INTERPRETING STUDENT RESPONSES USING SENTIMENT ANALYSIS AND TEXT-ANALYTICS

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Abstract - This paper discusses exploratory research which computationally examines over one and a half million words presented by first-year students as part of weekly online assignments over the Fall 2020 academic term. This work aims to explore whether computational analyses of first-year engineering student vocabulary can be employed to understand the levels of student motivation when learning engineering in an online environment. The investigation uses NVivo 12 Plus (NVivo), a data analysis software, to track the overall sentiment of weekly student discussion board responses and apply text queries to determine the number of responses that include words related to the expectancy-value theory. Applying this theory reveals trends in overall student motivation, with weeks four to six and eight to ten having an overall positive sentiment. This positive sentiment reveals higher levels of student motivation during those weeks.

Keywords: sentiment analysis, motivation, online learning, text analytics, engineering education, engineering, first-year engineering,

1. INTRODUCTION

1.1. Background

Due to the impact COVID-19 has on the contemporary educational landscape, and courses being moved online, methods of teaching and assessment used in an online context have become more prevalent. One of these methods includes the use of online discussion boards. An example of this is APS100 ($n = 1100$ students), a mandatory course for all first-year undergraduate engineering students at the University of Toronto. This course supports students' transition into first-year engineering studies by allowing them to develop and apply a greater understanding of the academic learning environment, the professional skills needed for success, and the professional nature of engineering [1]. The mandatory weekly discussion prompts aim to encourage reflection on academic/professional development. Each week students were given four prompts to select from, and responses were collected over the Fall 2020 academic term.

These responses were then computationally examined using Natural Language Processing (NLP).

1.2. Motivation

Existing literature suggests that online learning can be especially stressful for students, having an impact on their sentiment and appreciation of a course [2]. Currently, there is a scarce amount of computational surveying that is being done longitudinally (i.e. from the beginning to the end of a course) that shows how student sentiment changes in a first-year Canadian engineering education context. The gap in this research is the motivation for this work. By analyzing the sentiment of student responses to weekly online discussion boards, patterns in student motivation can be identified.

NLP is a type of artificial intelligence that analyzes the human language and allows computers to read and interpret text, measure sentiment, and categorize unstructured data [3] [4]. To identify patterns, trends, and/or prevailing themes from large volumes of data, natural language processing and text analytics are used together. As well, sentiment analysis, a sub-field of NLP, is used to identify the mood of the subject's work and define it as either positive, negative, or neutral [3]. For this research, NVivo 12 Plus (NVivo), a software which uses NLP is used to analyze response sentiment and words related to motivation, drawn from the Expectancy-Value Theory (EVT). This theory proposes that if a student expects to be successful in completing a task and believes it is worth doing, they will have more motivation. The reason for using natural language processing is the challenge of removing human bias and error when organizing and analyzing the data manually. As well, with over one and a half million words in the data set, the time and cost to conduct this work manually is infeasible. Using natural language processing allows for large volumes of unstructured data to be interpreted, categorized, and classified by sentiment, consistently without bias, in minimal time [3].

1.3. Problem Definition

The focus of this research surrounds the question: Can computational analysis of first-year engineering student vocabulary be employed to understand the levels of student motivation when learning engineering in an online environment?

1.4. Solutions Considered

Any approach that attempts to answer this question needs to abide by certain conditions. One condition imposed by the very nature of the question is that the solution needs to be able to digest student-generated communications. The communication can be textual or verbal, but it must be thematically diverse in order to avoid inherent bias in the results. For example, the data used cannot solely be focused on what makes students demotivated or vice-versa. Another bias combatting condition is that the data set needs to be generated by a student body with the size and diversity to adequately represent the first-year engineering population. This helps to account for individuals with exceptionally high or low levels of motivation. Finally, the theory by which the motivation levels are evaluated needs to be compatible with the limits of the analysis software and computational hardware available.

