DonorsChoose

DonorsChoose.org receives hundreds of thousands of project proposals each year for classroom projects in need of funding. Right now, a large number of volunteers is needed to manually screen each submission before it's approved to be posted on the DonorsChoose.org website.

Next year, DonorsChoose.org expects to receive close to 500,000 project proposals. As a result, there are three main problems they need to solve:

- How to scale current manual processes and resources to screen 500,000 projects so that they can be posted as quickly and as efficiently as possible
- How to increase the consistency of project vetting across different volunteers to improve the experience for teachers
- How to focus volunteer time on the applications that need the most assistance

The goal of the competition is to predict whether or not a DonorsChoose.org project proposal submitted by a teacher will be approved, using the text of project descriptions as well as additional metadata about the project, teacher, and school. DonorsChoose.org can then use this information to identify projects most likely to need further review before approval.

About the DonorsChoose Data Set

The `train.csv` data set provided by DonorsChoose contains the following features:

Feature	
`project_id`	A unique identifier for the proposed project. **Example**
`project_title`	Title of the project. • `Art Will Make Y` • `First`
`project_grade_category`	Grade level of students for which the project is targeted. One of t enumera • `Grade` • `Gr` • `Gr` • `Gra`

Feature	
project_subject_categories	One or more (comma-separated) subject categories for the proj following enumerated lis • Applied • Care • Health • History • Literacy & • Math & • Music & • Speci • • Music & • Literacy & Language, Math &
school_state	State where school is located ([Two-letter U.S. (https://en.wikipedia.org/wiki/List_of_U.S._state_abbreviations#Pos](https://en.wikipedia.org/wiki/List_of_U.S._state_abbreviations#Pos) **Ex**
project_subject_subcategories	One or more (comma-separated) subject subcategories for • • Literature & Writing, Social
project_resource_summary	An explanation of the resources needed for the project • My students need hands on literacy materials sensory need
project_essay_1	First applic
project_essay_2	Second applic
project_essay_3	Third applic
project_essay_4	Fourth applic
project_submitted_datetime	Datetime when project application was submitted. **Example:** 20 12:4
teacher_id	A unique identifier for the teacher of the proposed projec bdf8baa8fedef6bfeec7ae4f
teacher_prefix	Teacher's title. One of the following enumera • • • • • •
teacher_number_of_previously_posted_projects	Number of project applications previously submitted by the sa **E**

* See the section **Notes on the Essay Data** for more details about these features.

Additionally, the `resources.csv` data set provides more data about the resources required for each project. Each line in this file represents a resource required by a project:

Feature	Description
id	A `project_id` value from the `train.csv` file. **Example:** `p036502`
description	Desciption of the resource. **Example:** `Tenor Saxophone Reeds, Box of 25`

Feature	Description
`quantity`	Quantity of the resource required. **Example:** `3`
`price`	Price of the resource required. **Example:** `9.95`

Note: Many projects require multiple resources. The `id` value corresponds to a `project_id` in train.csv, so you use it as a key to retrieve all resources needed for a project:

The data set contains the following label (the value you will attempt to predict):

Label	Description
`project_is_approved`	A binary flag indicating whether DonorsChoose approved the project. A value of `0` indicates the project was not approved, and a value of `1` indicates the project was approved.

Notes on the Essay Data

Prior to May 17, 2016, the prompts for the essays were as follows:

- **project_essay_1:** "Introduce us to your classroom"
- **project_essay_2:** "Tell us more about your students"
- **project_essay_3:** "Describe how your students will use the materials you're requesting"
- **project_essay_3:** "Close by sharing why your project will make a difference"

Starting on May 17, 2016, the number of essays was reduced from 4 to 2, and the prompts for the first 2 essays were changed to the following:

- **project_essay_1:** "Describe your students: What makes your students special? Specific details about their background, your neighborhood, and your school are all helpful."
- **project_essay_2:** "About your project: How will these materials make a difference in your students' learning and improve their school lives?"

For all projects with project_submitted_datetime of 2016-05-17 and later, the values of project_essay_3 and project_essay_4 will be NaN.

In [120]:

```
%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.com/2/re/
import string
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer
from nltk.stem.wordnet import WordNetLemmatizer

# from gensim.models import Word2Vec
# from gensim.models import KeyedVectors
import pickle

from tqdm import tqdm
import os

from plotly import plotly
import plotly.offline as offline
import plotly.graph_objs as go
offline.init_notebook_mode()
from collections import Counter
from scipy.sparse import hstack
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.tree import DecisionTreeClassifier
from sklearn.model_selection import RandomizedSearchCV
from sklearn.model_selection import GridSearchCV
from sklearn import preprocessing
from sklearn.metrics import confusion_matrix
from prettytable import PrettyTable
import nltk
from nltk.sentiment.vader import SentimentIntensityAnalyzer
from sklearn.tree import DecisionTreeClassifier, export_graphviz
from sklearn import tree
from IPython.display import SVG
from graphviz import Source
from IPython.display import display
from sklearn.naive_bayes import MultinomialNB
from wordcloud import WordCloud
```

1.1 Reading Data

In [121]:

```
project_data = pd.read_csv('train_data.csv',nrows=10000)
resource_data = pd.read_csv('resources.csv')
```

Adding price attribute to project_data dataframe from resources using merge function

In [122]:

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

In [123]:

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

```
Number of data points in train data (10000, 19)
--------------------------------------------------
The attributes of data : ['Unnamed: 0' 'id' 'teacher_id' 'teacher_pref
ix' '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'
 'price' 'quantity']
```

In [124]:

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

```
Number of data points in train data (1541272, 4)
['id' 'description' 'quantity' 'price']
```

Out[124]:

	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

1.2 preprocessing of `project_subject_categories`

In [125]:

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

# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from-a-
# https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-in-
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", "Wa
        if 'The' in j.split(): # this will split each of the catogory based on spac
            j=j.replace('The','') # if we have the words "The" we are going to repl
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) e
        temp+=j.strip()+" " #" abc ".strip() will return "abc", remove the trailing
        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 [126]:

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

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

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", "Wa
        if 'The' in j.split(): # this will split each of the catogory based on spac
            j=j.replace('The','') # if we have the words "The" we are going to repl
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) e
        temp +=j.strip()+" "#" abc ".strip() will return "abc", remove the trailing
        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/22898595/408
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]))
```

1.3 Text preprocessing

In [127]:

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

In [128]:

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

Out[128]:

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

In [129]:

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

```
My students are English learners that are working on English as thei
r second or third languages. We are a melting pot of refugees, immig
rants, and native-born Americans bringing the gift of language to ou
r school. \r\n\r\n We have over 24 languages represented in our Engl
ish Learner program with students at every level of mastery.  We als
o have over 40 countries represented with the families within our sc
hool.  Each student brings a wealth of knowledge and experiences to
us that open our eyes to new cultures, beliefs, and respect.\"The li
mits of your language are the limits of your world.\"-Ludwig Wittgen
stein  Our English learner's have a strong support system at home th
at begs for more resources.  Many times our parents are learning to
read and speak English along side of their children.  Sometimes this
creates barriers for parents to be able to help their child learn ph
onetics, letter recognition, and other reading skills.\r\n\r\nBy pro
viding these dvd's and players, students are able to continue their
mastery of the English language even if no one at home is able to as
sist.  All families with students within the Level 1 proficiency sta
tus, will be a offered to be a part of this program.  These educatio
nal videos will be specially chosen by the English Learner Teacher a
nd will be sent home regularly to watch.  The videos are to help the
child develop early reading skills.\r\n\r\nParents that do not have
access to a dvd player will have the opportunity to check out a dvd
player to use for the year.  The plan is to use these videos and edu
cational dvd's for the years to come for other EL students.\r\nnanna
n
==================================================
The 51 fifth grade students that will cycle through my classroom thi
s year all love learning, at least most of the time. At our school,
97.3% of the students receive free or reduced price lunch. Of the 56
0 students, 97.3% are minority students. \r\nThe school has a vibran
t community that loves to get together and celebrate. Around Hallowe
en there is a whole school parade to show off the beautiful costumes
that students wear. On Cinco de Mayo we put on a big festival with c
rafts made by the students, dances, and games. At the end of the yea
r the school hosts a carnival to celebrate the hard work put in duri
ng the school year, with a dunk tank being the most popular activit
y.My students will use these five brightly colored Hokki stools in p
lace of regular, stationary, 4-legged chairs. As I will only have a
total of ten in the classroom and not enough for each student to hav
e an individual one, they will be used in a variety of ways. During
independent reading time they will be used as special chairs student
s will each use on occasion. I will utilize them in place of chairs
at my small group tables during math and reading times. The rest of
the day they will be used by the students who need the highest amoun
t of movement in their life in order to stay focused on school.\r\n
\r\nWhenever asked what the classroom is missing, my students always
say more Hokki Stools. They can't get their fill of the 5 stools we
```

```
already have. When the students are sitting in group with me on the
Hokki Stools, they are always moving, but at the same time doing the
ir work. Anytime the students get to pick where they can sit, the Ho
kki Stools are the first to be taken. There are always students who
head over to the kidney table to get one of the stools who are disap
pointed as there are not enough of them. \r\n\r\nWe ask a lot of stu
dents to sit for 7 hours a day. The Hokki stools will be a compromis
e that allow my students to do desk work and move at the same time.
These stools will help students to meet their 60 minutes a day of mo
vement by allowing them to activate their core muscles for balance w
hile they sit. For many of my students, these chairs will take away
the barrier that exists in schools for a child who can't sit still.n
annan
==================================================
How do you remember your days of school? Was it in a sterile environ
ment with plain walls, rows of desks, and a teacher in front of the
room? A typical day in our room is nothing like that. I work hard to
create a warm inviting themed room for my students look forward to c
oming to each day.\r\n\r\nMy class is made up of 28 wonderfully uniq
ue boys and girls of mixed races in Arkansas.\r\nThey attend a Title
I school, which means there is a high enough percentage of free and
reduced-price lunch to qualify. Our school is an \"open classroom\"
concept, which is very unique as there are no walls separating the c
lassrooms. These 9 and 10 year-old students are very eager learners;
they are like sponges, absorbing all the information and experiences
and keep on wanting more.With these resources such as the comfy red
throw pillows and the whimsical nautical hanging decor and the blue
fish nets, I will be able to help create the mood in our classroom s
etting to be one of a themed nautical environment. Creating a classr
oom environment is very important in the success in each and every c
hild's education. The nautical photo props will be used with each ch
ild as they step foot into our classroom for the first time on Meet
the Teacher evening. I'll take pictures of each child with them, hav
e them developed, and then hung in our classroom ready for their fir
st day of 4th grade.  This kind gesture will set the tone before eve
n the first day of school! The nautical thank you cards will be used
throughout the year by the students as they create thank you cards t
o their team groups.\r\n\r\nYour generous donations will help me to
help make our classroom a fun, inviting, learning environment from d
ay one.\r\n\r\nIt costs lost of money out of my own pocket on resour
ces to get our classroom ready. Please consider helping with this pr
oject to make our new school year a very successful one. Thank you!n
annan
==================================================
```

