

Tutoring writing spelling skills within a web-based platform for children

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Abstract According to the NMC Horizon Report (Johnson et al. in Horizon Report Europe: 2014 Schools Edition, Publications Office of the European Union, The New Media Consortium, Luxembourg, Austin, 2014 [1]), data-driven learning in combination with emerging academic areas such as learning analytics has the potential to tailor students' education to their needs (Johnson et al. 2014 [1]). Focusing on this aim, this article presents a web-based (training) platform for German-speaking users aged 8–12. Our objective is to support primary-school pupils—especially those who struggle with the acquisition of the German orthography—with an innovative tool to improve their writing and spelling competencies. On this platform, which is free of charge, they can write and publish texts supported by a special feature, called the intelligent dictionary. It gives automatic feedback for correcting mistakes that occurred in the course of fulfilling a meaningful writing task. Consequently, pupils can focus on writing texts and are able to correct texts on their own before publishing them. Additionally, they gain deeper insights in German orthography. Exercises will be recommended for further training based on the spelling mistakes that occurred. This article covers the background to German

orthography and its teaching and learning as well as details concerning the requirements for the platform and the user interface design. Further, combined with learning analytics we expect to gain deeper insight into the process of spelling acquisition which will support optimizing our exercises and providing better materials in the long run.

Keywords German spelling acquisition · Technology-enhanced learning · Learning analytics · Educational media

1 Introduction

This article presents the workflow and the interface design of a prototype in the field of German orthography with an approach on learning analytics (LA). German orthography is known to be relatively difficult to acquire and master, especially for primary-school pupils—as the Austrian national survey in 2015 showed [2]. The platform, IDeR-Blog,¹ which is described in Sect. 3, aims to address this issue by combining technology-enhanced learning (TEL) and LA [3, 4]. The platform, which is currently in its testing stage with our partners, serves as a motivating innovation for children to acquire German orthography more easily. Teachers and researchers are benefiting from the application, since it supports the decision-making process and provides them with possible educational interventions [4, 5] supported by the offered training database.

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The data produced in the field of education are used by various kinds of institutions worldwide [6]. This kind of interaction leaves traces, with the result that learner behaviour can be analysed [7]. The students' interactions with the learning platform are also captured for analysis in order to gain further understanding, knowledge, and insight into a learner's learning process [8]. This information can be used for early detection of learning issues and enables teachers to actively intervene [9, 10]. The platform IDer-Blog will use this information in order to enhance the acquisition of German orthography, since problems in the field of German orthography affect both primary-school pupils and university students in everyday life [3].

1.1 Outline

The next section is concerned with teaching and learning German orthography. It examines the theoretical background, modern approaches, and the use of digital media for writing, spelling, and publishing. The subsequent sections address the design and workflow of the platform, its prospects for self-learning, and the process of interface design. The fifth section presents preliminary results from the first three months of usage from our partner schools. The last section will focus on discussion and conclusion and provide the reader with an outlook.

2 Related work

2.1 Teaching and learning German orthography

If a continuum of orthographies is constructed, where shallow orthographies are located on the one side (e.g. Turkish, Serbian) and deep orthographies on the other (e.g. English, French), then German orthography can be found more or less in the middle. The reason for this position is that there is quite a clear relationship between phonemes and the graphemes in German [11]. This means that the phonemes, the smallest unit of the speech that marks a difference in meaning, e.g. the phonemes (“sounds”—notated with /)/h/and/m/, such as in the English terms <house> vs. <mouse> or the German terms <Haus> vs. <Maus> are strongly related to a certain grapheme (“letter” notated with <>). Following this example it would be the link between/h/and <H,h> and/m/and <M,m> . The application of the correspondences between phonemes and graphemes in order to convert spoken language into written language and vice versa is crucial for alphabetic writing systems and therefore also for German orthography [11]. Understanding and applying these correspondences is also crucial for the acquisition of reading and spelling. As soon as pupils understand these correspondences they are able to

apply an alphabetic strategy: this means that they can analyse all phonemes of spoken words and apply the basic correspondences between phonemes and graphemes in order to write them. This is a major developmental step, although it does not necessarily lead to orthographically correct spelling in German orthography. For example, the pupils hear the word/hut/(hat) and spell it correctly as <Hut>. Anyway, applying the alphabetic strategy for spelling the word/bilt/(picture) by considering the basic correspondences/b/-> , /i/-> <i>, /l/-> <l>, /t/-> <t> would lead to the incorrect spelling <*bilt>.

The reason for this is the morphological principle [11]: it supports the identification of a given morpheme and consequently the identification of its meaning by spelling it the same way even if the pronunciation is (slightly) different. For example, the word <Bild> (picture) is spelled with <d> although pronounced as/t/because it is pronounced as/d/in the plural form <Bilder> . Consequently, this morpheme is spelled the same in all possible morphologically complex words as <Bild> , e.g. <abbilden> “to represent”, <bebildert> “illustrated”, <bildhaft> “pictographic”, <bildlich> “figurative”, <Bildchen> “small picture”, etc.

The morphological principle, which is especially important for a morphologically rich language such as German, can be subsumed under the orthographic strategy [12]. In the German language and orthography it is appropriate to distinguish an orthographic, a morphological and a crossword strategy as in May [13]. The conceptualization of these three strategies—besides the basic alphabetic strategy—considers the complexity and systematology of German orthography. However, the notion of an “orthographic” strategy is still problematic as an orthographic strategy can serve as the umbrella term for all possible strategies concerning spelling. According to Nerius' [11] theory of German orthography, a lexical and syntactic principle also exists. A peculiarity of German orthography is the use of capital letters within sentences, which is a feature of the lexical principle according to Nerius [11], whereas other authors (e.g. [14]) assign it to the syntactic principle. This peculiarity causes a lot of problems in the acquisition process. Although most of the spellings that require the use of a capital letter within a sentence can be explained by the lexical principle of Nerius [11] due to their part-of-speech classification (e.g. concrete nouns such as <Haus> “house” and abstract nouns such as <Güte> “benignity”), others can be better explained by the syntactic principle. It is especially challenging to spell words correctly using capital letters because the position within a sentence requires it, whereas this part of speech is usually spelled with non-capital letters. For example, the preposition <für> “for” needs to be spelled with a capital letter in the phrase <das Für und Wider> “pros and cons”.

Grammatical knowledge is necessary in order to obey this rule. May's [13] crossword strategy covers these aspects of German orthography, among others.

In contrast to (former) approaches, which focus on the memorization of the correct spelling of words, new approaches to teaching and learning German orthography follow a concept that enables the learners to gain “cognitive clarity”. This means that the learner becomes aware of the structure of words [14] and obtains insight into the language [15]. Models dealing with the spelling competence of words take into account the automated spelling of words as well as meta-linguistic control systems [16]. Consequently, developing orthographic competence can be summed up by the combination and interaction of several aspects of knowledge, such as declarative knowledge, procedural knowledge, knowledge of problem solving, and metacognitive knowledge [14]. Following Müller [14] a good way of developing orthographic competence is to investigate language and orthography—most usefully in dialogue form.

Until now, this approach to teaching and learning German orthography can only be applied by teachers in the classroom or by tutors in tutoring lessons. Everybody who has worked with children acquiring orthography knows the following phenomenon: a child writes a text, and when asked to review it and to find (possible) mistakes the child does not find (all) the mistakes. But when the child is given a hint for discovering a mistake and/or is provided with feedback in order to correct it, he/she recognizes the mistake and corrects it. Insight into the language and orthography as well as metalinguistic awareness is raised by this means. Although this approach is an effective method for the learner, this 1:1 tuition can hardly be implemented within a classroom setting and parents probably do not have the necessary knowledge for providing it at home.

Consequently, there is the need to develop a digital system, which considers these aspects to make it available for as many pupils as possible. The *intelligent dictionary* of the web-based platform IDeRBlog tries to implement this approach of teaching and learning German orthography with the help of learning analytics methods for the first time.