Textual student responses were chosen as the data type to be examined as they are more readily available than verbal communications and are easier to process in large quantities compared to hard written responses. The data was collected from the core course, APS100, rather than other sources for two reasons. The first being that it is a mandatory course for all first-year engineering students. Since it encompasses the entire first-year engineering student population, its size and diversity are reflective of said population. The second reason for the selection of this course is that it mandated thematic diversity. Students were required to respond to one of four discussion topics each week. These topics covered different aspects of that week's curriculum (i.e. concepts taught in the course) and student life (e.g., midterms, reading week, personal experiences, etc.). These questions would correspond to a general theme and this theme would change on a weekly basis. To analyze this dataset, motivational theories featured in M. Svinicki's publication "A Guidebook On Conceptual Frameworks For Research In Engineering Education" [5] are taken into consideration. The conclusion from this discussion is that the Expectancy-Value Theory [6] and the Self-Determination Theory [7] are both viable candidates in this analysis due to their broad understanding of motivation [5] and their conduciveness to being implemented with computational analysis. This investigation uses the Expectancy-Value Theory due to its relative simplicity in terms of implementation compared to the Self-Determination Theory.

1.5. Theoretical Framework

Motivation is the driving force behind human actions [8]. It is the willingness to complete a task or achieve a goal [9]. There are many motivational theories which aim to explain the drive behind individuals' actions to complete or achieve a particular goal [10]. The framework used for this research is the Expectancy-Value Theory developed by Eccles-Parsons and her colleagues (1983). They proposed that expectancies and values directly impact an individual's performance [11]. In the engineering education context, this theory proposes that if a student expects to be successful in completing a task and believes it is worth doing, they will have more motivation [5].

1.6. Selected Methodologies

NVivo was selected due to the cost limitations and the technical capabilities of the researchers. NVivo requires minimal programming knowledge while providing the necessary features for this work, including sentiment analysis and text search queries.

2. METHODOLOGY

Fig. 1. This figure shows which words were used when analyzing the value and expectancy components of motivation. These words and their synonyms can be found in Svinicki's "A Guidebook On Conceptual Frameworks For Research In Engineering Education" [5].

Fig. 2. This flow chart is a visualization of the data processing methodology from data extraction to result compilation.

The data collected is sourced from the weekly discussion boards with approval from the University of Toronto's Research Ethics Board. Data collection begins after the course concludes. The information is collected from the discussion boards present on the Canvas LMS page and is stored in a CSV file. The original code that does this [12] is altered so that information linked to student identities is not imported. This ensures that responses are kept anonymous and cannot be traced to their authors [refer to Appendix A for the code alterations and Appendix B.1 for sample data]. A scrubbing program [refer to Appendix C] then removes HTML formatting from the data. All information enclosed by "<" and ">" symbols is removed [refer to Appendix B.2]. The scrubbed responses are then sorted into separate CSV files by the week they were assigned [refer to Appendix B.3]. The CSV data files are then converted to XLSX files and each file is imported as a separate "node" in NVivo.

The following process is applied to each node separately starting with the node containing responses from week one. Sentiment analysis is applied to the node using NVivo which outputs sorted collections of responses the software deems as having very positive, moderately positive, moderately negative, and very negative sentiment. A text search query is then applied to the very positive and very negative response collections. Collections of moderately negative and moderately positive responses are ignored as these responses contain sections with both positive and negative sentiment. Although this may also occur in responses deemed as very positive/negative, the conflict is considered to be inconsequential to the overall sentiment of the response.

Words drawn from the value component of EVT (refer to Fig. 1) are searched, and the number of references (the number of times the words appeared in the responses) are recorded. Another text search query is completed for the very positive and very negative responses, but instead, using the words drawn from the expectancy component of EVT (refer to Fig. 1). The references are recorded again. The files sorted into the sentiment nodes are then cleared, and this process is repeated for the remaining nodes (refer to Fig. 2 for a visualization). Once all the weeks are complete, the percentage of negative and positive references is calculated.

3. RESULTS

The graphs below (Fig.3 and Fig. 4) display the percentage of student responses classified as either very positive or very negative sentiment. Tables with the exact number of references and exact percentage values are provided in Appendix D.1 and Appendix D.2 respectively. The words drawn from the value component of the framework were found more in very positive responses compared to very negative. The lowest percentage of positive responses, and in consequence, highest percentage

of negative responses, were drawn from the fourth week. In regard to the expectancy component of the framework, responses fluctuated between higher percentages of very positive and very negatives sentiment. The highest percentage of positive responses occurred during the seventh week, and the highest percentage of negative responses during the eighth. These conclusions can be used to identify possible correlations to intrinsic motivations of first-year engineering students.