```
---------------------------------------------------------------------------
IndexError                                Traceback (most recent call
 last)
<ipython-input-129-009ab9740f10> in <module>
      6 print(project_data['essay'].values[1000])
      7 print("="*50)
----> 8 print(project_data['essay'].values[20000])
      9 print("="*50)
     10 print(project_data['essay'].values[99999])

IndexError: index 20000 is out of bounds for axis 0 with size 10000
```

In [130]:

```
# 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 [131]:

```
sent = decontracted(project_data['essay'].values[5000])
print(sent)
print("="*50)
```

```
My class is made up of students from various grade levels. We  work ha
rd in filling learning gaps and have students reach grade level. My st
udents are dealing with emotional issues that make it hard for them to
handle frustration with tasks and need a lot of individual attention.
By learning to work independently, my students will have the chance to
mainstream into other classrooms with their peer groups. Our biggest g
oal with my students is for them to learn not only to control their em
otions but to learn how to be students. Many of them have spent a larg
e amount of time absent from school for different reasons and need to
get into the routine of being in class and on task all day. Modeling g
ood classroom routines and task is important for them to master and mo
ve back into general education classrooms. Being apart of a Title 1 sc
hool means resources that students need are massive and a lot of suppl
ies are shared with parents to make sure homework is completed.Bouncy
Bands will give my students a way to get rid of anxiety, tension, and
energy all while staying at their desk and working independently.  Stu
dents will use the bands at either their desk or at a whole group tabl
e with a chair and avoid having to get up or be asked to stop moving.
Movement is the key to keeping students with ADHD and other disabiliti
es focused and finishing up their assignments or staying on task while
the teacher is teaching. \r\n       My goal is to help my students lea
rn helpful strategies that will allow them to join their peers in the
general education setting.   By learning how to maintain focus by gett
ing their wiggles and extra energy and grow academically.nannan
==================================================
```

In [132]:

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

```
My class is made up of students from various grade levels. We  work ha
rd in filling learning gaps and have students reach grade level. My st
udents are dealing with emotional issues that make it hard for them to
handle frustration with tasks and need a lot of individual attention.
By learning to work independently, my students will have the chance to
mainstream into other classrooms with their peer groups. Our biggest g
oal with my students is for them to learn not only to control their em
otions but to learn how to be students. Many of them have spent a larg
e amount of time absent from school for different reasons and need to
get into the routine of being in class and on task all day. Modeling g
ood classroom routines and task is important for them to master and mo
ve back into general education classrooms. Being apart of a Title 1 sc
hool means resources that students need are massive and a lot of suppl
ies are shared with parents to make sure homework is completed.Bouncy
Bands will give my students a way to get rid of anxiety, tension, and
energy all while staying at their desk and working independently.  Stu
dents will use the bands at either their desk or at a whole group tabl
e with a chair and avoid having to get up or be asked to stop moving.
Movement is the key to keeping students with ADHD and other disabiliti
es focused and finishing up their assignments or staying on task while
the teacher is teaching.          My goal is to help my students learn
helpful strategies that will allow them to join their peers in the gen
eral education setting.   By learning how to maintain focus by getting
their wiggles and extra energy and grow academically.nannan
```

In [133]:

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

```
My class is made up of students from various grade levels We work hard
in filling learning gaps and have students reach grade level My studen
ts are dealing with emotional issues that make it hard for them to han
dle frustration with tasks and need a lot of individual attention By l
earning to work independently my students will have the chance to main
stream into other classrooms with their peer groups Our biggest goal w
ith my students is for them to learn not only to control their emotion
s but to learn how to be students Many of them have spent a large amou
nt of time absent from school for different reasons and need to get in
to the routine of being in class and on task all day Modeling good cla
ssroom routines and task is important for them to master and move back
into general education classrooms Being apart of a Title 1 school mean
s resources that students need are massive and a lot of supplies are s
hared with parents to make sure homework is completed Bouncy Bands wil
l give my students a way to get rid of anxiety tension and energy all
while staying at their desk and working independently Students will us
e the bands at either their desk or at a whole group table with a chai
r and avoid having to get up or be asked to stop moving Movement is th
e key to keeping students with ADHD and other disabilities focused and
finishing up their assignments or staying on task while the teacher is
teaching My goal is to help my students learn helpful strategies that
will allow them to join their peers in the general education setting B
y learning how to maintain focus by getting their wiggles and extra en
ergy and grow academically nannan
```

In [134]:

```
# 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', "yo
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'hi
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself'
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that',
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has',
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because',
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'thro
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off',
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all',
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', '
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've",
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', '
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't"
            'won', "won't", 'wouldn', "wouldn't"}
```

In [135]:

```
# 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 = sentance.lower().strip()
    sent = ' '.join(e for e in sent.split() if e not in stopwords)
    sent = decontracted(sent)
    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
    preprocessed_essays.append(sent)
```

```
100%|██████████| 10000/10000 [00:01<00:00, 7294.97it/s]
```

In [136]:

```
# after preprocesing
preprocessed_essays[5000]
```

Out[136]:

```
'class made students various grade levels work hard filling learning g
aps students reach grade level students dealing emotional issues make
hard handle frustration tasks need lot individual attention learning w
ork independently students chance mainstream classrooms peer groups bi
ggest goal students learn not control emotions learn students many spe
nt large amount time absent school different reasons need get routine
class task day modeling good classroom routines task important master
move back general education classrooms apart title 1 school means reso
urces students need massive lot supplies shared parents make sure home
work completed bouncy bands give students way get rid anxiety tension
energy staying desk working independently students use bands either de
sk whole group table chair avoid get asked stop moving movement key ke
eping students adhd disabilities focused finishing assignments staying
task teacher teaching goal help students learn helpful strategies allo
w join peers general education setting learning maintain focus getting
wiggles extra energy grow academically nannan'
```

In [137]:

```
project_data['clean_essay'] = preprocessed_essays
```

In [138]:

```
project_data.drop(['project_essay_1','project_essay_2','project_essay_3','project_e
```

1.4 Preprocessing of `project_title`

- Decontract project titles, remove line breaks and extra spaces, convert everything to lowercase and then remove all the stop words.

In [139]:

```
preprocessed_titles = []

for title in tqdm(project_data['project_title'].values):
    title = title.lower().strip()
    title = ' '.join(e for e in title.split() if e.lower() not in stopwords)
    title = decontracted(title)
    title = title.replace('\\r', ' ')
    title = title.replace('\\"', ' ')
    title = title.replace('\\n', ' ')
    title = re.sub('[^A-Za-z0-9]+', ' ', title)
    preprocessed_titles.append(title)
```

```
100%|██████████| 10000/10000 [00:00<00:00, 65255.50it/s]
```

In [140]:

```
project_data['clean_title'] = preprocessed_titles
project_data.drop(['project_title'],axis=1,inplace=True)
```

Pre-processing teacher_prefix

In [141]:

```
#remove nan from teacher prefix:
#https://stackoverflow.com/questions/21011777/how-can-i-remove-nan-from-list-python
def remove_nan(prefix):
    if str(prefix)!='nan':
        pr = str(prefix)
        pr = re.sub("\\.","",pr) #remove dot from the end of prefix
        return pr
    return "none"

cleaned_teacher_prefix = project_data['teacher_prefix'].map(remove_nan)
project_data['clean_teacher_prefix'] = cleaned_teacher_prefix
```

In [142]:

```
project_data.drop(['teacher_prefix'],axis=1,inplace=True)
```

Pre-process project_grade_category

- Clean the project grade categories:
  - `Convert Grades 3-5 ==> Grades_3_5`

In [143]:

```
def clean_project_grades(grade):
    grade = re.sub("\-","_",grade)
    grade = re.sub(" ","_",grade)
    return grade.strip()

clean_grades = project_data['project_grade_category'].map(clean_project_grades)
project_data['clean_grade_category'] = clean_grades
```

In [144]:

```
project_data.drop(['project_grade_category'],axis=1,inplace=True)
```

In [145]:

```
# Dropping all features we won't need going forward
project_data.drop(['project_resource_summary'],axis=1,inplace=True)
project_data.drop(['Unnamed: 0','teacher_id'],axis=1,inplace=True)
```

In [146]:

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

Out[146]:

	id	school_state	project_submitted_datetime	teacher_number_of_previously_posted_proj
0	p253737	IN	2016-12-05 13:43:57	
1	p258326	FL	2016-10-25 09:22:10	

Assignment 10: Clustering

- step 1: Choose any vectorizer (data matrix) that you have worked in any of the assignments, and got the best AUC value.
- step 2: Choose any of the feature selection (https://scikit-learn.org/stable/modules/feature_selection.html)/reduction algorithms (https://scikit-learn.org/stable/modules/decomposition.html) ex: selectkbest features, pretrained word vectors, model based feature selection etc and reduce the number of features to 5k features
- step 3: Apply all three kmeans, Agglomerative clustering, DBSCAN
  - **K-Means Clustering:**
    ● Find the best 'k' using the elbow-knee method (plot k vs inertia_)
  - **Agglomerative Clustering:**
    ● Apply agglomerative algorithm (https://stackabuse.com/hierarchical-clustering-with-python-and-scikit-learn/) and try a different number of clusters like 2,5 etc.
    ● You can take less data points (as this is very computationally expensive one) to perform hierarchical clustering because they do take a considerable amount of time to run.
  - **DBSCAN Clustering:**
    ● Find the best 'eps' using the elbow-knee method (https://stackoverflow.com/a/48558030/4084039).
    ● You can take a smaller sample size for this as well.
- step 4: Summarize each cluster by manually observing few points from each cluster.
- step 5: You need to plot the word cloud with essay text for each cluster for each of algorithms mentioned in step 3.

