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ReadME – A System for Automated Writing Evaluation and Learning Management

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Abstract. Writing is an essential skill in the digital era, whether we are referring to essays, books, discourses, emails, or newsletters. Writing transcends individual words or sentences, and it considers the structuring of ideas and their presentation in a coherent manner. Document writing may involve an additional contributor besides the writer who produces the text, namely an evaluator whose task is to provide feedback for improvement. However, both authors and evaluators can experience anxiety in performing their tasks. Similarly, tutors may have limited time to perform in-depth writing assessments of their students' productions. The system presented in this paper – ReadME – aids both by providing automated methods for writers to evaluate their texts and improve them based on several layers of personalized suggestions. Moreover, evaluators have access to an automated evaluation and scoring mechanism performed by our system, thus being able to provide feedback in a timely manner. Advanced Natural Language Processing techniques are employed, designed currently to process texts written in Romanian and English languages.

Keywords: Essay Writing, Text Analysis, Automated Writing Evaluation, Learning Management System, Natural Language Processing.

1. Introduction

Writing is compulsory in a society driven by communication and moving towards the online environment. Looking over the world-wide school system with emphasis on the Romanian educational context, it is easily noticeable that the focus on teaching students how to write coherent and well-formatted

texts is quite limited. The school system still relies on traditional learning techniques, such as such as repetition, memorizing, or taking notes (Thornbury, 2006) and has yet to complete the transition to a research-oriented system, as stated in the Bologna Declaration of 2002 (Dascălu, 2011). Newly designed curricula encourage students to write more, to present their ideas in a structured fashion, and to bring evidence to support their opinions through argumentative essays. However, students are prone to have low writing motivation, writing anxiety, and poor performance on writing exams due to high expectations, with minimum to no training, (Martinez, Kock, & Cass, 2011).

From the tutor perspective, teachers or evaluators are expected to write comprehensive feedback for each graded essay, and even to suggest improvements to papers, together with additional information sources. Similar to their counterparts, they are overwhelmed by the amount of work and focus on singular paper requires. In Romania, a teacher is assigned, on average, a number of 15 students in accordance to a statistical report performed by EUROSTAT (Apostu et al., 2015).

Therefore, both students and tutors require tools to help them cope with the massive amount of information. Students need applications that teach them what are the most important elements to bear in mind while structuring and writing an essay, give feedback on their writing, proofread the text, track their writing and even more. Second, teachers require applications that grade written texts, highlight mistakes and correct grammar. Some of these requirements are already targeted by existing online applications and only few of them contain features for both teachers and students.

The next section describes the most important features to consider in automated writing evaluation, together with examples of applications that are available on the market. Section three presents an overview of key features of a Learning Management Systems (LMS). Section four details our ReadME application (Botarleanu, Dascalu, Sirbu, Crossley, & Trausan-Matu, 2018; Sirbu, Botarleanu, Dascalu, Crossley, & Trausan-Matu, 2018; Sirbu et al., 2018), designed to evaluate written texts and provide feedback regarding potential errors and writing style recommendations. It also argues the application's capabilities to be considered an Automated Writing Evaluation (AWE) system, but also a Learning Management System.

2. Automated Writing Evaluation Systems

AWE programs are developed to check and evaluate written texts (Grimes & Warschauer, 2010). They consist of two central parts, a scoring and a feedback generation component. The first AWE system was developed by Page (1966) and it evaluated essays in terms of surface features, such as: number of words, average sentence and word length, standard deviation of word length, number of commas etc. Nowadays these systems analyze the writing in terms of lexical, syntactic, discourse and grammar levels, and provide feedback and correction suggestions (Hockly, 2018). Afterwards, users review the feedback and incorporate it into the rewritten text. This process is iterative and usually requires more than one iteration in order to obtain the desired outcomes.

The benefits of such systems are obvious as the automated grading is considerably faster and less time consuming that using human evaluators. Feedback is received almost instantly, and multiple versions can be submitted for follow-up checks. However, the entire process lacks the social and interactive component, where tutors explain the feedback to students in a tailored fashion. In addition, Hamp-Lyons and Lockwood (2015) and Smith (2018) raise valid concerns. In the first publication, authors argue that AWEs can limit or misinterpret students' critical thinking, rhetorical knowledge, creativity, or their ability to adapt a text to a focus group. The second study states that students can learn to trick the system and write nonsense essays that score high points in AWE systems.

2.1. Grammarly

Grammarly (http://grammarly.com/; see Figure 1) is an online writing assistant that evaluates texts in terms of spelling, grammar and punctuation. It is one of the most well-known applications currently available, even though it was recently launched in 2016. It provides extensive feedback, together with corrections, enabling users to write clear and mistake-free texts (Nova, 2018). Grammarly also checks against plagiarism and, if it identifies a piece of text that is available in other documents, it suggests different citation possibilities.

A lightweight version of Grammarly is free to use, but to access all its features, users need to upgrade to the premium paid version. Grammarly

Premium identifies errors triggered by 250 grammar rules (ONeill & Russell, 2019). The total number of identified errors is higher, included in the following categories: contextual spelling (e.g., misspelled words, confused words), grammar (e.g., incorrect noun number), punctuation (e.g., comma missing), sentence structure (e.g., incomplete sentences), style (e.g., improper formatting), as well as potential vocabulary enhancements. The application is available only for English language.

Figure 1. Grammarly corrections (https://www.grammarly.com/blog/eliminating-eggcorns/).

2.2. e-Rater

e-Rater (Burstein, Chodorow, & Leacock, 2004) is an automated scoring environment system developed starting from 1999. It evaluates essays by extracting a set of features which reflect various aspects of written text. These features correspond to the items human readers consider important when awarding scores. The scoring features are afterwards combined in a statistical model that produces the final grade of the essay. Each feature has a different weight in the overall score, determined statistically in order to maximize the agreement with the human scoring. The engine supports a default feature weighting, or a custom one in which one or more features can be dominant. The most important features included in this engine are:

- Grammar – e.g., errors related to pronouns, missing possessives;
- Mechanics – e.g., errors related to punctuation, commas, hyphens;
- Style – e.g., errors related to word repetitions, inappropriate words;
- Usage – e.g., errors related to in missing or wrong articles, nonstandard verbs;
- Organization and development – statistics regarding the number of discourse units;

- Word choice – word frequency;
- Word length – average word length in the text;
- Positive features – correct use of collocations and prepositions.