Fig 3. This graph displays the percentage of student responses deemed as very negative or very positive, using words drawn from the value component of the framework.

Fig 4. This graph displays the percentage of student responses deemed as very negative or very positive, using words drawn from the expectancy component of the framework.

Student Motivation Throughout the Fall 2020 Academic Term			
Week	Value Component of Motivation	Expectancy Component of Motivation	Overall Motivation
1	Mostly Positive	Mostly Negative	No Conclusion
2	Mostly Positive	Mostly Negative	No Conclusion
3	Mostly Positive	Mostly Negative	No Conclusion
4	Mostly Positive	Mostly Positive	Relatively Positive
5	Mostly Positive	Mostly Positive	Relatively Positive
6	Mostly Positive	Mostly Positive	Relatively Positive
7	Mostly Positive	Mostly Negative	No Conclusion
8	Mostly Positive	Mostly Positive	Relatively Positive
9	Mostly Positive	Mostly Positive	Relatively Positive
10	Mostly Positive	Mostly Positive	Relatively Positive
11	Mostly Positive	Mostly Negative	No Conclusion
12	Mostly Positive	Mostly Negative	No Conclusion

Fig 5. This table displays the overall sentiment of student responses which include words related to EVT.

When identifying the trends in the data, weeks four to six and eight to ten have an overall positive sentiment. Relating this to the EVT, a relatively positive sentiment may correlate to higher levels of motivation during those weeks.

4. DISCUSSION

4.1. Understanding the trends in motivation

Referring to Fig.5, the motivation of students related to each component of the EVT is deemed as mostly positive or mostly negative depending on the percentage of responses with that assigned sentiment. If the week has a percentage of very positive responses greater than 50, that week is considered mostly positive. If the week has a percentage of very negative responses greater than 50, that week is considered mostly negative. For the overall motivation, the sentiment from both the value and expectancy components are analyzed. If both components are deemed mostly positive, the overall student motivation for that week is considered relatively positive. If the results differ in sentiment, no conclusions are drawn.

Results of the analyses describe the relative positive and negative sentiment regarding the components of motivation on a weekly basis. A mostly positive sentiment in the value component would indicate that the student body feels their productive situation (e.g., tasks, experiences, etc.) is valuable. A mostly positive sentiment for the expectancy component indicates that students feel that they are likely to succeed in their current situation. The inverse applies if the sentiment is mostly negative. Applying EVT to these results provides the insight that if the majority of the sentiment is positive in both the expectancy and value components for any given week, students are experiencing relatively high levels of motivation that week. Likewise, predominantly negative sentiments indicate low levels of motivation. Other combinations of sentiment do not clearly indicate the level of student motivation but show how students interpret the current situation.

Weeks four to six and eight to ten have an overall positive sentiment. This indicates that students may have higher levels of motivation to perform well in their

engineering education during these weeks. Another interesting point to note is that the value component of EVT has a predominantly positive sentiment throughout the semester while the sentiment of the expectation component fluctuates. This indicates that students consistently find their engineering instruction and coursework to be valuable and worthwhile. However, the students do not always feel they are able to achieve success in the program.

Identifying these trends in motivation using EVT as the framework provides potential areas of improvement in the (online) engineering education context. Finding that the expectancy component of motivation procures a mostly negative sentiment throughout the term, suggests that implementing new or improved methods to support student success and strengthen student's belief that they are able to achieve success in their studies may be of interest. Furthermore, this paper provides a foundation for further work to be done in this field and provides sources of error to consider in future work.

4.2. Sources of Error

During preprocessing, HTML formatting was removed from the text in order to eliminate words that were not written by students. The method by which this was conducted however allowed for the possibility of valuable data loss if any student incorporated the "<" symbol in their response. Intra-response data loss would occur when a student typed in a "<" symbol but a ">" symbol was present later in the response. Inter-response data loss would occur if a student typed a "<" symbol in their response and the next ">" symbol was found in another student's response. When examining the scrubbed data, the number of responses recorded was the same as before scrubbing confirming that inter-response data loss did not occur. It was not feasible to ascertain whether intra-response data loss was present, so it remains a possible source of error.