Note: Data Leakage

1. There will be an issue of data-leakage if you vectorize the entire data and then split it into train/cv/test.
2. To avoid the issue of data-leakage, make sure to split your data first and then vectorize it.
3. While vectorizing your data, apply the method fit_transform() on you train data, and apply the method transform() on cv/test data.
4. For more details please go through this link. (https://soundcloud.com/applied-ai-course/leakage-bow-and-tfidf)

2. Clustering

2.1 Splitting data into Train and cross validation(or test): Stratified Sampling

In [147]:

```
#Separating features and label column
Y = project_data['project_is_approved']
X = project_data.drop(['project_is_approved','id'],axis=1)
print("Shape of X: ",X.shape)
print("Shape of Y: ",Y.shape)
```

```
Shape of X:  (10000, 12)
Shape of Y:  (10000,)
```

In [148]:

```
# #separating data into train and test
# X_train, X_test, Y_train, Y_test = train_test_split(X,Y,test_size=0.30,stratify=Y
# print("Shape of X_train: ", X_train.shape)
# print("Shape of Y_train: ",Y_train.shape)
# print("Shape of X_test: ",X_test.shape)
# print("Shape of Y_test: ",Y_test.shape)
```

In [149]:

```
X.columns
```

Out[149]:

```
Index(['school_state', 'project_submitted_datetime',
       'teacher_number_of_previously_posted_projects', 'price', 'quant
ity',
       'clean_categories', 'clean_subcategories', 'essay', 'clean_essa
y',
       'clean_title', 'clean_teacher_prefix', 'clean_grade_category'],
      dtype='object')
```

2.2 Make Data Model Ready: encoding numerical, categorical features

2.2.1 Encoding Categorical Features

One hot encoding: clean_categories

In [150]:

```
from collections import Counter
my_counter = Counter()
for word in X['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]))
```

In [151]:

```
# we use count vectorizer to convert the values into one
vectorizer_category = CountVectorizer(vocabulary=list(sorted_cat_dict.keys()), lowe
vectorizer_category.fit(X['clean_categories'].values)

X_category_ohe = vectorizer_category.transform(X['clean_categories'].values)
#X_test_category_ohe = vectorizer_category.transform(X_test['clean_categories'].val
```

In [152]:

```
print(vectorizer_category.get_feature_names())
print("Shape of X after one hot encodig ",X_category_ohe.shape)
#print("Shape of X_test after one hot encodig ",X_test_category_ohe.shape)
print("Print some random encoded categories: ")
print(X_category_ohe[0].toarray())
#print(X_test_category_ohe[15].toarray())
```

```
['Warmth', 'Care_Hunger', 'History_Civics', 'Music_Arts', 'AppliedLear
ning', 'SpecialNeeds', 'Health_Sports', 'Math_Science', 'Literacy_Lang
uage']
Shape of X after one hot encodig  (10000, 9)
Print some random encoded categories:
[[0 0 0 0 0 0 0 0 1]]
```

One hot encoding: clean_subcategories

In [153]:

```
# count of all the words in corpus python: https://stackoverflow.com/a/22898595/408
my_counter = Counter()
for word in X['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]))
```

In [154]:

```
# we use count vectorizer to convert the values into one
vectorizer_subcategory = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()
vectorizer_subcategory.fit(X['clean_subcategories'].values)

X_subcategory_ohe = vectorizer_subcategory.transform(X['clean_subcategories'].value
X_subcategory_ohe = vectorizer_subcategory.transform(X['clean_subcategories'].value
```

In [155]:

```
print(vectorizer_subcategory.get_feature_names())
print("Shape of X subcategory after one hot encodig ",X_subcategory_ohe.shape)
#print("Shape of X_test subcategory after one hot encodig ",X_test_subcategory_ohe.
print("Print some random encoded categories: ")
print(X_subcategory_ohe[0].toarray())
#print(X_test_subcategory_ohe[10].toarray())
```

```
['Economics', 'FinancialLiteracy', 'CommunityService', 'ForeignLanguag
es', 'ParentInvolvement', 'Extracurricular', 'Civics_Government', 'Nut
ritionEducation', 'Warmth', 'Care_Hunger', 'SocialSciences', 'Characte
rEducation', 'PerformingArts', 'TeamSports', 'Other', 'College_CareerP
rep', 'Music', 'History_Geography', 'ESL', 'Health_LifeScience', 'Earl
yDevelopment', 'Gym_Fitness', 'EnvironmentalScience', 'VisualArts', 'H
ealth_Wellness', 'AppliedSciences', 'SpecialNeeds', 'Literature_Writin
g', 'Mathematics', 'Literacy']
Shape of X subcategory after one hot encodig  (10000, 30)
Print some random encoded categories:
[[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1]]
```

One hot encoding: school_state

In [156]:

```
# create a vocabulary for states
unique_states = np.unique(X['school_state'].values)

vectorizer_state = CountVectorizer(vocabulary=unique_states,lowercase=False,binary=
vectorizer_state.fit(X['school_state'].values)

X_school_state_ohe = vectorizer_state.transform(X['school_state'].values)
X_school_state_ohe = vectorizer_state.transform(X['school_state'].values)
```

In [157]:

```
print(vectorizer_state.get_feature_names())
print("Shape of X school_state after one hot encodig ",X_school_state_ohe.shape)
print("Shape of X school_state after one hot encodig ",X_school_state_ohe.shape)
print("Print some random encoded school_state: ")
print(X_school_state_ohe[0].toarray())
print(X_school_state_ohe[15].toarray())
```

```
['AK', 'AL', 'AR', 'AZ', 'CA', 'CO', 'CT', 'DC', 'DE', 'FL', 'GA', 'H
I', 'IA', 'ID', 'IL', 'IN', 'KS', 'KY', 'LA', 'MA', 'MD', 'ME', 'MI',
'MN', 'MO', 'MS', 'MT', 'NC', 'ND', 'NE', 'NH', 'NJ', 'NM', 'NV', 'N
Y', 'OH', 'OK', 'OR', 'PA', 'RI', 'SC', 'SD', 'TN', 'TX', 'UT', 'VA',
'VT', 'WA', 'WI', 'WV', 'WY']
Shape of X school_state after one hot encodig  (10000, 51)
Shape of X school_state after one hot encodig  (10000, 51)
Print some random encoded school_state:
[[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]]
[[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0
  0 0 0 0 0 0 0 1 0 0 0 0 0 0 0]]
```

One hot encoding: teacher_prefix

In [158]:

```
unique_teacher_prefix = np.unique(X['clean_teacher_prefix'])

vectorizer_teacher_prefix = CountVectorizer(vocabulary=unique_teacher_prefix,lowerc
vectorizer_teacher_prefix.fit(X['clean_teacher_prefix'].values)

X_teacher_prefix_ohe = vectorizer_teacher_prefix.transform(X['clean_teacher_prefix'
#X_test_teacher_prefix_ohe = vectorizer_teacher_prefix.transform(X['clean_teacher_p
```

In [159]:

```
print(vectorizer_teacher_prefix.get_feature_names())
print("Shape of X clean_teacher_prefix after one hot encodig ",X_teacher_prefix_ohe
#print("Shape of X_test clean_teacher_prefix after one hot encodig ",X_test_teacher
print("Print some random encoded clean_teacher_prefix: ")
print(X_teacher_prefix_ohe[0].toarray())
#print(X_test_teacher_prefix_ohe[15].toarray())
```

```
['Mr', 'Mrs', 'Ms', 'Teacher', 'none']
Shape of X clean_teacher_prefix after one hot encodig  (10000, 5)
Print some random encoded clean_teacher_prefix:
[[0 1 0 0 0]]
```

One hot encoding: project_grade_category

In [160]:

```
unique_grades = np.unique(X['clean_grade_category'])

vectorizer_grade = CountVectorizer(vocabulary=unique_grades,lowercase=False,binary=
vectorizer_grade.fit(X['clean_grade_category'].values)


X_grade_category_ohe = vectorizer_grade.transform(X['clean_grade_category'].values)
#X_test_grade_category_ohe = vectorizer_grade.transform(X_test['clean_grade_categor
```

In [161]:

```
print(vectorizer_grade.get_feature_names())
print("Shape of X_train clean_grade_category after one hot encodig ",X_grade_catego
#print("Shape of X_test clean_grade_category after one hot encodig ",X_test_grade_c
print("Print some random encoded clean_grade_category: ")
print(X_grade_category_ohe[0].toarray())
#print(X_test_grade_category_ohe[15].toarray())
```

```
['Grades_3_5', 'Grades_6_8', 'Grades_9_12', 'Grades_PreK_2']
Shape of X_train clean_grade_category after one hot encodig  (10000,
4)
Print some random encoded clean_grade_category:
[[0 0 0 1]]
```

2.2.2 Encoding Numerical features

Normalizing Price

In [162]:

```
price_vectorizer = preprocessing.Normalizer().fit(X['price'].values.reshape(1,-1))
```

In [163]:

```
X_price_normalized = price_vectorizer.transform(X['price'].values.reshape(1,-1))
#X_test_price_normalized = price_vectorizer.transform(X_test['price'].values.reshap
```

In [164]:

```
X_price_normalized
```

Out[164]:

```
array([[0.00314667, 0.00608573, 0.01051977, ..., 0.00719399, 0.0066759
9,
        0.00432087]])
```

Normalize teacher_number_of_previously_posted_projects

In [165]:

```
project_vectorizer = preprocessing.Normalizer().fit(X['teacher_number_of_previously
```

In [166]:

```
X_normal_previous_project = project_vectorizer.transform(X['teacher_number_of_previ
#X_test_normal_previous_project = project_vectorizer.transform(X_test['teacher_numb
```

2.3 Make Data Model Ready: encoding eassay, and project_title

2.3.5 Using Pretrained Models: Avg W2V : Essay

In [167]:

```
# stronging variables into pickle files python: http://www.jessicayung.com/how-to-u
# make sure you have the glove_vectors file
with open('glove_vectors', 'rb') as f:
    model = pickle.load(f)
    glove_words =  set(model.keys())
```

In [168]:

```
# average Word2Vec
def get_avg_w2v(corpus):
    avg_w2v_vectors=[]
    for sentence in tqdm(corpus): # for each review/sentence
        vector = np.zeros(300) # as word vectors are of zero length
        cnt_words =0; # num of words with a valid vector in the sentence/review
        for word in sentence.split(): # for each word in a review/sentence
            if word in glove_words:
                vector += model[word]
                cnt_words += 1
        if cnt_words != 0:
            vector /= cnt_words
        avg_w2v_vectors.append(vector)
    return avg_w2v_vectors

X_essay_avg_w2v_vectors = get_avg_w2v(X['clean_essay'])
#X_test_essay_avg_w2v_vectors = get_avg_w2v(X_test['clean_essay'])
```

```
100%|██████████| 10000/10000 [00:03<00:00, 3065.12it/s]
```

In [169]:

```
print("Shape of X_essay_avg_w2v_vectors",len(X_essay_avg_w2v_vectors),len(X_essay_a
#print("Shape of X_test_essay_avg_w2v_vectors ",len(X_test_essay_avg_w2v_vectors),l
```

```
Shape of X_essay_avg_w2v_vectors 10000 300
```

2.3.6 Using Pretrained Models: Avg W2V : Project Title

In [170]:

```
X_title_avg_w2v_vectors = get_avg_w2v(X['clean_title'])
#X_test_title_avg_w2v_vectors = get_avg_w2v(X_test['clean_title'])
```

```
100%|██████████| 10000/10000 [00:00<00:00, 55494.97it/s]
```

2.4 Choose the best data matrix on which you got the best AUC

- Choosing Word2Vec Embedding for text data and one hot encoding for the categorical features

- Selecting top 5000 features with SelectKBest

NOTE: SelectKBest uses chi squared test which assumes a frequency distribution and frequency distribution cannot be negative

Hence, Normalizing price and number_of_previously_submitted_projects.

