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	Description
`project_id`	A unique identifier for the proposed project. **Example:** `p036502`
`project_title`	Title of the project. **Examples:** • `Art Will Make You Happy!` • `First Grade Fun`
`project_grade_category`	Grade level of students for which the project is targeted. One of the following enumerated values: • `Grades PreK-2` • `Grades 3-5` • `Grades 6-8` • `Grades 9-12`

Feature	Description
project_subject_categories	One or more (comma-separated) subject categories for the project from the following enumerated list of values: • Applied Learning • Care & Hunger • Health & Sports • History & Civics • Literacy & Language • Math & Science • Music & The Arts • Special Needs • Warmth **Examples:** • Music & The Arts • Literacy & Language, Math & Science
school_state	State where school is located (Two-letter U.S. postal code (https://en.wikipedia.org/wiki/List_of_U.S._state_abbreviations#Postal_codes)). **Example:** WY
project_subject_subcategories	One or more (comma-separated) subject subcategories for the project. **Examples:** • Literacy • Literature & Writing, Social Sciences
project_resource_summary	An explanation of the resources needed for the project. **Example:** • My students need hands on literacy materials to manage sensory needs!</code
project_essay_1	First application essay*
project_essay_2	Second application essay*
project_essay_3	Third application essay*
project_essay_4	Fourth application essay*
project_submitted_datetime	Datetime when project application was submitted. **Example:** 2016-04-28 12:43:56.245
teacher_id	A unique identifier for the teacher of the proposed project. **Example:** bdf8baa8fedef6bfeec7ae4ff1c15c56

Feature	Description
`teacher_prefix`	Teacher's title. One of the following enumerated values: • `nan` • `Dr.` • `Mr.` • `Mrs.` • `Ms.` • `Teacher.`
`teacher_number_of_previously_posted_projects`	Number of project applications previously submitted by the same teacher. **Example:** `2`

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

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

from tqdm import tqdm
import os

from plotly import plotly
import plotly.offline as offline
import plotly.graph_objs as go
offline.init_notebook_mode()
from collections import Counter
```

1.1 Reading Data

In [2]:
```
project_data = pd.read_csv('train_new_data.csv')
resource_data = pd.read_csv('resources.csv')
```

In [3]:
```
print("Number of data points in train data", project_data.shape)
print('-'*50)
print("The attributes of data :", project_data.columns.values)
```

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

In [4]:
```
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[4]:

	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 [5]:
```
catogories = list(project_data['project_subject_categories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47301924/4084039

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

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

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

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

1.3 preprocessing of `project_subject_subcategories`

In [6]:
```
sub_catogories = list(project_data['project_subject_subcategories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47301924/4084039

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

sub_cat_list = []
for i in sub_catogories:
    temp = ""
    # consider we have text like this "Math & Science, Warmth, Care & Hunger"
    for j in i.split(','): # it will split it in three parts ["Math & Science", "Warmth", "Care & Hunger"]
        if 'The' in j.split(): # this will split each of the catogory based on space "Math & Science"=> "Math","
            j=j.replace('The','') # if we have the words "The" we are going to replace it with ''(i.e removing
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"Math & Science"=>"Math&Sci
        temp +=j.strip()+" "#" abc ".strip() will return "abc", remove the trailing spaces
        temp = temp.replace('&','_')
    sub_cat_list.append(temp.strip())

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

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

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

In [7]:
```
from collections import Counter
my_counter = Counter()
for word in project_data['school_state'].values:
    my_counter.update(word.split())
state_dict = dict(my_counter)
sorted_state_dict = dict(sorted(state_dict.items(), key=lambda kv: kv[1]))
```

In [8]:
```
from collections import Counter
my_counter = Counter()
for word in project_data['teacher_prefix'].values:
    my_counter.update(word.split())
prefix_dict = dict(my_counter)
sorted_prefix_dict = dict(sorted(prefix_dict.items(), key=lambda kv: kv[1]))
```

In [9]:
```
catogories = list(project_data['project_grade_category'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47301924/4084039

# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from-a-string
# https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-in-python
pgc_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","
            j=j.replace('The','') # if we have the words "The" we are going to replace it with ''(i.e removing
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"Math & Science"=>"Math&Sci
        temp+=j.strip()+" " #" abc ".strip() will return "abc", remove the trailing spaces
        temp = temp.replace('&','_') # we are replacing the & value into
    pgc_list.append(temp.strip())

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

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

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

1.3 Text preprocessing

In [10]:
```
# 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 [11]:
```
project_data.head(2)
```

Out[11]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime	project_title	project_e
0	0	p036502	484aaf11257089a66cfedc9461c6bd0a	Ms.	NV	18-11-2016 14:45	Super Sight Word Centers	Mos kinde student fro
1	3	p185307	525fdbb6ec7f538a48beebaa0a51b24f	Mr.	NC	12-08-2016 15:42	\"Kid Inspired\" Equipment to Increase Activit...	My stude the g students

In [12]:
```
# 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)
```

```
Most of my kindergarten students come from low-income households and are considered \"at-risk\". These kids
walk to school alongside their parents and most have never been further than walking distance from their hou
se. For 80% of my students, English is not their first language or the language spoken at home. \r\n\r\nWhil
e my kindergarten kids have many obstacles in front of them, they come to school each day excited and ready
to learn. Most students started the year out never being in a school setting. At the start of the year many
had never been exposed to letters. Each day they soak up more knowledge and try their hardest to succeed. Th
ey are highly motivated to learn new things every day. We are halfway through the year and they are starting
to take off. They know know all letters, some sight words, numbers to 20, and a majority of their letter sou
nds because of their hard work and determination. I am excited to see the places we will go from here!I curr
ently have a differentiated sight word center that we do daily during our literacy stations. The students ha
ve activities that relate to whatever sight word list they are on. This is one of their favorite station act
ivities. I want to continue to provide the students with engaging ways to practice their sight words. \r\n\r
\nI dream of having the students use QR readers to scan the sight words that they are struggling with and th
e Ipods reading the sight words with them. This would help so many of my students by giving them multiple ex
posures to the words. My students need someone who can go over these sight words daily and I can't always ge
t around to everyone to practice their flashcards with them. With the Ipods they would still have a way to p
ractice their sight words on a daily basis.nannan
==================================================
Our school is located the second smallest city in Los Angeles County. Our elementary school is 552 students
strong. We have 1 percent African American, and 98 percent Latinos. We have a 90percent socioeconomically di
sadvantaged population and 4 percent foster youth. 100% of our students get free lunch.\r\n     \r\n   Despi
te the many challenges they face, my students arrive every morning full of life, ready to learn, and excited
to get started on our day. I do my best to provide my students with creative and meaningful learning experie
nces.Every morning we begin our learning by coming to the rug and setting our goals for the day. We come tog
ether to begin our activities and we come together to end our activities. We also come to the carpet to just
have independent reading time. The carpet area is crucial part of our learning space.\r\n\r\n       \r\n
My students are currently, sitting in a torn, stained carpet that continues to deteriorate every day.  Some
of the strings have begun to run and the students can no longer just sit and focus. They have began to pull
and tug at the disintegrating carpet.\r\n\r\n\r\n      This carpet will allow my students to have a nice, cl
ean and soft place where we can meet and learn. They need a place where they can sit, focus and not worry ab
```

