Predicting the Structural Parts of the Plot on Elementary School Written Essays

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Abstract. Essay writing is an essential task throughout all life stages. In the final years of elementary education, classes are dedicated to narrative text production, requiring students to develop and organize their ideas and thoughts in a logical sequence. The process of correcting and identifying the structural elements of the narrative plot in texts is a routine task for educators, which generates an overload and hampers the implementation of a formative, unbiased assessment that supports the enhancement of students' writing skills. Providing automatic identification of the structural elements of the narrative plot, considering this educational stage and the Brazilian Portuguese language, is an underexplored issue in the field of natural language processing. The aim of this research is to analyze the performance of predicting the structural elements of the narrative plot in narrative text productions of Brazilian elementary school students. The experimental research includes a corpus of 3099 narrative sentences obtained and annotated through the formative assessment project of the Brazil in School program of the Ministry of Education.

Keywords: Natural Language Processing · Narrative Essays · Learning Analytics

1 Motivation for Research

Despite playing a crucial role in both personal and professional advancement, effective writing instruction faces significant challenges, such as the lack of specific and constructive feedback for students, the limitation of time dedicated to instruction, and the insufficiency of adequate resources for writing practice [8]. On the other hand, factors that have been shown to facilitate this process include collaboration among teachers, the adoption of innovative teaching strategies, and access to technological resources [1]. Therefore, research identifying the elements that foster or hinder writing instruction is of utmost relevance. Such knowledge not only enables the improvement of writing instruction approaches but also provides a deeper understanding of the reasons why writing instruction can be, at present, effective or ineffective [8].

A. M. Olney et al. (Eds.): AIED 2024 Workshops, CCIS 2151, pp. 342–347, 2024.
https://doi.org/10.1007/978-3-031-64312-5_41

Textual production requires students to organize and integrate various ideas, being widely considered as the most appropriate way to assess educational skills and competencies in writing [20]. In the Brazilian context, it is evident that the development of writing ability among students represents an ongoing challenge. This is reflected in the reality of various basic education schools, which, in many cases, have faced difficulties in effectively stimulating the writing capacity of both elementary and high school students. This difficulty has been evident in the results of large-scale assessments in recent years [15].

Essay writing is a type of textual production, which represents a common practice in educational institutions to assess students' writing skills, requiring a well-defined structure [9]. In the classroom environment, essay writing plays a crucial role as a tool to assess the outcomes of learning in writing, guide the educational process, and measure student progress [26]. Despite its widespread application in education, manual essay grading is a costly activity that demands considerable time from teachers [4,10,12]. During the process of large-scale grading, it is common for teachers to face challenges in maintaining a rigorous level in the evaluation of texts [3,8]. The associated cost, reliability, and evaluator subjectivity are, furthermore, factors that limit the efficiency of manual grading of textual productions [15].

The narrative text type is utilized in the production of various textual genres in elementary education, unlike in high school, where students develop expository-argumentative text productions [19]. The narrative text type includes elements such as narrator, plot, characters, time, and space. It fosters the student's ability to "construct knowledge of the world, of the text-producing subject themselves, and, consequently, of verbal language, which can be of great educational value" [19]. Such narrative elements are essential to characterize the text as narrative, and this requires teachers to analyze textual productions to identify them and provide useful feedback to students on what is missing and what needs to be improved, offering personalized teaching.

Personalized teaching has gained momentum in recent years, especially during the period of remote education, which facilitated the generation of data in the educational context due to the massive adoption of digital tools in school environments [6]. The data generated from student interactions with digital tools can be used to monitor, analyze, predict, intervene, recommend, and, most importantly, improve the quality of the teaching and learning process through LALearning Analytics techniques [23]. In this context, Natural Language Processing (NLP) is a subfield of artificial intelligence that uses computational techniques to analyze a language, whether spoken or written, in digital format [2]. There have been applications of NLP techniques for automatic essay scoring in the context of basic education, which assist teachers in providing more assertive, effective, and timely feedback for writing improvement, allowing the teacher to use their pedagogical time focused on devising strategies to address the most recurrent writing difficulties of students [17].

2 Research Question

The narrative plot, a central element in the teaching of textual production in the context of Brazilian basic education, is traditionally divided into three structuring parts: introduction, complication, and resolution. The "introduction" establishes the setting, introducing the characters and the context, and is essential for engaging the reader from the beginning of the narrative [5]. These structuring parts of the plot are fundamental for the development of students' narrative writing skills, allowing them to express complex and creative ideas in a clear and coherent manner. Understanding and effectively applying these structures are essential for the development of students' narrative writing skills, contributing to the enhancement of their literary competences and effective communication. Studies in education emphasize the importance of narrative in learning, highlighting how the practice of narrative writing can improve critical thinking and personal expression of students [24].