2.2 Writing, spelling, and digital media

Computers, tablets, and other mobile devices are highly attractive for children. Surprisingly, there are almost no elaborated concepts for integrating German language learning and digital media in the area of text writing and spelling. A great deal of discussion and public debate is dedicated to the question of whether writing with the keyboard instead of handwriting is harmful to children. In consensus with Berndt & Thelen [17], however,

questioning the use of digital media in education is pointless, since digital media determine our lives and the aim should be to gain expertise in using them. Two contrasting positions can currently be identified concerning this issue:

One position favours handwriting for pupils. A survey conducted in Germany revealed that 59.1% of the interviewed mothers and 91.6% of the interviewed teachers think that learning to write by hand is “very important” (cf. [18]). The other position acknowledges the advantages of text produced with digital media. Frederking [19] highlights two advantages of using computers for text production: on the one hand, the didactic principle “writing is rewriting” can easily be put into practice; on the other hand, the correction of (spelling) mistakes can easily be made. Abraham [20] states that the potential of writing aids such as spelling correction, syntax check and automatic word completion is not considered in didactic settings. Moreover, he criticizes that the programming of these writing aids is merely based on the standard language, which hinders young users from applying them.

Although using word processing programs and other digital work environments and using the aids on offer are initial steps, these are not sufficient in themselves. The need for developing didactic concepts that make use of the advantages of digital media in text writing, such as how the IDeRBlog-Project does it, is a dictate of teaching and learning languages in the twenty-first century. Without much doubt, offering human–computer interaction tools that help improve learning in a specific domain, such as writing and spelling, will increase the acceptance of the use of digital media in learning environments. It is essential that they dispose additional value for teachers and students. Furthermore, due to technical developments and the availability of digital media at any time, holding on to traditional approaches generates a gap between everyday life and formal educational environments. For example, it will be difficult to make a child look up a word in a printed dictionary when online dictionaries are available. Apart from that online dictionaries often provide more specific information (e.g. declination of the searched noun, a list of phrases with this word, etc.) than printed ones. The future challenge of teaching will be how to make adequate use of online dictionaries and autocorrection systems.

Although teaching and learning of spelling will change due to digital environments, spelling competence will undoubtedly always be important and probably even gain importance, as the core function of orthography is to facilitate reading. The reason for this is that publishing texts on the Internet are becoming easier and consequently more and more people are potential readers of a text. Aspects of this such as being sensitive to misspelled words, knowing how to correct them, using spelling aids and applying strategies to prevent spelling errors in the long run

[3, 21] will always be crucial. The consideration of these aspects of spelling competence is fundamental for the applied approach in the IDeRBlog-Project.

2.3 Spelling, text writing, and publishing

As mentioned previously, spelling must not be seen isolated from other aspects of language skills but as one aspect of text writing. The results of Reichhardt [22], who analysed spelling competence and text-writing competence in German-speaking 3rd graders, show that there is little correlation between those two competencies. Consequently, the writers of good texts are not necessarily good spellers and vice versa [22]. In the context of spelling competence when writing texts there is also empirical evidence from Austria [2]. A survey of various competencies in the German language, such as reading, text writing, spelling, language awareness, and listening, was conducted in 2015 with 76,552 Austrian 4th graders. It shows that 27% of the children tested have problems using correct language in terms of spelling and grammar when writing a text. This means that they are, for example, not able to consider basic phenomena of German orthography, to spell frequently used words correctly and/or to apply correct grammar.

In accordance with Reichhardt [22] both spelling competence and text-writing competence need to be improved. The reason for this conflation is that a higher spelling competence relieves the working memory in order to have greater capacities to focus on the complex task of text writing.

Nevertheless, spelling should not be trained in isolation. Unfortunately, this seems to be a common approach as can be traced in the large quantity of online and offline spelling exercises that are available—most of which are based on the behaviourist concept. Mann [23] already claimed that the communicative aspect plays a vital role in teaching and learning spelling and that this communicative aspect can be realized by publishing texts. Twenty-five years later, the requirement she recommended can easily be fulfilled. Most children have access to the Internet, which provides them with many possibilities for publishing content—known or unknown by teachers and parents. There is thus an urgent need to provide web-based platforms, where pupils can publish texts in a guided way with added didactic value. Additionally, Frederking [24] states that web-based systems are ideal for implementing modern didactic approaches in literacy classes.

To our knowledge, there are currently only two web-based platforms in the German-speaking countries for publishing texts, namely youtype² and myMoment.³ It

should be noted, however, that they are altogether different from the IDeRBlog-Platform.

Both platforms are developed and hosted in Switzerland. Following the description on the platform itself and the article of Schneider [25] the development of the platform myMoment started in 2005. It is described as a platform where children from grade 1 to grade 5 can write and immediately publish texts without being corrected by teachers. Consequently, the only correction feature available is that other users can rate the published texts and can report inappropriate behaviour. Furthermore, children need to decide to which genre the published text should belong (e.g. funny stories, fantasy, or poems). All published texts can be read without being registered. A registration is only necessary for writing, publishing, and commenting. The platform youtype focuses more at the integration of multimedia as users can also add pictures, videos, and audio (cf. [26]). The users are older than the users of myMoment as the target group are pupils from 5th grade.⁴ The users can create an avatar for themselves and publish their creations under specific categories, e.g. news, short stories, stars, etc., which can be viewed without registration; however, it is necessary to be registered in order to make comments. These two platforms seem to focus more on the process of publishing and media education, whereas the IDeRBlog-Platform combines publishing and media education to spelling acquisition by applying learning analytics.

2.4 Learning analytics

LA focuses on “the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs” [27]. According to Campell [28], an analysis process has five steps: capture, report, predict, act, and refine. Clow [29] used these five steps as a basis for his iterative learning analytics cycle which states that the loop should be closed. Khalil and Ebner [8] added stakeholders to the cycle according to their visions and missions. In addition, they highlight some of the ethical issues of LA and proposed an anonymization framework to preserve the privacy of students [30]. The learners’ data have to be processed in a specific mode in order to conduct scientific analysis and support teachers and students with the adaption of their teaching and learning approach [31]. As part of the previous frameworks, an adequate visualization has to be applied to present the feedback as simple and informative as possible to the stakeholders [32, 33]. Furthermore, analytical

² Available online: <http://www.youtype.ch> (Accessed 13 November 2016).

³ Available online: <http://www.mymoment.ch> (Accessed 11 November 11 2016).

⁴ Available online: <http://edu-imedias.ch/module/> (Accessed 11 November 2016).

approaches to model a learner's profile based on their answering behaviour and the analysis of different error types can lead to findings that help to enhance the whole learning process [34, 35].

3 The platform

3.1 The concept

The platform IDeRBlog tries to combine the development of writing skills, the acquisition of orthographic competence, and the use of modern means of communication and digital instruments [3]. The aim is not to replace handwriting with typing on a keyboard, but rather to take advantage of the digital age: on the one hand, a text written on the platform can be published as a blog entry in a private, class, or school blog. Thereby, the platform is “providing relevant reasons and audiences for writing” [36]. On the other hand, the text is first analysed automatically for spelling mistakes and can consequently be edited several times. It is expected that the motivation to formulate a text and to revise it many times is higher with the prospect of publishing it, compared to typical essay writing in a classroom [3].

The analysis is conducted by the core of the platform, the *intelligent dictionary*, which also serves as the basis for training orthographic skills. The only prerequisite is that children have acquired the alphabetic principle of German orthography. This means that the children should apply at least the basic correspondences between phonemes and graphemes. The deeper understanding of other strategies, e.g. the morphological strategy, is supported by the *intelligent dictionary*. It categorizes mistakes in order to offer specific feedback and hints for correcting the misspelled words. In doing so, the children should be encouraged to reflect and think about the language in order to become aware of the word structure [37] and consider these insights in their spelling.

Based on the mistakes it also provides a qualitative analysis of orthographic problems for teachers. Additionally, these categories of mistakes are connected with a number of exercises in the training database [3]. With all these offered features, the platform meets several demands for a spelling learning software as formulated by Berndt and Thelen [17].

The platform for the project is currently in the testing phase with our partner schools and interested third-party schools. The official rollout to the public will start in summer term 2017. The current workflow and the general concept to ensure age-appropriate usability and interface design [4] will be described briefly in the following sections.

3.2 Design

It is a web-based application with state-of-the-art technology such as HTML5, responsive web design, and web services. The application server is implemented with the GRAILS⁵ web application framework version 3.x for Java platforms with Apache Tomcat 7⁶ and handles the communication from students and the teachers. Figure 1 shows the IDeRBlog system, which can be used after prior registration with a separate user management system.