The system was initially developed to score the GMAT essays automatically. The score provided by e-rater matched to a proportion of 87 – 94% the score given by a human validator. Moreover, to underline the importance of coherence and cohesion in regard to the textual complexity on one's essays, e-rater implements the centering theory model introduced by Grosz, Weinstein, and Joshi (1995).

Based on e-Rater, the ScoreItNow! Online Writing Practice (Nagano) tool has been developed to help students prepare for the Analytical Writing section of the GRE General Test (see Figure 2).

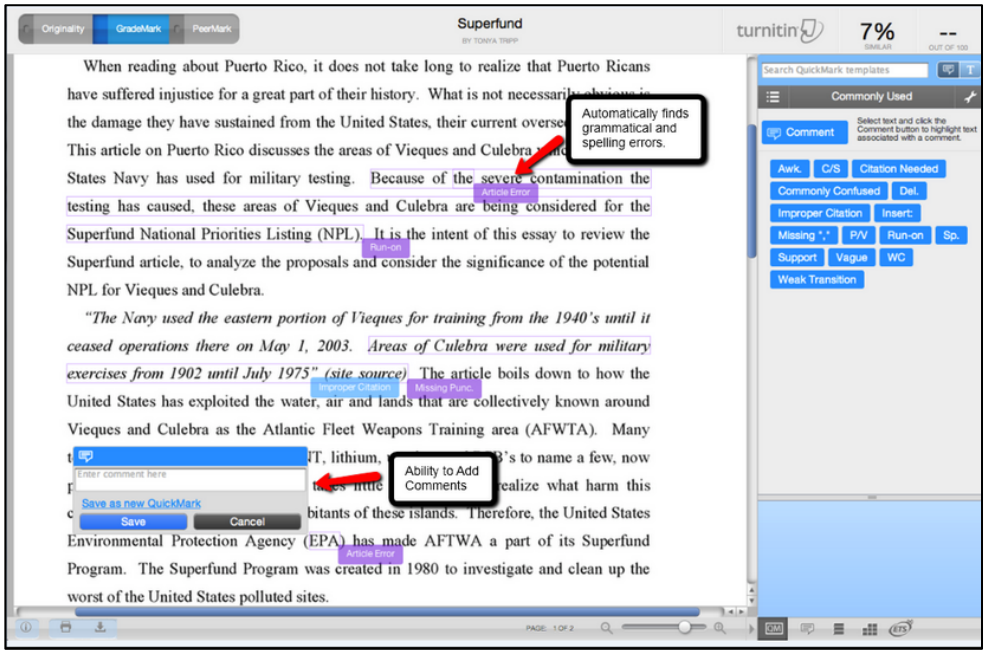

Figure 2. ScoreItNow! Online Writing Practice Interface (https://dxrgroup.com/scoreitnow/demo).

2.3. My Access! and My Editor

MY Access! (Elliot & Mikulas, 2004) (http://www.vantagelearning.com/products/my-access-school-edition/) is a web-based tool that evaluates essays

in terms of semantics, syntactics and discourse. It was used in schools across the United States of America to analyze essays and compare the results with essays scored by humans. The application scores the essays on a 1-6 or 1-4 scale. Besides automated scoring and feedback, MY Access! offers model essays, scoring rubrics, graphic organizers, dictionaries, and thesauri. It also generates progress reports for students and teachers indicating individual and group scores. This application comes hand in hand with My Editor, which provides spelling, grammar and word usage corrections and suggestions.

3. Learning Management Systems

Learning Management Systems are software applications used to administrate, track, and deliver educational content, such as educational courses, trainings, or development programs (Weaver, Spratt, & Nair, 2008). The most important functions of an LMS are represented in Figure 3.

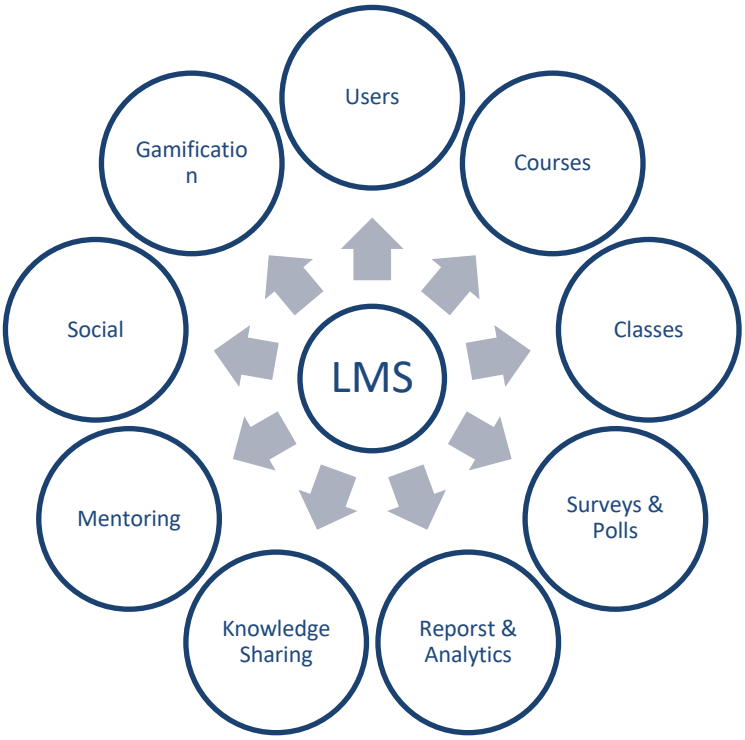

Figure 3. Features of a Learning Management System.