out their seating coming apart.nannan
==========
Our Pre-K students come from very diverse backgrounds. Many come through our doors with developmental and co mmunication delays and learn how to engage with the world around them through play and collaborate social-em otional skills. Our students also come to us from home environments that are identified as being \"at-risk\" due to family income, languages spoken at home, and other developmental and medical situations. Though they are diverse, they all come to us with the same excitement and desire to learn.The sandbox will provide our s tudents will excellent opportunities for the development and practice of fine motor skills, social skills, a nd communication. By having a place where students can sit and play closely with their peers, we can effecti vely teach and work on the social skills that we actively teach in the classroom. \r\nThough we have a great outdoor space, we don't have many opportunities for our students to be close and interact cooperatively outs ide. With this sandbox and the play materials, our kids will be able to get valuable sensory input and tacti le stimulation, all while learning through play!nannan
==========
Chicago schools, like many urban school districts across America, have been fighting against the challenges of the current state of education; severe budget cuts, lack of resources, increased classroom sizes, lead in the drinking water, and many others. When basic needs in school are not being met, the power of education to transform our young people is hindered. \r\n\r\nIn a few short weeks, I am proud to be joining the team of education warriors as I will be stepping into my own classroom as a first year teacher. My new school, being both 98% African American and 75% low income, faces many challenges similar to the other schools in Chicago. \r\n\r\nI am thrilled to be working with a group of about 90 eager 4th grade readers and writers. Like every child, regardless of race or socioeconomic background, they deserve the best teachers, education, and resour ces. It is the job of myself, my fellow teachers and staff of my school to make sure that happens. Despite t hese challenges, I am dedicated to teaching the strongest culturally relevant, identity confirming, social j ustice curriculum that I can!\"People don't realize how a man's whole life can be changed by one book.\" -Ma lcolm X\r\n\r\nDo you remember reading that one book in elementary school that changed your life? There's a good chance you were able to relate to the character in the book. But what happens in schools that are predo minantly African American and Latino when students only have access to reading books about white characters and animals? These books are windows into other people's lives. Many classroom libraries are missing mirrors into their student's lives. Young people, like 11 year old Marley Dias, are bringing awareness to this issu e. Dias launched a list of books, calling it 1,000 Black Girl Books. \r\n\r\nBeing in a school that is 98% A frican American, my goal is similar. I want my students to walk into their classroom library and find more t han a bin of books labeled \"Multicultural Books.\" I want my students to see reflections of themselves in e very genre. I want them to see people of color in positions of power and doing amazing things in the world. I want my students to hear some of the real stories about history and important people. I truly believe that having access to these books during read alouds, mini lessons, silent reading, and to check out will foster a love for reading. This love for reading will change lives.nannan
==========
Many of our students walk into their classrooms excited and always ready to tackle their work day! The stude nts at this K-5 school are given opportunities to grow and are always encouraged to be themselves! Our stude nts are comprised of many different backgrounds and cultures. Our teachers and staff always make our student s their number one priority. \r\n\r\nThe students at our school are unique and amazing in their own way. Eve ry day they take on their school challenges and try their best to succeed. No matter what our teachers embra

```
ce and support the students for their efforts. Our students know they can count on us as teachers and staff
and we know that we can count on them to learn and succeed.\r\n\r\n\r\nThese students participate in our Pos
itive Behavior Support (PBS) program to increase academic performance, increase safety, decrease problem beh
avior and establish positive school outcomes. PBS is a researched based positive intervention system that is
used to create and support positive school culture by increasing positive behavior, social competence and ac
ademic performance. This support system is expected to help reinforce positive conduct and reduce challengin
g behaviors. For example, when students demonstrate positive behaviors they will earn “Tiger Bucks”. Once th
ey earn their bucks they will be able to use them to shop at our PBS store and they may have enough to parti
cipate in our monthly socials, which students have a privilege of attending themed parties. \r\n\r\nPBS will
help our students stay focused and help them show improvement! Essentially, by purchasing items for our PBS
project, such as Lego, markers, boards, kitchen set, toy cars, and many other items listed in our cart will
help students decrease problem behaviors and improve academic performance in school. Our program will help r
einforce a desired positive school culture in turn rewarding students to make good decisions. These supplies
will help us encourage our students to be the best students they can be and teach them all that good that co
mes with being on their best behavior!\r\nnannan
==================================================
```

In [13]:

```python
# 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 [14]:
```
sent = decontracted(project_data['essay'].values[20000])
print(sent)
print("="*50)
```

```
Chicago schools, like many urban school districts across America, have been fighting against the challenges of
the current state of education; severe budget cuts, lack of resources, increased classroom sizes, lead in the
drinking water, and many others. When basic needs in school are not being met, the power of education to trans
form our young people is hindered.  \r\n\r\nIn a few short weeks, I am proud to be joining the team of educati
on warriors as I will be stepping into my own classroom as a first year teacher. My new school, being both 98%
African American and 75% low income, faces many challenges similar to the other schools in Chicago. \r\n\r\nI
am thrilled to be working with a group of about 90 eager 4th grade readers and writers. Like every child, rega
rdless of race or socioeconomic background, they deserve the best teachers, education, and resources. It is th
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s, I am dedicated to teaching the strongest culturally relevant, identity confirming, social justice curriculu
m that I can!\"People do not realize how a man is whole life can be changed by one book.\" -Malcolm X\r\n\r\nD
o you remember reading that one book in elementary school that changed your life? There is a good chance you w
ere able to relate to the character in the book. But what happens in schools that are predominantly African Am
erican and Latino when students only have access to reading books about white characters and animals? These bo
oks are windows into other people is lives. Many classroom libraries are missing mirrors into their student is
lives.  Young people, like 11 year old Marley Dias, are bringing awareness to this issue. Dias launched a list
of books, calling it 1,000 Black Girl Books. \r\n\r\nBeing in a school that is 98% African American, my goal i
s similar. I want my students to walk into their classroom library and find more than a bin of books labeled
\"Multicultural Books.\" I want my students to see reflections of themselves in every genre. I want them to se
e people of color in positions of power and doing amazing things in the world. I want my students to hear some
of the real stories about history and important people. I truly believe that having access to these books duri
ng read alouds, mini lessons, silent reading, and to check out will foster a love for reading. This love for r
eading will change lives.nannan
==================================================
```

In [15]:
```
# \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)
```

```
Chicago schools, like many urban school districts across America, have been fighting against the challenges of
the current state of education; severe budget cuts, lack of resources, increased classroom sizes, lead in the
drinking water, and many others. When basic needs in school are not being met, the power of education to trans
form our young people is hindered.      In a few short weeks, I am proud to be joining the team of education w
arriors as I will be stepping into my own classroom as a first year teacher. My new school, being both 98% Afr
ican American and 75% low income, faces many challenges similar to the other schools in Chicago.     I am thri
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of race or socioeconomic background, they deserve the best teachers, education, and resources. It is the job o
f myself, my fellow teachers and staff of my school to make sure that happens. Despite these challenges, I am
dedicated to teaching the strongest culturally relevant, identity confirming, social justice curriculum that I
can! People do not realize how a man is whole life can be changed by one book.  -Malcolm X    Do you remember
reading that one book in elementary school that changed your life? There is a good chance you were able to rel
ate to the character in the book. But what happens in schools that are predominantly African American and Lati
no when students only have access to reading books about white characters and animals? These books are windows
into other people is lives. Many classroom libraries are missing mirrors into their student is lives.  Young p
eople, like 11 year old Marley Dias, are bringing awareness to this issue. Dias launched a list of books, call
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my students to walk into their classroom library and find more than a bin of books labeled  Multicultural Book
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positions of power and doing amazing things in the world. I want my students to hear some of the real stories
about history and important people. I truly believe that having access to these books during read alouds, mini
lessons, silent reading, and to check out will foster a love for reading. This love for reading will change li
ves.nannan
```

In [16]:
```
#remove spacial character: https://stackoverflow.com/a/5843547/4084039
sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
print(sent)
```