GRAILS is based on Groovy⁷ and uses different established frameworks such as Spring⁸ and Hibernate⁹ to operate. The database server uses MySQL¹⁰ for the advantage of high on-demand scalability and performance as well as the possibility to optimize the query load on the server. To ensure a clean and manageable project the model view controller (MVC) pattern is used [38].

The texts submitted by the student are first analysed automatically for spelling mistakes. The conventional system of dividing the text into sentences and further into tokens is used for this. After the part-of-speech tagging [39] the tokens, if identified by the intelligent dictionary, are assigned to categories. Based on this information the *intelligent dictionary* will provide age-appropriate feedback, according to the detected spelling mistake in connection with its phenomenon. Further spelling mistakes are handled by our support spellchecker Language Tools [38].

3.3 Intelligent dictionary and feedback

The main idea behind the *intelligent dictionary* is providing hints for appropriate corrections whenever a spelling mistake is made. This is in contrast with conventional auto-correction systems, which only provide the information that something is wrong and/or immediately provide the correct word. The intelligent feedback system considers the requirement for the acquisition of orthography to offer exercises and hints that allow the autonomous and mainly strategy-based correction in a motivating context [40]. Additionally, several aspects of the German orthography system [e.g. 11] and its modern approaches in teaching and

⁵ GRAILS, available online: <https://grails.org/> (Accessed 10 February 2017).

⁶ Apache Tomcat, available online: <http://tomcat.apache.org/> (Accessed 10 February 2017).

⁷ Groovy Language, available online: <http://www.groovy-lang.org/> (Accessed 10 February 2017).

⁸ Spring Framework, available online: <http://projects.spring.io/spring-framework/> (Accessed 10 February 2017).

⁹ Hibernate Framework, available online: <http://hibernate.org/> (Accessed 10 February 2017).

¹⁰ MySQL database, available online: <https://www.mysql.com> (Accessed 10 February 2017).

learning—as described in Sect. 2—are considered in the development. In short, the feedback for correcting a mistake is formulated in such a way that the learner must think about the spelling [3].

The following example illustrated in Fig. 2 shows how the feedback works.

Figure 2 shows the sentence “Mein Pfert Rannte ganz shnell im Gallop” which means “My horse galloped very fast” (literally translated: “My horse ran very fast in gallop”). In this sentence four orthographic mistakes can be found (<*Pfert> instead of <Pferd>, <*Rannte> instead of <rannte>, <*shnell> instead of <schnell> and <*Gallop> instead of <Galopp>). The three mistakes, marked in red, are mistakes that are categorized. Consequently, the *intelligent dictionary* can provide a specific feedback.

The mistake <*Pfert> instead of <Pferd> shows that the phoneme–grapheme–correspondences are applied correctly (alphabetic strategy), though it is spelled incorrectly due to the morphological principle. Consequently, the user gets the feedback “Extend the word and deduce the spelling”. The word can be extended, for example, by forming the plural. On adding the plural suffix, the word changes from a word with one syllable to a word with two syllables and the devoiced consonant is voiced. This strategy should enable the child to choose the correct grapheme.

The mistake “Rannte” does not consider the syntactic principle, as the verb is written with a capital letter. The feedback “Think about the part of speech and deduce the spelling” should thus be a sufficient hint to make the child correct the mistakes. Children are usually familiar with the rule that nouns are spelled with a capital letter and other words are not.

In the case of the “shnell” mistake, users are prompted to have a closer look at the graphemes as the <c> in the grapheme <sch> is missing. This mistake is located at the level of phoneme–grapheme–correspondences. As one phoneme is represented by a complex grapheme with three letters, omissions can occur.

The feedback is kept short and simple. It can be assumed that some users cannot make use of the hint given for correcting the word, because they do not understand the intention of the feedback. The platform offers additional courses for pupils in order to guarantee that children can benefit from the feedback independent of the teaching approach chosen by the teacher and their state of knowledge when starting to use the platform. These courses explain for example the background knowledge required for the feedback in order to understand the feedback: “Extend the word and deduce the spelling”, it is necessary to know how a word can be extended and what is meant by

deducing the spelling. This is explained by the online course with the child appropriate title “d-t g-k p-b”.¹¹

The mistake marked in yellow is not yet categorized in the *intelligent dictionary*. As a result the feedback says only: “possible mistake found”. This feedback is provided because, in addition to the categorized mistakes in our *intelligent dictionary*, a grammar and spell checker support proofreading. This is necessary because the *intelligent dictionary* cannot cover all spelling mistakes due to the infinite number of all possible words and possible mistakes. Nevertheless, users should not have the impression that a word is correct just because it is not categorized yet.

Additionally, the feedback for the spelling mistakes is linked to the categories of the qualitative analysis for teachers. In that way teachers can retrieve a qualitative analysis based on mistakes that occurred, before and after the feedback was given. Consequently, requirements for qualitative analysis of misspellings are considered [3, 42].

3.4 General workflow for text creation and correction

A student, as shown in Fig. 3, can write her/his text in the writing area provided (1). First, the text will be analysed orthographically by the *intelligent dictionary* (2) [3]. Proper feedback, based on the spelling mistake and error category, will be provided to the student. Then he/she has the choice either to try correcting the text (3) as often as he/she wants or to submit the text directly (4). This intermediate step encourages pupils to correct spelling mistakes in an independent and self-reflexive way [43]. After submission, the teacher receives a notification (5) and reviews the text for further correction and/or improvements as well as personal notes to the student (6). The result and report are then delivered back to the students for review (7) or, if necessary, the teacher can hand the text back to the student with further instructions for corrections (7a). The student then repeats the correction process (step 1–4) and resubmits the text. After this step the text may be published in the blogs provided subject to permission from the student (8). Based on the recommendations made by the system, the student can choose between different online and offline exercises (9) and/or do the exercises suggested by the teacher (10).

3.5 Student’s workflow

Figure 4 shows the detailed workflow of a student. After the login, an overview over all submitted texts will be

¹¹ Available online: <http://typo3.lpm.uni-sb.de/iderblog/fuer-erwach-sene/schuelerkurse/rhythmisches-verlaengern/kurs-dt-gk-pb-am-wor-tende/> (Accessed 11 November 2016).