An LMS supports multiple categories of users and types of roles, thus granting restrictive access to the functionalities and resources provided by the system. The most important types of users are students and teachers, but the list can be extended with parents, visitors, administrators, etc. The role of a teacher is to add content (text, images, links etc.), control what information students can access, manage courses, enroll students to courses, provide homework and assignments to students, track students' progress, and provide feedback to them. Students can access the information provided by the teacher submit homework, track their progress and leave feedback for the teacher.

According to a study published online by FinancesOnline (https://financesonline.com), the top three LMS services of 2019 are Talent LMS (http://www.talentlms.com), SAP Litmos LMS (https://www.litmos.com), and Docebo (https://www.docebo.com/). These systems are presented in the following sub-sections, together with Moodle LMS (https://moodle.com), one of the most frequently used open-source alternative.

3.1. Talent LMS

Talent LMS is an online cloud-based software used mostly in enterprises to train and inform employees, partners, and customers (see Figure 4).

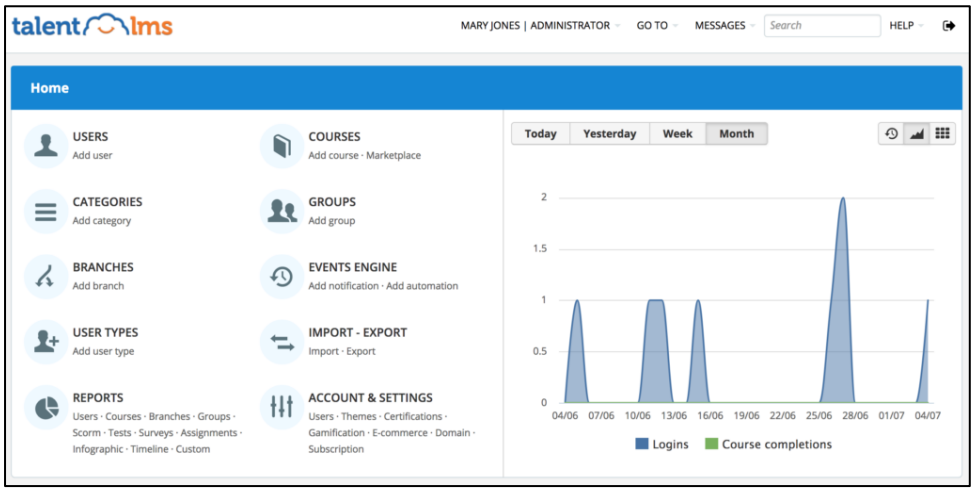

Figure 4. Talent LMS (http://www.talentlms.com).

It can easily be applied to different domains such as healthcare, aviation, call center, automotive, or education in general. The engine offers content loading (e.g. presentations, videos), blended learning (e.g., combining online courses with live presentations), different learning paths (i.e., restrictions on the way courses can be completed), gamification (e.g., earning badges, points, levels), certifications, surveys, e-commerce, user management and reporting. Talent LMS has various subscription plans, including a free one for five users and ten courses.

3.2. SAP Litmos LMS

SAP Litmos LMS is a simple and easy to use system suitable for smaller groups of up to 100 users. It is designed for trainers, managers and instructors, and offers features such as: content creation tools, live courses, custom branding, surveys, assessments, quizzes, real-time reporting, gamification and e-commerce shopping cart. SAP Litmos LMS offers a tree trial and subscriptions per month according to the number of users (see Figure 5).

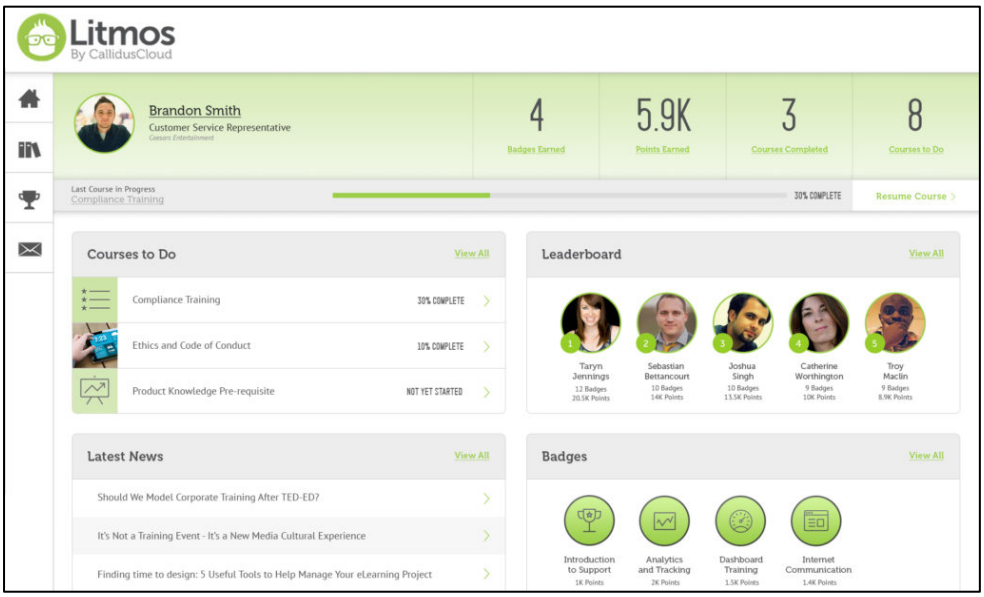

Figure 5. SAP Litmos LMS interface (https://www.litmos.com).

3.3. Docebo

Docebo is a SaaS e-learning system that uses Artificial Intelligence to tag and

analyze content in order to understand who will benefit most from it, followed up by enrolment suggestions to administrators and managers. The application (see Figure 6) offers the following key features: courses catalog, enrollment rules, learning plans, external trainings, coaching, audit trails, notifications, user management, gamification, and e-commerce solutions. The software gives a free trial and different subscription plans based on the acquired modules.