In [171]:

```
from sklearn import preprocessing
#Use minmax scalar
mm_scaler = preprocessing.MinMaxScaler()
#Apply transform, this is equivalent to X = X-min(X)/Max(X)-Min(X)
X_price_normalized = mm_scaler.fit_transform(X['price'].values.reshape(-1,1))
#X_test_price_normalized = mm_scaler.fit_transform(X_test['price'].values.reshape(-

X_previous_project_normalized = mm_scaler.fit_transform(X['teacher_number_of_previo
#X_test_previous_project_normalized = mm_scaler.fit_transform(X_test['teacher_numbe
```

In [172]:

```
f1 = X_school_state_ohe
f2 = X_category_ohe
f3 = X_subcategory_ohe
f4 = X_grade_category_ohe
f5 = X_teacher_prefix_ohe
f6 = np.array(X_price_normalized).reshape(-1,1)
f7 = np.array(X_normal_previous_project).reshape(-1,1)

X_w2v = hstack((f1,f2,f3,f4,f5,f6,f7,X_essay_avg_w2v_vectors,X_title_avg_w2v_vector
X_w2v.shape
```

Out[172]:

```
(10000, 701)
```

Applying K-Means Clustering

Hyperparameter Tuning: Finding K using elbow-knee method

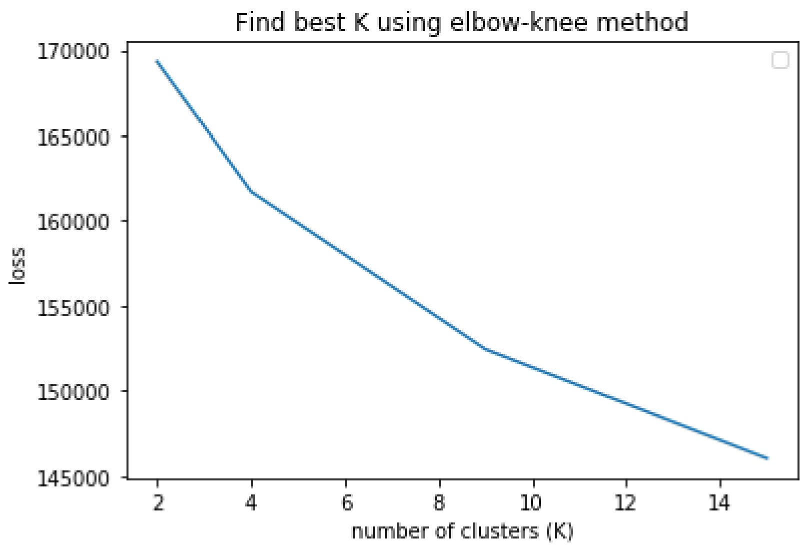
In [54]:

```
from sklearn.cluster import KMeans
def computeLossForClusterCenters(number_of_centers,data):
    loss = []
    for k in tqdm(number_of_centers):
        kmeans = KMeans(n_clusters=k, random_state=0, n_jobs=-1)
        kmeans.fit(data)
        loss.append(kmeans.inertia_)
    return loss

def plotGraph(number_of_centers, loss):
    plt.plot(number_of_centers, loss)

    plt.title("Find best K using elbow-knee method")
    plt.xlabel('number of clusters (K)')
    plt.ylabel('loss')
    plt.legend()
```

In [55]:

```
number_of_centers = [2, 4, 9, 15]
loss = computeLossForClusterCenters(number_of_centers,X_w2v)
plotGraph(number_of_centers,loss)
```

```
100%|██████████| 4/4 [2:53:01<00:00, 2634.61s/it]
No handles with labels found to put in legend.
```



Clustering data with the best value of K= 9

In [56]:

```
kmeans = KMeans(n_clusters=9, random_state=0, n_jobs=-1)
kmeans.fit(X_w2v)
```

Out[56]:

```
KMeans(algorithm='auto', copy_x=True, init='k-means++', max_iter=300,
    n_clusters=9, n_init=10, n_jobs=-1, precompute_distances='auto',
    random_state=0, tol=0.0001, verbose=0)
```

In [57]:

```
kmeans.labels_
```

Out[57]:

```
array([5, 7, 7, ..., 4, 1, 6], dtype=int32)
```

Generating word cloud for each cluster

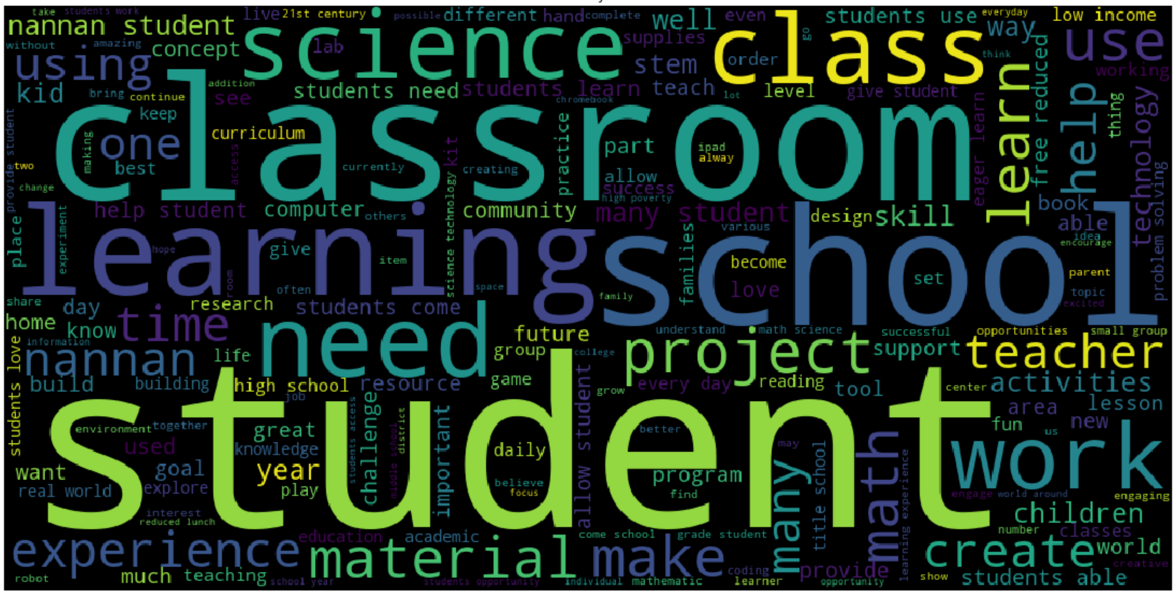
In [177]:

```
def generate_word_cloud(data,allocated_clusters):
    cluster_essay = {}
    df = data.reset_index(drop=True)
    df['allocated_cluster'] = np.array(allocated_clusters)
    cluster_centers = np.unique(allocated_clusters)
    for k in cluster_centers:
        cluster_df = df.loc[(df['allocated_cluster']==k)]
        unique_string=(" ").join(cluster_df['clean_essay'].values)
        cluster_essay[k] = unique_string

    for k, essay in cluster_essay.items():
        wordcloud = WordCloud(width = 1000, height = 500).generate(essay)
        plt.figure(figsize=(25,10))
        plt.imshow(wordcloud)
        plt.axis("off")
        plt.title('The word cloud with essay text for cluster no. %s'%(k))
        plt.show()
        plt.close()
    return cluster_essay
```

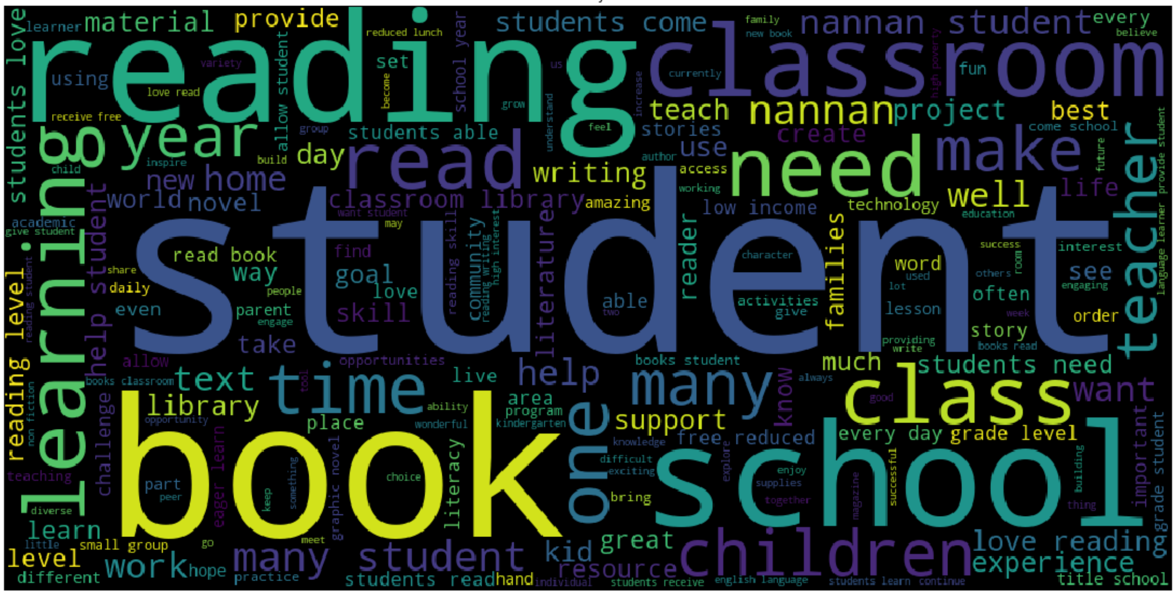
In [97]:

```
cluster_essays = generate_word_cloud(X,kmeans.labels_)
```