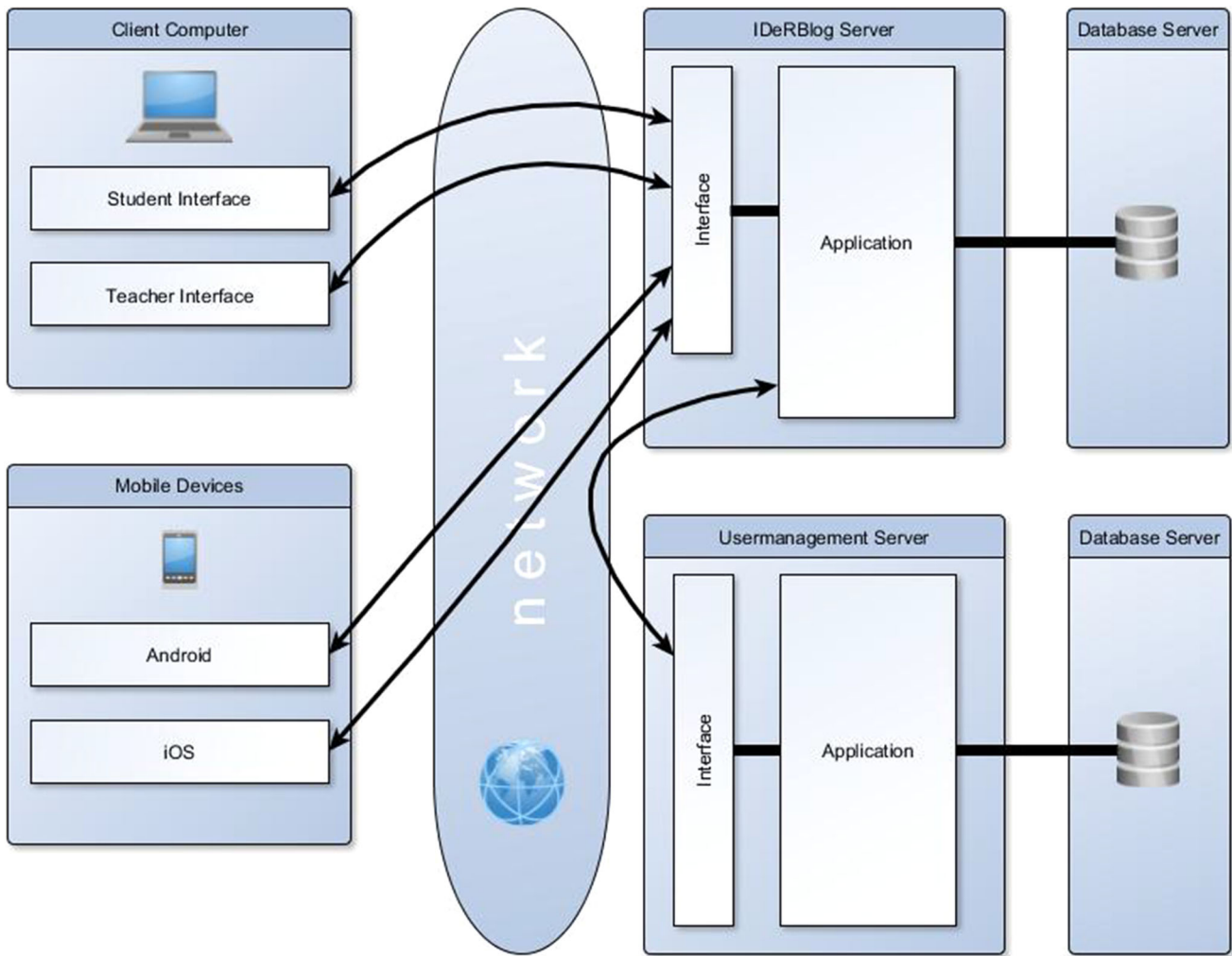


Fig. 1 Architecture [38]

Fig. 2 Example sentence with 4 feedbacks [41]

Mein **Pfert** **Rannte** ganz **shnell** im **Gallop**.

Hinweis zum Ausbessern:

Überlege, welche Wortart das ist und leite die Schreibweise ab.

Hinweis zum Ausbessern:

Möglicher Rechtschreibfehler gefunden

Hinweis zum Ausbessern:

Verlängere das Wort und leite die Schreibweise am Wortende ab.

Hinweis zum Ausbessern:

Sprich das Wort deutlich aus und überprüfe, ob du alle Buchstabenverbindungen richtig geschrieben hast.

provided together with the feedback given by the teacher as well as further information and hints for possible self-study exercises, provided by the training database. Further, the student will be informed if a previously submitted text needs further improvement, suggested by the

teacher. The process of text creation/rewriting is outlined in Fig. 4 as well. The process is designed to be as simple as possible in order to ensure an easy usability, and the platform can be started directly with a single click after the login button.

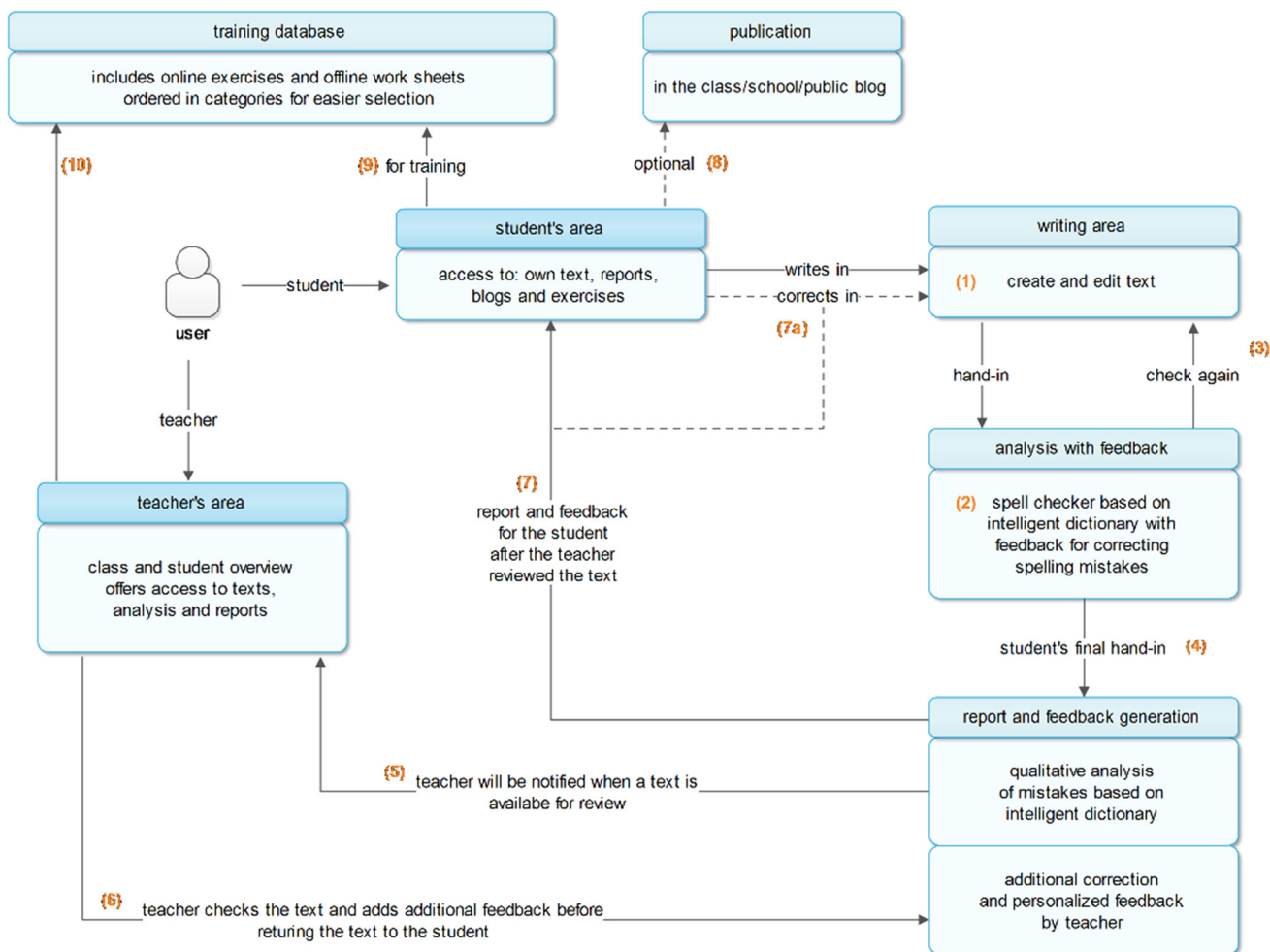


Fig. 3 General workflow of the text creating and reviewing process, based on [44]

3.6 Teacher’s workflow

Figure 5 shows the workflow of the teacher. A separate user manager is provided in order to offer teachers easy registration and class/school administration. If a student forgets his/her password a reset for the password is easy to do.

The teacher area of the IDeRBlog system gives an overview of all texts of the classes in which the teacher is active. In the class overview the teacher will be informed when new texts for correction are available. An overview of mistakes that have occurred as well as suggested exercises will be provided for the class and for individual students. This information can then be used for early detection of learning issues and enables teachers to undertake a proper intervention [9, 10].

Once a new text is available, the teacher can review the text and correct it if necessary. Additionally, it is possible to categorize errors which may not have been detected and categorized by the *intelligent dictionary*. This ensures a qualitative analysis of all the spelling mistakes in the text.

The *intelligent dictionary* will be extended as a result, ensuring that the system will recognize and categorize the error correctly in future submissions after a linguistic expert reviewed the suggestions.

