A German Corpus of Reflective Sentences

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Abstract

Reflection about a learning process is beneficial to students in higher education (Bubnys, 2019). The importance of machine understanding of reflective texts grows as applications supporting students become more widespread. Nevertheless, due to the sensitive content, there is no public corpus available yet for the classification of text reflectiveness. We provide the first open-access corpus of reflective student essays in German. We collected essays from three different disciplines (Software Development, Ethics of Artificial Intelligence and Teacher Training). We annotated the corpus at sentence level with binary reflective/non-reflective labels, using an iterative annotation process with linguistic and didactic specialists, mapping the reflective components found in the data to existing schemes and complementing them. We propose and evaluate linguistic features of reflectiveness and analyse their distribution within the resulted sentences according to their labels. Our contribution constitutes the first open-access corpus to help the community towards a unified approach for reflection detection.

1 Introduction

Consciously experienced and reflected practice is a prerequisite for professionalization (Donald, 1983). For pre-service teachers, reflection is crucial because it belongs to the core competencies of prospective teachers (Combe and Kolbe, 2004; Hänsel, 1996; Shandomo, 2010). In literature, several types of reflection can be found. Core reflection deals with the core of one's personality: mission and identity (Korthagen and Vasalos, 2005), while self-reflection refers to thinking about one's own behaviour, actions, thoughts or attitudes (Bubnys, 2019). The reflection process can be either guided using prompts to indicate the structure of the reflection (Allas et al., 2020), or free, where

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* indicates equal contribution.

the reflection process follows no given structure (Sturgill and Motley, 2014). In our corpus, we mainly focus on guided self-reflection.

Educational staff must assess students' reflection texts, yet this is a non-trivial and time-consuming task. Machine learning methods can provide possibilities to create such applications. However, the first step towards this is identifying whether reflection is present in a text or not. Collections of student essays in machine-readable formats have been created for the last two decades for various machine learning tasks, such as automated essay scoring (Foltz et al., 1999), argumentation mining (Wang et al., 2020), reflection detection and automated feedback (Wulff et al., 2020). However, to the best of our knowledge, there is no open-source corpus of reflective essays currently available. The reason, in our opinion, lies in the challenges that this kind of data brings. From an ethical point of view, these data are sensitive, since they can be highly personal. In addition, essays are usually collected in an educational setting, and it might be against regulations to publish them. Furthermore, inspiring students to reflect is difficult. As a literature review shows, students mostly write descriptive sentences when journaling (Dyment and O'connell, 2010).

We thus contribute a publicly available, balanced text corpus of reflective and descriptive sentences from students of various universities and disciplines as the first step towards a benchmark for reflection detection in texts. For this, we collected essays from three different sources and anonymized them. We then pre-processed texts into sentences and added manual sentence level annotations according to a synthesised taxonomy, engaging professional linguists and didactic specialists to refine our criteria. We present our quantitative and qualitative linguistic analysis of the resulted corpus. The link to our data can be found in Appendix A.
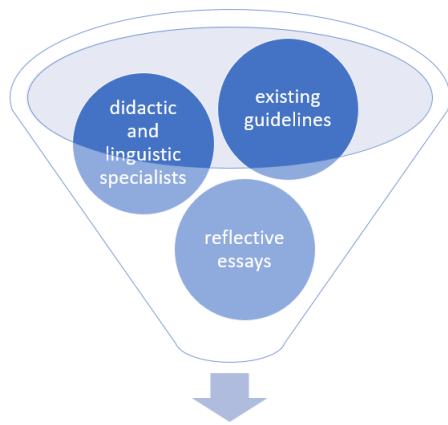
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Figure 1: The main components of our approach.

2 Related Work

In the context of the multi-genre essay collection, significant works include the British Academic Written English (BAWE) (Nesi and Gardner, 2012, 2013), the Uppsala Student English Corpus (USE) (Axelsson and Berglund, 2002), and the Michigan Corpus of Upper-Level Student Papers (MICUSP) (Römer and Swales, 2010). Several efforts were undertaken to create a specialized reflective corpus of students essays at sentence level, namely in pre-service and early teachers settings (Wulff et al., 2020; Murphy, 2015) or medical students and personnel (Liu et al., 2019a; Olex et al., 2020). For the didactic case specifically, there has been increasing work in automated detection of reflective sentences in the didactic context (Geden et al., 2021; Jung and Wise, 2020; Liu et al., 2019c; Wulff et al., 2020; Ullmann, 2019, 2017, 2015). However, none of the used corpora are publicly available.