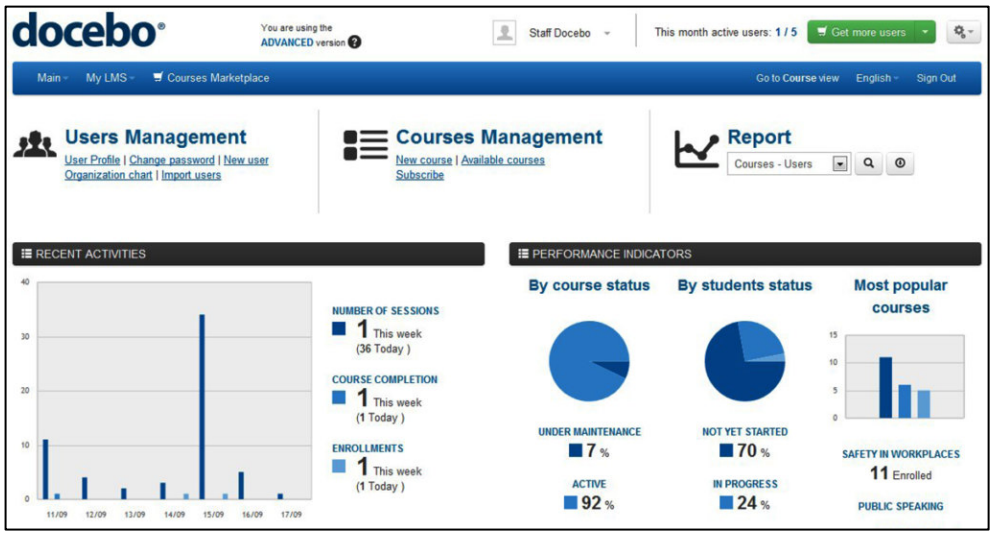

Figure 6. Docebo LMS (https://www.docebo.com/).

3.4. Moodle LMS

Moodle LMs (see Figure 7) is an open source learning platform that supports three types of accounts: teachers, students, and administrators. It offers course creation functionalities, peer- and self- assessments, file management, multimedia integration, calendar, notifications with custom alerts, reporting and logging, user management, as well as multilingual capabilities. Moodle includes a free version, together with additional payment plans for more functionalities, such as document converter, automated backups and extra plugin packs.

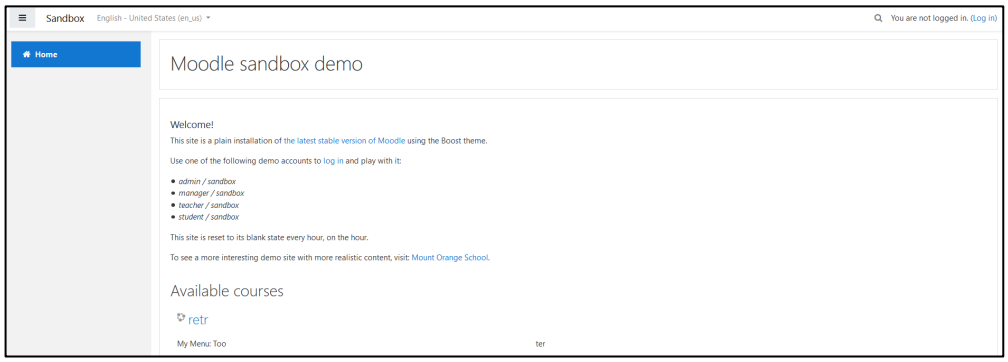

Figure 7. Moodle LMS (https://sandbox.moodledemo.net/)

4. ReadME

As previously seen from the descriptions of existing applications, most solutions evaluate texts written only in English; therefore, the need for other language support emerges. Moreover, the applications do not offer services suited for both teachers and students. Usually, they provide the analysis and feedback generation parts, and use a third-party application to integrated management features. ReadME (see Figure 8) is an interactive online application designed to support both Romanian and English languages, and incorporates the features of both AWE and LMS systems. ReadME exposes two flows. A student (trainee) flow, which automatically evaluates written texts and provides personalized feedback and scoring, together with a teacher (mentor) flow which delivers educational content and tracks user progress.

ReadME is designed to increase the quality of the learning process by improving user's writing style. Written texts can consist of homework or classroom tests in the form of essays, reviews, compositions, etc. proposed by teachers. Besides its educational purpose, ReadME can be used to improve the readability of general texts (for example online articles) by offering customized feedback.

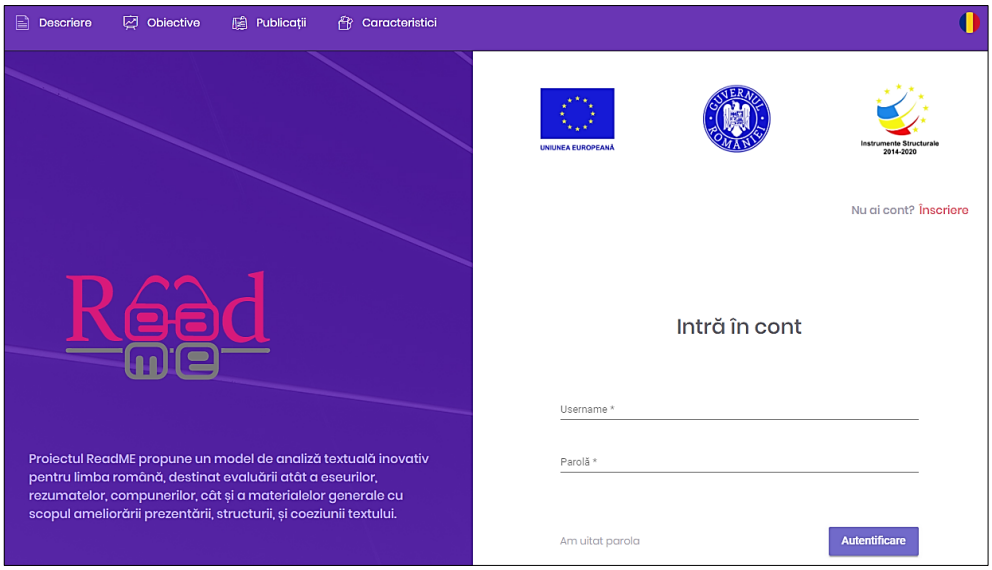

Figure 8. ReadME web application.