```
Chicago schools like many urban school districts across America have been fighting against the challenges of t
he current state of education severe budget cuts lack of resources increased classroom sizes lead in the drink
ing water and many others When basic needs in school are not being met the power of education to transform our
young people is hindered In a few short weeks I am proud to be joining the team of education warriors as I wil
l be stepping into my own classroom as a first year teacher My new school being both 98 African American and 7
5 low income faces many challenges similar to the other schools in Chicago I am thrilled to be working with a
group of about 90 eager 4th grade readers and writers Like every child regardless of race or socioeconomic bac
kground they deserve the best teachers education and resources It is the job of myself my fellow teachers and
staff of my school to make sure that happens Despite these challenges I am dedicated to teaching the strongest
culturally relevant identity confirming social justice curriculum that I can People do not realize how a man i
s whole life can be changed by one book Malcolm X Do you remember reading that one book in elementary school t
hat changed your life There is a good chance you were able to relate to the character in the book But what hap
pens in schools that are predominantly African American and Latino when students only have access to reading b
ooks about white characters and animals These books are windows into other people is lives Many classroom libr
aries are missing mirrors into their student is lives Young people like 11 year old Marley Dias are bringing a
wareness to this issue Dias launched a list of books calling it 1 000 Black Girl Books Being in a school that
is 98 African American my goal is similar I want my students to walk into their classroom library and find mor
e than a bin of books labeled Multicultural Books I want my students to see reflections of themselves in every
genre I want them to see people of color in positions of power and doing amazing things in the world I want my
students to hear some of the real stories about history and important people I truly believe that having acces
s to these books during read alouds mini lessons silent reading and to check out will foster a love for readin
g This love for reading will change lives nannan
```

In [17]:
```
# 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', 'between', 'into', 'through', 'during', 'before', 'af
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'over', 'under', 'again', 'f
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'any', 'both', 'each', 'few',
            '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',
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't", 'doesn', "doesn't", 'had
            "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',
            'won', "won't", 'wouldn', "wouldn't"]
```

In [18]:
```
# 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 not in stopwords)
    preprocessed_essays.append(sent.lower().strip())
```

```
100%|██████████| 109248/109248 [01:43<00:00, 1054.53it/s]
```

In [19]:
```
# after preprocesing
preprocessed_essays[20000]
```

Out[19]:
```
'chicago schools like many urban school districts across america fighting challenges current state education s
evere budget cuts lack resources increased classroom sizes lead drinking water many others when basic needs sc
hool not met power education transform young people hindered in short weeks i proud joining team education war
riors i stepping classroom first year teacher my new school 98 african american 75 low income faces many chall
enges similar schools chicago i thrilled working group 90 eager 4th grade readers writers like every child reg
ardless race socioeconomic background deserve best teachers education resources it job fellow teachers staff s
chool make sure happens despite challenges i dedicated teaching strongest culturally relevant identity confirm
ing social justice curriculum i people not realize man whole life changed one book malcolm x do remember readi
ng one book elementary school changed life there good chance able relate character book but happens schools pr
edominantly african american latino students access reading books white characters animals these books windows
people lives many classroom libraries missing mirrors student lives young people like 11 year old marley dias
bringing awareness issue dias launched list books calling 1 000 black girl books being school 98 african ameri
can goal similar i want students walk classroom library find bin books labeled multicultural books i want stud
ents see reflections every genre i want see people color positions power amazing things world i want students
hear real stories history important people i truly believe access books read alouds mini lessons silent readin
g check foster love reading this love reading change lives nannan'
```

1.4 Preprocessing of `project_title`

In [20]:
```
# similarly you can preprocess the titles also
# similarly you can preprocess the titles also
from tqdm import tqdm
preprocessed_project_titles = []
# tqdm is for printing the status bar
for sentence in tqdm(project_data['project_title'].values):
    sent = decontracted(sentence)
    sent = sent.replace('\\r', ' ')
    sent = sent.replace('\\"', ' ')
    sent = sent.replace('\\n', ' ')
    sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
    # https://gist.github.com/sebleier/554280
    sent = ' '.join(e for e in sent.split() if e not in stopwords)
    preprocessed_project_titles.append(sent.lower().strip())
```

```
100%|██████████| 109248/109248 [00:04<00:00, 24167.40it/s]
```

1.5 Preparing data for models

In [21]:
```
project_data.columns
```

Out[21]:
```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
       'project_submitted_datetime', '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',
       'clean_categories', 'clean_subcategories', 'clean_pgc', 'essay'],
      dtype='object')
```

we are going to consider

```
- school_state : categorical data
- clean_categories : categorical data
- clean_subcategories : categorical data
- project_grade_category : categorical data
- teacher_prefix : categorical data

- project_title : text data
- text : text data
- project_resource_summary: text data (optinal)

- quantity : numerical (optinal)
- teacher_number_of_previously_posted_projects : numerical
- price : numerical
```

1.5.1 Vectorizing Categorical data

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

In [22]:
```
# we use count vectorizer to convert the values into one
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict.keys()), lowercase=False, binary=True)
categories_one_hot = vectorizer.fit_transform(project_data['clean_categories'].values)
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encodig ",categories_one_hot.shape)
```

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

In [23]:
```
# we use count vectorizer to convert the values into one
vectorizer = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=False, binary=True)
sub_categories_one_hot = vectorizer.fit_transform(project_data['clean_subcategories'].values)
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encodig ",sub_categories_one_hot.shape)
```

```
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolvement', 'Extracurricular', 'Civics_Governm
ent', 'ForeignLanguages', 'NutritionEducation', 'Warmth', 'Care_Hunger', 'SocialSciences', 'PerformingArts',
'CharacterEducation', 'TeamSports', 'Other', 'College_CareerPrep', 'Music', 'History_Geography', 'Health_LifeS
cience', 'EarlyDevelopment', 'ESL', 'Gym_Fitness', 'EnvironmentalScience', 'VisualArts', 'Health_Wellness', 'A
ppliedSciences', 'SpecialNeeds', 'Literature_Writing', 'Mathematics', 'Literacy']
Shape of matrix after one hot encodig  (109248, 30)
```

In [24]:
```
# you can do the similar thing with state, teacher_prefix and project_grade_category also

from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_state_dict.keys()), lowercase=False, binary=True)
vectorizer.fit(project_data['school_state'].values)
print(vectorizer.get_feature_names())


state_one_hot = vectorizer.transform(project_data['school_state'].values)
print("Shape of matrix after one hot encodig ",state_one_hot.shape)
```

```
['VT', 'WY', 'ND', 'MT', 'RI', 'SD', 'NE', 'DE', 'AK', 'NH', 'WV', 'ME', 'HI', 'DC', 'NM', 'KS', 'IA', 'ID',
'AR', 'CO', 'MN', 'OR', 'KY', 'MS', 'NV', 'MD', 'CT', 'TN', 'UT', 'AL', 'WI', 'VA', 'AZ', 'NJ', 'OK', 'WA', 'M
A', 'LA', 'OH', 'MO', 'IN', 'PA', 'MI', 'SC', 'GA', 'IL', 'NC', 'FL', 'NY', 'TX', 'CA']
Shape of matrix after one hot encodig  (109248, 51)
```

In [25]:
```
vectorizer = CountVectorizer(vocabulary=list(sorted_pgc_dict.keys()), lowercase=False, binary=True)
vectorizer.fit(project_data['clean_pgc'].values)
print(vectorizer.get_feature_names())
project_grade_category_one_hot = vectorizer.transform(project_data['clean_pgc'].values)
print("Shape of matrix after one hot encoding ",project_grade_category_one_hot.shape)
```