Using the current method of chronologically sorting the data according to due date introduces error as some students may have submitted responses after the week that the discussions were due. The course instructor did give the assurance that an overwhelming majority of responses were submitted during the prescribed week, but this evidence is anecdotal. This error could have been avoided if the data were originally sorted based on the time of submission rather than the prescribed due date.

Another source of potential error arises from a few individual prompts encouraging biased responses as described in Section 1.4. This, however, does not occur every week and in any given week, the biased prompts only make up a quarter of all prompts available. It can be argued that the biased prompts may be more popular and therefore have greater influence over the result. The extent to which this is true could be statistically analyzed although this analysis was not conducted for this report. The presence of

these few biased prompts was accepted in favour of the diversity the responses reflected and the sheer volume at which they were present.

Errors are also present in the sentiment analysis of the data. When using sentiment analysis in NVivo, sentences are searched for particular words that are deemed either to have inherent positive or negative sentiment [13]. If the words drawn from the expectancy and value theory, already have a positive or negative sentiment attached to them (i.e., they are not neutral in sentiment) possible inaccuracies may arise. The influence of this error cannot be gauged as QSR International (the company behind NVivo's development) does not release a word bank of which words the software considers as bearing positive/negative sentiment. Additionally, this version of NVivo cannot recognize, and therefore properly interpret, slang, double negatives, sarcasm, dialect variations, idioms or ambiguity present in the text [13]. The significance of this error can be reduced by using multiple sentiment analysis software provided by different companies and then averaging the results.

5. CONCLUSIONS & FUTURE WORK

The sentiment of student responses, which included words drawn from the EVT, is found in this work. Using EVT as the framework for this research, higher levels of motivation are related to higher percentages of positive sentiment from both the value and expectancy components. However, with no conclusions being found for six out of the twelve weeks, there remains much improvement in this area of study. Future work may include identifying methods to mitigate the potential sources of error included in this process. Additionally, findings using EVT can be compared to findings using the Self-Determination Theory. Additionally, trends in motivation found from this research can be compared to student workload calendars. By doing so, possible correlations between presumed workload and motivational levels may be found.

References

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APPENDIX A: CHANGES MADE TO HTML EXTRACTION CODE

A.1 Modified “index.js”

```
const capi = require('node-canvas-api')
const { flatten } = require('./util')
const writeToCSV = require('./writeToCSV')

const getDiscussionTopicIds = courseId => capi.getDiscussionTopics(courseId)
  .then(discussions => discussions.map(x => x.id))

// recursively get nested replies and flatten result
const getNestedReplies = (replyObj, participants, topicId) => {
  const replies = replyObj.hasOwnProperty('replies')
    ? flatten(
      replyObj.replies.map(replyObj => getNestedReplies(replyObj, participants))
    ) : []

  return [{
    message: replyObj.message,
    likes: replyObj.rating_sum,
    timestamp: replyObj.created_at,
    parentId: replyObj.parent_id || topicId,
    id: replyObj.id
  }, ...replies]
}

const getDiscussions = async courseId => {
  const discussionTopicIds = await getDiscussionTopicIds(courseId)
  const discussionAndTopic = await Promise.all(
    discussionTopicIds
      .map(topicId => Promise.all([
        capi.getFullDiscussion(courseId, topicId),
        capi.getDiscussionTopic(courseId, topicId)
      ]))
  )
  return discussionAndTopic.map([discussion, topic]) => {
    const topicTitle = topic.title
    const topicMessage = topic.message
    const timestamp = topic.created_at
    const topicId = topic.id
    const participants = discussion.participants
    const replies = discussion.view.length > 0
      ? discussion.view
        .filter(x => !x.deleted)
        .map(reply => getNestedReplies(reply, participants, topicId))
      : []
    return {
      topicTitle,
      topicMessage,
      id: topicId,
      timestamp,
      replies
    }
  })
}

Promise.all([
  171197//{course id} add course ID here!
].map(courseId => getDiscussions(courseId))
  .then(discussions => writeToCSV(courseId, discussions))
])
```