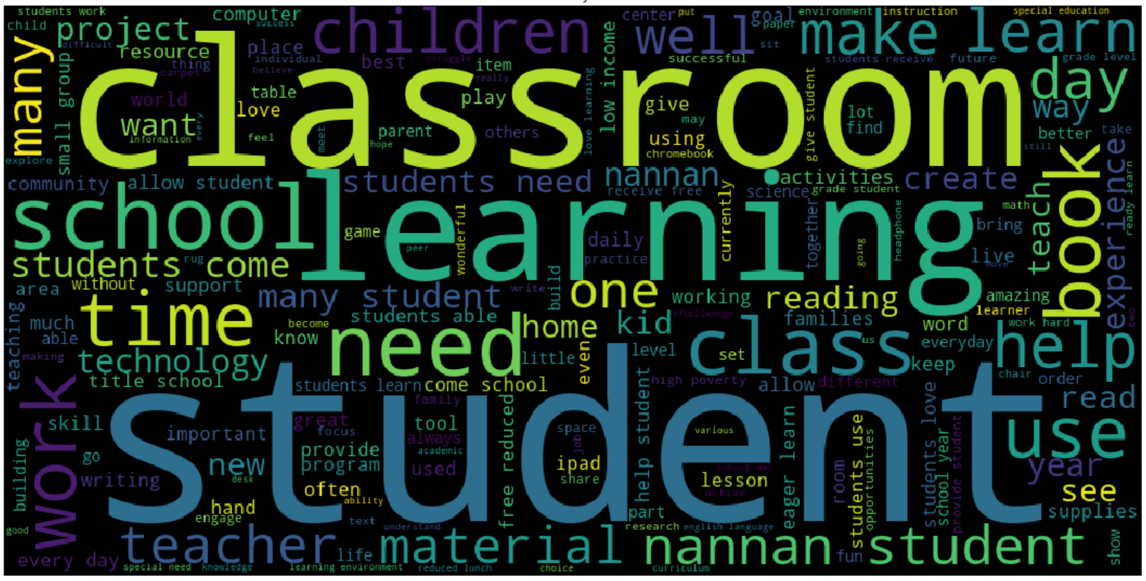
The word cloud with essay text for cluster no. 0



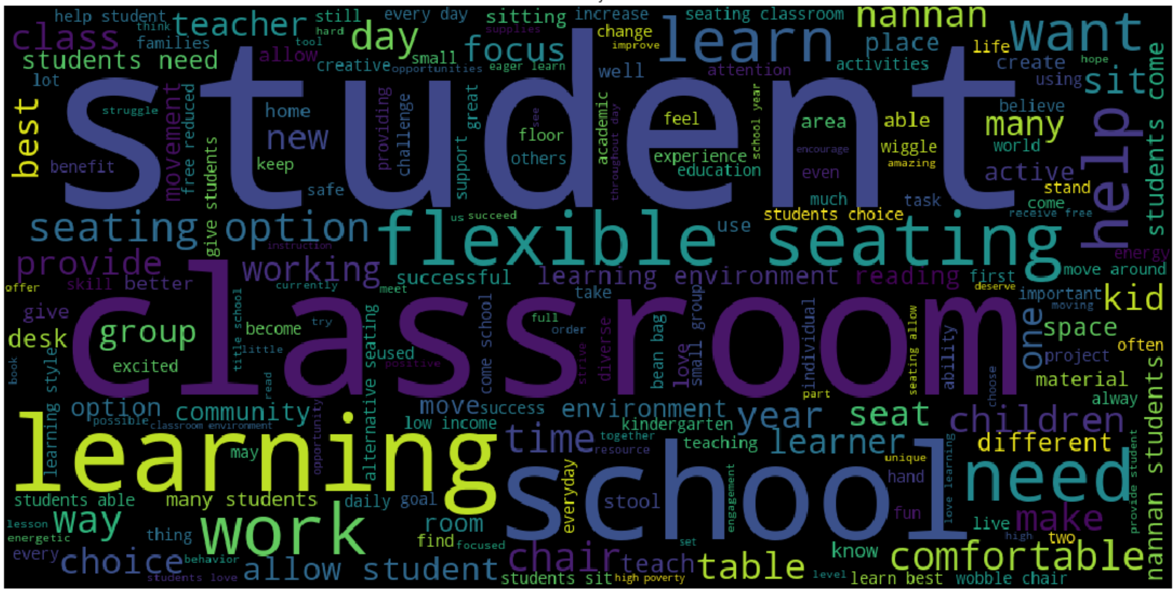
The word cloud with essay text for cluster no. 1



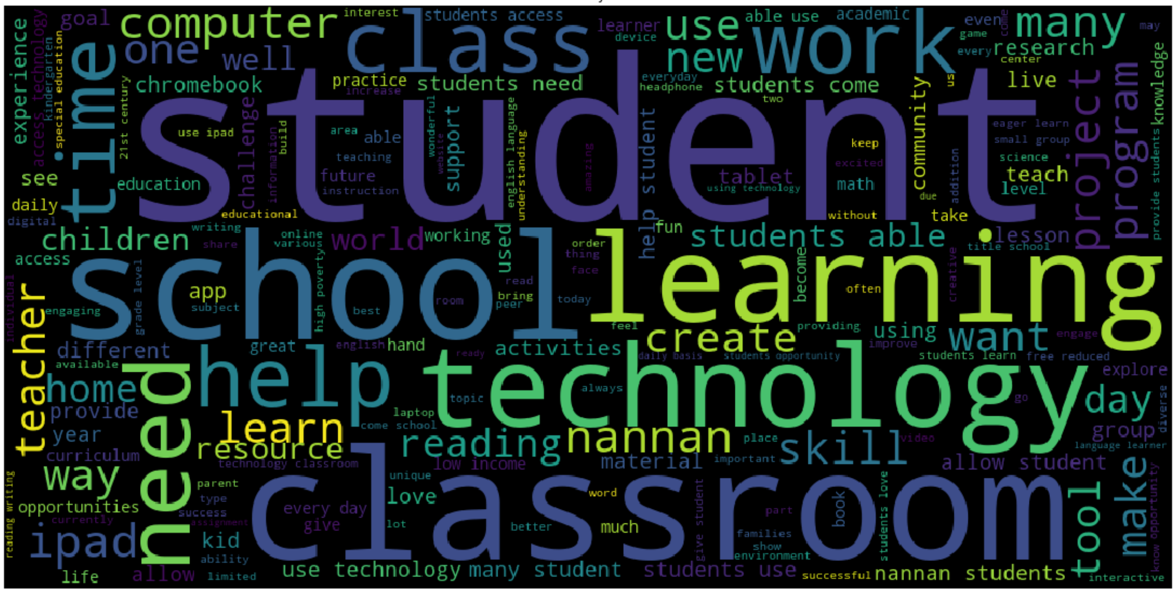
The word cloud with essay text for cluster no. 2



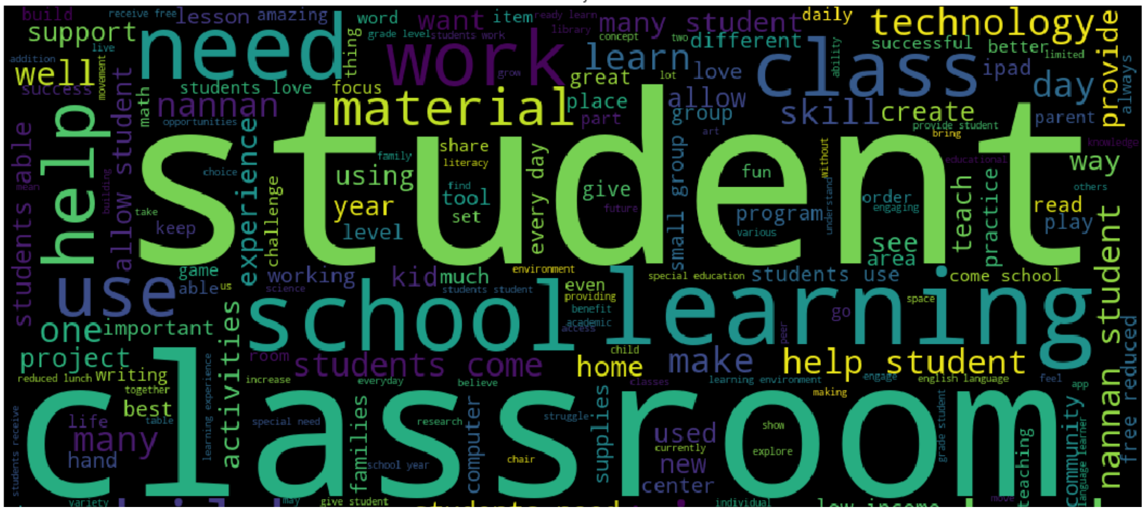
The word cloud with essay text for cluster no. 3