```
['Grades9-12', 'Grades6-8', 'Grades3-5', 'GradesPreK-2']
Shape of matrix after one hot encoding  (109248, 4)
```

In [26]:
```
vectorizer = CountVectorizer(vocabulary=list(sorted_prefix_dict.keys()), lowercase=False, binary=True)
vectorizer.fit(project_data['teacher_prefix'].values)
print(vectorizer.get_feature_names())
teacher_prefix_one_hot = vectorizer.transform(project_data['teacher_prefix'].values)
print("Shape of matrix after one hot encodig ",teacher_prefix_one_hot.shape)
```

```
['Dr.', 'Teacher', 'Mr.', 'Ms.', 'Mrs.']
Shape of matrix after one hot encodig  (109248, 5)
```

1.4.2 Vectorizing Text data

From previous assignments its been observed that BOW has best AUC

1.4.2.1 Bag of words

In [27]:
```
# We are considering only the words which appeared in at least 10 documents(rows or projects).
vectorizer = CountVectorizer(min_df=10)
text_bow = vectorizer.fit_transform(preprocessed_essays)
print("Shape of matrix after one hot encodig ",text_bow.shape)
```

```
Shape of matrix after one hot encodig  (109248, 16623)
```

In [28]:
```
text=project_data['essay'][0:5000]
text.shape
```

Out[28]:
```
(5000,)
```

1.4.2.2 Bag of Words on `project_title`

In [29]:
```
# you can vectorize the title also
# before you vectorize the title make sure you preprocess it
vectorizer = CountVectorizer(min_df=10)
text_bow_p_t= vectorizer.fit_transform(preprocessed_project_titles)
print("Shape of matrix after one hot encodig ",text_bow_p_t.shape)
```

```
Shape of matrix after one hot encodig  (109248, 3329)
```

1.5.3 Vectorizing Numerical features

In [30]:
```
price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_index()
project_data = pd.merge(project_data, price_data, on='id', how='left')
```

In [31]:
```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s
# standardization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScale
from sklearn.preprocessing import StandardScaler

# price_standardized = standardScalar.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329.   ... 399.   287.73   5.5 ].
# Reshape your data either using array.reshape(-1, 1)

price_scalar = StandardScaler()
price_scalar.fit(project_data['price'].values.reshape(-1,1)) # finding the mean and standard deviation of this d
print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0])}")

# Now standardize the data with above maen and variance.
price_standardized = price_scalar.transform(project_data['price'].values.reshape(-1, 1))
```

```
Mean : 298.11934259666083, Standard deviation : 367.49634838483496
```

In [32]:
```
price_standardized
```

Out[32]:
```
array([[ 0.00506306],
       [ 1.05130475],
       [ 0.15613939],
       ...,
       [ 0.6823487 ],
       [-0.12157765],
       [ 0.10851987]])
```

In [33]:
```
price_scalar.fit(project_data['teacher_number_of_previously_posted_projects'].values.reshape(-1,1)) # finding th
print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0])}")

# Now standardize the data with above maen and variance.
teacher_number_of_previously_posted_projects_standardized = price_scalar.transform(project_data['teacher_number_
teacher_number_of_previously_posted_projects_standardized
```

```
Mean : 11.153211042765085, Standard deviation : 27.777015452500134
```

Out[33]:
```
array([[ 0.53449907],
       [ 0.17448919],
       [ 1.11051488],
       ...,
       [-0.36552563],
       [-0.36552563],
       [-0.36552563]])
```

1.5.4 Merging all the above features

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

In [34]:
```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack
# with the same hstack function we are concatinating a sparse matrix and a dense matirx :)
X = hstack((categories_one_hot, sub_categories_one_hot, state_one_hot, project_grade_category_one_hot,teacher_pr
X.shape
```

Out[34]: (109248, 20053)

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.

2. Clustering

2.4 Dimensionality Reduction on the selected features

Since we are considering only 5k points we will consider only 500 best features.We use PCA for dimensionality reduction

In [35]:
```
from sklearn import decomposition
X=X.tocsr()
S_new = X[0:5000,:]
S_new = S_new.toarray()
pca = decomposition.PCA(n_components=500)
# Fit the PCA and transform the data
X_pca = pca.fit_transform(S_new)
```

In [36]:
```
X_pca.shape
```

Out[36]:
```
(5000, 500)
```

2.5 Apply Kmeans

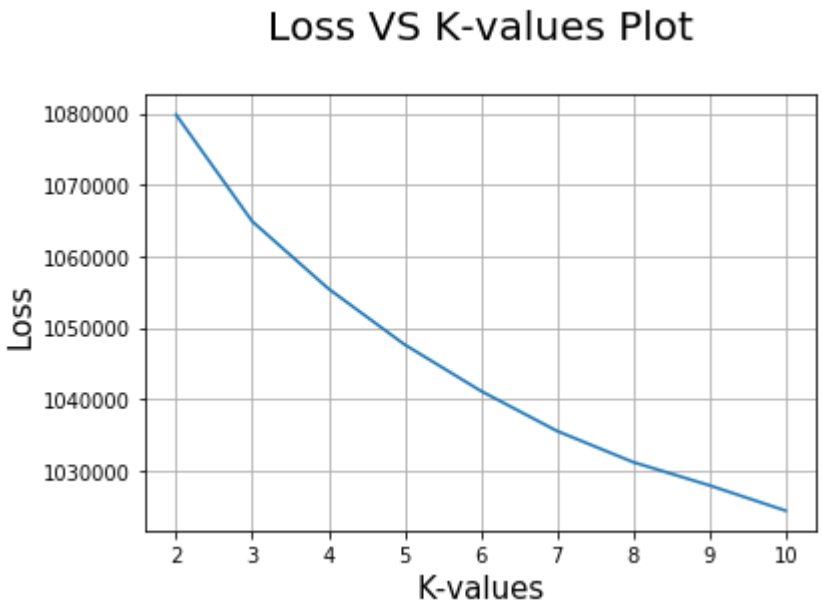
Finding best K value

In [40]:
```
from sklearn.cluster import KMeans
```

In [54]:
```

