my students le
arn to read will help them become successful f
or many years to come. This will give them con
fidence and pride in their abilities. Please c

onsider being apart of this process.
==========
When you grew up, you may have heard the words \"Sit still,\" \"Stop wiggling,\" or \"If you can't sit still, stand up!\" I know I did. I don't want my growing students to feel that they must be statues or zombies in order to learn. Research shows us they don't have to. In fact, it's better to move!\r\n\r\nMy students are curious learners who want opportunities to grow and expand their knowledge of the world. The majority of our students come from low-income families and our school works hard to meet the needs of these students and connect with the families to increase student attendance. As a Title I school, the students often come from homes where comfort is second to necessity, and cleanliness and orderliness may be lacking in their home environment. Having a place to sit and learn that is tailored to their needs is a new idea for many students who may have to share basic furniture like chairs or beds at home. Many students also have identified learning disabilities or simply need to move more than a regular seat provides for.In our urban area, our elementary school has to use a corner blacktop area of the adjacent junior high school as a PE and our outdoor play equipment consists of a tree house climbing area with one slide with some balance pods. Exercise balls will help the students improve their circulation and core muscle strength while exercising their brain as well. Besides the health benefits, research has shown that sitting on these exercise balls for moderate amounts of time helps students in school. In a USA Today article f

```
rom 2009, college students surveyed about thei
r experience using exercise balls instead of c
hairs noted \"improvement in their ability to
pay attention, concentrate, take notes, engage
 in classroom discussions and take exams.\" I
know the balls may not be the preferred method
 for all students and I heavily research any n
ew project or material used in the classroom.
Therefore I am asking for a half class set, so
 the students may take turns with a chair-part
ner and have the benefits of both tailbone sup
port and core-muscle strengthening. \r\n\r\nTh
is is not a 'fad', it is a tool to help studen
ts grow and learn.\r\n\r\nI requested this pro
ject for a previous school I worked at and the
 results spoke for themselves. We hear a lot a
bout students with difficulties concentrating
and sitting still, and there are conflicts abo
ut the pros and cons of medication and the dif
ficulties of diagnosis. With these balls, I ho
pe we can alleviate some difficulties, improve
 health and concentration, and help our studen
ts focus on what's really important. Students
will also learn responsibility, problem solvin
g, and the benefits of sharing by 'co-owning'
the ball with their table partner. Please help
 us make our dream real!nannan
================================================
====
```

In [20]:

```
# 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 [21]:

```
sent = decontracted(project_data['essay'].values[2000])
print(sent)
print("="*50)
```

```
My P.E. classes consist of students ranging fr
om kindergarten through 4th grade. These guys
love to move their bodies during our 30-minute
 gym time. We are a lower income school and th
ey do not always have the opportunity to parti
cipate in organized activities due to cost and
 transportation issues.\r\nSafety concerns oft
en prevent playing or riding bikes around the
neighborhood. A combination of these factors o
ften result in my students choosing sedentary
type activities versus staying physically acti
ve outside of their school day.\r\n\r\n\r\nHow
 do children feel about squats, jumping jacks,
 knee raises, pushups, and exercise in general
? BORING! That is, until you roll them a stabi
lity ball (fit drum), hand them a couple of dr
umsticks, and turn up the volume to some catch
y dance tunes. Before you know it, these same
```

```
kids are begging to exercise with the fit drum
s in order to share routines that were created
 by THEMSELVES, at their own HOMES, and on the
ir own TIME.\r\n\r\nPhysically active children
 become physically active adults. Your donatio
n to the fit drum project will help my student
s reach their goal of being active for at leas
t 60-minutes a day.  Because students can drum
 on just about anything and anywhere, they hav
e decided this project would help them to stay
 active outside of their school day. They beli
eve the fit drums will help them be active by:
 practicing and creating high energy routines
at home, turning their fit drum routines into
videos that can be accessed at home by their c
lassmates, leading the class through their own
 routines during P.E. class, and researching a
nd developing nutritional tips that would help
 their bodies perform at the highest levels po
ssible. One student even started a wildfire of
 excitement by stating she was going to start
her own neighborhood fit drum band!\r\n\r\n\r\
nnannan
================================================
====
```

In [22]:

```
# \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 P.E. classes consist of students ranging fr
om kindergarten through 4th grade. These guys
love to move their bodies during our 30-minute
```

gym time. We are a lower income school and they do not always have the opportunity to participate in organized activities due to cost and transportation issues. Safety concerns often prevent playing or riding bikes around the neighborhood. A combination of these factors often result in my students choosing sedentary type activities versus staying physically active outside of their school day. How do children feel about squats, jumping jacks, knee raises, pushups, and exercise in general? BORING! That is, until you roll them a stability ball (fit drum), hand them a couple of drumsticks, and turn up the volume to some catchy dance tunes. Before you know it, these same kids are begging to exercise with the fit drums in order to share routines that were created by THEMSELVES, at their own HOMES, and on their own TIME. Physically active children become physically active adults. Your donation to the fit drum project will help my students reach their goal of being active for at least 60-minutes a day. Because students can drum on just about anything and anywhere, they have decided this project would help them to stay active outside of their school day. They believe the fit drums will help them be active by: practicing and creating high energy routines at home, turning their fit drum routines into videos that can be accessed at home by their classmates, leading the class through their own routines during P.E. class, and researching and developing nutritional tips that would help their bodies perform at the highest levels possible. One student even started a wildfire of excitement by stating she was going to start her own neighborhood fit drum band! nannan

In [23]:

```
#remove spacial character: https://stackoverflow.com/a/584354
7/4084039
sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
print(sent)
```

```
My P E classes consist of students ranging fro
m kindergarten through 4th grade These guys lo
ve to move their bodies during our 30 minute g
ym time We are a lower income school and they
do not always have the opportunity to particip
ate in organized activities due to cost and tr
ansportation issues Safety concerns often prev
ent playing or riding bikes around the neighbo
rhood A combination of these factors often res
ult in my students choosing sedentary type act
ivities versus staying physically active outsi
de of their school day How do children feel ab
out squats jumping jacks knee raises pushups a
nd exercise in general BORING That is until yo
u roll them a stability ball fit drum hand the
m a couple of drumsticks and turn up the volum
e to some catchy dance tunes Before you know i
t these same kids are begging to exercise with
 the fit drums in order to share routines that
 were created by THEMSELVES at their own HOMES
 and on their own TIME Physically active child
ren become physically active adults Your donat
ion to the fit drum project will help my stude
nts reach their goal of being active for at le
ast 60 minutes a day Because students can drum
 on just about anything and anywhere they have
 decided this project would help them to stay
active outside of their school day They believ
e the fit drums will help them be active by pr
acticing and creating high energy routines at
```

```
home turning their fit drum routines into vide
os that can be accessed at home by their class
mates leading the class through their own rout
ines during P E class and researching and deve
loping nutritional tips that would help their
bodies perform at the highest levels possible
One student even started a wildfire of excitem
ent by stating she was going to start her own
neighborhood fit drum band nannan
```

In [24]:

```
# https://gist.github.com/sebleier/554280
# we are removing the words from the stop words list: 'no', '
nor', 'not'
stopwords= ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', '
ourselves', 'you', "you'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', 'b
etween', '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', 'each', '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', "co
uldn't", 'didn', "didn't", 'doesn', "doesn'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 [25]:

```
# Combining all the above stundents
from tqdm import tqdm
preprocessed_essays = []
# tqdm is for printing the status bar
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.lower() not
in stopwords)
    preprocessed_essays.append(sent.lower().strip())
```

```
100%|██████████████████████████████████| 1000
0/10000 [00:24<00:00, 407.51it/s]
```

In [26]:

```
# after preprocesing
preprocessed_essays[2000]
```

Out[26]:

```
'p e classes consist students ranging kinderga
rten 4th grade guys love move bodies 30 minute
 gym time lower income school not always oppor
```

```
tunity participate organized activities due co
st transportation issues safety concerns often
 prevent playing riding bikes around neighborh
ood combination factors often result students
choosing sedentary type activities versus stay
ing physically active outside school day child
ren feel squats jumping jacks knee raises push
ups exercise general boring roll stability bal
l fit drum hand couple drumsticks turn volume
catchy dance tunes know kids begging exercise
fit drums order share routines created homes t
ime physically active children become physical
ly active adults donation fit drum project hel
p students reach goal active least 60 minutes
day students drum anything anywhere decided pr
oject would help stay active outside school da
y believe fit drums help active practicing cre
ating high energy routines home turning fit dr
um routines videos accessed home classmates le
ading class routines p e class researching dev
eloping nutritional tips would help bodies per
form highest levels possible one student even
started wildfire excitement stating going star
t neighborhood fit drum band nannan'
```

2.2 Preprocessing of project_title

In [27]:

```
# printing some random reviews
print(project_data['project_title'].values[0])
print("="*50)
print(project_data['project_title'].values[150])
print("="*50)
print(project_data['project_title'].values[1000])
print("="*50)
```

```
A flexible classroom for flexible minds!
================================================
====
Inner City Reading Intervention Needs
================================================
====
Have You Heard, \"If You Can't Sit Still, Stan
d Up?\"
================================================
====
```

In [28]:

```
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 [29]:

```
sent = decontracted(project_data['project_title'].values[2000
])
print(sent)
print("="*50)
```

```
Drumming Our Way to a Healthier Lifestyle
==========================================
====
```

In [30]:

```
sent = sent.replace('\\r', ' ')
sent = sent.replace('\\"', ' ')
sent = sent.replace('\\n', ' ')
print(sent)
```

```
Drumming Our Way to a Healthier Lifestyle
```

In [31]:

```
sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
print(sent)
```

```
Drumming Our Way to a Healthier Lifestyle
```

In [32]:

```
# Combining all the above stundents
from tqdm import tqdm
preprocessed_essays = []
# tqdm is for printing the status bar
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.lower() not
in stopwords)
    preprocessed_essays.append(sent.lower().strip())
```

```
100%|██████████████████████████████████| 10000
/10000 [00:01<00:00, 6603.05it/s]
```

In [33]:

```
# after preprocesing
preprocessed_essays[2000]
```

Out[33]:

```
'drumming way healthier lifestyle'
```

In [34]:

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

Out[34]:

	Unnamed: 0	id	teacher_id	teacher_prefix	schoo
10	57854	p099430	4000cfe0c8b2df75a218347c1765e283	Ms.	
49	59086	p226990	49e24758e486dabc3dbeb6e55c84532b	Mrs.	

In [35]:

```
print(project_data.shape)
print(project_data.columns)
```

```
(10000, 20)
Index(['Unnamed: 0', 'id', 'teacher_id', 'teac
her_prefix', 'school_state',
       'Date', 'project_grade_category', 'proj
ect_title', 'project_essay_1',
       'project_essay_2', 'project_essay_3', '
```

```
project_essay_4',
       'project_resource_summary',
       'teacher_number_of_previously_posted_pr
ojects', 'project_is_approved',
       'price', 'quantity', 'clean_categories'
, 'clean_subcategories',
       'essay'],
      dtype='object')
```

4.Vectorizing Text data

4.1 Essay

In [36]:

```
vectorizer = CountVectorizer(min_df=10)
vectorizer.fit(project_data['essay'].values) # fit has to hap
pen only on train data

# we use the fitted CountVectorizer to convert the text to ve
ctor
essay_bow = vectorizer.transform(project_data['essay'].values
)

print("After vectorizations")
print("Shape of matrix essay_bow:", essay_bow.shape)
```

```
After vectorizations
Shape of matrix essay_bow: (10000, 6390)
```

4.2 Project_title

In [37]:

```
vectorizer = CountVectorizer(min_df=10)
vectorizer.fit(project_data['project_title'].values) # fit ha
s to happen only on train data

# we use the fitted CountVectorizer to convert the text to ve
ctor
title_bow = vectorizer.transform(project_data['project_title'
].values)

print("After vectorizations")
print("Shape of matrix project_title:", title_bow.shape)
```

```
After vectorizations
Shape of matrix project_title: (10000, 673)
```

4.3 Project_resource_summary

In [38]:

```
vectorizer = CountVectorizer(min_df=10)
vectorizer.fit(project_data['project_resource_summary'].values
) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to ve
ctor
summ_bow = vectorizer.transform(project_data['project_resourc
e_summary'].values)

print("After vectorizations")
print("Shape of matrix project_title:", summ_bow.shape)
```

```
After vectorizations
Shape of matrix project_title: (10000, 1545)
```

5.Catogorical features:one hot encoding

5.1 Clean_categories

In [39]:

```
vectorizer = CountVectorizer()
# we use the fitted CountVectorizer to convert the text to ve
ctor
clean_category_ohe = vectorizer.fit_transform(project_data['c
lean_categories'].values)

print("After vectorizations")
print(clean_category_ohe.shape)
print(vectorizer.get_feature_names())
```

```
After vectorizations
(10000, 9)
['appliedlearning', 'care_hunger', 'health_spo
rts', 'history_civics', 'literacy_language', '
math_science', 'music_arts', 'specialneeds', '
warmth']
```

5.2 Clean_subcategories

In [40]:

```
vectorizer = CountVectorizer()

# we use the fitted CountVectorizer to convert the text to ve
ctor
clean_subcategory_ohe = vectorizer.fit_transform(project_data
['clean_subcategories'].values)
```

```
print("After vectorizations")
print(clean_subcategory_ohe.shape)
print(vectorizer.get_feature_names())
```

```
After vectorizations
(10000, 30)
['appliedsciences', 'care_hunger', 'charactere
ducation', 'civics_government', 'college_caree
rprep', 'communityservice', 'earlydevelopment'
, 'economics', 'environmentalscience', 'esl',
'extracurricular', 'financialliteracy', 'forei
gnlanguages', 'gym_fitness', 'health_lifescien
ce', 'health_wellness', 'history_geography', '
literacy', 'literature_writing', 'mathematics'
, 'music', 'nutritioneducation', 'other', 'par
entinvolvement', 'performingarts', 'socialscie
nces', 'specialneeds', 'teamsports', 'visualar
ts', 'warmth']
```

5.3 Teacher_prefix

In [41]:

```
project_data.teacher_prefix = project_data.teacher_prefix.fil
lna('')
project_data['teacher_prefix'].value_counts()
```

Out[41]:

```
Mrs.       5273
Ms.        3508
Mr.        1015
Teacher     203
Dr.           1
Name: teacher_prefix, dtype: int64
```

In [42]:

```
vectorizer = CountVectorizer()

# we use the fitted CountVectorizer to convert the text to ve
ctor
teacher_ohe = vectorizer.fit_transform(project_data['teacher_
prefix'].values)


print("After vectorizations")
print(teacher_ohe.shape)
print(vectorizer.get_feature_names())
```

```
After vectorizations
(10000, 5)
['dr', 'mr', 'mrs', 'ms', 'teacher']
```

5.4 School_state

In [43]:

```
vectorizer = CountVectorizer()

# we use the fitted CountVectorizer to convert the text to ve
ctor
state_ohe = vectorizer.fit_transform(project_data['school_sta
te'].values)

print("After vectorizations")
print(state_ohe.shape)
print(vectorizer.get_feature_names())
```

```
After vectorizations
(10000, 51)
['ak', 'al', 'ar', 'az', 'ca', 'co', 'ct', 'dc
```

```
', 'de', 'fl', 'ga', 'hi', 'ia', 'id', 'il', '
in', 'ks', 'ky', 'la', 'ma', 'md', 'me', 'mi',
 'mn', 'mo', 'ms', 'mt', 'nc', 'nd', 'ne', 'nh
', 'nj', 'nm', 'nv', 'ny', 'oh', 'ok', 'or', '
pa', 'ri', 'sc', 'sd', 'tn', 'tx', 'ut', 'va',
 'vt', 'wa', 'wi', 'wv', 'wy']
```

5.5 Project_grade_category

In [44]:

```
project_data.project_grade_category = project_data.project_gr
ade_category.str.replace('\s+', '_')
project_data.project_grade_category = project_data.project_gr
ade_category.str.replace('-', '_')
project_data['project_grade_category'].value_counts()
```

Out[44]:

```
Grades_PreK_2    4074
Grades_3_5       3391
Grades_6_8       1563
Grades_9_12       972
Name: project_grade_category, dtype: int64
```

In [45]:

```
vectorizer = CountVectorizer(lowercase=False, binary=True)

# we use the fitted CountVectorizer to convert the text to ve
ctor
grade_ohe = vectorizer.fit_transform(project_data['project_gr
ade_category'].values)

print("After vectorizations")
print(grade_ohe.shape)
print(vectorizer.get_feature_names())
```

```
After vectorizations
(10000, 4)
['Grades_3_5', 'Grades_6_8', 'Grades_9_12', 'G
rades_PreK_2']
```

6.Numerical features

6.1 Price

In [46]:

```
from sklearn.preprocessing import StandardScaler
standard_vec = StandardScaler(with_mean = False)
# this will rise an error Expected 2D array, got 1D array ins
tead:
# array=[105.22 215.96  96.01 ... 368.98  80.53 709.67].
# Reshape your data either using
# array.reshape(-1, 1) if your data has a single feature
# array.reshape(1, -1)  if it contains a single sample.
standard_vec.fit(project_data['price'].values.reshape(-1,1))

price = standard_vec.transform(project_data['price'].values.r
eshape(-1,1))


print("After vectorizations")
print(price.shape)
```

```
After vectorizations
(10000, 1)
```

6.2

Teacher_number_of_previously_posted_projects

In [47]:

```
from sklearn.preprocessing import StandardScaler
standard_vec = StandardScaler(with_mean = False)
# this will rise an error Expected 2D array, got 1D array ins
tead:
# array=[105.22 215.96  96.01 ... 368.98  80.53 709.67].
# Reshape your data either using
# array.reshape(-1, 1) if your data has a single feature
# array.reshape(1, -1)  if it contains a single sample.
standard_vec.fit(project_data['teacher_number_of_previously_p
osted_projects'].values.reshape(-1,1))

prev_projects_std = standard_vec.transform(project_data['teac
her_number_of_previously_posted_projects'].values.reshape(-1,1
))

print("After vectorizations")
print(prev_projects_std.shape)
```

```
C:\Users\Bhuvana Chandrahasan\Anaconda3\lib\si
te-packages\sklearn\utils\validation.py:429: D
ataConversionWarning:

Data with input dtype int64 was converted to f
loat64 by StandardScaler.