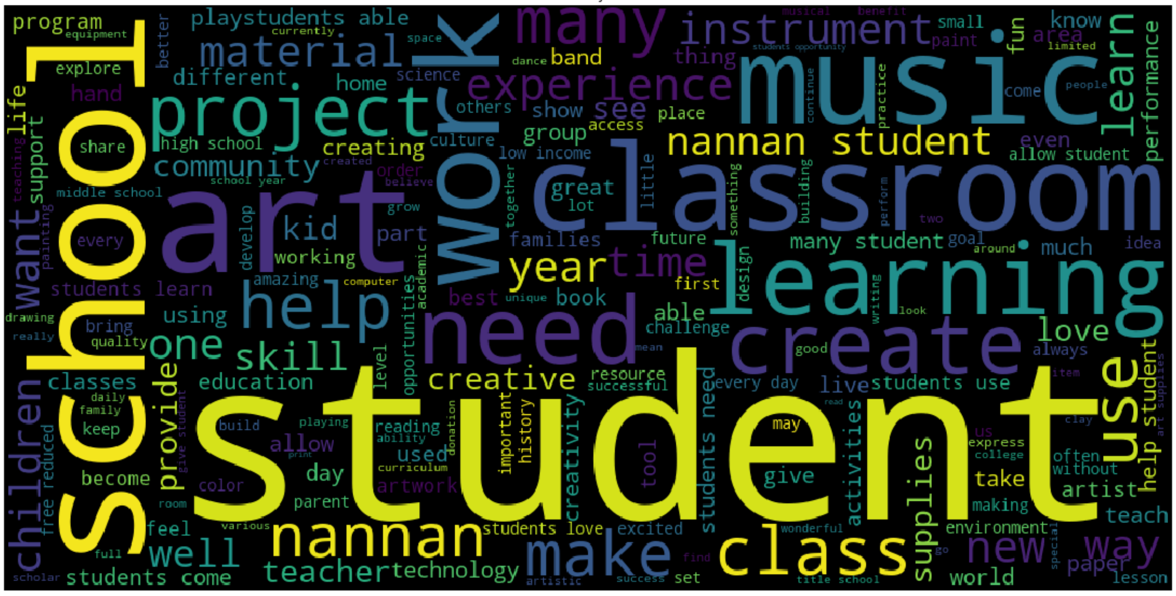
The word cloud with essay text for cluster no. 4



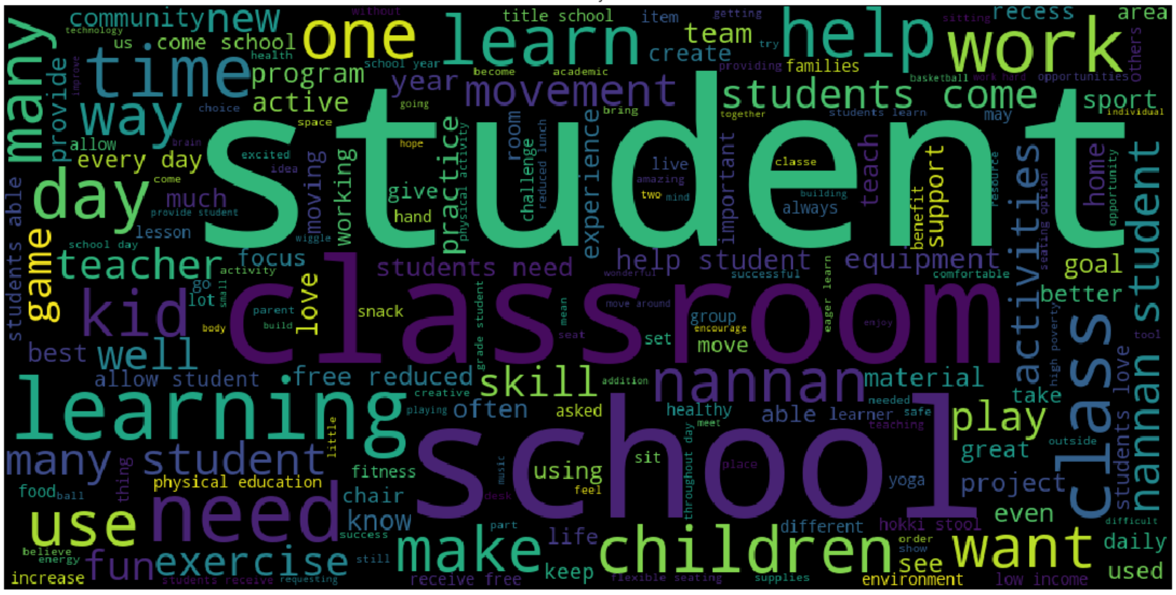
The word cloud with essay text for cluster no. 5



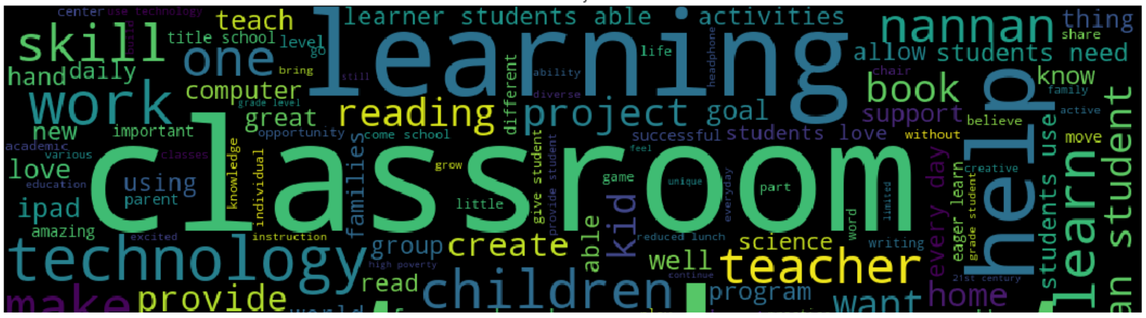
The word cloud with essay text for cluster no. 6



The word cloud with essay text for cluster no. 7



The word cloud with essay text for cluster no. 8



In [102]:

```
a = "my name is neeraj"
list(Counter(a.split()).items())
```

Out[102]:

```
[('my', 1), ('name', 1), ('is', 1), ('neeraj', 1)]
```

Observations

In [180]:

```
from prettytable import PrettyTable
from collections import Counter
def print_obervations(clusterEssays):
    table = PrettyTable()
    table.field_names = ["Cluster No", "No. of words in cluster", "Most frequent wo

    for key, ess in clusterEssays.items():
        word_freq_list = list(Counter(ess.split()).items())
        freq_dict = dict(sorted(word_freq_list, key=lambda x: x[1], reverse=True))
        table.add_row([key, len(ess.split()), ",".join(list(freq_dict.keys())[:10])

    print (table)
```

In [181]:

```
print_obervations(cluster_essays)
```

```
+------------+-----------------------+----------------------------
-----------------------------------------------+
| Cluster No | No. of words in cluster |                          Mo
st frequent words                             |
+------------+-----------------------+----------------------------
-----------------------------------------------+
|     0      |         223734         |   students,school,learning,cl
assroom,learn,science,math,help,nannan,many   |
|     1      |         179393         |    students,reading,books,sch
ool,read,classroom,love,learning,help,many    |
|     2      |         266104         |     students,school,learning,
classroom,learn,help,nannan,many,not,need     |
|     3      |         54867          | students,classroom,learning,s
eating,school,work,learn,flexible,help,nannan |
|     4      |         69508          |   students,technology,school,
classroom,learning,use,learn,help,many,not    |
|     5      |         212953         |     students,school,learning,
classroom,help,learn,many,nannan,need,not     |
|     6      |         111892         |       students,school,art,mus
ic,learning,many,learn,nannan,help,work       |
|     7      |         176207         |     students,school,classroo
m,learning,help,learn,day,not,many,nannan      |
|     8      |         138841         |  students,school,classroom,le
arning,learn,help,technology,use,nannan,many  |
+------------+-----------------------+----------------------------
-----------------------------------------------+
```

Applying Agglomerative Clustering

Taking only 5000 points for agglomerative clustering

In [173]:

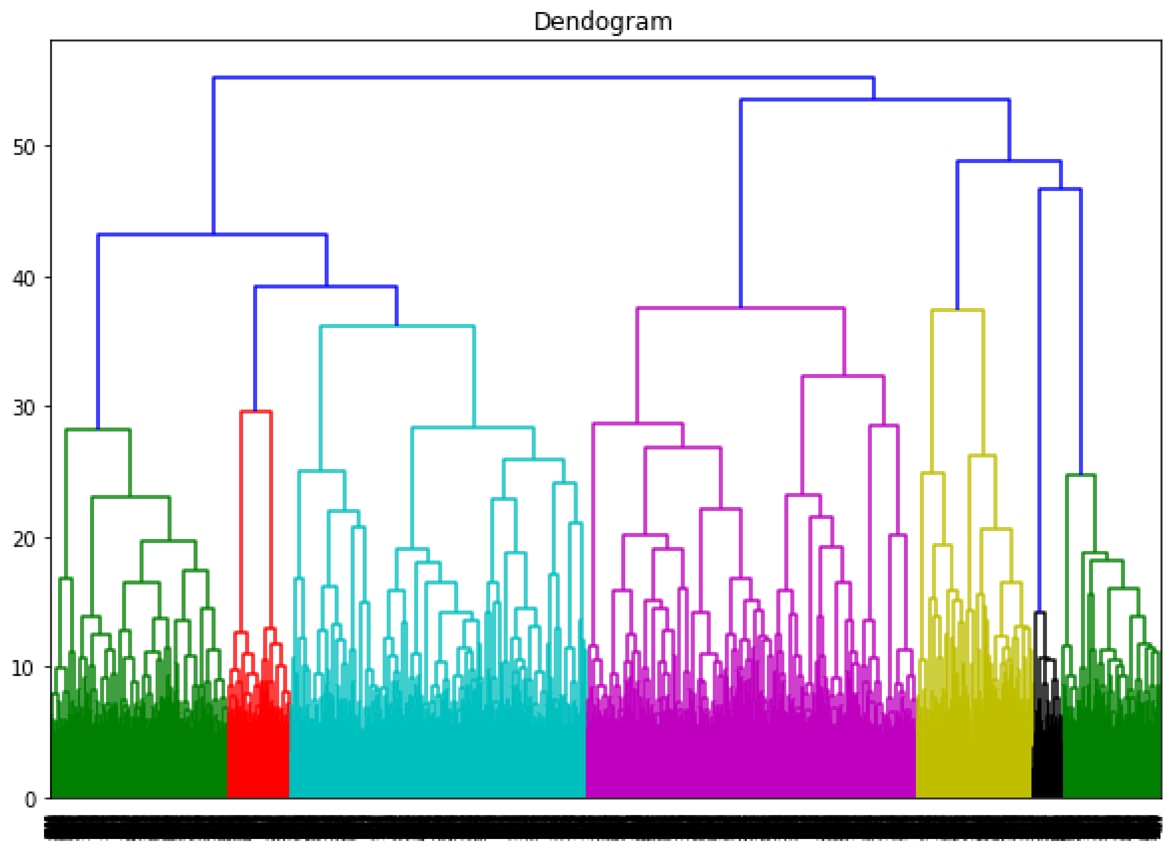
```
X_agg = X_w2v.todense()[:5000]
X_agg.shape
```

