Sentiment in Academic Texts

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Abstract — **The problem of sentiment analysis has been widely studied in the past several decades. The research in the area has been predominantly based on data collated from online messages, microblogs, reviews, etc. Significantly fewer studies have been conducted based on academic discourse and especially school textbooks. However, sentiment analysis of academic texts can help answer pressing issues relating the ways in which different referents are presented in contemporary Russian school textbooks. In this paper, we analyze the distribution of sentiment words and phrases in a Corpus of Russian school textbooks on History (Grades 10–11) and Social Sciences (Grades 5 – 11). The results of the study demonstrate that the discourse within (1) History textbooks used in the 10th and 11th grades of Russian schools and (2) Social Studies textbooks written by Nikitin for Russian schools (Grades 5 – 11) contains predominantly negative sentiment: the writers select negatively valenced words and prefer presenting negative referents. By contrast, the discourse within the set of Social Studies textbooks written by Bogolubov revealed a predominantly positive bias. The authors discuss the implications of these trends in relation to the potential impact of the tone of educational discourse on learning.**

I. INTRODUCTION

Over the last 15 years sentiment analysis of texts has become a classic section in computer science with numerous researchers working in the area. Mäntylä et al. [1] argue that by 2017 Scopus database had indexed over 7000 articles which either describe sentiment analysis as a method or use it in the research presented. Sentiment analysis is typically viewed as a method that "involves discerning subjective material and extracting attitudinal information such sentiment, opinion, mood and emotion" [2]. The most highly cited article written by B. Pang and L. Lee [3] offers a brief history of sentiment analysis and covers possible applications of sentiment analysis. Paradoxically, B. Pang and L. Lee do not include education within the list of the areas where sentiment analysis is actively used. Likewise, a cluster analysis of 7000 articles, carried out in [1], identified the following seven main areas of application of sentiment analysis: society, security, travel, finance, corporate, medical, and entertainment. The area in which sentiment analysis is most often applied is the analysis of consumers' opinions on goods and services [4].

Though opinions matter a great deal in education, there have been relatively few applications of sentiment analysis in the literature. Analyzing the role of sentiment analysis in education sector Archana R.P. and Kishore B. concluded that sentiment analysis has strong potential to extract useful information about teaching methodologies and course curricula [5]. Likewise, Hussam Hamdanet et al. [6] concluded

that sentiment analysis on educational data has strong potential to help improve teaching (see also [7]).

One area of education that naturally invites sentiment analysis is the examination of school textbooks. For example, one study conducted by John Sell and Ingrid G. Farreras [8] analyzed 66 Introductions to Psychology college textbooks published over the last century. Their study revealed a significant emotional shift in the texts, toward a more negative and guarded tone in the textbooks.

Despite the potential impact, there are few publications on the tone of textbooks. This is a crucial line of research because it can contribute to our understanding of textbook discourse. A systematic, informative and insightful description of the nature of textbook discourse, and its role, and pedagogic potential in the context of secondary schools is of great importance to modern society, and particularly education.

As sentiment analysis aims to automatically identify and evaluate opinions and emotions in text, the goal of sentiment analysis in this study is to examine the extent to which Russian History and Social Studies textbooks represent positive or negative opinions. It is especially significant now as disputes over modern Russian school textbooks have been held for over two decades [9]. Russian textbooks have been criticized for many things but mostly for interpretations of history, and transmitting views of official national history to the next generations. In 2013, Russia released " Concept of New Textbooks and Reference Books of Methods of Teaching History" [10] calling for emphasizing development of Russia, the Patriotic War of 1812 and the Great Patriotic War (1941 - 1945), patriotism and national consciousness, tolerance, and pride for Russia. The "Concept" also calls for an objective history of the tragic events such as the Revolution, the Civil War, political repression etc. and the ways the country was overcoming these tragedies [10].