3 Data Collection

We collected essays of different lengths in both English and German from students and pre-service teachers. We used the sentence segmenter of SpaCy (Honnibal et al., 2020) to obtain a total of 4232 sentences. During the annotation process, we performed manual anonymization, eliminated all the occurring personal information, including mentioned social media accounts, as well as student and teaching staff names. We describe below how data from the individual sources were collected. For more details on the segmentation, anonymization, and consent processes, see Appendix A.

Dundee teaching placement essays   With the agreement of the University of Dundee, we scraped 122 reflective essays in English written by students in teacher training during their placements in primary and secondary school in 2018. The students had to upload their essays in the form of an e-Portfolio on Glow Blogs[1], a provider of WordPress tools used by the Scottish educational centers. The data reflect their impressions of the Scottish educational system in general and school approaches in particular, the acquired skills, their background, role models, insecurities, and motivations to become a teacher.

We translated the essays into German using DeepL[2] and manually corrected conflicting translations that occurred due to inconsistent formatting. After segmentation into simple sentences, we obtained a total of 3595 sentences.

Ethics of AI and Software development   Using a questionnaire, we collected a set of guided reflective essays in German and English from students of the Free University and the Technical University of Berlin taking a Software Development project or the Ethics of AI lecture. Data was collected repeatedly at an interval of a few weeks.

The students were asked to reflect on the learning outcome since the previous collection. They were guided by a set of questions developed using Gibbs' reflective cycle (Gibbs, 1988), thus spanning the following topics: description of the action they took during their work/learning process, evaluating what they have learned and how to apply it further, what challenges they encountered, and which feelings they note. Additionally, they had to rate how their perception and their competencies of the topic changed and to describe why. After segmentation, we obtained a total of 637 sentences.

4 Annotation Guidelines

4.1 Reflection on the topic

Reflection on the topic accompanies the complex learning process and helps to integrate new knowledge into the existing one and further elaborate on it. In contrast to self-reflection, the object of reflection is part of the subject domain.

We developed our annotation criteria based on the Structure of the Observed Learning Outcome (SOLO) taxonomy (Biggs and Collis, 1982), which

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[1]https://blogs.glowscotland.org.uk/glowblogs/
[2]https://www.deepl.com/translator

was proposed to assess the quality of learning. This taxonomy allows us to identify successful criteria, as it clearly defines the reflection steps. We adapted the three last levels of the taxonomy: multistructural, relational and extended abstract level. At the multistructural level, learners understand the relationship between different aspects but it's relationship to the whole remains unclear. At the relational level, aspects of knowledge are combined to form a structure. At the extended abstract level, knowledge is generalized to build a new domain. From the multi-structural level, we adapted the 'combine' action to the following criteria: (1) putting entities into relation (e.g., part of, opposite, but not providing an example). From the relational level, we adopted several criteria: (2) criticism, (3) evaluation and comparison between methods or objects, (4) analysis (e.g., causality, purpose, contributions), (5) classification and assessment of entities. Based on the last extended abstract level, we developed the two following criteria: (6) generating and formulating hypotheses and theorizing, (7) proposal of alternative implementation (suggestions how something could have been done in a different way).

4.2 Self-reflection

To annotate self-reflection, we adapted the schemes proposed by Shum et al. (2017) and Ullmann (2017), searching for evidence of the categories proposed by the authors in our own data. If the sentence met one or more of these requirements, we annotated it as reflective.

From Ullmann (2017) we included: (1) emotions and feelings, if they were followed by the cause or description of the circumstances which provoked them; (2) strategy adaptation based on previous experience, (3) different perspectives, and (4) outcome (lessons learned, future intentions, and action plans). From Shum et al. (2017), we implemented rhetoric components and expressions denoting: (5) learning something specific, (6) experimentation and ability, (7) increased confidence or ability, (8) applying theory into practice, (9) retrospection (e.g., *'it would have helped us'*, *'I should have done it'*), (10) expressions of reflecting specifically and (11) shifts in perception and beliefs. From the intersection of both schemes we included (12) personal beliefs, assumptions, self-assessment and (13) recognition of difficulties, which we aligned with rhetoric expressions of challenge and expressions describing the unexpected to

prior assumptions.