3.7 Training database

The platform provides a training database. The platform contains online and offline exercises (currently 260 in total). Online exercises exclusively developed for the project are being added. The preselection of exercises helps teachers to support students with the improvement of the performance in problematic/challenging areas identified by LA. These exercises and worksheets are ordered congruently in categories and subcategories of spelling mistakes to provide a better overview [3]. All exercise types are available for free to both teachers and students [45]. Figure 6 shows the overview of exercises for students. The menu on the left offers “Üben im Internet” (online exercises), “Üben mit Arbeitsblättern” (printable offline exercises, e.g. worksheets), “Suche Online Übungen” and

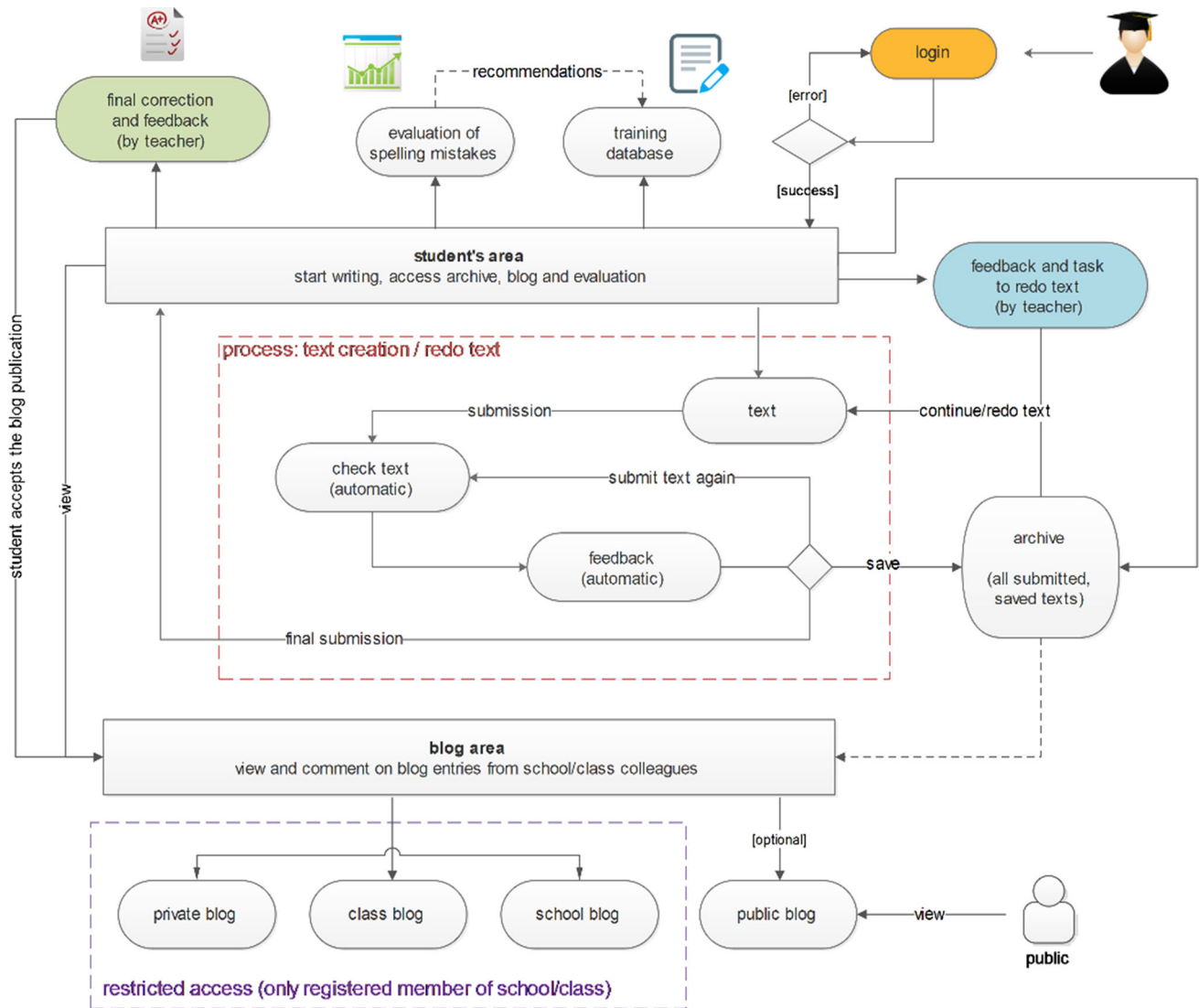


Fig. 4 Student’s workflow, based on [44]

“Suche Arbeitsblätter” (search forms for the online and offline exercises) and “Rechtschreibkurse” (spelling courses). After selecting something on the left, the student can choose between subcategories to refine the search.

The training database offers existing exercises categorized in a way that corresponds to the categories of the qualitative analysis; it also includes online exercises exclusively developed for the IDeRBlog-Platform. The advantage of the exclusive exercise is that the used words are the same as the categorized ones for the *intelligent dictionary*.

4 Interface design

The platform is designed for primary-school children, aged 8–12. The focus lies on a graphically appealing and age-appropriate web interface [46]. As suggested in the NMC

Horizon Report [1], we reviewed the possibility of including the pupils as co-designers in the process. A graphic designer created drafts and colour schemes for the project that have been examined and rated by students from different schools and classes. The favoured design by the majority has then been developed further and integrated into the platform. The process is shown in Fig. 7.

In order to guarantee a good usability of the platform, we had to ensure that students can reach the most important parts of the platform in less than five clicks. This convenient accessibility in combination with attractive figures should ensure high motivation in fulfilling the task of writing texts. In ongoing usability tests [47] we continue to improve the concept step by step [3].

In the next subsections, interesting areas are presented in the form of screenshots from the testing system with a brief description.

4.1 Student's login view

After the login, the student can choose between 4 tasks, as shown in Fig. 8: “*Einen Text schreiben*” (starts the process of writing a new text, as described in the previous section), “*Meine Texte ansehen*” (overview over all saved and submitted texts plus all texts corrected and returned by the teacher), “*Mein Blog*” (accesses the private/class/school blog system) and “*zur Auswertung*” (a benchmark of the student based on the submitted texts and recommendations for exercises is made here).

4.2 Student's writing area

As described in Fig. 4 and shown in Fig. 8, after the login, the student can start the writing process with a single click. Figure 9 shows the first review stage with information concerning wrongly written words (in this case two). Further information on how to handle this error will be displayed by clicking on the highlighted word. With this information, it should be possible for the student to correct the word and submit the text for an additional review, if necessary. This intermediate step facilitates independent and self-reflexive corrections among pupils [43].

4.3 Teacher's correction area

The teacher is informed after the student makes a final submission. He or she then has the opportunity to review the different versions of contributions by a student (if there has been more than one) in order to examine the independent correction potential. Furthermore, as shown in Fig. 10, the teacher is able to correct the text, add notes, and provide feedback in order to make it ready for (optional) publication on the blog. If the text needs further improvements, the teacher can hand the text back to the student “*Zurückgeben*”. Based on the information presented in the text (e.g. too much personal information about the family), the teacher can choose to mark it as “do not blog”. In this case, the text will only be published in the student's personal blog to which only he/she has access to (no access for class, school, or public). Additionally, errors which may not have been detected and categorized by the *intelligent dictionary* can be categorized in this step. Once the teacher has finished the review, the student will be informed and can review the text and take further actions, for example look at the online courses or exercises recommended either by the teacher or the system to improve his or her own writing ability.

Figure 10 in detail: the first text area presents the contribution from the student (1). Errors are marked accordingly. The second text area is for the teacher's correction (2). Feedback for the student can be given in area (3), internal notes for the teacher in area (4). Information about the text

(number of sentences, words, spelling mistakes, etc.) is shown in (5). Actions available to the teacher are also given: “continue later” (6), “give back to student” (7), “complete the correction” (8), and “allow the text to be blogged” (9).

4.4 Class evaluation and exercise recommendation

Recommendations for exercises are based on a pupil's spelling mistakes or the mistakes of a whole class. Using this information the teachers can detect problems in specific orthographic areas.

As the example in Fig. 11 shows, the teacher gets an overview of the problematic orthographic areas based on the categories of the *intelligent dictionary* (“Lehrerkategorie”). Furthermore, he/she can see which words are misspelled and how often (“Fehlerwörter (Vorkommen)“/“Anzahl”). In order to provide the adequate exercises links to selected online and print exercises come along with the qualitative analysis for ensuring there is enough material for practising on (“Übungen”).

We also plan to take the progress pupils make into account. After sufficient data are provided the user can review his or her progress over the months, to see the development concerning the average length of the text and the spelling mistakes. We are currently discussing further possibilities for teachers, students, and parents with our partner schools.