C:\Users\Bhuvana Chandrahasan\Anaconda3\lib\si
te-packages\sklearn\utils\validation.py:429: D
ataConversionWarning:

Data with input dtype int64 was converted to f
loat64 by StandardScaler.
```

```
After vectorizations
(10000, 1)
```

6.3 Quantity

In [48]:

```
from sklearn.preprocessing import StandardScaler
standard_vec = StandardScaler(with_mean = False)
# this will rise an error Expected 2D array, got 1D array ins
tead:
# array=[105.22 215.96  96.01 ... 368.98  80.53 709.67].
# Reshape your data either using
# array.reshape(-1, 1) if your data has a single feature
# array.reshape(1, -1)  if it contains a single sample.
standard_vec.fit(project_data['quantity'].values.reshape(-1,1
))

quantity = standard_vec.transform(project_data['quantity'].va
lues.reshape(-1,1))

print("After vectorizations")
print(quantity.shape)
```

```
C:\Users\Bhuvana Chandrahasan\Anaconda3\lib\si
te-packages\sklearn\utils\validation.py:429: D
ataConversionWarning:

Data with input dtype int64 was converted to f
loat64 by StandardScaler.

C:\Users\Bhuvana Chandrahasan\Anaconda3\lib\si
te-packages\sklearn\utils\validation.py:429: D
ataConversionWarning:
```

```
Data with input dtype int64 was converted to f
loat64 by StandardScaler.
```

```
After vectorizations
(10000, 1)
```

7. K-Means

Merging all the above features

In [49]:

```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack
bow = hstack((essay_bow,title_bow,summ_bow,clean_category_ohe,clean_subcategory_ohe,state_ohe,teacher_ohe,grade_ohe,price,prev_projects_std,quantity)).tocsr()

print("Final Data matrix")
print(bow.shape)
```

```
Final Data matrix
(10000, 8710)
```

use only top 5000 Features using selectKbest

In [50]:

```
y=project_data['project_is_approved']
```

In [51]:

```
from sklearn.feature_selection import SelectKBest, chi2

x_bow = SelectKBest(chi2, k=5000).fit_transform(bow,y)
```

In [52]:

```
x_bow.shape
```

Out[52]:

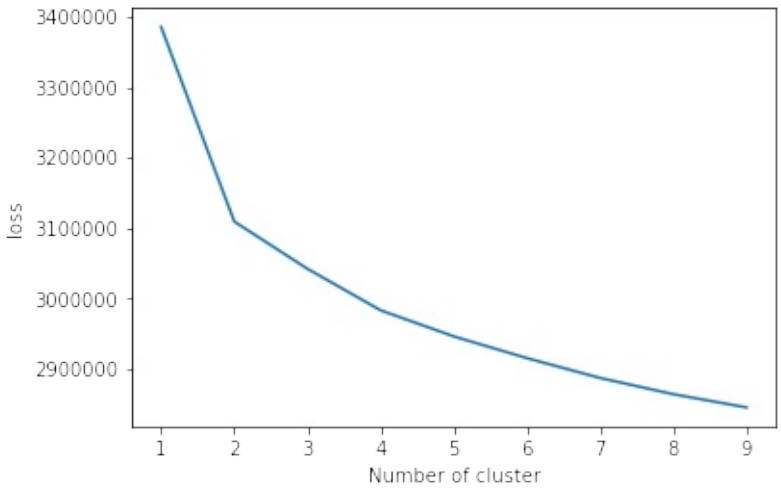
```
(10000, 5000)
```

K-Means

In [56]:

```
from sklearn.cluster import KMeans

loss = []
k=range(1, 10)

for k in tqdm(k):
    kmeans = KMeans(n_clusters=k)
    kmeans.fit(x_bow)
    loss.append(kmeans.inertia_)

plt.figure()
plt.plot(range(1, 10), loss)
plt.xlabel("Number of cluster")
plt.ylabel("loss")
plt.show()
```

```
100%|██████████████████████████████████████████| 9/9 [3:41:13<00:00, 1857.05s/it]
```



In [57]:

```
#Perfoming kmeans with best k
kmeans = KMeans(n_clusters=2)
kmeans.fit(x_bow)
```

Out[57]:

```
KMeans(algorithm='auto', copy_x=True, init='k-
means++', max_iter=300,
    n_clusters=2, n_init=10, n_jobs=1, precomp
ute_distances='auto',
    random_state=None, tol=0.0001, verbose=0)
```

In [59]:

```
#Distributing different datapoints to respective clusters
cluster_1=[]
cluster_2=[]

for i in range(x_bow.shape[0]):
    if kmeans.labels_[i] == 0:
        cluster_1.append(project_data.iloc[i])
    elif kmeans.labels_[i] == 1:
        cluster_2.append(project_data.iloc[i])
```

In [62]:

```
positive=0
negative=0
words=len(cluster_1)
for i in cluster_1:
    if i['project_is_approved']==1:
        positive=positive+1
    else:
        negative=negative+1

print("Projects Approved %age in cluster 1 ",(positive/words*
100))
print("Projects Not Approved %age in cluster 1 ",(negative/wo
rds*100))
```