Out[173]:

```
(5000, 701)
```

In [108]:

```
import scipy.cluster.hierarchy as shc
#algo_title = 'Agglomerative Clustering'
plt.figure(figsize=(10, 7))
plt.title("Dendogram")
dend = shc.dendrogram(shc.linkage(X_agg, method='ward'))
```



In [182]:

```
from sklearn.cluster import AgglomerativeClustering

aggcluster = AgglomerativeClustering(n_clusters=5, affinity='euclidean', linkage='w
aggcluster.fit_predict(X_agg)
```

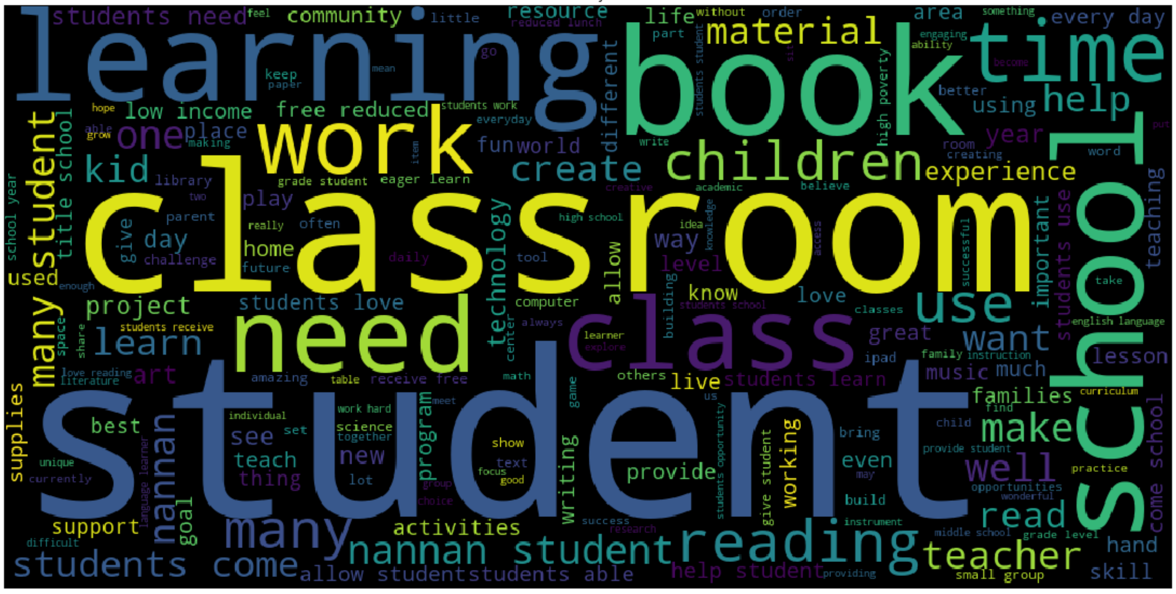
Out[182]:

```
array([2, 0, 3, ..., 0, 0, 3])
```

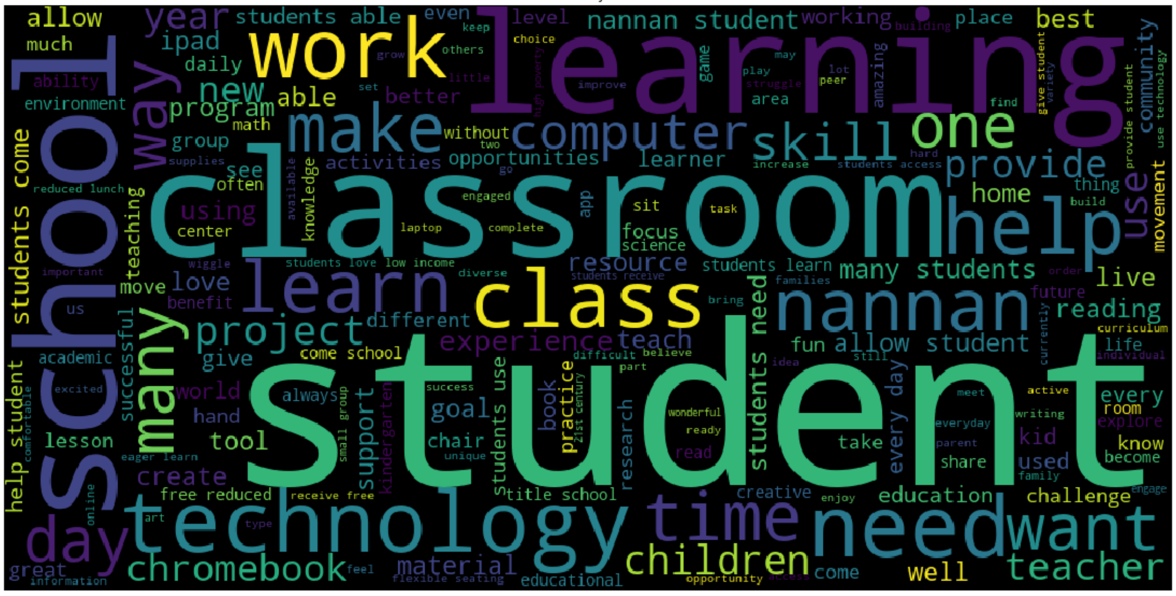
In [183]:

```
agg_custer_essay = generate_word_cloud(X[:5000],aggcluster.labels_)
```

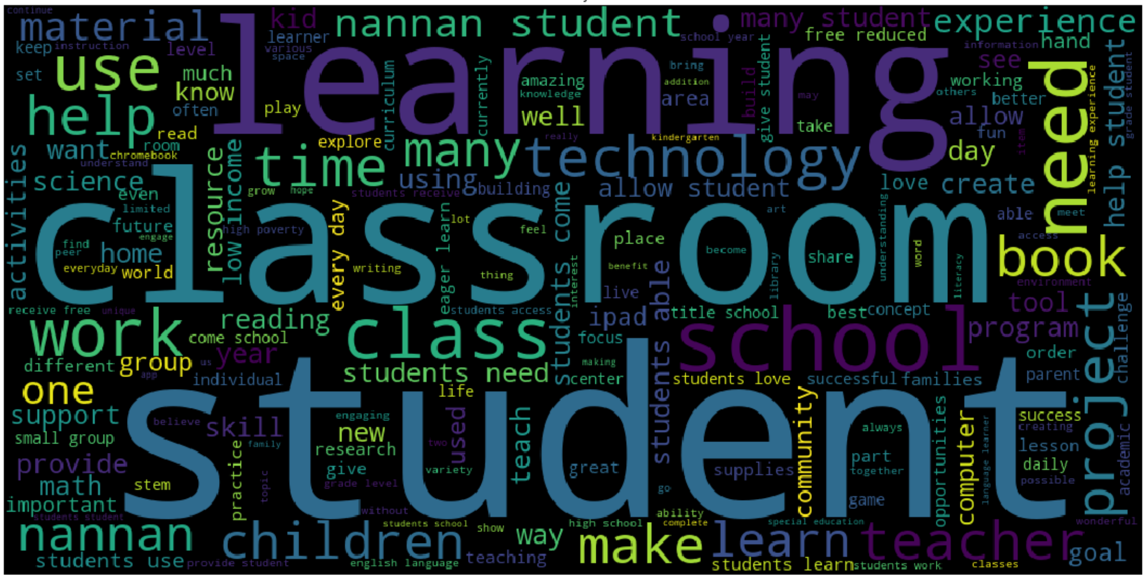
The word cloud with essay text for cluster no. 0



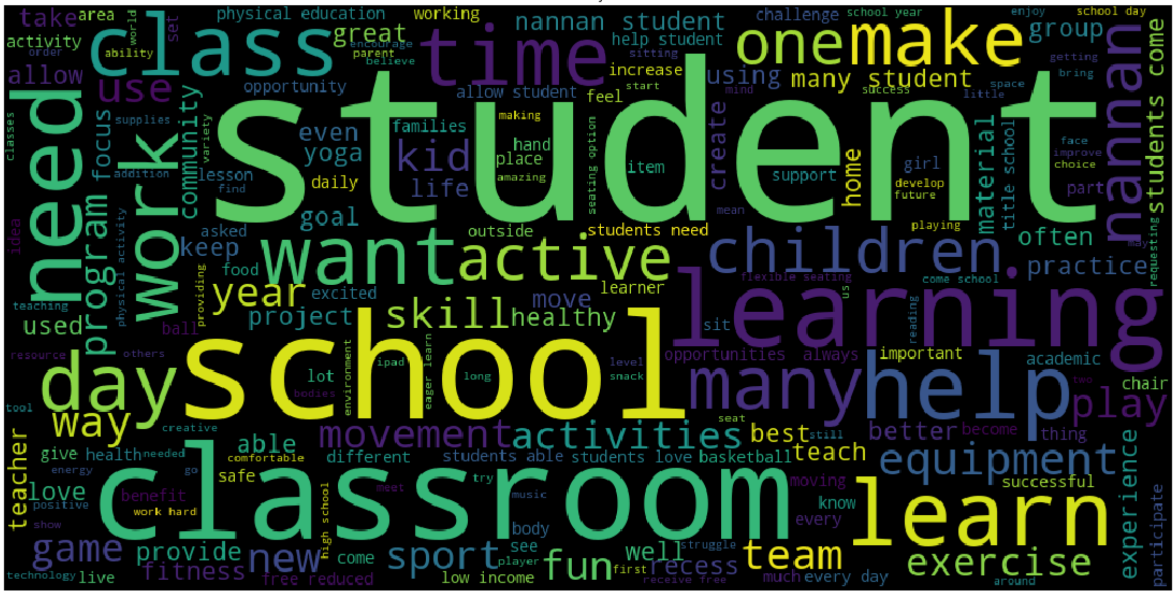
The word cloud with essay text for cluster no. 1