4.1. ReadME as AWE

ReadME is an interactive application designed to automatically evaluate written texts and provide personalized feedback and scoring. The application helps users strengthen their essay writing skills in terms of presentation, structure, and text cohesion. The feedback generation pipeline is a wizard-style graphical interface, containing the following steps for Romanian language: text input or direct file upload, diacritics restauration, morpho-syntactic analysis, and feedback generation at different granularities (see Figure 9). For the English language, the diacritics restauration is skipped as this transformation is not applicable. The first step is mandatory for the analysis, as it receives the text from the user, either by direct input, or by file upload (PDF or text files). Afterwards, language detection is performed automatically using Language Tool (https://languagetool.org), which alters the follow-up steps from the wizard.

The next step of the analysis consists of diacritics restauration (see Figure 10). In the left part of the screen the original text is shown, while the words that should contain diacritics are underlined with a red color. The righthand side contains a list of the changes automatically identified by the system. The

user can see the match between the underlined word from the right part and the corresponding correction by either clicking the word, or the correction. To accept the changes, users click on the word highlighted with purple. The interface does not contain an “accept all” button, as some of the suggestions might not match the context of the document.

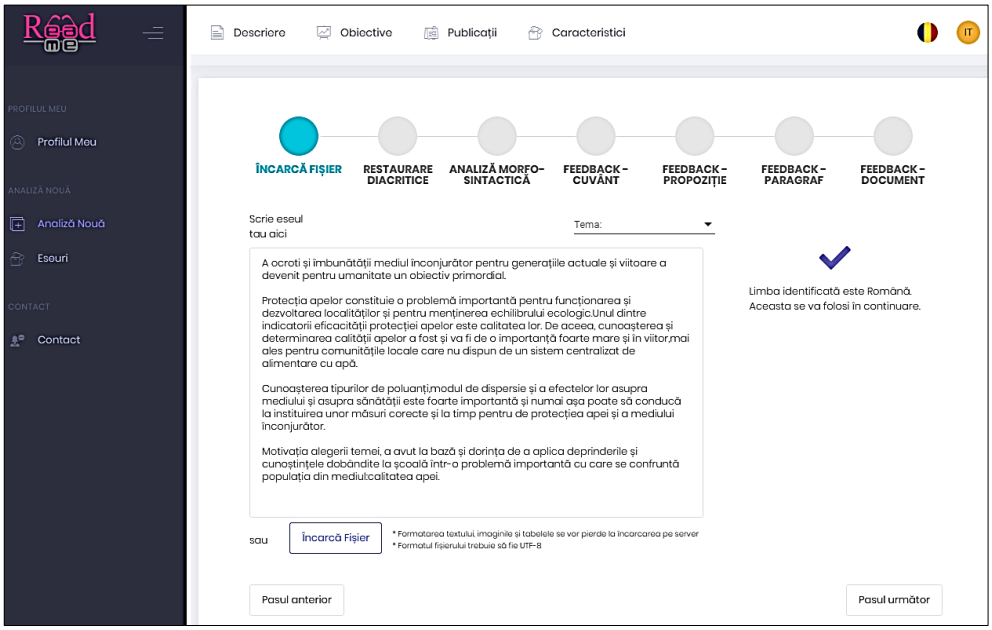

Figure 9. Processing pipeline for Romanian language.

Diacritics are extensively used in Romanian language. Statistically, 26% of all Romanian words contain at least one character with diacritics (i.e. “ă”, “â”, “î”, “ț”, “ș”) (Ruseti, Cotet, & Dascalu, 2018); this means that the words must be restored to their correct form in order to have a precise analysis of the text. The architecture of the diacritics restauration incorporates a deep neural network model composed of three paths (Ruseti, Cotet, & Dascalu, 2018) to prediction whether a character should accept diacritics, namely: fixed window of characters, current word embedding and current sentence embedding for contextual information.

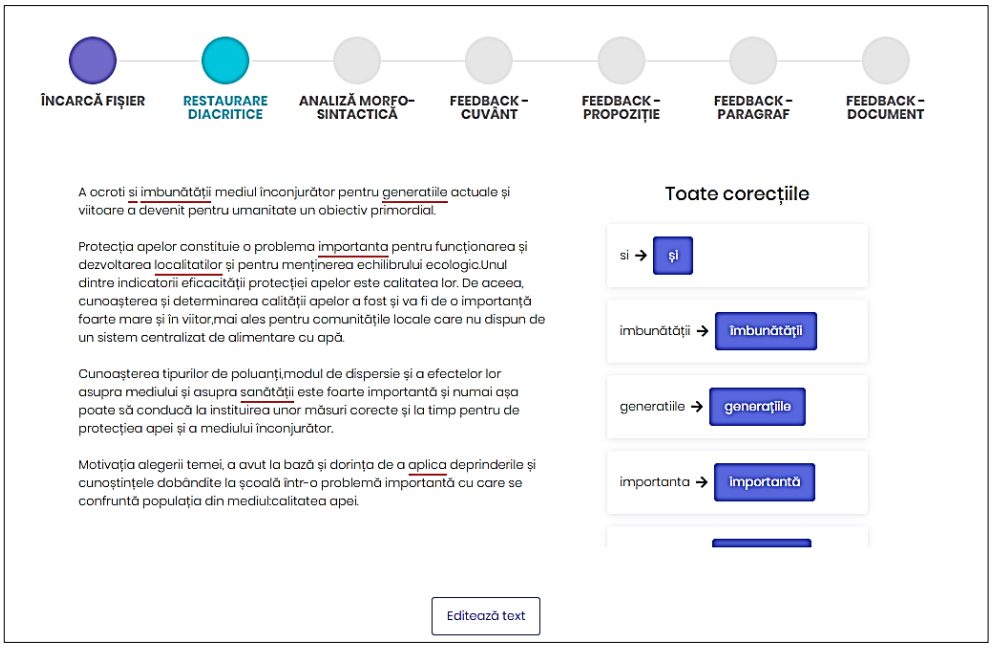

Figure 10. Diacritics restauration for Romanian language.