Identifying the structuring parts of a narrative plot in educational texts through Automated Essay Scoring techniques represents a significant challenge, especially when considering the complexity and variety of elements that compose a narrative [21]. In this context, multi-label classification emerges as a promising approach, capable of dealing with the multifaceted nature of narrative texts [25]. Faced with a challenging and still underexplored scenario in scientific research, this study aims to evaluate narrative essays employing Machine Learning models with a multi-label classification strategy. The research is conducted with the goal of answering the following question: How to automate the process of detecting the structuring parts of the plot through the analysis of sentences from narrative essays of elementary school students?

3 Research Methodology

This section describes the methodology that will be conducted to analyze the performance of automation in detecting the structuring parts of the narrative plot in textual productions, using different Machine Learning models applying multi-label classification. To achieve the proposed objectives, the research will have a quantitative approach, classifying itself, in terms of its nature, as experimental. This study is characterized as applied research, given that it focuses on the practical application of theoretical knowledge to enhance the automatic evaluation of plots in narrative essays [7,14].

In terms of procedures, the research adopts both bibliographic and experimental approaches. The bibliographic approach is used to build a solid foundation of theoretical knowledge by reviewing existing literature on automatic text evaluation, multi-label classification, and natural language processing. On the other hand, the experimental approach is employed to test hypotheses and validate the efficacy of the proposed multi-label classification models [13]. Together, these methods provide a comprehensive and detailed understanding of the problem under study, allowing not only to describe and explore the phenomenon but also to apply and test solutions in the field of educational assessment.

The methodology employed in this study follows these steps: (i) Annotated dataset: a procedure conducted by two annotators where disagreements were resolved by a third, more experienced annotator; Sentences: division of essays into sentences for classification of the structuring parts of the plot; Structuring parts of the plot: definition of the presence or absence of each structuring part of the plot in each sentence separately; Feature extraction: extraction of features that will be used for training the models; Model training: the process of selection, training, and testing of machine learning models on sentences from narrative essays; Analysis of results: evaluation of the models and multi-label approaches selected. All stages have been executed, and preliminary results have been obtained.

4 Initial Results and Expected Contributions

In this section, we present the preliminary results of this study, whose goal is to automate the identification of the structuring parts of the plot in narrative essays by students in the final years of Brazilian elementary education. This effort aims to assist the evaluation process of teachers, using machine learning models in the context of learning analytics. The experiments employed various Machine Learning (ML) models on a corpus of narrative texts from 6th to 9th-grade students in Brazilian schools. These models were applied using a multi-label classification strategy.

The investigation carried out in this research focused on the applicability of different Machine Learning (ML) models, emphasizing multi-label classification algorithms. One of the findings is the superior performance of the Label Powerset (LP) with XGBoost (XGB) and Linguistic Inquiry and Word Count (LP-XGB-LIWC) model, which stands out significantly in the context of analyzing the detection of the structuring parts of the plot in narrative texts. When compared to other models, it shows superior performance, as evidenced by higher scores in key metrics, such as Micro-F1 and Subset Accuracy (SA), with scores of 0.742 and 0.681, respectively, as well as a Macro-F1 of 0.509 and a Hamming Loss of 0.181. This performance indicates the model's remarkable ability to accurately classify narrative text sentences according to parts of the plot, which are critical for understanding the narrative.

Recent studies have demonstrated the importance of computational analysis of narratives [16,18,21], thereby showing that narrative productions of elementary school students can benefit from this trend, where it aids teachers in more standardized corrections with less bias due to fatigue or lack of standardization. This assistance process is not limited to objectivity in evaluation but extends to enriching the educational experience of students, providing a technological solution that can enhance the understanding of key elements of narratives [11]. Through automation, it is possible to identify patterns and structures in essays that might go unnoticed in human evaluation, offering valuable educational insights and promoting a more holistic approach to teaching writing [22].

Regarding contributions, this study aims to contribute both socially and academically. Social Contribution: will be demonstrated by its ability to implement concrete improvements for the Brazilian teaching community. This will be achieved through the development of an innovative methodology for the automated correction of narrative essays, facilitating the evaluation of texts by teachers in the final years of elementary education. Such an approach aims to decrease the teaching workload, reducing the time and costs associated with the evaluation process. Moreover, the adoption of this methodology will contribute to enhancing the quality of students' textual production, acting as an unbiased and impartial assessment tool. The practical relevance of this research will be evidenced through experiments in formative writing assessments, conducted in schools participating in the Brazil School Program of the Ministry of Education (MEC), demonstrating its positive impact and applicability. Academic Contribution: This study aims to enrich the understanding of narrative essay assessment, especially through the implementation of multi-label classification models. The mentioned methodology promotes a more effective identification of the distinctive characteristics present in each structuring segment of the plot in students' textual productions. Such an approach allows for a more detailed and comprehensive evaluation of the plot as a whole. Thus, the experimental research contributes to the corpus of studies dedicated to this theme, expanding the scope of knowledge in the field of automated essay scoring and providing valuable insights for future educational applications.