A.2 Modified “util.js”

```
const flatten = arr => arr.reduce((acc, cur) => {
  Array.isArray(cur)
    ? [...acc, ...cur]
    : [...acc, cur]
}, [])

const flattenTopicAndReplies = discussions => {
  return discussions.reduce((acc, cur) => {
    const timestamp = cur.timestamp
    const discussionId = cur.id
    const topicTitle = cur.topicTitle
    const topicMessage = cur.topicMessage

    acc.push({
      type: 'topic',
      timestamp,
      discussionId,
      topicTitle,
      topicMessage
    })

    flatten(cur.replies).forEach(reply => {
      acc.push({
        type: 'reply',
        timestamp: reply.timestamp,
        parentId: reply.parentId,
        message: reply.message
      })
    })

    return acc
  }, [])
}

module.exports = {
  flatten,
  flattenTopicAndReplies
}
```

A.2 Modified “writeToCSV.js”

```
const fs = require('fs')
const path = require('path')
const fswrite = fs.writeFileSync
const fsappend = fs.appendFileSync

const writeHeader = (pathToFile, header) => fswrite(pathToFile, header + '\n\n')
const append = (pathToFile, row) => fsappend(pathToFile, row + '\n\n')

const escapeComment = comment => comment ? `'${comment.replace(/"/g, '"')}'` : ''

const writeToCSV = (courseId, data) => {
  const csv = path.join(__dirname, `output/${courseId}-discussion.csv`)

  const header = [
    'post_id',
    'post_parent_id',
    'discussion_topic_title',
    'discussion_topic_message',
    'post_message',
    'count_of_likes',
    'timestamp'
  ]

  writeHeader(csv, header)

  data.forEach(discussion => {
    append(csv, [ // write discussion to CSV
      discussion.id, // discussion topics cannot have a
      'parent_id',
      escapeComment(discussion.topicTitle),
      escapeComment(discussion.topicMessage),
      '',
      discussion.timestamp
    ])

    discussion.replies.forEach(reply =>
      reply.forEach(response => {
        append(csv, [ // write replies to CSV
          response.id,
          response.parentId,
          escapeComment(discussion.topicTitle),
          escapeComment(discussion.topicMessage),
          escapeComment(response.message),
          response.likes,
          response.timestamp
        ])
      })
    )
  })
}

module.exports = writeToCSV
```

APPENDIX B: DATA

B.1 Raw Data

A sample of data as recoded by the data collected program.

[illegible]

B.1 Scrubbed Data

A sample of data after being processed by the HTML scrubbing program.