k_values = [2,3,4,5,6,7,8,9,10]
loss_value = []
for i in k_values:
    clf= KMeans(n_clusters=i, n_jobs=-1)
    clf.fit(X_pca)
    kmeans=clf.inertia_
    loss_value.append(kmeans)
```

ELBOW METHOD

In [55]:
```
#Draw Loss VS K values plot
plt.plot(k_values, loss_value)
plt.xlabel('K-values',size=15)
plt.ylabel('Loss',size=15)
plt.title('Loss VS K-values Plot\n',size=20)
plt.grid()
plt.show()
```



From Graph we can conclude that K=3 is best hyperparameter

In [41]:
```
kmean_bow= KMeans(n_clusters=3, n_jobs=-1)
s=kmean_bow.fit(X_pca)
```

Creating word cloud using essay

In [42]:
```
def word_cloud(essay):
    from wordcloud import WordCloud, STOPWORDS
    comment_words = ' '
    stopwords = set(STOPWORDS)
    for val in essay :
        val = str(val)
        tokens = val.split()
    for i in range(len(tokens)):
        tokens[i] = tokens[i].lower()
    for words in tokens :
        comment_words = comment_words + words + ' '
    wordcloud = WordCloud(width = 800, height = 800, background_color ='white', stopwords =
    stopwords,min_font_size = 10).generate(comment_words)
    plt.figure(figsize = (6, 6), facecolor = None)
    plt.imshow(wordcloud)
    plt.axis("off")
    plt.tight_layout(pad = 0)
    plt.show()
```

In [43]:
```
word_bow = text.values
```

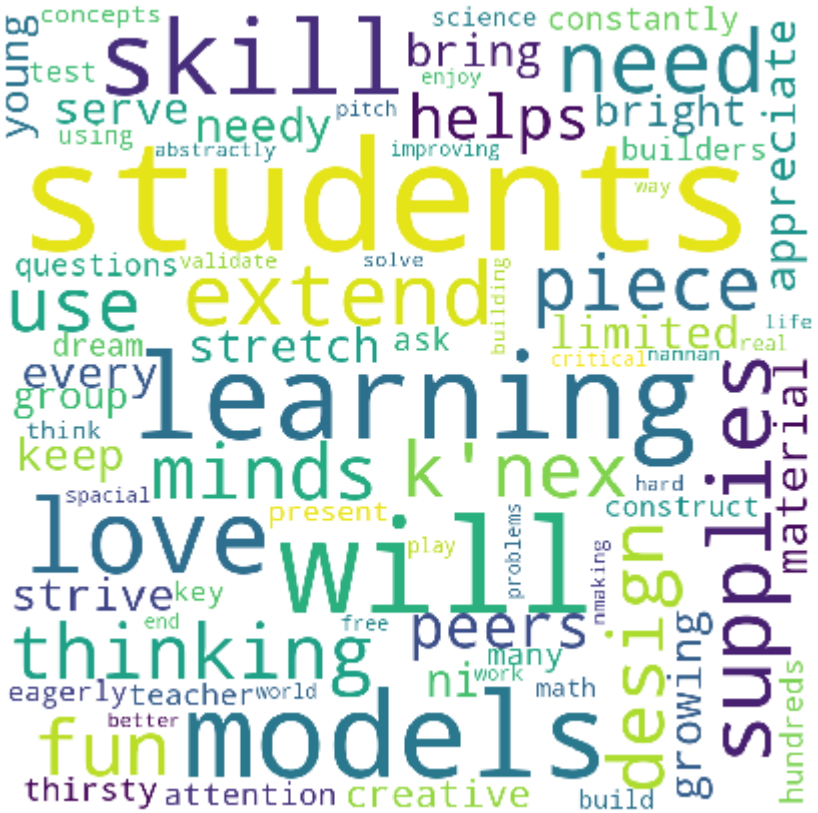
Assigning reviews to clusters

In [44]:
```
cluster1 = []
cluster2 = []
cluster3 = []


for i in range(s.labels_.shape[0]):
    if s.labels_[i] == 0:
        cluster1.append(word_bow[i])
    elif s.labels_[i] == 1:
        cluster2.append(word_bow[i])
    elif s.labels_[i] == 2:
        cluster3.append(word_bow[i])
    else:
        cluster4.append(word_bow[i])


# Number of reviews in different clusters
print("No. of reviews in Cluster-1 : ",len(cluster1))
print("No. of reviews in Cluster-2 : ",len(cluster2))
print("No. of reviews in Cluster-3 : ",len(cluster3))
```

```
No. of reviews in Cluster-1 :  1699
No. of reviews in Cluster-2 :  2740
No. of reviews in Cluster-3 :  561
```

Printing word cloud for cluster 1

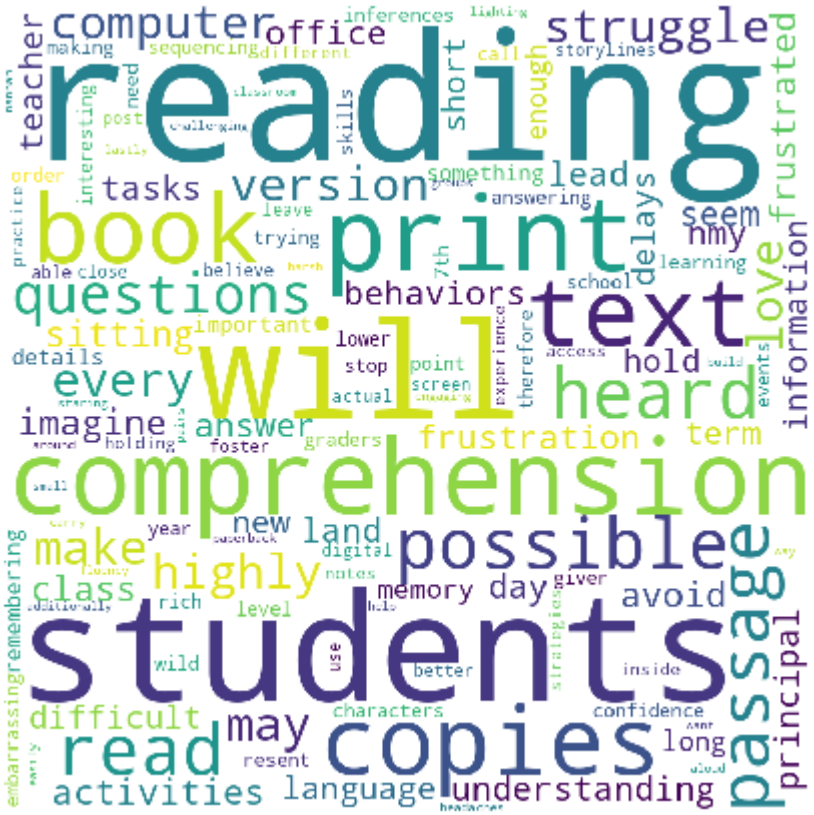
In [89]:
```
word_cloud(cluster1)
```



The reviews in this cluster are more related to social life of student with his batchmates and teachers.

Printing word cloud for cluster 2

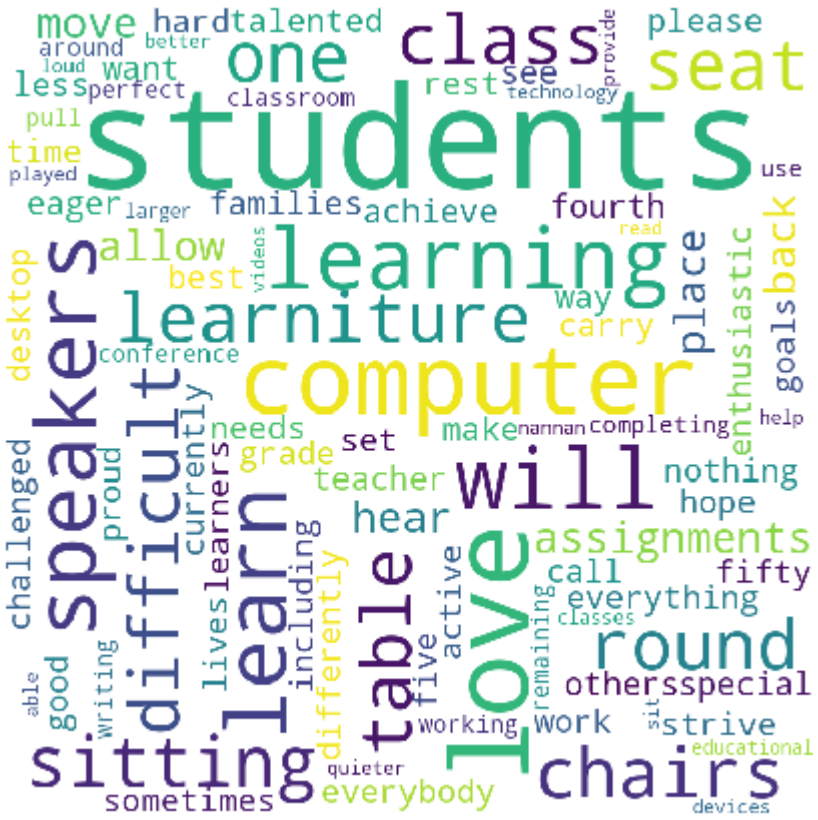
In [90]:
```
word_cloud(cluster2)
```



Observation: The reviews in this cluster have words that are more related to a students life inside a classroom.

Printing word cloud for cluster 3

In [91]:
```
word_cloud(cluster3)
```



Observation: In this cluster the words are more related to qualities and materials a student should have while studying in school.

2.6 Apply AgglomerativeClustering

In [58]:
```
from sklearn.cluster import AgglomerativeClustering
model1 = AgglomerativeClustering(n_clusters=2).fit(X_pca)
```

In [93]:
```
text_agglo=text[0:5000].values
text_agglo.shape
```

Out[93]:
```
(5000,)
```

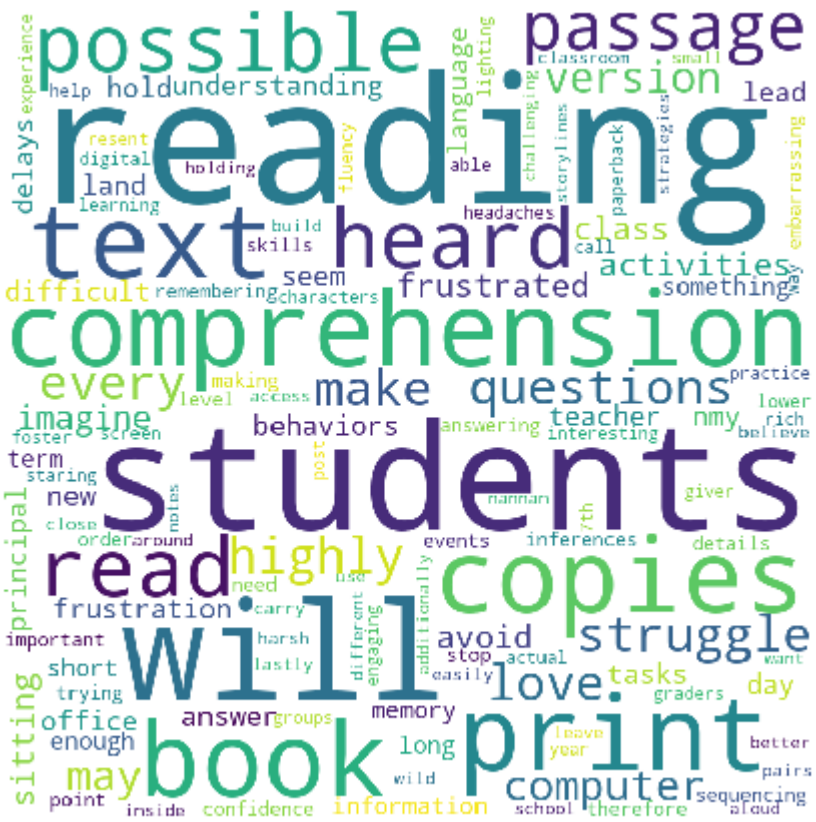
Assigning reviews to clusters

In [94]:
```
cluster1 = []
cluster2 = []