Hirschfelder (1982) [11] argues that instructional materials and classroom language significantly affect students' development of knowledge and their perceptions of self and others. The influence of a textbook is even more critical if we speak about teaching such disciplines as History and Social studies which are supposed to teach and transmit ideologies. Researchers warn that "Distortion and bias … have existed for as long as history writing itself" [12] and the answer to the question "What are consequences and implications of the writing of biased history?" is summarized in Henry Graff's laconic quote: "an unreal view of the world" (see [12, p.262])

In this study, we employ the traditional lexicon-based approach[3]., thus applying the Dictionary of sentiment

lexicon on the Corpus we compiled for the study [13]. A successful use of sentiment lexicons with topic modeling was used in a recent paper by Tutubalina and Nikolenko [14]. Solovyev and Ivanov in [15] used a combined (hybrid) approach applying automatic and manual methods to compile a dictionary. In [16], Tutubalina and Nikolenko developed a new technique that extends existing approaches to sentiment-based topic modeling; it is also called aspect-based opinion mining in this field since these models are usually applied to user reviews and opinions regarding certain products with the goal of mining specific aspects. Using optimization of sentiment priors, the work improved sentiment classification in such sentiment topic models as JST and Reverse-JST, ASUM, and USTM, training new aspect-specific lexicons of sentiment words based on a small set of seed sentiment words.

To the best of our knowledge, sentiment analysis has not yet been implemented on Russian academic discourse. In this study, we use the corpus of textbooks on Social Studies and History for Russian secondary and high schools. The first problem addressed in the study is the overall tone of the textbooks in the Corpus. We assume a priori that the overall tone of textbooks is supposed to be neutral while the presentation of educational material must be weighed, objective, and unemotional. This is our first null hypothesis.

On the other hand, Augustine et al. in [17] and Kloumann et al. in [18] convincingly demonstrated, using modern English discourse as an example, that people use positive words more often than negative ones. This effect is known as a positive bias. Unfortunately, the Russian discourse remains much more understudied than English. Though it has been suggested that adjectives used in the Russian discourse also demonstrate a positive bias [119]. Another result of the same work confirmed in discourses of 20 languages of completely different cultures suggests the universal character of positive bias for all human languages. If this is so, one would expect a positive tone in Russian school textbooks (the second null hypothesis).

The remainder of this paper is organized as follows. Section II (Positive bias) critically reviews principal theories and studies relevant to the current study. Modern research paradigms have established the significance of sentiment evaluation of academic discourse, the role of textbooks in education, shaping learners' attitude, identities and culture. Section II concludes by identifying a research niche in literature, i.e. the need to examine discourse bias(es) in History and Social Studies textbooks used in modern Russia. Section III presents the Datasets and Tools used to capture the sentiment of a text. Before coming to our discussion in Section IV, Section III also introduces and describes the experimental results. The variety of discourses enabled us to conduct inter- and intra-author comparative studies to obtain an objective picture of Russian academic discourse. In Section IV we discuss the results observed and provide a comparison of the three sub-corpora under study. This section also suggests some perspectives for future studies.

II. POSITIVE BIAS

To understand the importance of the results reported in the article, we find it necessary to briefly review the publications on "positive bias". Originally the idea of positive bias was formulated by J. Boucher, and C. E. Osgood in 1969 when they observed that "people tend to look on (and talk about) the bright side of life" [20]. Positive bias in everyday conversations was registered and described in [21]. In addition, [22] observed positive correlations between word frequency in modern English discourse and their positivity. Later on, with the help of Amazon Mechanical Turk [23], positive bias was verified for the 5000 most frequent words in English. Every word received no fewer than 50 ratings [18]. [24] discovered correlations between word frequency and their positivity for Italian. The research shows that modern languages have more positive than negative words. By contrast, emotive words demonstrate negative bias "across generations and across cultures", i.e. in the group of emotive words there are more negative than positive words [25].

Russian history education and school textbooks on Social studies attracted interest of many scholars [26]. [27] provide a comprehensive analysis of "the narrative templates" to represent certain historic figures in Russian history and the role patriotism plays in modern Russian history textbooks, but our literature review failed to find any results of sentiment analysis of Russian academic discourse; thus we view a study aimed at discovering an emotional bias of a Russian academic discourse a research niche.

At the moment, the Russian system of education is undergoing a tremendous transformation to meet the requirements of modern competitive world. Detection of textbooks 'mood' based on sentiment analysis could play a promising and defining role in education policy making. It is especially important nowadays when the country is introducing education reforms and looking for its unique national identity. In the modern world, textbooks are viewed as key components of ideological platforms for assessing the world. Textbooks are also the first and consequently one of the most important sources for forming national identities [28].