	A	B	C	D	E	F	G	H	I
post_id	post_parediscussion_title	topic_discussion_title	me_post_message	count_of_timestamp					
898566	Optional+Ungraded f {Update: Thanks for showing community care in this			2020-11-07T14:20:45Z					
2578369	898566 Optional+Ungraded f {Update: Thanks for /Does anyone remem			16 2020-11-07T20:24:41Z					
2590911	2578369 Optional+Ungraded f {Update: Thanks for /Honestly I feel			7 2020-11-07T05:00:59Z					
2631140	2578369 Optional+Ungraded f {Update: Thanks for /That's exactly how I feel, Yes,			8 2020-11-07T23:14:17Z					
2649756	2578369 Optional+Ungraded f {Update: Thanks for /Thanks for your reply! Itâs c			2020-11-09T12:04:00Z					
2664817	2578369 Optional+Ungraded f {Update: Thanks for /Thanks sharing, Medina.Â Â			2020-11-11T09:11:04Z					
8769272	2578369 Optional+Ungraded f {Update: Thanks for /Hey Medina ∓			2020-11-13T19:29:08Z					
2591359	898566 Optional+Ungraded f {Update: Thanks for /I wish i could say			7 2020-11-08T06:31:17Z					
2612228	2591359 Optional+Ungraded f {Update: Thanks for /It sucks because I f			5 2020-11-07T03:31:16Z					
2679098	2591359 Optional+Ungraded f {Update: Thanks for /Thanks for sharing			2020-11-13T19:53:44Z					
2620984	898566 Optional+Ungraded f {Update: Thanks for /I am writing this right			4 2020-11-06T02:08:11Z					
2631260	2620984 Optional+Ungraded f {Update: Thanks for /In these posts make me so sad t			2020-11-07T03:35:17Z					
2620984	Optional+Ungraded f {Update: Thanks for /Thank you for being			2020-11-13T12:30:58Z					
2629587	898566 Optional+Ungraded f {Update: Thanks for /Having not done			4 2020-11-06T23:46:02Z					
2631302	2629587 Optional+Ungraded f {Update: Thanks for /I honestly don't think			1 2020-11-07T03:38:39Z					
2623508	2629587 Optional+Ungraded f {Update: Thanks for /Thank you for the re			1 2020-11-07T09:30:52Z					
2679705	2629587 Optional+Ungraded f {Update: Thanks for /The first year of			2020-11-13T21:36:35Z					
2645017	898566 Optional+Ungraded f {Update: Thanks for /εἰς ἅμα--εἰς ἅμα εὐδοκί			3 2020-11-09T03:59:04Z					
2652397	2645017 Optional+Ungraded f {Update: Thanks for /Hey K&A, this kind c			2 2020-11-10T01:08:50Z					
2679658	2645017 Optional+Ungraded f {Update: Thanks for /			1 2020-11-13T21:14:21Z					
2574939	898566 Optional+Ungraded f {Update: Thanks for /As said in video			2 2020-11-07T23:12:00Z					
2629617	2574939 Optional+Ungraded f {Update: Thanks for /That video is pure			1 2020-11-06T23:52:00Z					
2578104	2574939 Optional+Ungraded f {Update: Thanks for /This is very true. I think Profess			2020-11-07T20:08:38Z					
2578265	2574939 Optional+Ungraded f {Update: Thanks for /I like the comparison to sinusoï			2020-11-07T20:38:125Z					
2679604	2574939 Optional+Ungraded f {Update: Thanks for /Community care is			2020-11-13T21:12:13Z					
2653754	898566 Optional+Ungraded f {Update: Thanks for /Honestly, saying I			2 2020-11-10T09:23:29Z					
2679651	2653754 Optional+Ungraded f {Update: Thanks for /			2020-11-13T21:23:07Z					
868200	CHOICE C - What are No message			2020-11-16T15:52:59Z					
2425591	868200 CHOICE C - What are No message			2020-11-17T00:31:58Z					
2461574	2425591 CHOICE C - What are No message			2020-11-17T03:10:58Z					
2596083	2425591 CHOICE C - What are No message			2020-11-17T21:37:55Z					
2550024	2425591 CHOICE C - What are No message			2020-11-29T18:52:66Z					

APPENDIX C: CODE FOR HTML SCRUBBING PROGRAM

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <stdbool.h>

#define MAXLENGTH 65535
#define MEMORY 1000001

void AppendFile (FILE* FilePtr, char ListOfChar[1000001], int StopPosition);
char ReadCharFromFile (FILE* FilePtr, int OffsetFromStart);
bool DetectFileEnd (FILE* FilePtr, long int OffsetFromStart);

int main(void) {

    FILE* TempFile;
    FILE* TargetFile;
    char* TargetFileAddress = (char*)calloc(MAXLENGTH+1, sizeof(char));
    char* TempFileAddress = "TempTxtFile.txt";
    char CharacterReservoir[MEMORY];
    char CurrentChar = 'a';
    int ReservoirCounter = 0;
    int Counter = 0;
    int LengthOfAddress = 0;
    long int Cursor = -1;
    bool FileEnded = false;

    //Setting up the temporary file
    TempFile = fopen(TempFileAddress, "w+"); // Creates a blank text file where the
    filtered content is temporarily stored in the same directory as the program

    //If the file cannot be created, an error message will pop up and the program will
    end
    if(TempFile == NULL) {
        printf("Error -- Temporary file cannot be created!\n");
        exit(1);
    }
    fclose(TempFile); //Close file for now

    //Locating target file
    printf("Please enter (without surrounding in quotations) the PATH (file address
    including file name) of the .txt file you want to clean\n");
    fgets(TargetFileAddress, MAXLENGTH, stdin); //Gets PATH to .txt file from user

    //Removing newline character from PATH
    Counter = 0;
    while(TargetFileAddress[Counter] != '\n') {
        Counter++;
    }
    TargetFileAddress[Counter] = '\0';

    //Array is shortened to conserve memory
    Counter = 0;
    while(TargetFileAddress[Counter] != '\0') { //Counts how many characters are in
    the string
        Counter++;
    }

    LengthOfAddress = Counter+1;
    TargetFileAddress = (char*)realloc(TargetFileAddress,
    LengthOfAddress*sizeof(char)); //Adjusts size of pointer to length of address
```