for i in range(model1.labels_.shape[0]):
    if model1.labels_[i] == 0:
        cluster1.append(text_agglo[i])
    else :
        cluster2.append(text_agglo[i])

# Number of reviews in different clusters
print("No. of reviews in Cluster-1 : ",len(cluster1))
print("No. of reviews in Cluster-2 : ",len(cluster2))
```

```
No. of reviews in Cluster-1 :  2926
No. of reviews in Cluster-2 :  2074
```

Printing cluster1 wordcloud

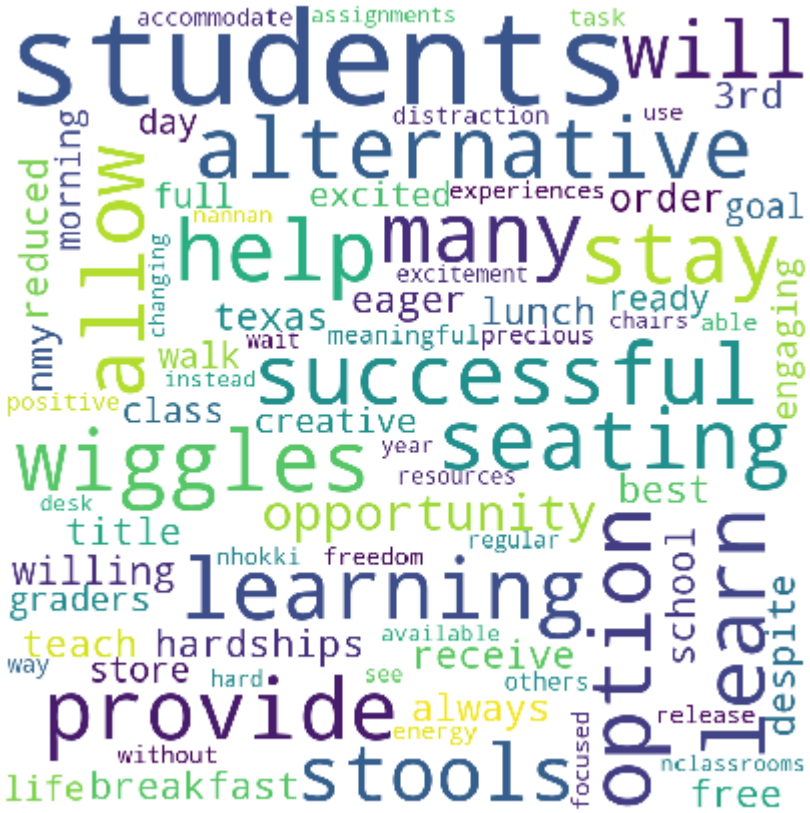
In [95]:
```
word_cloud(cluster1)
```



Observation: Materials required for academics are mentioned in reviews

Printing word cloud for cluster 2

In [96]:
```
word_cloud(cluster2)
```



In [ ]:
```
Observation:
    The reviews in cluster are more related to qualities a good student must have.
```

Observation: there are words that are frequently repeated such as student,learning,learn,class,questions,interesting and teacher are repeating in both clusters.

Agglomerative Clusterng for n_clusters=5

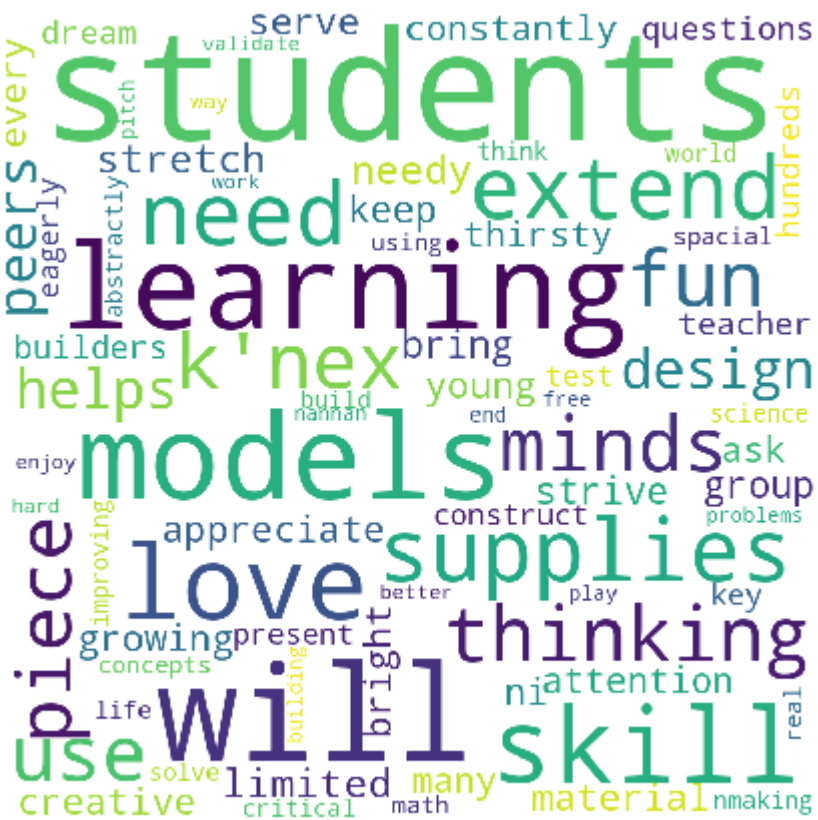
In [59]:
```
model2 = AgglomerativeClustering(n_clusters=5).fit(X_pca)
```

In [132]:
```
cluster1 = []
cluster2 = []
cluster3 = []
cluster4 = []
cluster5 = []