III. DATASETS AND TOOLS

A. Russian Academic Corpus

We investigate two collections of Russian texts: Social Sciences textbooks and History textbooks. For the purpose of this study, we explore the corpus of Russian textbooks on Social studies for middle and high school [29, 30, 31]. The Russian Academic Corpus (RAC) was compiled of two batteries of textbooks for Russian students. It contains 45380 sentences from 14 textbooks: edited by Bogolyubov (BOG) and by Nikitin (NIK). The sizes of BOG and NIK collections of texts are presented in Table I. Additionally, we digitized and pre-processed six History textbooks. The collection includes textbooks of Russian and world history written by different authors for the 10th and 11th grades: Soboleva, Volobueva, Guryanov, Petrov, Plenko, Ponomarev. Quantitative information about History textbooks is presented in Table II. The structure of corpus is presented graphically in Fig. 1. RAC is divided into two subject domains and contains 20 texts. The total size of the corpus is around 1 million tokens.

TABLE. I PROPERTIES OF THE PRE-PROCESSED CORPUS OF TEXTBOOKS ON SOCIAL STUDIES.

	Tokens		Sentences		Words per sent.	
Grade	BOG	NIK	BOG	NIK	BOG	NIK
5-th	–	17,221	–	1,499	–	11.49
6-th	16,467	16,475	1,273	1,197	12.94	13.76
7-th	23,069	22,924	1,671	1,675	13.81	13.69
8-th	49,796	40,053	3,181	2,889	15.65	13.86
9-th	42,305	43,404	2,584	2,792	16.37	15.55
10-th	75,182	39,183	4,468	2,468	16.83	15.88
10-th*	98,034	–	5,798	–	16.91	–
11-th	–	38,869	–	2,270	–	17.12
11-th*	100,800	–	6,004	–	16.79	–

Note. An asterisk marks Textbooks developed for more advanced learners

TABLE II. PROPERTIES OF THE PREPROCESSED TEXTBOOKS ON HISTORY.

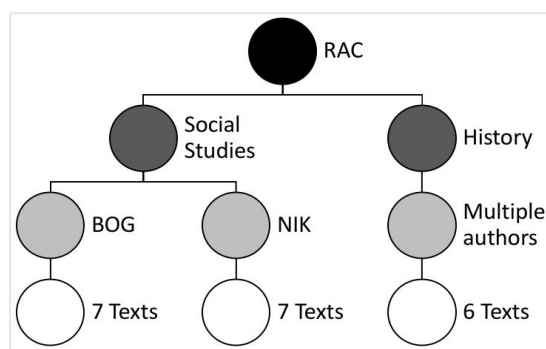| Author / Grade	Tokens	Sentences	Words per sentence
Soboleva / 10-th	81544	7116	11.46
Volobuyev/ 10-th	40949	3676	11.14
Guryanov / 11-th	100331	9393	10.68
Petrov / 11-th	85409	8536	10.01
Plenko / 11-th	63804	5292	12.06
Ponomarev / 11-th	44833	4003	11.2

Fig. 1. Structure of the Russian Academic Corpus.

B. Annotation and preprocessing of RAC

All texts in the corpus were preprocessed in the very same manner. Preprocessing included tokenization, splitting text into sentences and Part-of-Speech tagging (using the TreeTagger for Russian: http://www.cis.uni-muenchen.de/~schmid/tools/TreeTagger/). During the preprocessing step we excluded all extremely long sentences (longer than 120 words: 34 sentences in total) as well as very short sentences (shorter than 5 words: around 10,000 sentences in total, 11,6%) which we consider outliers. Clearly, such sentences may not be outliers in other domains; however, in the case of school textbooks, sentences shorter than 5 words are outliers. Extremely short sentences mostly appear as names of chapters and sections of the textbooks or picture captions. Sentences of five to seven words in Russian are viewed as short sentences; the average sentence length (in our corpus) is greater than 10. Extremely long sentences (more than 120

words) are typically excerpts from legal documents or quotations from Constitution of the Russian Federation.

C. Russian Sentiment Lexicon: RuSentiLex

Russian sentiment lexicon is referred in the study as RuSentiLex [32]. The lexicon was built using several sources: opinionated words from domain-oriented Russian sentiment vocabularies, slang and curse words extracted from Twitter, objective words with positive or negative connotations from a news collection. In cases where different sentiment orientations related to different word senses, the words were linked to the concepts in the thesaurus of Russian language RuThes. All lexicon entries were classified into four sentiment categories (negative, positive/negative, positive, neutral) and three types of sentiment (fact, feeling, opinion). In our study, neutral words registered in the dictionary were excluded from calculations of sentiment in the academic texts under study.