```
Projects Approved %age in cluster 1  87.185508
21871855
Projects Not Approved %age in cluster 1  12.81
4491781281449
```

In [64]:

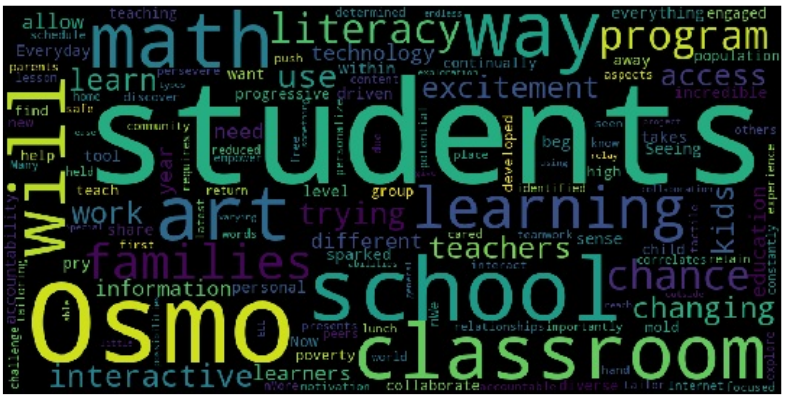
```
positive=0
negative=0
words=len(cluster_2)
for i in cluster_2:
    if i['project_is_approved']==1:
        positive=positive+1
    else:
        negative=negative+1

print("Projects Approved %age in cluster 2 ",(positive/words*
100))
print("Projects Not Approved %age in cluster 2 ",(negative/wo
rds*100))
```

```
Projects Approved %age in cluster 2  82.647100
```

```
72659923
Projects Not Approved %age in cluster 2  17.35
289927340077
```

In [65]:

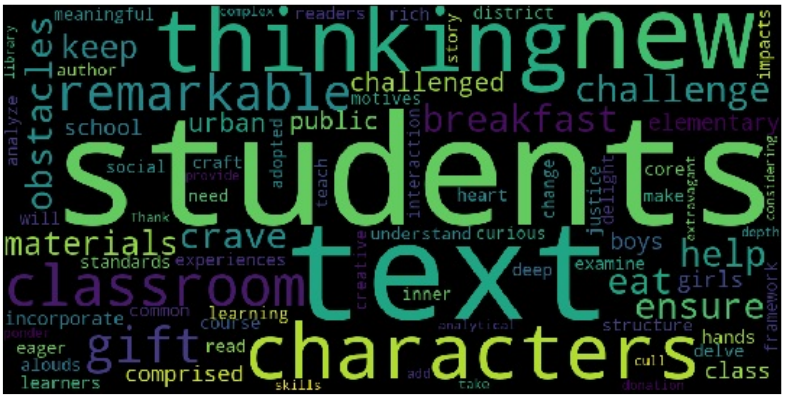
```
#https://www.geeksforgeeks.org/generating-word-cloud-python/

from wordcloud import WordCloud
essay_cluster1 =cluster_1[0]['essay']

wordcloud = WordCloud(width = 1000, height = 500).generate(es
say_cluster1)

# plot the WordCloud image
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



In [66]:

```
#https://www.geeksforgeeks.org/generating-word-cloud-python/

from wordcloud import WordCloud
```

```
essay_cluster2=cluster_2[0]['essay']

wordcloud = WordCloud(width = 1000, height = 500).generate(es
say_cluster2)

# plot the WordCloud image
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



Observations:

1.We can see that all 2 clusters have around 82% positive and 12% negative points.

2.Most common words in cluster 1 and 2 are "students","classroom," "learning".

Agglomerative

In [53]:

```
x_bow = x_bow.toarray()
```

In [54]:

```
#https://scikit-learn.org/stable/modules/generated/sklearn.cluster.AgglomerativeClustering.html
from sklearn.cluster import AgglomerativeClustering
Agg = AgglomerativeClustering(n_clusters = 2)
Agg.fit(x_bow)
```

Out[54]:

```
AgglomerativeClustering(affinity='euclidean',
compute_full_tree='auto',
            connectivity=None, linkage='ward',
            memory=Memory(cachedir=None), n_cl
usters=2,
            pooling_func=<function mean at 0x0
000009C7F144598>)
```

In [55]:

```
#Distributing different datapoints to respective clusters
cluster_1=[]
cluster_2=[]

for i in range(x_bow.shape[0]):
    if Agg.labels_[i] == 0:
        cluster_1.append(project_data.iloc[i])
    elif Agg.labels_[i] == 1:
        cluster_2.append(project_data.iloc[i])
```

In [56]:

```
positive=0
negative=0
words=len(cluster_1)
for i in cluster_1:
    if i['project_is_approved']==1:
        positive=positive+1
    else:
        negative=negative+1

print("Projects Approved %age in cluster 1 ",(positive/words*
100))
print("Projects Not Approved %age in cluster 1 ",(negative/wo
rds*100))
```

```
Projects Approved %age in cluster 1  83.177570
09345794
Projects Not Approved %age in cluster 1  16.82
2429906542055
```

In [61]:

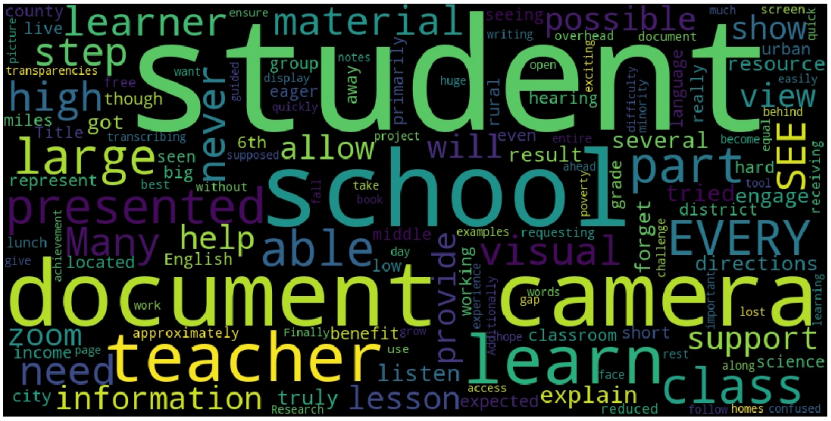
```
positive=0
negative=0
words=len(cluster_2)
for i in cluster_2:
    if i['project_is_approved']==1:
        positive=positive+1
    else:
        negative=negative+1

print("Projects Approved %age in cluster 2 ",(positive/words*
100))
print("Projects Not Approved %age in cluster 2 ",(negative/wo
rds*100))
```

```
Projects Approved %age in cluster 2  89.347336
```

```
83420856
Projects Not Approved %age in cluster 2  10.65
2663165791449
```

In [60]:

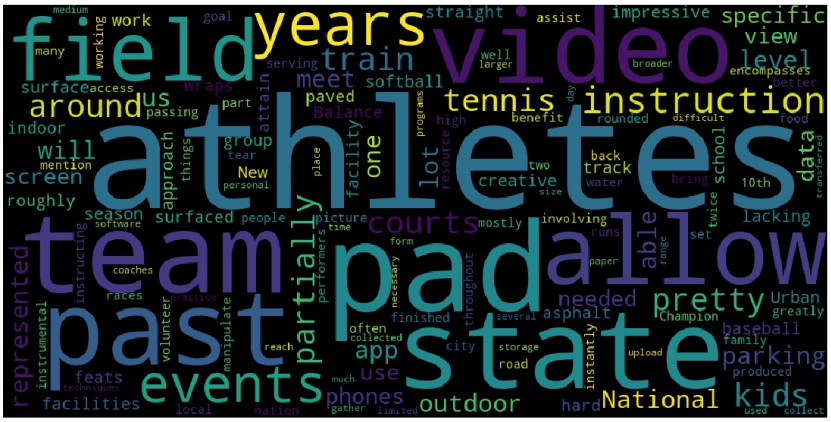
```
from wordcloud import WordCloud
#convert list to string and generate
essay_cluster1=cluster_1[0]['essay']
wordcloud = WordCloud(width = 1000, height = 500).generate(es
say_cluster1)
plt.figure(figsize=(25,10))
plt.imshow(wordcloud)
plt.axis("off")
plt.savefig("your_file_name"+".png", bbox_inches='tight')
plt.show()
plt.close()
```



In [62]:

```
from wordcloud import WordCloud
#convert list to string and generate
essay_cluster2=cluster_2[0]['essay']
wordcloud = WordCloud(width = 1000, height = 500).generate(es
say_cluster2)
plt.figure(figsize=(25,10))
plt.imshow(wordcloud)
```

```
plt.axis("off")
plt.savefig("your_file_name"+".png", bbox_inches='tight')
plt.show()
plt.close()
```



Observations:

1.We can see that,the 2 clusters have around 82% positive and 10% negative points.

2.Cluster1 and Cluster2 does not have any common words.

DBSCAN

In [54]:

```
#https://datascience.stackexchange.com/questions/10162/knn-distance-plot-for-determining-eps-of-dbscan
from sklearn.neighbors import NearestNeighbors

from sklearn.neighbors import NearestNeighbors
neigh = NearestNeighbors(10,0.5,metric='euclidean')
neigh.fit(x_bow)
```

Out[54]:

```
NearestNeighbors(algorithm='auto', leaf_size=3
0, metric='euclidean',
          metric_params=None, n_jobs=1, n_neigh
bors=10, p=2, radius=0.5)
```

In [55]:

```
p=neigh.kneighbors(x_bow, 10, return_distance=True)
```

In [73]:

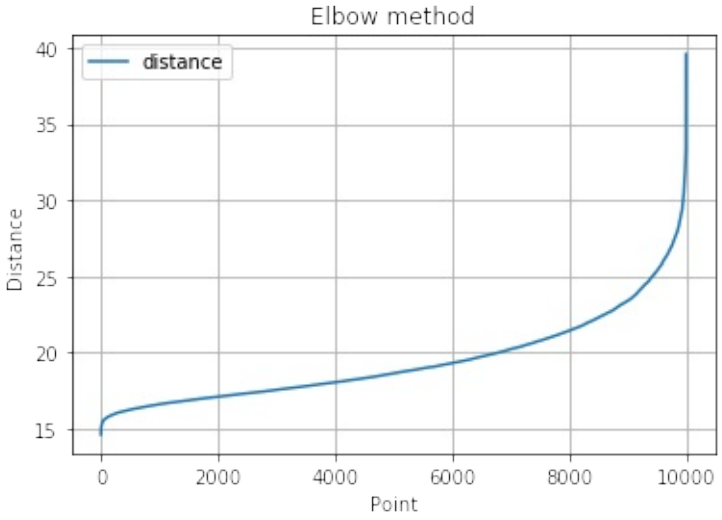
```
i=0
distance=[]
while(i<10000):
    distance.append(p[0][i][9])
    i=i+1
```

In [74]:

```
distance.sort()
```

In [75]:

```
plt.plot(distance,label="distance")
plt.legend()
plt.xlabel("Point")
plt.ylabel("Distance")
plt.title("Elbow method")
plt.grid()
plt.show()
```



In [76]:

```
from sklearn.cluster import DBSCAN
db = DBSCAN(eps=20, min_samples=10).fit(x_bow)
```

In [77]:

```
labels = db.labels_
```

In [78]:

```
#https://scikit-learn.org/stable/auto_examples/cluster/plot_dbscan.html
# Number of clusters in labels, ignoring noise if present.
n_clusters_ = len(set(labels)) - (1 if -1 in labels else 0)
n_noise_ = list(labels).count(-1)
print('Estimated number of clusters: %d' % n_clusters_)
print('Estimated number of noise points: %d' % n_noise_)
```

```
Estimated number of clusters: 1
Estimated number of noise points: 2359
```

In [84]:

```
#Distributing different datapoints to respective clusters
cluster_1=[]
for i in range(x_bow.shape[0]):
    if db.labels_[i] == 0:
        cluster_1.append(project_data.iloc[i])
    else :
        pass
```

In [85]:

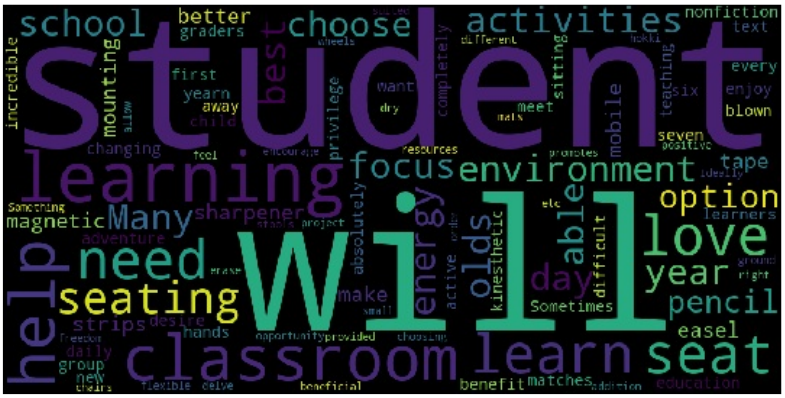
```
positive=0
negative=0
words=len(cluster_1)
for i in cluster_1:
    if i['project_is_approved']==1:
        positive=positive+1
    else:
        negative=negative+1

print("Projects Approved %age in cluster 1 ",(positive/words*
100))
print("Projects Not Approved %age in cluster 1 ",(negative/wo
rds*100))
```

```
Projects Approved %age in cluster 1  82.829472
58212275
Projects Not Approved %age in cluster 1  17.17
0527417877242
```

In [87]:

```
#https://www.geeksforgeeks.org/generating-word-cloud-python/
```

```
from wordcloud import WordCloud
words1=cluster_1[0]['essay']
wordcloud = WordCloud(width = 1000, height = 500).generate(wo
rds1)

# plot the WordCloud image
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



Observations:

1.We can see that the cluster have around 82% positive and 17% negative points.
2.Most frequent words in cluster 1 are "students" , "classroom", "learning", "classroom".