for i in range(model2.labels_.shape[0]):
    if model2.labels_[i] == 0:
        cluster1.append(text_agglo[i])
    elif model2.labels_[i] == 1:
        cluster2.append(text_agglo[i])
    elif model2.labels_[i] == 2:
        cluster3.append(text_agglo[i])
    elif model2.labels_[i] == 3:
        cluster4.append(text_agglo[i])
    else:
        cluster5.append(text_agglo[i])



# Number of reviews in different clusters
print("No. of reviews in Cluster-1 : ",len(cluster1))
print("No. of reviews in Cluster-2 : ",len(cluster2))
print("No. of reviews in Cluster-3 : ",len(cluster3))
print("No. of reviews in Cluster-4 : ",len(cluster4))
print("No. of reviews in Cluster-5 : ",len(cluster5))
```

```
No. of reviews in Cluster-1 :  2074
No. of reviews in Cluster-2 :  1939
No. of reviews in Cluster-3 :  606
No. of reviews in Cluster-4 :  211
No. of reviews in Cluster-5 :  170
```

Printing word cloud for cluster 1

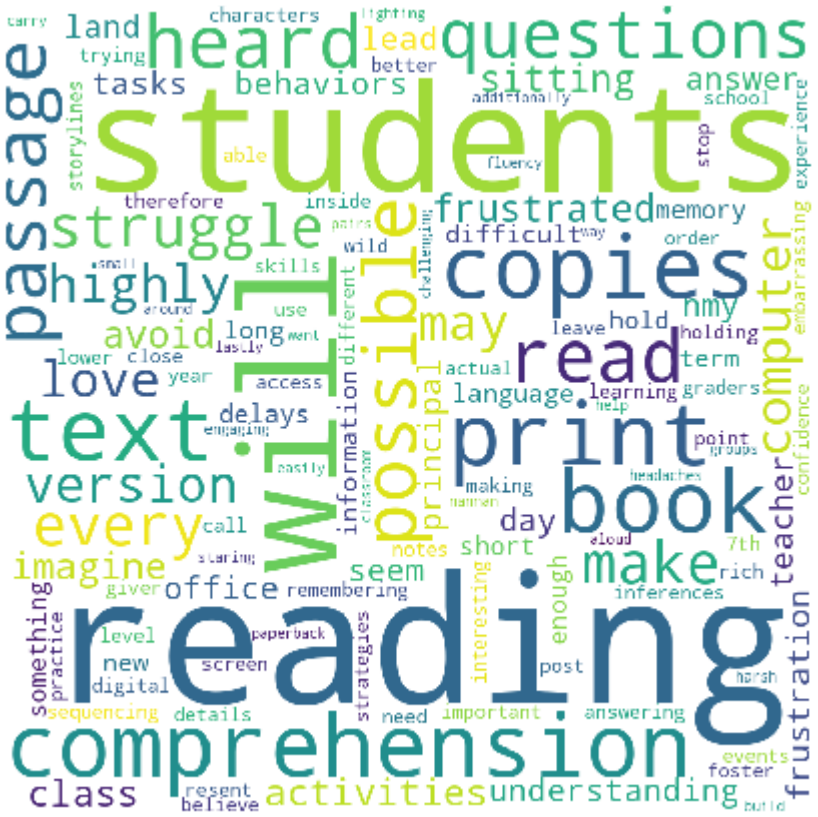
In [103]:
```
word_cloud(cluster1)
```



Observation: This cluster has reviews which have words that are related to social skills a student should have.

Printing word cloud for cluster 2

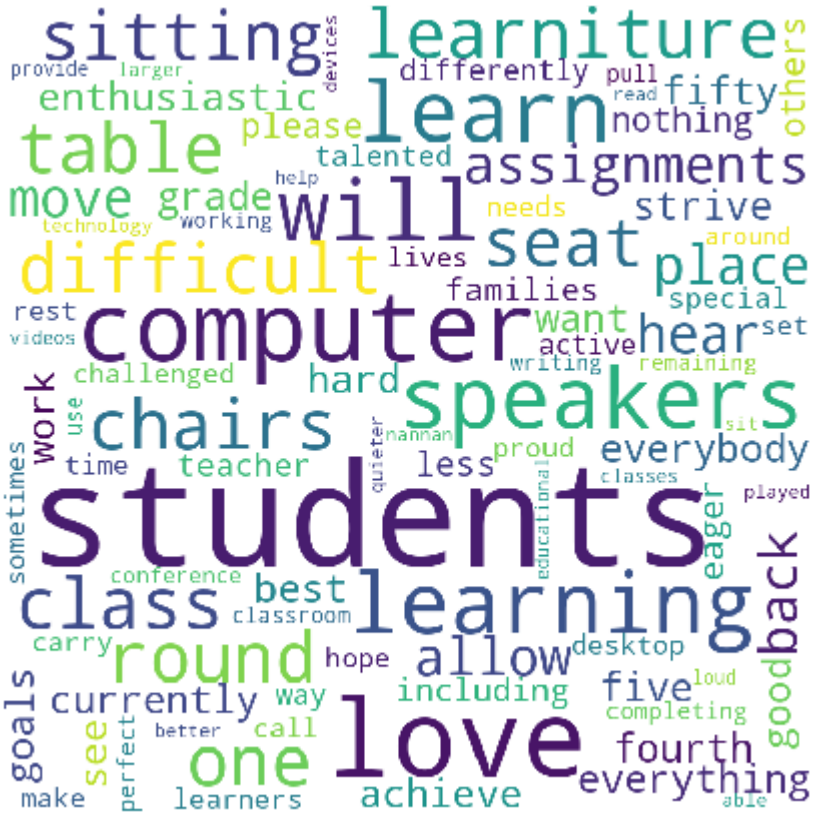
In [104]:
```
word_cloud(cluster2)
```



Observation: The reviews in this cluster have words that we observe here are mostly related to academics and materials used for studies.

Printing word cloud for cluster 3

In [105]:
```
word_cloud(cluster3)
```



Observation: in this cluster the reviews have words that are more related to students life in classroom

Printing word cloud for cluster 4

In [133]:
```
word_cloud(cluster4)
```

Observation: The reviews in cluster have words which are more related to skills a student must have.

Printing word cloud for cluster 5

In [107]:
```
word_cloud(cluster5)
```

Observation: the reviews in this cluster have words which are combination of other 4 cluster reviews.

2.7 Apply DBSCAN

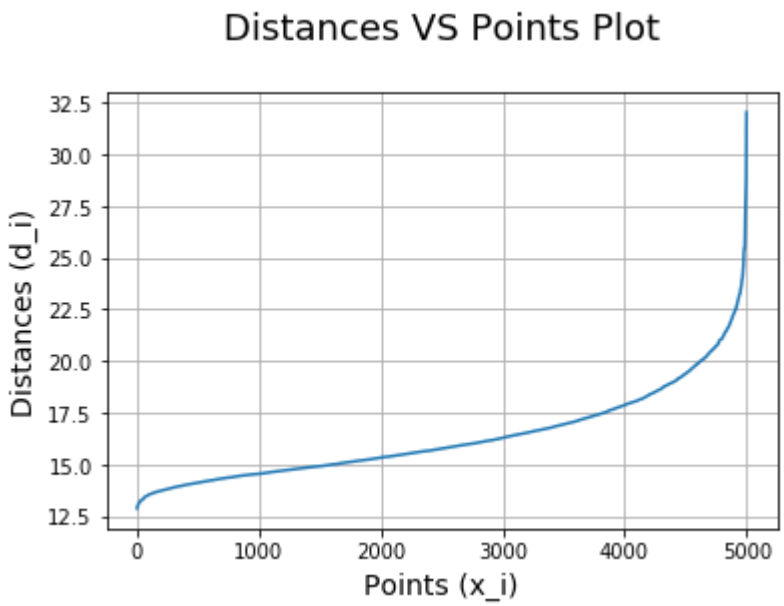
In [80]:
```
# Function definition for implementing DBSCAN
def dbscan(eps, samples, X):
    from sklearn.cluster import DBSCAN
    db= DBSCAN(eps=eps, min_samples=samples, n_jobs=-1).fit(X)