5 Preliminary results

5.1 Usage statistics

The platform has been in use at our partner schools since October 2016. In the period from October 2016 until December 2016 the system has mainly been in use by classes at our two partner schools. Usage dropped in December 2016, due to the Christmas and the winter holidays as can be seen in Fig. 12. Since mid-January 2017 we have started to invite interested third-party schools to participate by offering online courses, which has led to an increase in usage.

In 2017 several training sessions designed for teachers will be held in different cities of Austria and Germany during the summer term. It is expected that these face-to-face trainings will have a further positive effect on the usage.

5.2 Submitted texts

In the period from October 2016 until January 2017, 277 submissions from 258 students have been corrected by teachers. By the end of January, 14 submissions were in review process by teachers and 69 submissions are in the

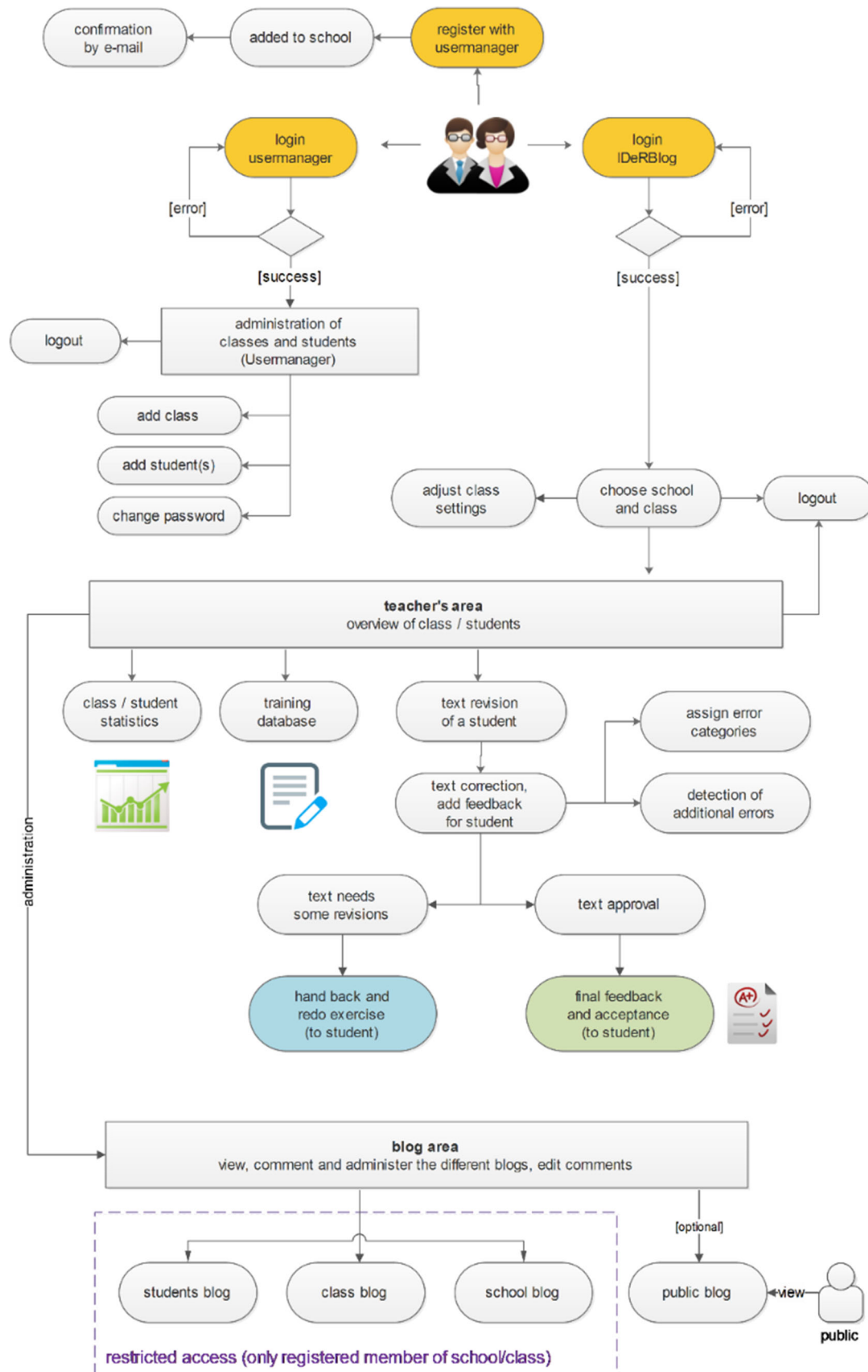


Fig. 5 Teacher’s workflow, based on [44]

Fig. 6 Training exercise overview for students



Fig. 7 Figure creation: first prototypes (left) and final figures on the webpage (right) [44]



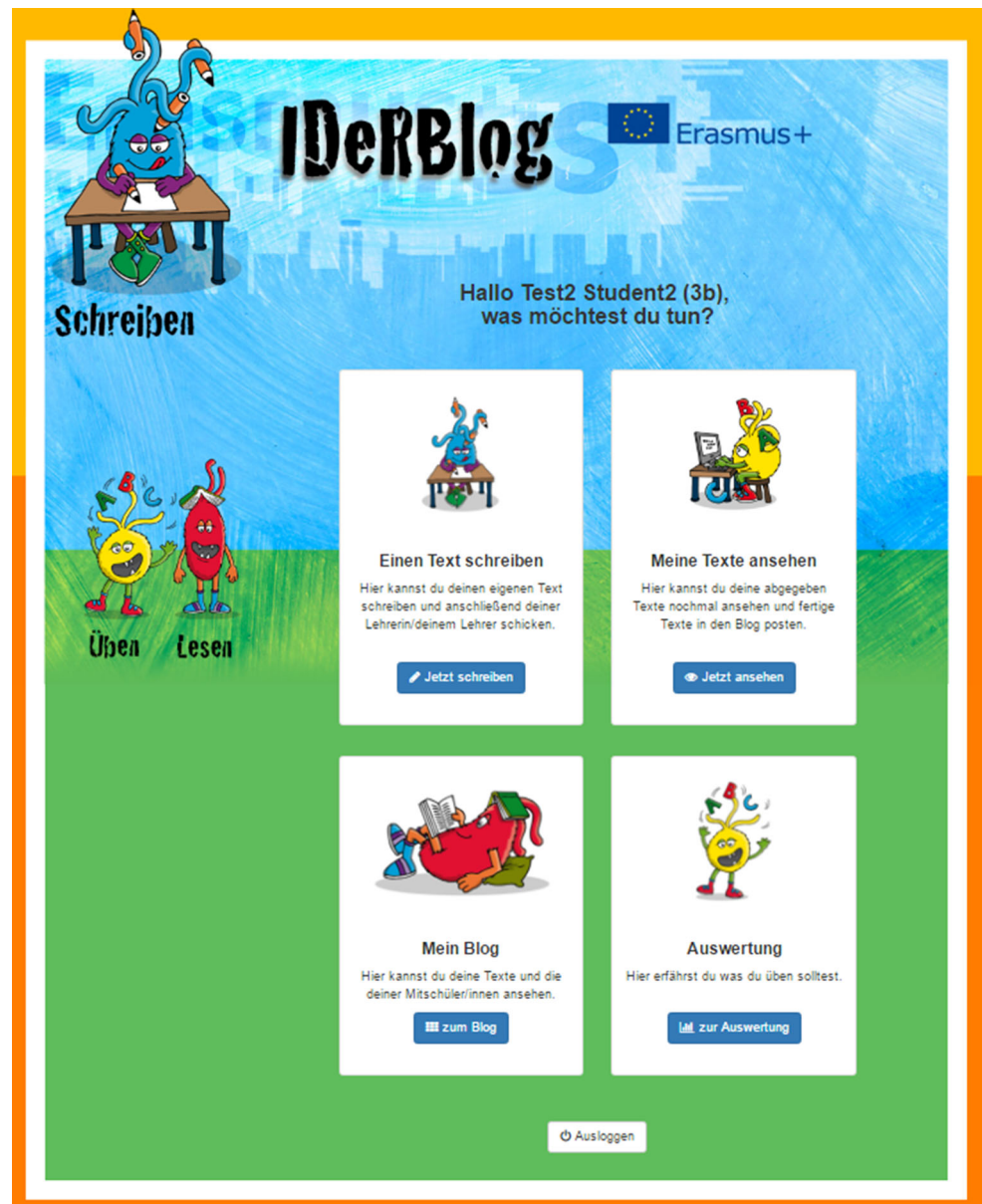
queue to be reviewed. This makes a total of 360 submitted texts on the system. Considering the relatively small number of schools and classes involved and the short period of usage the number of submitted texts is impressive. It can be concluded that the acceptability level is relatively high and oral reports of the partner schools indicate that writing on the platform is indeed motivating for the users.