RuSentiLex was originally generated automatically from the above-mentioned resources, after which it was carefully checked by experts. This vocabulary is extensively used in modern studies [33-35]. Lexical ambiguity in the dictionary was removed by assigning different keys to different meanings of words. The main statistical parameters of RuSentiLex are provided in Tables 3-5.

TABLE III. QUANTITATIVE CHARACTERISTICS OF RUSENTILEX VOCABULARY: SENTIMENT ORIENTATION

Sentiment orientation	Number
Negative	8,475
Positive/negative	163
Positive	2,883
Neutral	485

TABLE IV. QUANTITATIVE CHARACTERISTICS OF THE RUSENTILEX VOCABULARY: SENTIMENT TYPES

Sentiment type	Number
Fact	3,391
Feeling	1,199
Opinion	7,426

TABLE V. QUANTITATIVE CHARACTERISTICS OF THE RUSENTILEX VOCABULARY: PART-OF-SPEECH

Part-of-Speech	Number
Nouns	4,537
Adjectives	2,596
Verbs	2,025
Noun Groups	1,290
Verb Groups	1,304
Others	267

In the present study, RuSentiLex is used to search RAC for sentiment words. We start with direct matching of lemmas from lexicon to the lemmas from the corpus. If two lemmas coincide, we proceed with careful comparison of their PoS-tags. This is important, because ambiguity can add noise to the results of direct matching. It is obvious that, for an accurate

assessment of the sentiment of sentences, complete syntactic analysis is needed, since positive and negative words may be in the sphere of action of the negation operator. However, calculations show that this occurs in no more than 1% of cases, which does not affect the experimental data presented. Therefore, in this paper, it was decided not to conduct a syntax analysis. Due to its complexity, parsing can lead to interpretation errors. Thus, the analysis implies matching of a pair: (lemma, PoS-tag).

D. Setup of Experiments.

The experimental design is motivated by the hypotheses of interest. To this end, we calculated the frequency of sentiment words occurring in each document. Taking into account the sparsity of words having sentiment, we multiply the result by 1000. Thus, in all calculations we measure the number of occurrences per 1000 words (or incidence per 1000 words in a document).

In the first experiment we compared sentiment words in two collections (NIK and BOG) across the grade levels to find a tendency. Using two collections is a crucial element as it confirms stable results (unaffected by variations in style of one author).

In the second experiment we analyze sentiment orientation in both collections on Social Studies and study trends of positive and negative sentiment words.

In the third experiment we use the collection of textbooks on History. As the collection covers only the 10th and 11th grades, we use it as a test of generalization of the results reported in Experiments 1 and 2.

IV. DISCUSSION OF RESULTS

Figure 2 shows the number of sentiment words in each textbook (5 – 11) classified into three groups: words denoting fact, feeling and opinion. Each entry in the table includes Sentiment Word Incidence per 1000 words. We can observe a downward trend in emotional coloring of the texts across the grade level in books of BOG and NIK (see Figure I below).

Another trend observed in Fig.3 is a decrease in judgmental words, which can be interpreted as providing high school students with greater opportunities to form their own opinion. It is an accepted view that judgmental words, such as 'a horde of invaders', 'decent', 'bad' and others convey both meaning and attitude [37].