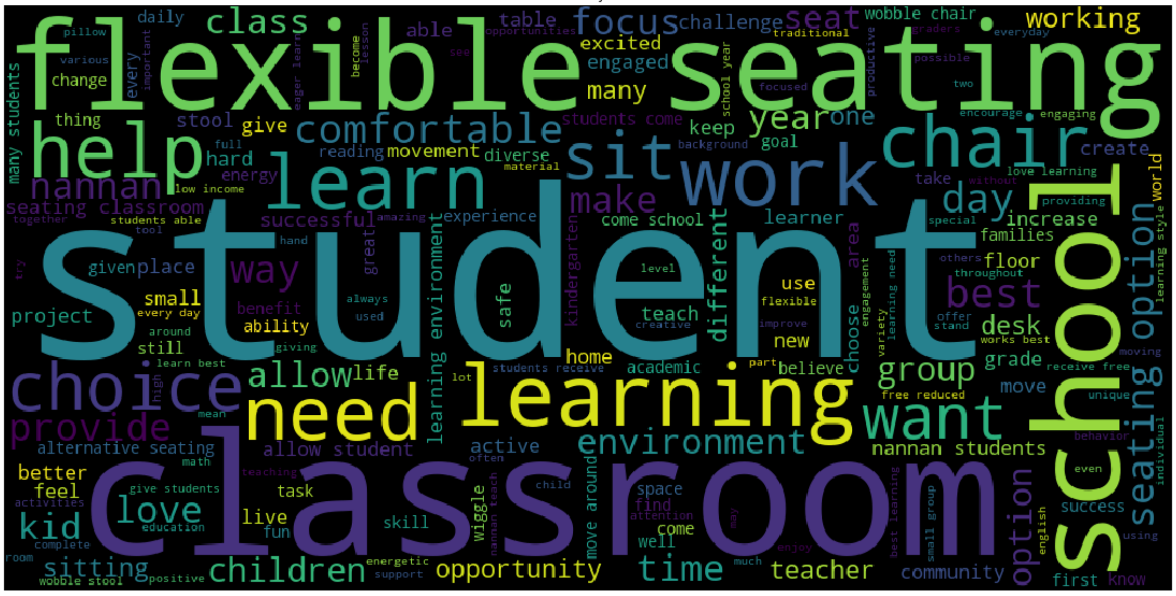
The word cloud with essay text for cluster no. 2



The word cloud with essay text for cluster no. 3



The word cloud with essay text for cluster no. 4



Obervations

Obervations

In [184]:

```
print_obervations(agg_custer_essay)
```

```
+------------+------------------------+-------------------------------
--------------------------------------------+
| Cluster No | No. of words in cluster |                           Mos
t frequent words                            |
+------------+------------------------+-------------------------------
--------------------------------------------+
|     0      |         346281          |  students,school,classroom,le
arning,reading,help,learn,many,not,nannan   |
|     1      |          73950          | students,school,learning,clas
sroom,technology,learn,help,use,many,nannan |
|     2      |         214527          | students,school,learning,clas
sroom,learn,help,many,nannan,use,technology |
|     3      |          67749          |    students,school,classroom,
learning,help,not,day,learn,many,nannan     |
|     4      |          18006          | students,classroom,seating,le
arning,school,flexible,learn,work,sit,best  |
+------------+------------------------+-------------------------------
--------------------------------------------+
```

Applying DBSCAN

In [186]:

```
X_agg.shape
```

Out[186]:

```
(5000, 701)
```

In [198]:

```
from sklearn.neighbors import KDTree

algo_title = 'DBSCAN Clustering'
# https://stackoverflow.com/questions/12893492/choosing-eps-and-minpts-for-dbscan-r
minPts = 8
'''
1. build a k-d tree from the given data to facilitate NN query in log time.

2. for each point in the dataset compute its distance from the minPts nearest neigh

3. choose the largest value of distance from the NN for each point and append in a

4. sort the distances in the list and plot them

5. epsilon corresponds to the critical change in the curve.

'''
tree = KDTree(X_agg)

epss = []
for xi in tqdm(X_agg):
    epss.append(tree.query(xi, return_distance=True, k=minPts)[0][0][-1])
epss.sort()
```

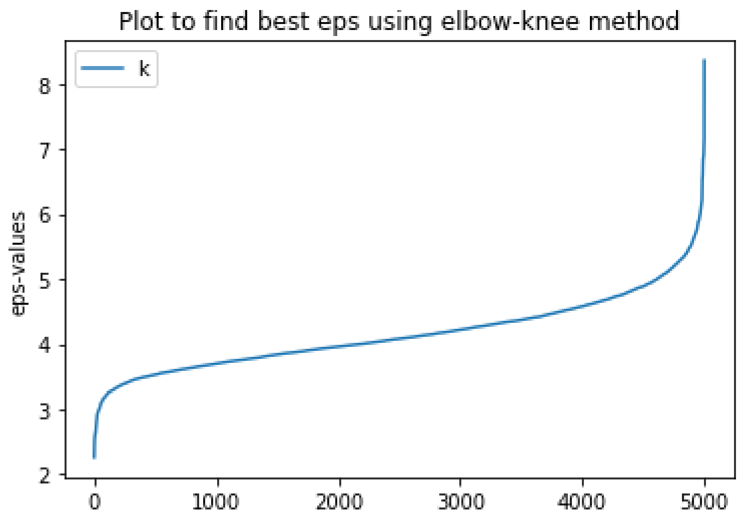
```
100%|██████████| 5000/5000 [00:42<00:00, 118.93it/s]
```

In [197]:

```
plt.plot(range(0,5000), epss)
plt.title("Plot to find best eps using elbow-knee method")
plt.ylabel('eps-values')
plt.legend('knee-curve')
```

Out[197]:

```
<matplotlib.legend.Legend at 0x7f6786371358>
```



Choosing the value of eps = 5 by oberving the above plot

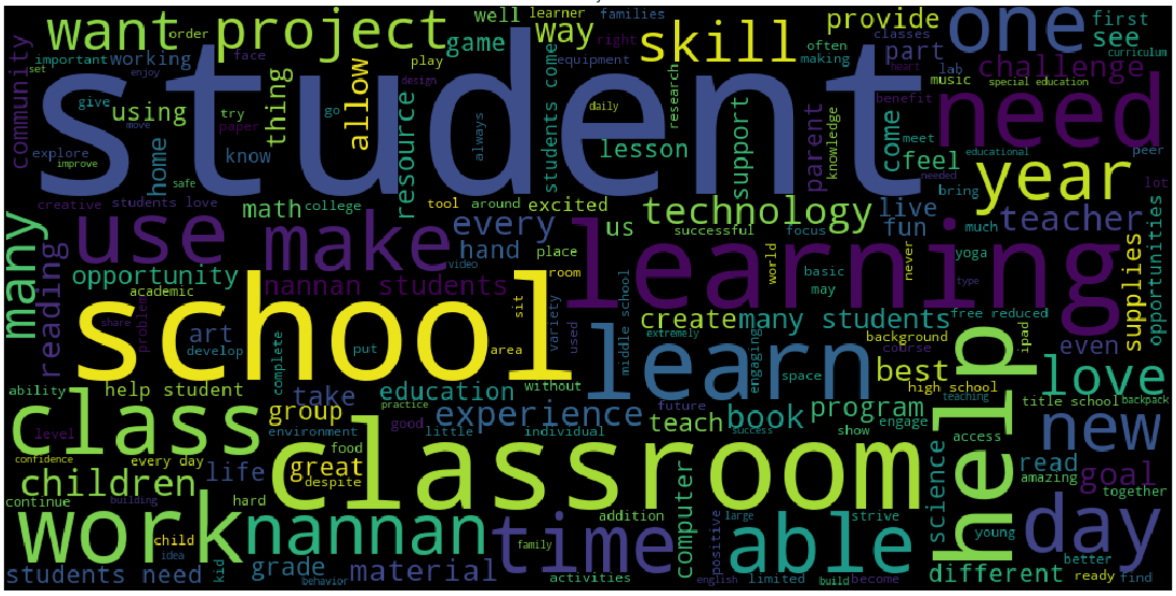
In [199]:

```
from sklearn.cluster import DBSCAN

dbsc = DBSCAN(eps=5, min_samples=minPts).fit(X_agg)
```

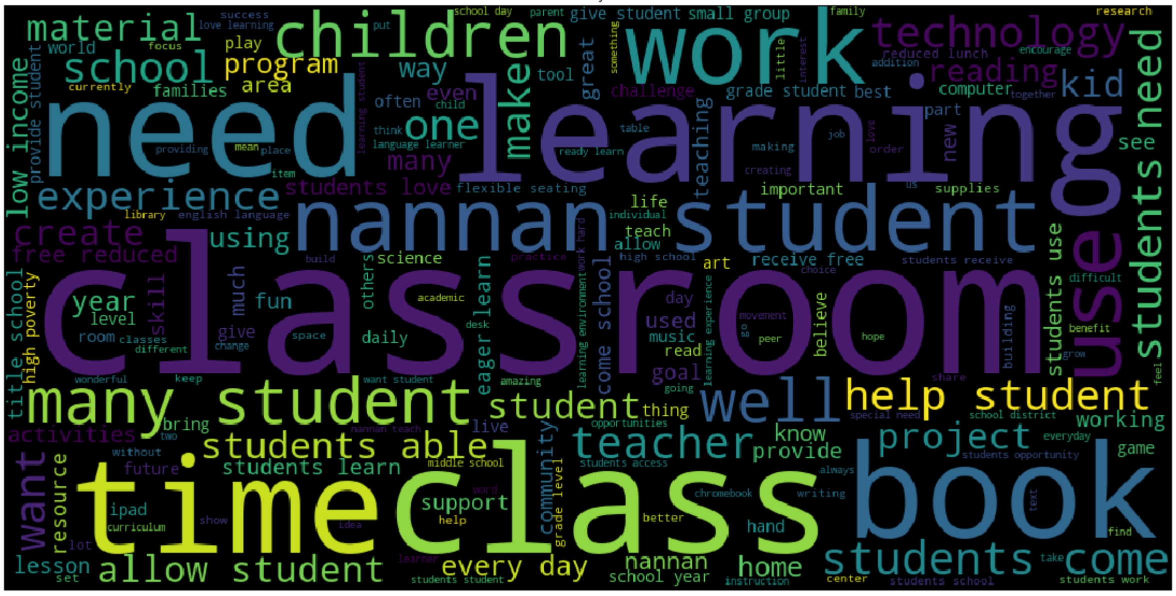
In [202]:

```
dbsc_essays = generate_word_cloud(X[:5000],dbsc.labels_)
```

The word cloud with essay text for cluster no. -1



The word cloud with essay text for cluster no. 0



Observations

In [203]:

```
print_obervations(dbsc_essays)
```

```
+------------+------------------------+------------------------------
-------------------------------------+
| Cluster No | No. of words in cluster |                        Most f
requent words                        |
+------------+------------------------+------------------------------
-------------------------------------+
|     -1     |          18495          | students,school,learning,clas
sroom,not,help,nannan,learn,many,need |
|     0      |          702018         | students,school,learning,clas
sroom,learn,help,many,nannan,not,need |
+------------+------------------------+------------------------------
-------------------------------------+
```

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