5.3 Spelling errors

Before the partner schools and their pupils could start to use the system, the *intelligent dictionary* needed to be put

through a final test. For this test we collected 60 essays written by third-grade pupils in the project group. After digitalization and anonymization, the texts and their mistakes were analysed by the prototype of the intelligent dictionary. A total of 549 spelling mistakes were found in these texts. Our *intelligent dictionary* responded to 95 of these 549 spelling mistakes with appropriate feedback, which means it provided 17.3% coverage for the total spelling mistakes found in the 60 essays (for details see [38]). As this first proof of concept is based on handwritten texts which have been digitalized, we conducted a further analysis based on texts written on the IDeRBlog-Platform. These 429 texts are written by 149 students in

Fig. 8 Student's login view



grade 3, 4, 5, and 6 in the period between end of October 2016 and end of January 2017. In sum, these texts contain 22,139 words. The length of these texts varies and ranges from short texts of one sentence only to long texts of 23 sentences. A total of 3170 spelling mistakes were found in these texts, representing a spelling mistake rate of 14.32%. In total, 726 of these mistakes could be categorized and our *intelligent dictionary* provided appropriate feedback. The other 2444 mistakes were recognized by our supporting spellchecker Language Tool. Compared to the identification rate of the first proof of concept (see [38]), which is based on hand-written texts, the identification rate of this

analysis, based on the actual use of the platform, increased from 17.30 to 22.90%.

In the context of the qualitative aspects in this analysis we can see that one category covers almost half of all mistakes. In total, 49.31% of the mistakes recognized by the *intelligent dictionary* are mistakes of neglecting the use of capital letters, e.g. <*hase> instead of <Hase> “rabbit” or <*wasser> instead of <Wasser> “water”. The other half of the mistakes is covered by 15 categories, ranging from 18.32%—in the case of gemination, e.g. <*Brile> instead of <Brille> “glasses”—to 0.14%—in the case of spelling with one vowel instead of two, e.g. <*par> instead of <paar> “some”.

Fig. 9 Student's writing area. The first text field shows errors and hints for correction. In the second text field, the student is able to correct his/her text. The 3 buttons below are: (1) save, (2) check again, and (3) submit to the teacher. The button below these three is used to cancel the process



This analysis shows, as already stated in [38], that it cannot be expected that all mistakes will be recognized by the system and this is especially true for mistakes disregarding the phoneme–grapheme–correspondences (e.g. <*schemkt> instead of <schenkt> “he/she/it donates”) since there is an infinite number of possible mistakes. A further constraint affects the spelling of names or places and the use of English or other foreign words (e.g. <*Matsh> instead of <match>) that cannot be categorized in advance.

5.4 Usability tests

Evaluations have been conducted with six teachers from our partner schools and two teachers from other institutions. We used the thinking aloud test method [48, 49] to check the usability of the platform from the teachers' perspective. Before the testing, the teachers were interviewed about their computer and Internet experience.

The task assigned included the creation of a class, adding students to it, correcting a submitted text from the student and administer the blog. The overall acceptance and feedback was positive due to the fact that all the teachers have competences in the field of computer and Internet usage, which emerged in the interviews referred to. Some minor usability problems concerning the naming of buttons and teachers' workflow have been detected and fixed to provide good user experience for the teachers in the future.

In the case of the students: as stated in the previous chapter we included students from our partner schools in the process of designing the platform to ensure a good usability. Furthermore we ensured that the students can start doing a task in less than 5 mouse clicks (e.g. it is possible to start writing a text after 1 click and to continue writing after 2 clicks). Our partner schools are providing continuous feedback on usage, usability, and problems. Most of the students are digital natives [50] with experi-

Fig. 10 Teacher’s correction area

Maria Muster (1a)

Korrektur der Aufgabe

Aufgabe abgegeben am 14. Okt. 2016 um 12:02 Uhr

Fehler und Hinweise ⓘ

mit Rückmeldung von IDeRBlog in Rot und zusätzliche in Gelb

Fritzi und ich sind **im** Zoo und haben einen **stargen** Tiger gesehen. **Aigentlich** auch einen Seehund der spielte. Unterwegs haben wir Popcom gekauft und Eis gegessen. Die Wellensittiche waren süß und der **ander** Vogel ist auch süß.

(1)

Korrektur der Abgabe: ⓘ

Fritzi und ich sind im Zoo und haben einen starken Tiger gesehen. Eigentlich auch einen Seehund der spielte. Unterwegs haben wir Popcom gekauft und Eis gegessen. Die Wellensittiche waren süß und der andere Vogel ist auch süß.

(2)

Verbleibende Zeichen: 1774

Rückmeldung an die Schülerin/den Schüler: ⓘ

Auf diesen Text bezogene Rückmeldung an die Schülerin/den Schüler (optional)

(3)

Verbleibende Zeichen: 1000

Aktionen:

Später fortsetzen (6)

Zurückgeben (7)

Korrektur abschließen (8)

Text darf von Schüler/in als Blogeintrag veröffentlicht werden: ⓘ

Ja (9)

Informationen zum Text

Sätze: 4
Zeichen (mit Leerzeichen): 225
Zeichen (ohne Leerzeichen): 189
Fehlerwörter im Text: 5
davon angezeigt mit iW Feedback: 2
davon zusätzlich angezeigt: 3

(5)

interne Notiz (nur für Lehrkräfte sichtbar) ⓘ

Lehrkraft-Notizen. Werden nicht der Schülerin/dem Schüler angezeigt, können jedoch von anderen Lehrkräften eingesehen werden. (optional)

(4)

Verbleibende Zeichen: 1000

Fig. 11 Example view of the qualitative analysis of spelling mistakes for teachers