In the texts of both authors, a decreasing tendency is observed for using positively and negatively colored words across the grade level (Fig.3).
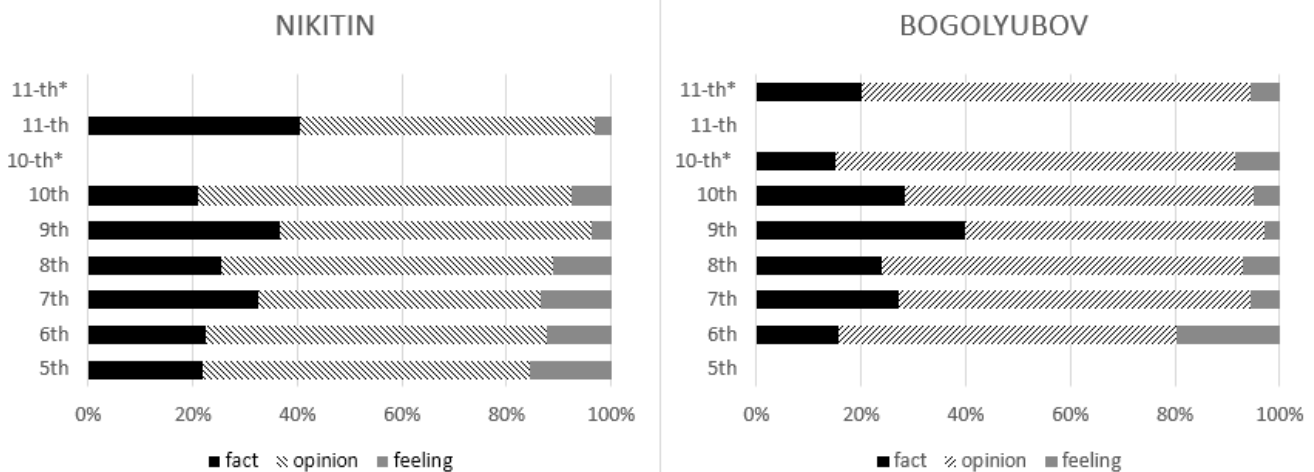

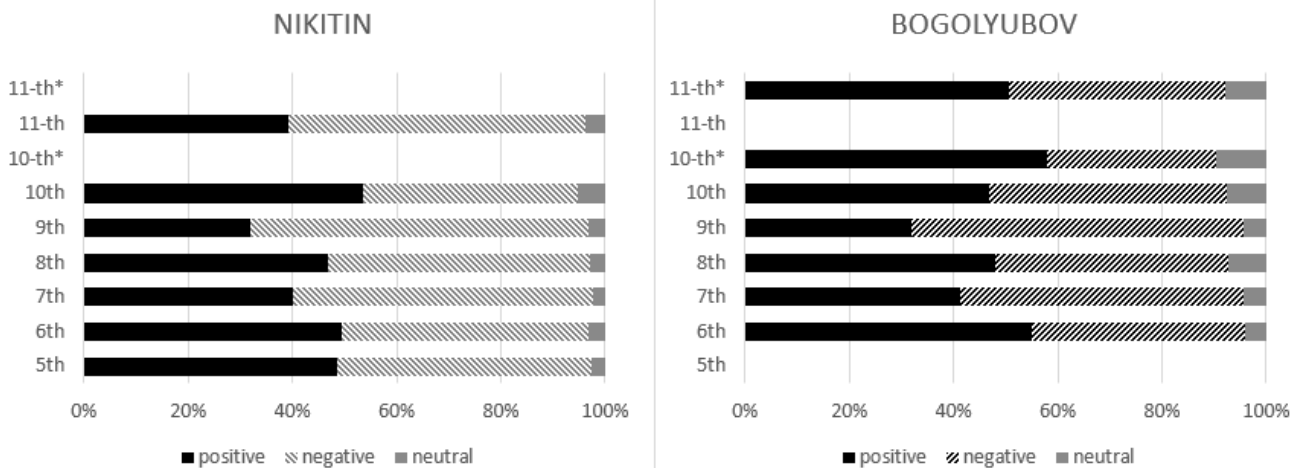Fig. 2. Sentiment Word Incidence in RAC. Number of Occurrences per 1000 Words

Fig. 3. Sentiment Word Frequencies in Each Part of RAC: Positive, Negative and Neutral Words (occurrences/ 1000 words)

Comparison of authors' ratios of positive and negative words produced the most interesting results: NIK has a noticeable (up to 20%) prevalence of negative words which contradicts the positive bias of the discourse discussed in the Introduction. In BOGs texts, the ratio is approximately the same. This leads to the conclusion that the Corpus does not provide similar patterns of change across the grade levels.

In History textbooks, the number of both positive and negative words increase dramatically: (1) positive words - from 7.53 per 1000 words in the 10th grade to 18.44 words in the 11th grade; (2) negative words – from 10.36 per 1000 words in the 10th grade to 29.25 words in the 11th grade.

Classifications of three types of sentiment: fact, feeling, or opinion are presented in Figures 4 – 6 (see Appendix).