We also introduced new categories based on our data and the didactic nature of our project: (14) rhetoric questions, (15) decisions (motives and the decision-making process), (16) motivation. We also determined conditional categories, that, similar to feelings, are annotated, taking into consideration the broader context and given reasons. These are opinions, evaluations, rendition of the words of others, generalisations, doubts (e.g., 'it seems', 'it may be'), 'even if A, not B' patterns, own interpretations of definitions, recommendations.

Contrary to Ullmann (2017) and Shum et al. (2017), we categorize descriptive sentences that describe the context of the event that triggers reflection as non-reflective. We support this decision by contrasting their linguistic feature distributions in Section 6.

5 Annotation Process

We manually annotated the collected sentences according to the synthesised guidelines presented in Section 4. If a sentence met at least one of the enumerated criteria we annotated it as reflective, even if it was a long sentence which also consisted of non-reflective components. The sub-corpora from the Software Project and Ethics of AI lectures were annotated in parallel by four annotators (the first authors and our two collaborating didactic specialists from the Friedrich-Alexander University Erlangen-Nürnberg). The initial inter-annotator agreement was low: 0.64 between first authors, 0.32 between first authors and didactic specialists, and 0.33 between the didactic specialists. Consequently, we refined our annotation guidelines and re-annotated the dataset. The Dundee sub-corpus was annotated by the first author, while the third author annotated 100 random sentences in order to verify consistency. The inter-rater agreement between the annotators was 0.66, which is considered substantial (Landis and Koch, 1977; Stemler and Tsai, 2008). Overall, we see that the annotation of reflectiveness is a problematic and tedious task, rather impossible using crowd-sourcing and requiring rounds of discussions and criteria harmonization among inter-disciplinary professionals, as also addressed by Ullmann (2019).

6 Analysis

6.1 Methodology

We investigate morphological features inspired from (Ullmann, 2015; Liu et al., 2019b; Murphy, 2015). However, we hypothesize that reflective sentences also differ in syntactic categories. Using a list of respective subordinate conjunctions and punctuation, we extracted main types of subordinate clauses and their length, e.g clause of purpose ('Within the framework of our group, we additionally met online on average once a week *to share research results and plan the next project steps.*', len=10); clause of reason ('I volunteered *because I want to learn to make better slides and I want to get better at presenting.*', len=17).

We compared the feature distribution in reflective versus non-reflective sentences. The resulted distribution of classes is balanced, with 2177 reflective and 1970 non-reflective sentences. We normalized feature counts according to the number of tokens per sentence, transforming them into frequency counts. As our features were mostly non-normally distributed, we applied non-parametric U-tests (Wilcoxon-Mann-Whitney) and multiple-test correction with Benjamini-Hochberg Procedure (N=45 tests). Since we find a large number of significant features, we further restricted our criteria. We filtered out features with medians lying on 0 (i.e., where more than 50% of the counts are 0), which is not taken into consideration by the U-test. Instead, it considers mean ranks, i.e., the arithmetic average of the positions in the list.

6.2 Results

The number of tokens in the sentence appears to be one of the most discriminating factors: reflective sentences tend to be longer, while non-reflective sentences are often nominal and/or contain short enumerations. At the same time, reflective sentences tend to be complex (with both subordinate or coordinate clauses using respective conjunctions). Relative clauses are the most frequent in reflective sentences, as they bring additional details describing the subject. Contrary to our expectations, the clauses of reason and purpose, typically used in justifications, show only a slight positive trend for reflective sentences in the Dundee sub-corpus, possibly because it often illustrates a situation and can contain descriptive causes and goals, e.g., *'We did not go outside because of the rain'*. The trend does become stronger in the self-reflection sub-corpora.