The next step of the flow is morpho-syntactic analysis (see Figure 11), where the following categories of errors are identified (Florea, Dascalu, Sirbu, & Trausan-Matu, 2019): dissonances, repetitions, and punctuation errors. The reference corpus for these errors was constructed starting from 226 PDF files containing different morpho-syntactic mistakes encountered in media channels, TV and radio (Florea, Dascalu, Sirbu, & Trausan-Matu, 2019).

The last step of the wizard consists of feedback generation, where the text is analyzed using the complexity indices generated by the ReaderBench framework (Dascalu, Crossley, McNamara, Dessus, & Trausan-Matu, 2018), calibrated either for Romanian language, or for English (Sirbu et al., 2018). Some examples of indices used by the ReadME system are:

- surface indices which offer statistical information about the different textual elements, as well as punctuation marks from the text;
- syntax indices which provide insights on the usage of different parts of speech or syntactic dependencies from the text;
- semantic, cohesion and discourse structure features.

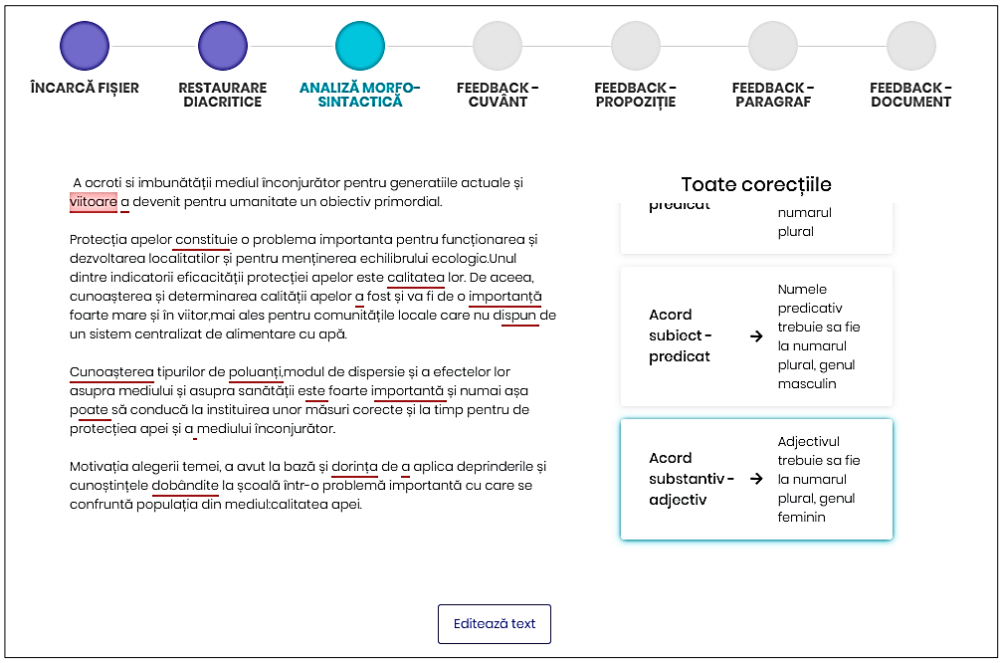

Figure 11. Morpho-syntactic analysis for Romanian language

Starting from these indices, feedback is generated using a rule-based system. The indices are either grouped into components using a PCA transformation or are used individually; for each value, minimum and maximum thresholds are set. When the text is analyzed, the values of the indices of each component are compared to those of the thresholds and, when outside the specific range for a domain, the rule is triggered. Each rule displays different messages to the user interface in order to avoid monotony. The user interface displays the feedback at four granularity levels: document, paragraph, phrase, and word.

Figure 12 presents the phrase-level feedback for a text written in Romanian. The interface is split in two parts. The left side displays the original text. Each phrase is underlined with a red color based on the severity level of the identified issues. When the user hovers over each phrase, the phrase is highlighted and, on click, the feedback suggestions are displayed on the right part of the screen (e.g., the number of nouns in the phrase is too high). In all previous steps that generate feedback, the user can manually edit the text. This action triggers a feedback regeneration event, all the information from the interface being regenerated for the new input.

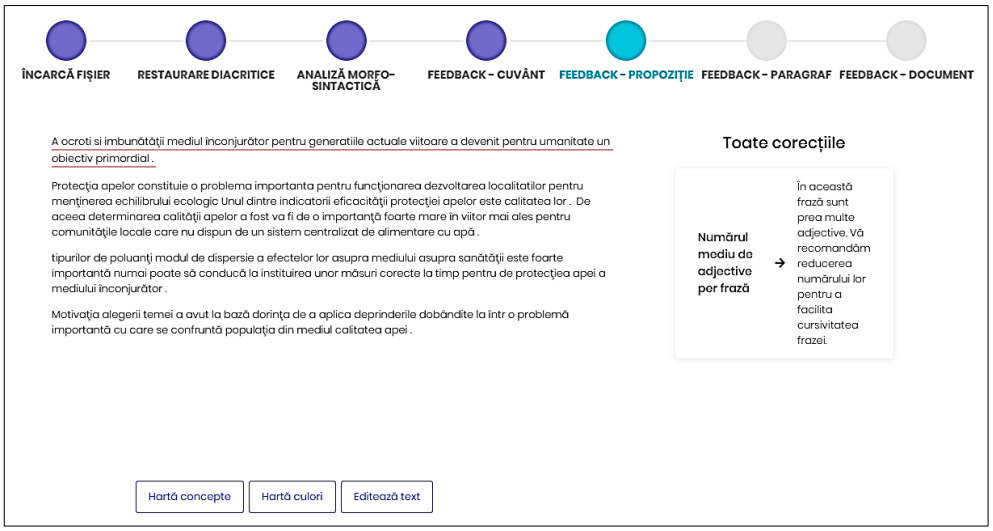

Figure 12. Feedback generation for Romanian language.

Two additional visualization features were introduced in order to provide contextualized views of the used words, namely a heatmap (see Figure 13) and a concept map (see Figure 14), both representing the most relevant concepts used in the text.