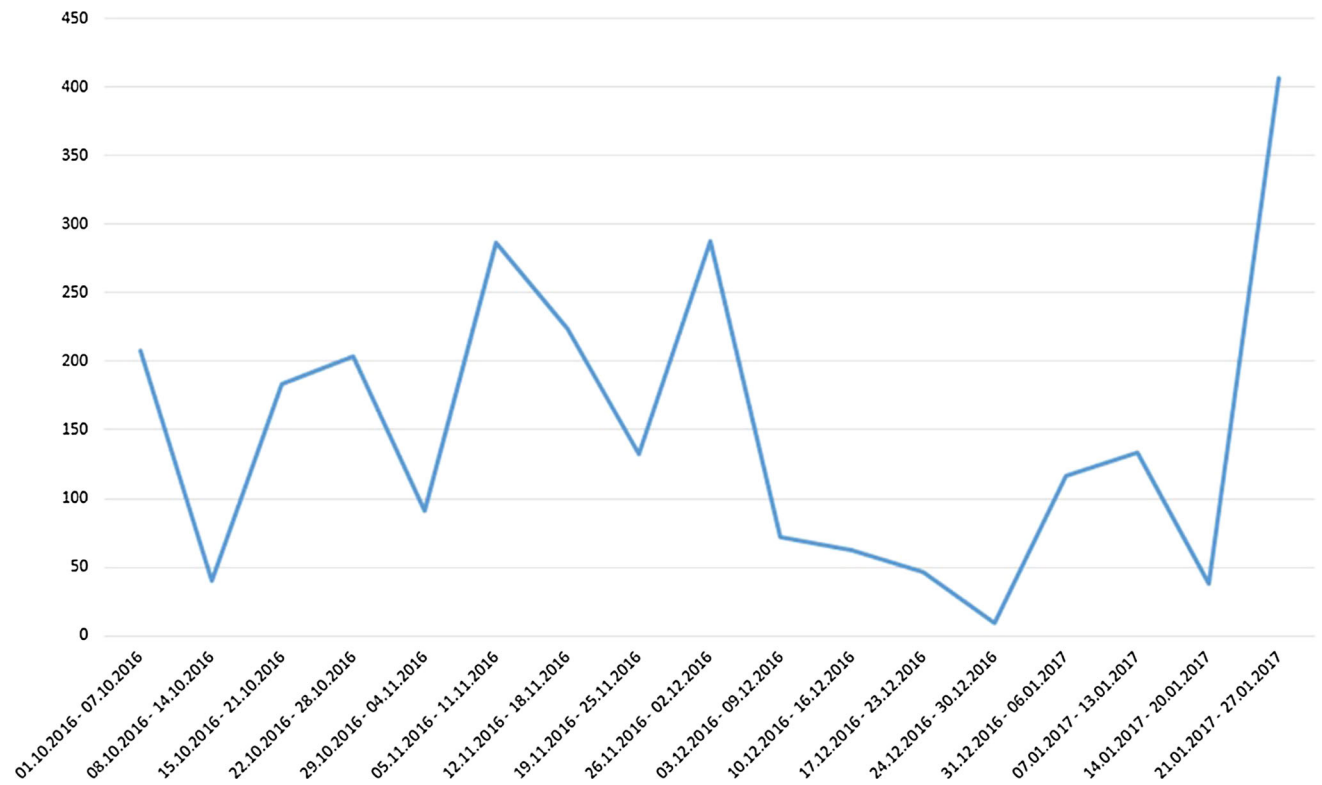
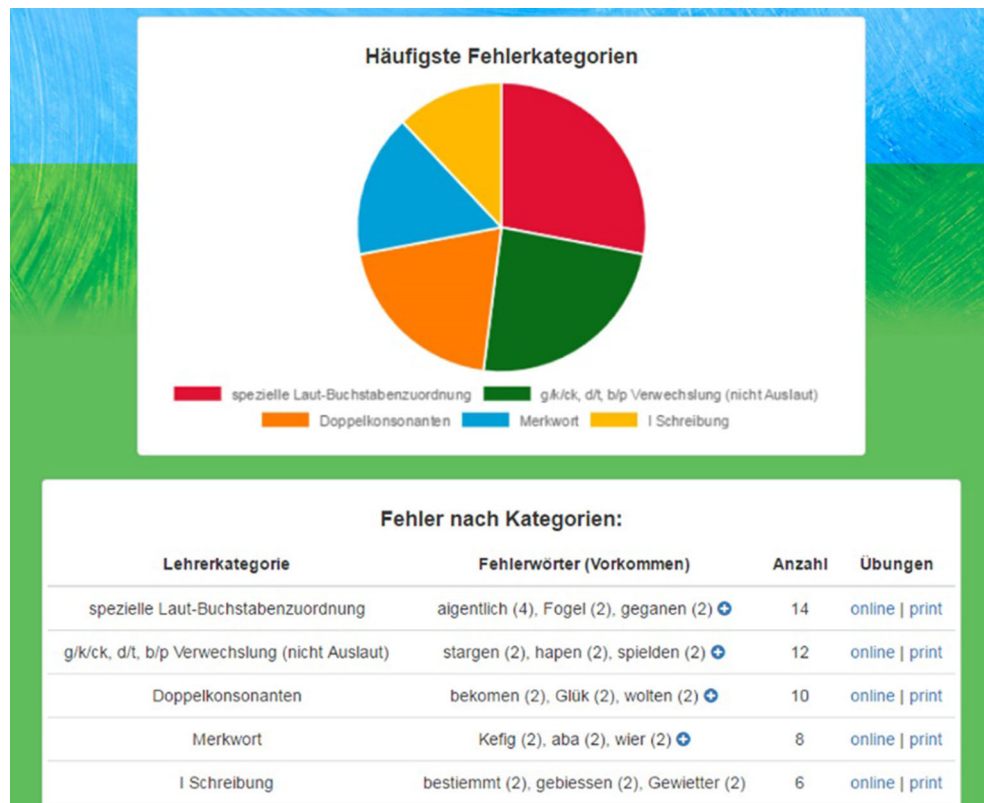


Fig. 12 Weekly login statistics

ence in using computers and digital media. The platform is easy to use and in general is self-explanatory. In some cases the text creation process took a little longer, because of inexperience with keyboards and/or inability to use the ten-finger system, especially among younger students.

6 Discussion and outlook

This article presents the architecture of a newly developed platform for children aged 8–12, with the goal of motivating them to improve their spelling skills by writing and publishing texts in a blog. Furthermore, it gives insight to the first experiences collected due to the use of schools and pupils in a classroom setting. The unique feature of this platform is that during the text creation process, students benefit from automatic feedback provided by the *intelligent dictionary*. This feedback is based on categories with age-appropriate responses for mistakes. As described in the previous section, the *intelligent dictionary* is able to recognize almost 23% of the mistakes in texts written by pupils from grades 3 to 6. This is a very promising finding considering that this is a prototype and furthermore the infinite number of words, word forms, and the contingent potential mistakes. Furthermore, the platform provides a qualitative analysis for teachers, who can use the results to help the pupils to improve their spelling. A training database provides teachers and students with suitable exercises for supervised and unsupervised learning. It is planned that LA will be used for in-depth analysis [31] of the misspellings that occurred to help understand the process of spelling acquisition in detail. Subsequently, the results together with an overview of mistakes that are possibly made on a systematic basis will be presented to students, teachers, and parents in an appropriate form. Over the long term, this will allow the measurement of a student's performance [51]. In order to fulfil these expectations, pupils should use the system more intensively. The platform offers a unique combination of writing, feedback on spelling mistakes, and text publishing in a single application, which is likely to bring a very positive impact for didactic approaches, education, and science [3]. We expect to see increasing use of the platform—especially after the training for teachers' in summer term 2017—and as a consequence more data will be produced for making greater use of language analytics. We will be able to better understand the process of spelling acquisition by carrying out an in-depth analysis of the spelling mistakes learners make. In addition, we will be able to make predictions about future performance of students. Furthermore, learning materials can be improved by using these results by considering the most problematic areas of spelling acquisition based on

empirical evidence. For teachers and parents, in particular, the platform will offer a benchmark for the student performance and provide recommendations for personalized exercises and reflection on these recommended exercises. The results will be presented with age-appropriate graphics and information for students as well as their parents and teachers.

The spelling mistakes in the *intelligent dictionary* are categorized by different linguistically predefined aspects, which have been further fine-tuned. An analytical approach can help to discover correlations of occurred spelling mistakes from these categories. Similar approaches can be found in the literature of other educational fields such as mathematics [52–54].

Furthermore, we will be able to analyse the words usage frequency of pupils aged between 8 and 12. This will be very useful for all areas of language teaching since word lists by frequency are currently available only on the basis of adult language use and not on that of the words used by children.

The system allows to conduct analysis on various levels from fine-grained to coarse-grained. Concerning fine-grained analyses, for example, we will be able to state how often a specific word is used in general and also how often it is spelled either correctly or incorrectly. In the context of misspelled word forms we will be able to carry out further distribution analyses in different categories. In coarse-grained analyses, for example, we will be able to make meaningful statements about the distribution of mastering and disregarding specific categories and orthographic phenomena.

Due to the fact that the *intelligent dictionary* only contains a selection of words and their misspellings, a great deal of free space is available for improving the system by adding new words and their potential misspellings based on the actual performance of the users.

As some categories take into account the differences in pronunciation in different German dialects, we can gain some insight into the impact of dialects in spelling acquisition.

A frequent feature of recommender systems or learning applications [52] is that users can be clustered according to their so-called answering behaviour to the system. This can be defined as simple spelling mistakes or the evolution of spelling mistakes made by the users over time and in accordance with influencing parameters. A similar approach can be found in the work of Taraghi et al. [55], which considers simple mistakes in multiplication problems. Last but not least, if user clustering is already implemented, further research can be done to achieve an adaptive learning algorithm that can be implemented in an intelligent learning application using common machine learning approaches in education [52, 55]. In such an

application the system is able to intelligently adapt the learning algorithm to the new requirements of the learner, in dependence on the competence level he or she has achieved. Furthermore, the adaptive algorithm would be able to provide the learner with appropriate learning exercises, which will help the user to reach the next competence level.

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