References

1. Ahumada, S., Bañales, G., Graham, S., Torres, M.L.: Facilitators and barriers to writing instruction in Chile: teachers' preparation and knowledge about teaching writing. Read. Writ. **36**, 1867–1899 (2023)
2. Alhawiti, K.M.: Natural language processing and its use in education. Int. J. Adv. Comput. Sci. Appl. **5**(12) (2014)
3. de Ávila, R.L., Soares, J.M.: Uso de técnicas de pré-processamento textual e algoritmos de comparação como suporte à correção de questões dissertativas: experimentos, análises e contribuições. In: Brazilian Symposium on Computers in Education (Simpósio Brasileiro de Informática na Educação-SBIE), vol. 24, p. 727 (2013)
4. Correnti, R., Matsumura, L.C., Wang, E., Litman, D., Rahimi, Z., Kisa, Z.: Automated scoring of students' use of text evidence in writing. Read. Res. Q. **55**(3), 493–520 (2020)
5. Elliott, J.: Using narrative in social research: qualitative and quantitative approaches. In: Using Narrative in Social Research, pp. 1–232 (2005)
6. Gaftandzhieva, S., Docheva, M., Doneva, R.: A comprehensive approach to learning analytics in Bulgarian school education. Educ. Inf. Technol. **26**(1), 145–163 (2021)
7. Gil, A.C.: Como elaborar projetos de pesquisa. Atlas, São Paulo (2002)
8. Graham, S.: Changing how writing is taught. Rev. Res. Educ. **43**(1), 277–303 (2019)
9. Graham, S., Perin, D.: Writing next-effective strategies to improve writing of adolescents in middle and high schools (2007)
10. Hussein, M.A., Hassan, H., Nassef, M.: Automated language essay scoring systems: a literature review. PeerJ Comput. Sci. **5**, e208 (2019)

11. Jones, S., Fox, C., Gillam, S., Gillam, R.B.: An exploration of automated narrative analysis via machine learning. PLoS ONE **14**(10), e0224634 (2019)
12. Ke, Z., Ng, V.: Automated essay scoring: a survey of the state of the art. In: IJCAI, vol. 19, pp. 6300–6308 (2019)
13. Kerlinger, F.N., Lee, H.B.: Foundations of Behavioral Research. Harcourt College Publishers (2000)
14. Marconi, M.A., Lakatos, E.M.: Fundamentos de metodologia científica, 5th edn. Atlas, São Paulo (2003)
15. Passero, G., Ferreira, R., Dazzi, R.L.S.: Off-topic essay detection: a comparative study on the Portuguese language. Revista Brasileira de Informática na Educação **27**(03), 177–190 (2019). https://doi.org/10.5753/rbie.2019.27.03.177
16. Piper, A.: Computational narrative understanding: a big picture analysis. In: Proceedings of the Big Picture Workshop, pp. 28–39 (2023)
17. Ramesh, D., Sanampudi, S.K.: An automated essay scoring systems: a systematic literature review. Artif. Intell. Rev. **55**(3), 2495–2527 (2022)
18. Ranade, P., Dey, S., Joshi, A., Finin, T.: Computational understanding of narratives: a survey. IEEE Access **10**, 101575–101594 (2022)
19. Rezende, N.L., de Souza, M.C.: Do ensino escolar da escrita de textos narrativos. Linha D'Água **31**(2), 143–158 (2018)
20. Rodrigues, F., Oliveira, P.: A system for formative assessment and monitoring of students' progress. Comput. Educ. **76**, 30–41 (2014)
21. Santana, B., Campos, R., Amorim, E., Jorge, A., Silvano, P., Nunes, S.: A survey on narrative extraction from textual data. Artif. Intell. Rev. **56**(8), 8393–8435 (2023)
22. da Silva Filho, M.W., et al.: Automated formal register scoring of student narrative essays written in Portuguese. In: Anais do II Workshop de Aplicações Práticas de Learning Analytics em Instituições de Ensino no Brasil, pp. 1–11. SBC (2023)
23. de Sousa, E.B., Alexandre, B., Ferreira Mello, R., Pontual Falcão, T., Vesin, B., Gašević, D.: Applications of learning analytics in high schools: a systematic literature review. Front. Artif. Intell. **4**, 737891 (2021)
24. Toolan, M.J.: Narrative: A Critical Linguistic Introduction. Routledge (2013)
25. Unal, F.Z., Guzel, M.S., Bostanci, E., Acici, K., Asuroglu, T.: Multilabel genre prediction using deep-learning frameworks. Appl. Sci. **13**(15), 8665 (2023)
26. Zupanc, K., Bosnić, Z.: Automated essay evaluation with semantic analysis. Knowl.-Based Syst. **120**, 118–132 (2017)