Russian history, as does the history of any nation, has a number of topics, which can be defined as "contentious in some way" [37], and this fact only leaves textbook authors with an unenviable task of demonstrating their attitude towards the topics of this kind. But biases in textbooks may negatively affect students' development and even deprive them of developing critical thinking, namely, the ability to sift arguments and evaluate the quality of evidence.

V. CONCLUSION

This article provides the results of the first experience of sentiment analysis conducted on the corpus of textbooks on Social Studies and History (Grades 5 – 11) used in Russian secondary and high schools. We identified and categorized opinions expressed in three batteries of school textbooks, i.e. textbooks on Social Studies edited by (1) Bogolubov, (2) Nikitin and (3) History textbooks with the aim to determine whether the writer's attitude towards a particular topic is positive, negative, or neutral.

The variety of subjects (History and Social studies) and authors (2 of Social studies books and 6 of History textbooks) enabled us to carry out inter- and intra-author comparative studies and obtain an objective picture of the overall tone of the text. Sentiment analysis of school textbooks revealed an unexpected phenomenon: the predominance of negative vocabulary over positive in the textbooks on History and, to a lesser extent, in the textbooks on Social studies. This contradicts the well-known pattern of the predominance of positive vocabulary in modern written and oral discourse as a whole. The authors view the results of the research quite alarming, as school textbooks, from our point of view, are supposed to be written in predominantly positive tone thus forming a positive picture of the world and a positive attitude in the classroom.

We consider that potential perspective of the research lies in contrasting academic discourses in different languages which requires compiling an accessible academic (textbook) corpus and availability of dictionaries of sentiment vocabulary of different languages. Other potential perspectives of the research include investigation of the dynamics of judgments/tones/attitudes in narrations of (1) certain historical events, (2) certain historic personalities. In terms of the approaches applied we view machine learning approach as an alternative to the lexicon based approach used in the paper [38]. This is especially urgent for Russia, where the attitude to history changed over the last century more than once: after the revolution of 1917, and then, as the leadership of the country changed, in 1956, 1964, 1992. Sentiment analysis of textbooks is undoubtedly an important research area which can be used to improve education by defining opinion, sentiment, and subjectivity in the texts taught and thus helping improve textbooks and teaching.
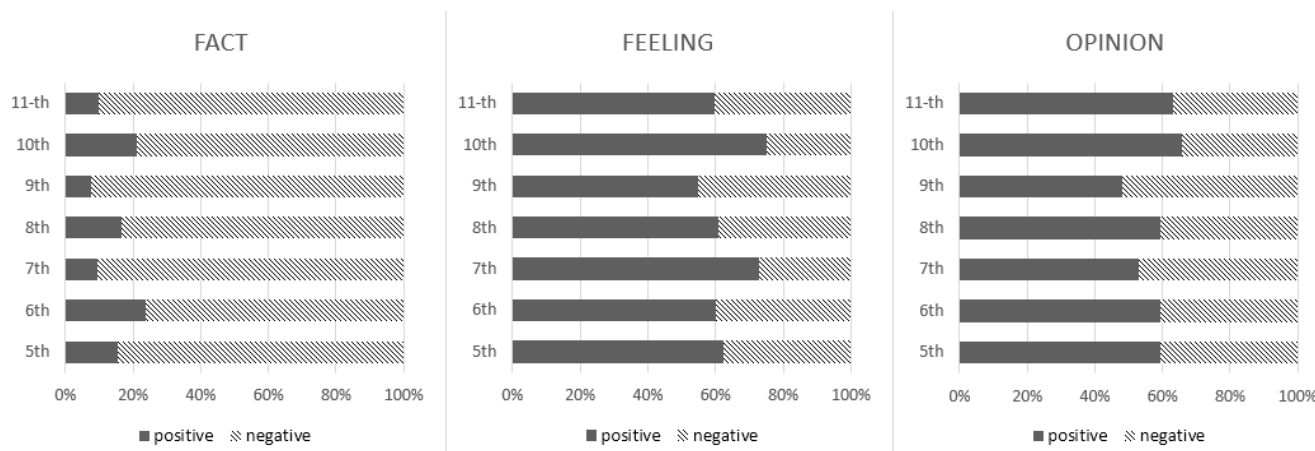
ACKNOWLEDGMENT