    # Number of clusters in labels, ignoring noise(-1) if present.
    n_clusters = len(set(db.labels_))
    print("Number of minpoints for cluster =",samples, " , Epsilon=",eps,"and clusters=",n_clusters)
    print("Labels(-1 is for Noise) : ",set(db.labels_))
    print()
    return db
```

Computing Distance between n neighbour and other points

In [71]:
```
def n_neighbour(X , n):
    distances = []
    for point in X:
        dist = np.sort(np.sum((X-point)**2,axis=1),axis=None)
        distances.append(dist[n-1])
    return np.sqrt(np.array(distances))
```

KNEE-METHOD

In [72]:
```
min_points = 2*X_pca.shape[1]

# Computing distances of nth-nearest neighbours
distances = n_neighbour(X_pca,min_points)
sorted_distance = np.sort(distances)
points = [i for i in range(X_pca.shape[0])]

# Draw distances(d_i) VS points(x_i) plot
plt.plot(points, sorted_distance)
plt.xlabel('Points (x_i)',size=15)
plt.ylabel('Distances (d_i)',size=15)
plt.title('Distances VS Points Plot\n',size=20)
plt.grid()
plt.show()
```



we can see there is a sharp rising in graph at dist=20. so we will take best eps=20

In [81]:
```
db1 = dbscan(20, min_points,X_pca)
```

```
Number of minpoints for cluster = 1000  , Epsilon= 20 and clusters= 2
Labels(-1 is for Noise) :  {0, -1}
```

In [116]:
```
text_db=text[0:5000].values
```

Assigning sparse or noise points to noise cluster and dense points to dense_cluster

In [131]:
```
noise = []
dense_cluster = []
for i in range(db1.labels_.shape[0]):
    if db1.labels_[i] == -1:
        noise.append(text_db[i])
    else :
        dense_cluster.append(text_db[i])

# Number of reviews in different clusters
print("No. of reviews in noise cluster: ",len(noise))
print("No. of reviews in dense cluster : ",len(dense_cluster))
```

```
No. of reviews in noise cluster:  46
No. of reviews in dense cluster :  4954
```

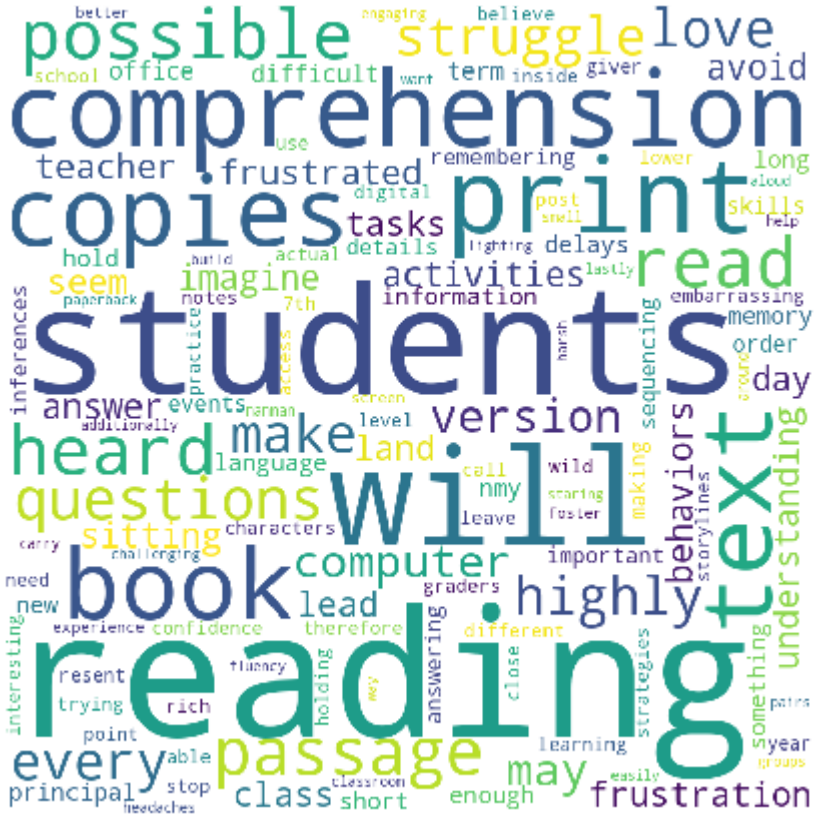
Plotting word cloud for noise points

In [121]:
```
word_cloud(noise)
```

Observation: If we observe in noise cluster the most words are materialistic things required by students

Plotting word cloud for dense points

In [122]:
```
word_cloud(dense_cluster)
```



Observation: here if we see the cluster we can see the words which are more related to qualities which are important for students.There are no materialistic things present in cluster

3. Conclusions

Please write down few lines of your observations on this assignment.

In [134]:
```
from prettytable import PrettyTable
p1 = PrettyTable()
p1.field_names = ["Vectorizer","Model","Optimal_Cluster"]
p1.add_row(['BOW','KMeans',3])
p1.add_row(['BOW','agglomerative',2])
p1.add_row(['BOW','agglomerative',5])
p1.add_row(['BOW','DBSCAN',2])
print(p1)
```

```
+------------+---------------+-----------------+
| Vectorizer |     Model     | Optimal_Cluster |
+------------+---------------+-----------------+
|    BOW     |     KMeans    |        3        |
|    BOW     | agglomerative |        2        |
|    BOW     | agglomerative |        5        |
|    BOW     |     DBSCAN    |        2        |
+------------+---------------+-----------------+
```

Overall Conclusion:

We can see that most project proposals are more student centered as we cn see for most frequent words in reviews are students,learning,computer,reading,book,love,classroom are repeating in every cluster.the materials required by students and project are more focused on improving socil life of students as well.