We can observe the presence of solid justification with our 'claims' feature, which checks matches with opinion words (e.g., 'standpoint', 'sure', 'convinced', 'opinion'), and 'supports', which is a collective count of subordinate clauses of reason, purpose, concession, condition and adversation. All subordinate clauses we measured are generally more present in the reflective part of the data set, and the mean length of clauses of reason and purpose is also generally longer. Concessive clauses appear to be the most numerous in this kind of texts. Reflective sentences also show higher probability of explicit coherency markers with discursive connectives (e.g., 'although', 'however').

As for the tenses used, reflective sentences are more often written using the Future tenses, while non-reflective utterances show slight preference of the Past tenses.

Our 'personalizing' marker, which shows usage of first person singular and plural of pronouns (personal, possessive and reflexive), is found to be significantly more present in reflective sentences, as also found by (Ullmann, 2015), as well as a number of adverbs, verbs and adjectives (Murphy, 2015). However, we also measured usage of the German indefinite impersonal pronoun *'man'*, which similarly to English pronoun 'one' can be considered a tool to generalize, distance the authors from the opinion they express, and make it less personal (hence, 'distancing' feature). Counter-intuitively, it was also found slightly more used in reflective sentences, rather than in descriptive ones.

Interestingly, our data also shows a negative trend for lexical words in reflective sentences and a positive one for stop words, which means that reflective sentences tend to be wordier, but less informative.

High modality words (e.g. 'actually', 'categorically') strongly correlate with sentence reflectiveness, while modal verbs and subjunctive mood (German *Konjunktiv* I and II) show the same trend in all but Dundee sub-corpus. This trend discrepancies between the original German and translated English data calls for further investigation into differences between reflection articulation in different languages.

7 Conclusion

With the proposed corpus, we aim to make the first step towards a more unified approach to reflection detection. At the moment, it is not possible to

compare existing models, as there is no publicly available benchmark for this task. To address this issue, we created an open-source annotated text corpus of reflective and descriptive sentences from students of various universities and disciplines. We also provide the quantitative and qualitative analysis of the gathered data and describe the annotation procedure and quality assurance measures we took.

Our work has several limitations. Our annotators are not native German speakers, which can influence labeling. However, this will be re-visioned with later versions of the corpus, as we plan to increase the number of annotators and include native speakers. Another drawback is the automatic translation of the English data into German. While we plan to quantitatively increase our corpus with German data in the future, the Dundee sub-corpus provides a valuable addition. This way, however, it largely influence the results for language-specific features such as subjunctive mood presence, which can appear in translations, but which are still much more common to German than to modern English.

We address the low inter-annotators agreement problem with harmonization sessions and refinement of the coding scheme to ensure coverage of complicated instances. We report that with each iteration, inter-annotator agreement increased significantly. Thus, we reckon that a fruitful discussion of linguists and specialists of the field in the focus of the task, being a time-consuming process, is the only probable answer to the annotation of cognitive, subjective categories.

8 Future work

Sentence level segmentation has significant disadvantage compared to text level processing. Nevertheless, for modern classification algorithms, there is a need for an immense amount of data points. Thus, we decide to trade off context for the sake of robustness. In the future, we aim to prove the hypothesis that textual level reflection can still be reconstituted, computing an overall reflectiveness score. Finally, binary classification is only the first step, while we plan to add a more granular reflection level categories according to (Fleck and Fitzpatrick, 2010), sentiment polarity, emotions and the position of the sentence in Gibb's cycle (Gibbs, 1988). We also plan to expand the corpus with a larger number of guided reflections from different disciplines. Our overall goal is automated reflec-

tive essay analysis, which we plan to compare to the existing results by (Ullmann, 2019; Wulff et al., 2020), in order to propose an adequate level of feedback that matches the student's needs.

9 Acknowledgements

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A Data collection

The entire questionnaire, including the consent form, the code for linguistic feature annotation and the data-set divided into training and test sets for the benchmark purposes are available on OSF depository: https://osf.io/ug9r8/ and Github : https://github.com/oanaucs/german_reflective_corpus.

A.1 Guided Reflection Questions (German)

1. Bitte denken Sie an die Erfahrung die Sie während der Aufgabenlösung gemacht haben - aus Ihrer Perspektive. Wer war dabei, was haben Sie gelöst, wann und wo? Erklären Sie bitte welche Entscheidungen und warum Sie sie getroffen haben. Bitte schreiben Sie vollständige Sätze.