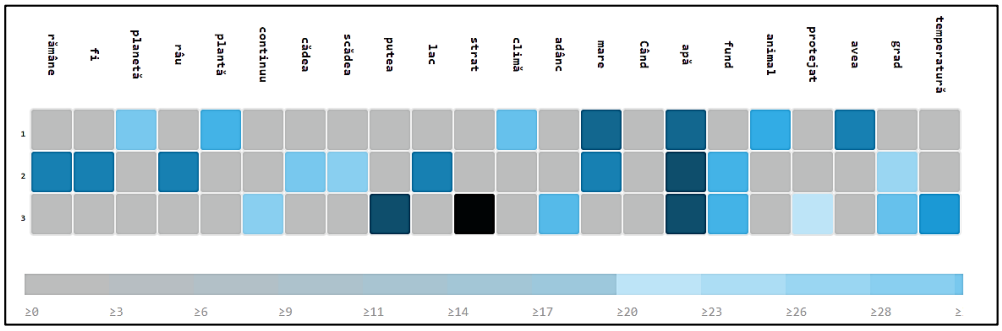

Figure 13. ReadME concept heatmap.

The visualization from Figure 13 presents the keywords from each sentence. Darker colors suggest the keyword is highly representative for the corresponding sentence.

The keywords from the concept map (Gutu-Robu et al., 2018) represent the nodes and their size is proportional to the keyword's relevance. The links

between the keywords reflect the semantic similarity between two nodes, and the edge length is inversely proportional to the semantic similarity between the linked nodes.

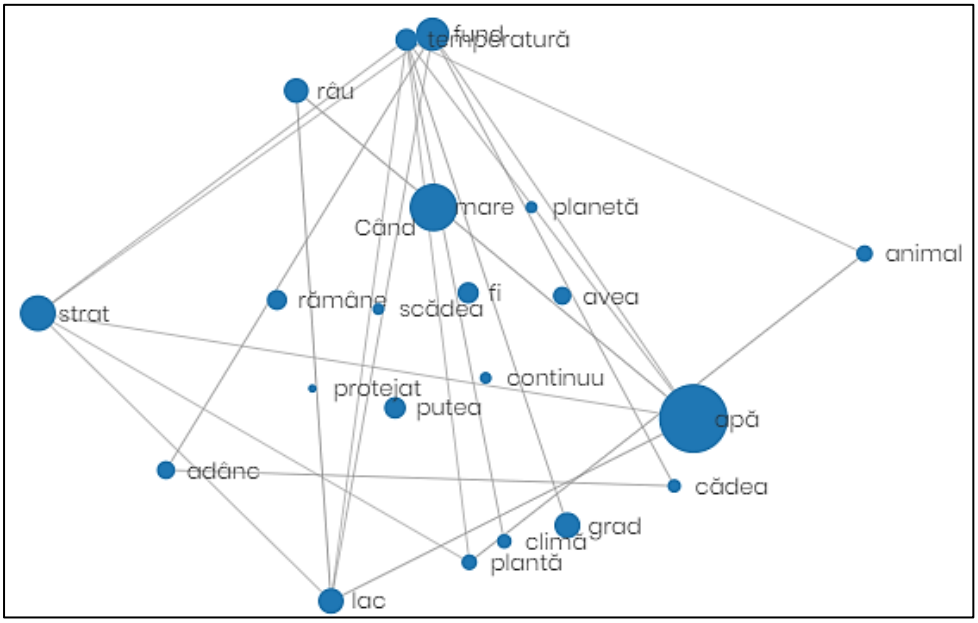

Figure 14. ReadME concept map.

4.2. ReadME as LMS

As an LMS, ReadME provides a flow for user management and registration, together with specific interfaces for mentors and trainees. Mentors can upload homeworks, manage a list of trainees, view the trainees' uploaded essays, view the system scoring for an essay, grade, and provide additional feedback. Trainees can view their list of uploaded essays, the feedback from the system and from the mentor, the corresponding grades, and the list of homework provided by the mentor.

The application's registration process and login are simple and straightforward, the user being asked to fill in just the username and password for a login, and account details (first name, last name, username, email, password and role) for the registration process. In this phase, only teachers and students can register for the application. As a security consideration, administrators are created when the application is deployed. Other administrator accounts can be added only by an existing administrator from

the administration page.

Both mentors and trainees have a personal profile page (see Figure 15) which can be accessed from the right corner of the interface. The page is divided into two columns. The first column includes general information about the profile. Trainees see the total number of essays (e.g., 18), the highest scored essay (e.g., 50 / 100 points), and the name of the mentor. On the other side, mentors are shown the total number of students, the current homework and the number of uploaded essays for that homework. In the right part of the interface, general account information such as name, username, email, and role are displayed. Trainees are displayed an additional field, the mentor's username, which can be changed.

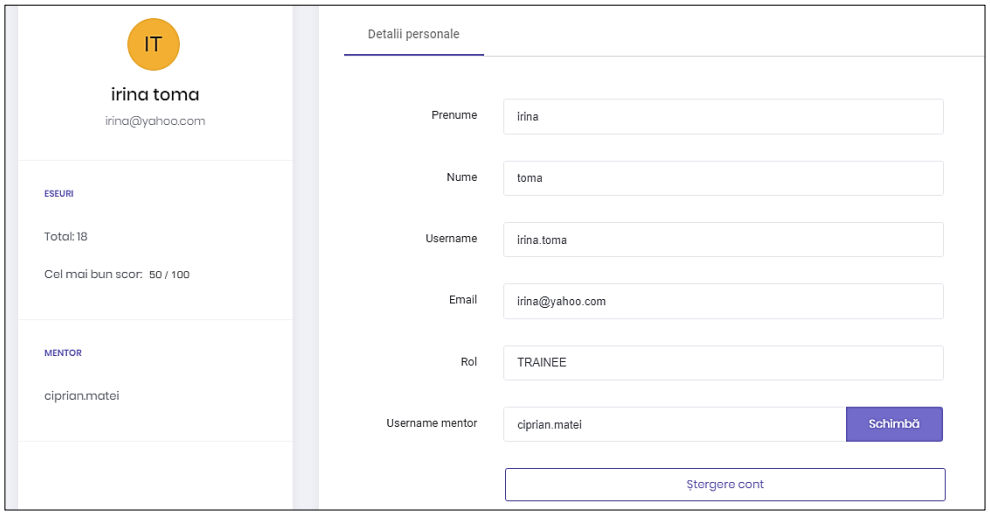

Figure 15. Trainee user profile.