```

TargetFile = fopen(TargetFileAddress, "r"); //Opens unen input .txt file for
reading to make sure it exists
//If the file cannot be opened, an error message will pop up and the program will
end
if(TargetFile == NULL) {
    printf("Error -- File cannot be opened/failed!\n");
    exit(1);
}
else{
    printf("File found and opened successfully!\n");
}
fclose(TargetFile);

//Add an ending sequence to the file that is not expected to be written in the
responses
TargetFile = fopen(TargetFileAddress, "a");
CharacterReservoir[0] = '|';
CharacterReservoir[1] = '0';
CharacterReservoir[2] = '_';
CharacterReservoir[3] = 'o';
CharacterReservoir[4] = '|';
AppendFile(TargetFile, CharacterReservoir, 4);
fclose(TargetFile);

//The entire target file is copied to the temporary file character by character.
Any HTML formatting enclosed and including '<' and '>' is omitted
printf("Starting HTML cleaning...\n");
FileEnded = false;
Cursor = -1;

while (FileEnded == false) {
    ReservoirCounter = -1;
    TargetFile = fopen(TargetFileAddress, "r");

    while ((ReservoirCounter < (MEMORY-1)) && (FileEnded == false)){ //Keeps on
reading characters from source and storing them in the array. Ends when array is full
or end of file is reached.
        Cursor++;
        CurrentChar = ReadCharFromFile(TargetFile, Cursor);

        if (CurrentChar == '<') { //HTML formatting detected
            while (CurrentChar != '>') { //Skipping HTML formatting
                Cursor++;
                CurrentChar = ReadCharFromFile(TargetFile, Cursor);
            }
        }

        else if ((CurrentChar == '|') && (DetectFileEnd(TargetFile, Cursor) ==
true)) { //If first character of ending sequence is detected
            FileEnded = true; //Stop the read cycle of target file and write cycle
to temp file
        }

        else if ((CurrentChar == '\n') && (ReadCharFromFile(TargetFile, Cursor+1)
== '\n')) { //Accounts for the C program reading the enter in the text file as two
newline characters
            ReservoirCounter++;
            CharacterReservoir[ReservoirCounter] = '\n';
            Cursor++; //Skips reading the next newline character
        }

        else { //Normal text is detected
            ReservoirCounter++;
            CharacterReservoir[ReservoirCounter] = CurrentChar;
        }
    }
    fclose(TargetFile); //Reading Sequence is ended

    TempFile = fopen(TempFileAddress, "a");
    AppendFile(TempFile, CharacterReservoir, ReservoirCounter); //Storing current
data in reservoir into temp file
    fclose(TempFile);

    printf("%ld characters have been processed from the original file\n", Cursor);

    TempFile = fopen(TempFileAddress, "a"); //Adding ending sequence to temp file
    CharacterReservoir[0] = '|';
    CharacterReservoir[1] = '0';
    CharacterReservoir[2] = '_';
    CharacterReservoir[3] = 'o';
    CharacterReservoir[4] = '|';
    AppendFile(TargetFile, CharacterReservoir, 4);
    fclose(TempFile);
    printf("Cleaned data copied to temporary file\nBeginning data transfer to original
file...\n");

    //Target file is wiped clean
    TargetFile = fopen(TargetFileAddress, "w");
    fclose(TargetFile);

    //The temporary file will be copied back over to the target file but the ending
sequence will be omitted
    FileEnded = false;
    Cursor = -1;

    while (FileEnded == false) {
        ReservoirCounter = -1;
        TempFile = fopen(TempFileAddress, "r");

        while ((ReservoirCounter < (MEMORY-1)) && (FileEnded == false)){ //Keeps on
reading characters from source and storing them in the array. Ends when array is full
or end of file is reached.
            Cursor++;
            CurrentChar = ReadCharFromFile(TempFile, Cursor);

            if ((CurrentChar == '|') && (DetectFileEnd(TempFile, Cursor) == true)) {
//If first character of ending sequence is detected
                FileEnded = true; //Stop the read cycle of temp file and write cycle
to target file
            }
        }
    }
}

```