2. Bitte reflektieren Sie über das Gelernte durch die Aufgabenlösung. Was haben Sie gelernt? Sind Sie selbstbewusster geworden? Werden Sie das Gelernte in der Praxis anwenden? Was haben Sie vor? Was hätten Sie besser machen können? Bitte schreiben Sie vollständige Sätze.

3. Bitte denken Sie jetzt an die Schwierigkeiten die während der Aufgabenlösung aufgetaucht sind. Was waren die Herausforderungen? Ist etwas unerwartetes passiert? Haben Ihre vorherige Annahmen (z.B. Zeit für die Aufgabe) doch nicht gestimmt? Bitte schreiben Sie vollständige Sätze.

4. Erklären Sie bitte wie Ihre Wahrnehmung gegenüber das Thema verändert hat. Bitte schreiben Sie vollständige Sätze.

5. Erklären Sie bitte wie Ihre Wahrnehmung gegenüber Ihre Kompetenzen verändert hat. Bitte schreiben Sie vollständige Sätze.

6. Erklären Sie bitte wie sich während und nach der Aufgabenlösung gefühlt haben. Welche Emotionen haben Sie erlebt? Wie haben sich Ihre persönliche Überzeugungen verändert? Bitte schreiben Sie vollständige Sätze.

A.2 Guided Reflection Questions (English)

1. Please think about the experience you had while solving the task - from your perspective. Who was there, what did you solve, when and where? Please explain your decisions and why you made them. Please write complete sentences.

2. Please reflect on what you have learned through the assignment. What was new? Have you become more confident? Will you apply what you have learned in practice? What do you plan to do? What could you have done better? Please write complete sentences.

3. Please think now about the difficulties that arose during the task solution. What were the challenges? Did something unexpected happen? Were your previous assumptions (e.g., time for the task) not correct after all? Please write complete sentences.

4. Please explain how your perception towards the subject has changed. Please write complete sentences.

5. Please explain how your perception towards your competencies has changed. Please write complete sentences.

6. Please explain how you felt during the task and after solving it. What emotions did you experience? How did your personal beliefs change? Please write complete sentences.

Table 1: Linguistic features. The coloured features are the most relevant ones according to our analysis.

Feature	Effect size	P-value
Surface statistics		
Number of tokens	1389296.0	<0.001
Number of characters	2206504.0	0.273905
Stop words	1519336.0	<0.001
Lexical words	1584599.5	<0.001
Foreign words	2098738.5	<0.001
Negations	2042086.0	<0.001
Parts of Speech		
Number of adjectives	1945153.5	<0.001
Number of adverbs	1946744.0	<0.001
Number of prepositions	2188743.0	0.1456593
Number of demonstratives	2020975.0	<0.001
Number of numerals	2133089.5	1E-07
Number of proper nouns	2041038.0	<0.001
Number of nouns	1823595.5	<0.001
Number of pronouns	1677706.0	<0.001
Number of verbs	1754766.0	<0.001
Subordinate clauses		
Purpose	2133162.5	1.3e-06
Length of purpose	2143140.0	8.6e-06
Reason	1961005.5	<0.001
Length of reason	2084323.0	<0.001
Condition	2080748.5	<0.001
Consecutive	2225781.0	0.2218441
Temporal	2194652.5	0.0291472
Modal	2200269.5	0.0009057
Relative	2069188.5	3E-07
Consession	2187280.5	1.28e-05
Adversation	2226559.0	0.2559304
General Syntax		
Coordination conjunctions	1825060.5	<0.001
Subordination conjunctions	1631024.0	<0.001
Complex sentences	1644350.0	<0.001
Simple sentences	1868503.5	<0.001
Moods		
Modal verbs	2134704.0	<0.001
Subjunctive	1995376.5	<0.001
High modality words	1906942.0	<0.001
Patterns		
I+ finite verb	2006681.5	<0.001
To be + adjective	1968976.5	<0.001
Justification words		
Claims	1909487.0	<0.001
Supports	1800356.5	<0.001
Miscellaneous		
Discourse markers	1952871.0	<0.001
Personalizing	1687035.5	<0.001
Distansing	2181423.0	0.0001956
Tenses		
Present	2108015.5	0.0003568
Future	2175966.0	1.06e-05
Past	2138633.0	0.0051358