For the mentor, the righthand side contains two additional tabs, besides the one with the personal details. The second tab, called "Students", contains the list of trainees assigned to the current mentor. Here, the list can be sorted based on username or email, and users can be deleted from the list. The delete does not remove the user account, but retracts the user from the mentor's list. The last tab represents the proposed homework and displays all the themes proposed by the current mentor (see Figure 16). The themes which have a green mark are active, meaning trainees can upload essays; active themes cannot be deleted. In the upper part of the interface new themes can be added.

The mandatory fields needed to be inputted for adding a new theme are its, title, description, and deadline.

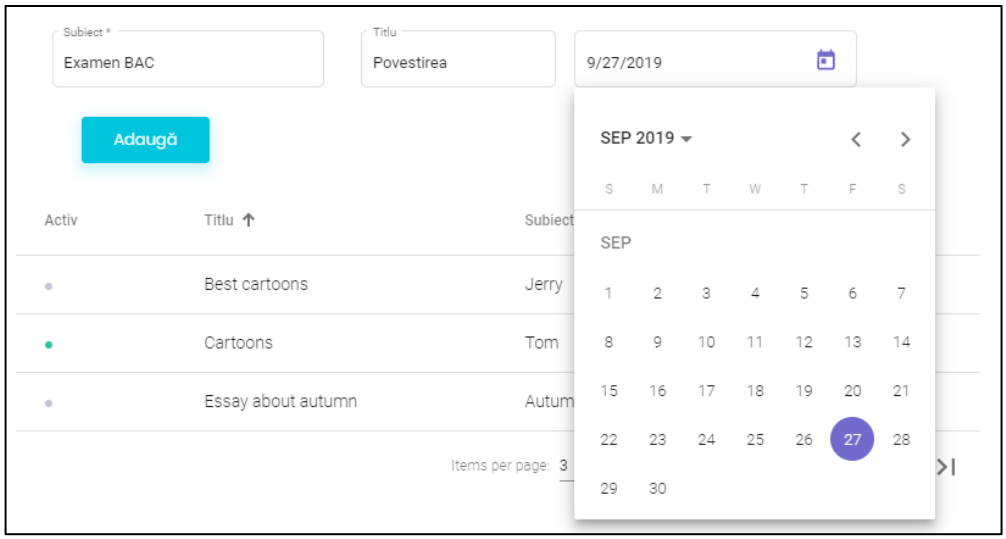

Figure 16. Adding a new homework.

Both types of users can view the corresponding uploaded essays in the essays section (Figure 17).

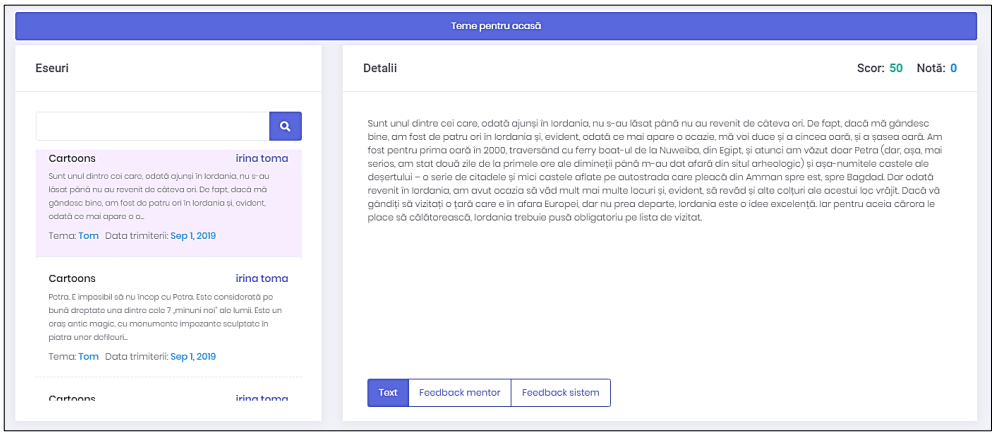

Figure 17. The mentor's essays list.

The difference between the flows is that trainees view only their essays and search through them with different keywords. The essay information consists of the original text, the mentor feedback, together with system

feedback and corresponding scores. Trainees cannot modify the information. The mentor flow is similar, but the essay list is composed by the trainees' uploaded submissions. The mentor can view the generated feedback score and can provide personal feedback together with an updated score.

5. Conclusions and Future Work

ReadME is an online, lightweight application that evaluates written documents using sequential feedback presented within the wizard component. ReadME includes state-of-the-art Natural Language Processing techniques aimed to support home users (e.g., bloggers, students / people wanting to improve their writing style of a literary text), educational institutions (e.g., schools, high schools, universities), private organizations (e.g., publishers, press trusts), as well as other interested authorities.

ReadME is available for Romanian and English languages and it distinguishes itself from the other applications on the market through its dual workflows, namely essay analysis and essay management. These two flows fit the needs of two types of users, both students (trainees) and teachers (mentors).

The existence of such a specialized solution in the market will lead to the emergence of innovative services, alignment of texts to an adequate level of expression for a targeted audience, as well as automated identification of fluctuations in writing style, together with recommendations of structure improvements. Subsequently, the mechanisms built especially for Romanian and English languages can be further internationalized through an incremental process; nevertheless, specific resources and corpora are required to train and finetune the system.

As future extensions, we aim to include relevant essay samples that can be used as reference models for writing essays. Moreover, a "try me mode" will be included in order to check the system's capabilities without the need of a registered account. Nevertheless, this mode will be limited to a maximum number of characters per essay, as well as a maximum number of texts that can be evaluated.

Acknowledgments

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