```

        else if ((CurrentChar == '\n') && (ReadCharFromFile(TempFile, Cursor+1) ==
'\n')) { //Accounts for the C program reading the enter in the text file as two newline
characters
            ReservoirCounter++;
            CharacterReservoir[ReservoirCounter] = '\n';
            Cursor++; //Skips reading the next newline character
        }

        else { //Normal text is detected
            ReservoirCounter++;
            CharacterReservoir[ReservoirCounter] = CurrentChar;
        }
    }
    fclose(TempFile); //Reading Sequence is ended

    TargetFile = fopen(TargetFileAddress, "a");
    AppendFile(TargetFile, CharacterReservoir, ReservoirCounter); //Storing current
data in reservoir into temp file
    fclose(TempFile);

    printf("%ld characters have been transferred to the original file\n", Cursor);
    printf("HTML cleaning complete!\n");

    //Remove temporary file and end program
    if (remove(TempFileAddress) == 0) {
        printf("Temporay file deleted successfully\n");
    }
    else {
        printf("Unable to delete temporary file. File is located in the same directory
as this program and is named: TempTxtFile.txt\n");
    }
    printf("Ending program...\n");
    return 0;
}

void AppendFile (FILE* FilePtr, char ListOfChar[MEMORY], int StopIndex) {

    for(int i=0; i<=StopIndex; i++){
        fflush(FilePtr);
        fprintf(FilePtr, "%c", ListOfChar[i]);
    }

    return;
}

char ReadCharFromFile (FILE* FilePtr, int OffsetFromStart) {

    char Output = 'a';

    fseek(FilePtr, OffsetFromStart, SEEK_SET); //Brings cursor to current position of
interest
    fscanf(FilePtr, "%c", &Output);

    return Output;
}

bool DetectFileEnd (FILE* FilePtr, long int OffsetFromStart) {

    bool Output = false;
    char CurrentChar = 'a';
    long int Offset = OffsetFromStart;

    CurrentChar = ReadCharFromFile(FilePtr, Offset);

    //Testing for the ending sequence
    if (CurrentChar == '|') {
        Offset++;
        CurrentChar = ReadCharFromFile(FilePtr, Offset);

        if (CurrentChar == 'O') {
            Offset++;
            CurrentChar = ReadCharFromFile(FilePtr, Offset);

            if (CurrentChar == '_') {
                Offset++;
                CurrentChar = ReadCharFromFile(FilePtr, Offset);

                if (CurrentChar == 'o') {
                    Offset++;
                    CurrentChar = ReadCharFromFile(FilePtr, Offset);

                    if (CurrentChar == '|') {
                        Output = true;
                    }
                    else {
                        Output = false;
                    }
                }
            }
            else {
                Output = false;
            }
        }
        else {
            Output = false;
        }
    }
    else {
        Output = false;
    }
}

return Output;
}

```

APPENDIX D: RESULTS

D.1 Number of References Based on Sentiment

Value Component of Motivation			
Week	Very Positive References	Very Negative References	Total References
1	116	25	141
2	171	47	218
3	116	37	153
4	78	42	120
5	141	38	179
6	27	8	35
7	78	33	111
8	114	53	167
9	122	31	153
10	156	21	177
11	93	39	132
12	291	30	321

Expectancy Component of Motivation			
Week	Very Positive References	Very Negative References	Total References
1	43	50	93
2	64	72	136
3	35	41	76
4	139	74	213
5	43	33	76
6	9	4	13
7	14	37	51
8	23	9	32
9	67	54	121
10	22	20	42
11	31	39	70
12	24	31	55

D.2 Percentage of References Based on Sentiment

Value Component of Motivation		
Week	Very Positive References (%)	Very Negative References (%)
1	82.27	17.73
2	78.44	21.56
3	75.82	24.18
4	65	35
5	78.77	21.23
6	77.143	22.86
7	70.27	29.73
8	68.26	31.74
9	79.74	20.26
10	88.14	11.86
11	70.46	29.54
12	90.65	9.35

Value Component of Motivation		
Week	Very Positive References (%)	Very Negative References (%)
1	46.24	53.76
2	47.06	52.94
3	46.05	53.95
4	65.26	34.74
5	56.58	43.42
6	69.23	30.77
7	27.45	72.55
8	71.88	28.12
9	55.37	44.63
10	52.38	47.62
11	44.29	55.71
12	43.64	56.36