Fig. 4. Sentiment Word Frequencies in NIK: Positive Vs. Negative Words. (occurences/ 1000 words)
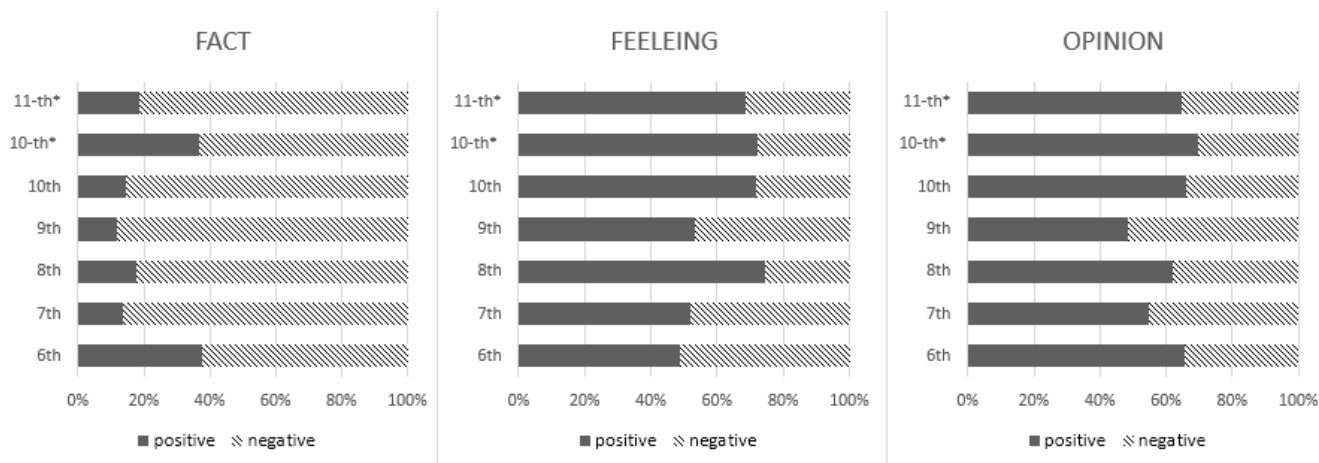
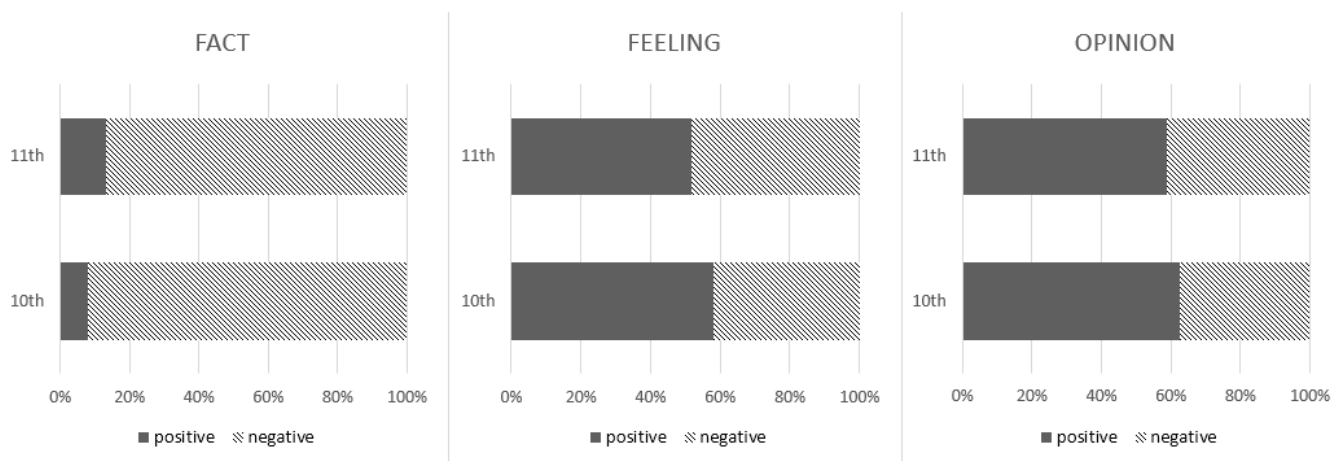Fig. 5. Word Frequencies in BOG: Positive Vs. Negative Words. (occurrences/ 1000 words)

Fig. 6. Sentiment Word Frequencies in History Textbooks: Sentiment Types. (occurrences/ 1000 words)

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