

Designing an E-Learning Platform for Reading Comprehension

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Abstract: In this paper we present an innovative e-learning platform that was specifically designed to support the teaching of reading comprehension skills. First, we describe the principal difficulties of reading in a foreign language and then detail how the multitude of exercise types the presented system has at its disposal, gives support in acquiring reading comprehension skills. We show a few more supportive features of our platform and furthermore present the intuitive WYSIWYG style authoring tool which constitutes a major benefit for language tutors in creating and modifying the contents of the platform. Finally, some technical details are sketched and future developments of the platform are discussed that may also be of particular interest for the maintainers of other, similar e-learning systems.

Introduction

Language Training Online is a unique e-learning platform that has been developed in cooperation of the Language Centre and the Institute for Information Systems and Software Technology of the University of Passau. The platform is specifically designed to help strengthen the reading comprehension skills of students with particular attention paid to the difficulties of reading in a foreign language. While the platform has been developed in a modular way and is fully capable of handling learning content from other fields, suitability for reading comprehension has always been the major goal in its design.

One of the core features realized in the platform is a multitude of exercise types that are embedded in a comprehensive didactical approach to train reading comprehension skills in a particularly effective way. Students are required to apply a wide variety of reading skills and strategies during the exercise sessions, guided by the tutorial component in the form of reading hints, time limits or appropriate wording of the exercises themselves. Another central component that has been crucial for the success of the platform is its integrated authoring tool that allows for an efficient and intuitive content creation and maintenance. The tool provides a convenient, yet powerful WYSIWYG style interface for all aspects of exercise editing which language tutors find very efficient to use.

As one of its greatest advantages, the tool presented in this paper can be used independently from the given learning context, i.e., it is in no way restricted to languages but can be used in any field of learning and/or instruction, such as law, geography, history, etc. In fact, it has already been successfully used in CBT/WBT training arrangements for bank employees. However, in the context of Russian Online many functions have been newly designed or adapted to the specific needs of language learning (such as mark-up exercises, drag-and-drop exercises including pictures or whole text passages), thus greatly widening the scope of the tool.

The main contributions of this paper are:

- The design of an e-learning platform with particular focus on reading comprehension;
- Various exercise types that are specifically targeted to the goal of the platform;
- Concepts that further support the learners;
- The description of an intuitive and convenient authoring tool;
- The presentation of technical aspects of the presented platform, e.g., details of the object-oriented modeling of the described exercise types;

The rest of the paper is organized as follows: In section 2 we present the *Language Training Online* platform that realizes the concepts described in this paper and serves as a reference implementation. In section 3 we will discuss didactical aspects such as the special requirements for training reading comprehension skills and the various exercise types to fulfill these requirements, as well as features of the authoring tool. We describe technical aspects of the implementation in section 4, detailing the object-oriented modeling of our exercises and discussing future developments such as the integration of the platform into a campus management system. We finish with a conclusion and some ideas of future work.

Running Example

To illustrate the concepts of our paper, we will first describe our platform *Language Training Online* which was built to realize the described concepts and which is currently in use at the language centre of our university to supplement the classroom lessons with learning units for autonomous study. The platform is centered around a portal website that mainly contains administrative functions such as user management and course enrollment. Furthermore, extensive statistics are provided both for the learners to give them feedback about their learning progress and for the teachers to inform them how well the students do with the exercises.

The portal allows *students* to launch the available learning units in a Java-based dedicated player application which displays the texts and associated exercises of a learning unit. The player is able to automatically correct individual exercises, providing immediate feedback to students about the correctness of their answers, pointing out mistakes as necessary. When all exercises of a learning unit have been completed, the results are transmitted back to the web server and are stored there for statistical aggregation. The platform offers additional aids, for example, an electronic vocabulary book, to further support the students in their learning the foreign language, as we will detail later. *Tutors* may use the web platform to edit the contents and administrative data (e.g., allowed number of repetitions for an exercise) of the learning units, using a WYSWYG style authoring tool. They can also handle all aspects of course enrollment and user management for their lectures.

The platform includes a multi-client capability which supports running several instances on the same server independently of each other. Therefore, each division at the language centre has its own installation that they can use for their courses, while the entire platform can be maintained centrally. We use concrete examples from “*Russian Online*” within the scope of this paper, as the Russian division was involved in the initial development of the platform and their client therefore has the most comprehensive contents.

Didactical Aspects

Reading Comprehension of a Foreign Language

Lutjeharms (Lutjeharms 1998) describes reading as a “complicated task that figures many kinds of knowledge, abilities and psychological factors which may vary individually. Also, text types, reading goals and reading styles may vary strongly” (see (Lutjeharms 1998)). In this context, we can distinguish searching, orienting, cursory, total and argumentative reading, among others (see (Helbig 1998), (O’Malley 1990) and (Anderson 1991) for a more detailed characterization of different reading styles). Therefore, great flexibility is a central requirement of a platform to train reading comprehension. It must support the various kinds of exercises (Alderson 2000) that are required to train the different reading styles and also accommodate individual learners’ interests as far as possible.

When reading texts in our mother language, we normally apply necessary previous knowledge automatically and unconsciously. However, when reading in a foreign language (Nuttall 1996), this strategy cannot be applied as successfully as we usually lack sufficient knowledge and connotations specific to the foreign culture.

Finally, unfamiliar grammar, syntactical structures and insufficient vocabulary skills pose a significant challenge in understanding a text (see Koda 2005). In particular, a learner is usually unaware of the problems arising from foreign cultural knowledge.

A platform with the goal of developing the reading abilities in a foreign language has to take all these factors into account. We will now describe how the available exercise types of our platform are designed with this goal in mind.

Available Exercise Types

A learning unit of *Russian Online* consists of a sequence of texts and exercises. Text pages form the basis of the subsequent exercises and may contain embedded images and other HTML formatting (e.g., bold text or tables). See (Radde et al. 2006) for a discussion of the didactical concepts behind the arrangement of texts and exercises. As visual aids for the students, the texts can be assigned various semantic labels (e.g., grammar description or word explanation) and different levels of difficulty. This is important in so far as within a given group, learners rarely have exactly the same level of competency. Hence, there must be some degree of differentiation as far as texts and exercises are concerned: A stronger learner will, in fact, rapidly be bored by texts and exercises that seem to be too easy for him or her, whereas others might find just the same elements perfectly adapted to their needs.

The text units consist of authentic Russian text material and form an important part of the whole teaching concept. However, the distinctive feature of the presented platform is its multitude of exercise types. The exercises are designed to be solved interactively within the player application, which then verifies the learner's answer. If necessary, the user will be informed about the number of mistakes and may then try to solve the exercise again (depending on how many attempts have been allowed for the particular exercise by the teacher). After the user has used up the allowed attempts without finding the correct solution, the player will display a suggested correction to him or her. With some exercise types, this may be achieved by adding marks to the last answer that are similar to corrections that a teacher would give in writing. For others, the correct solution and the student's answer are shown next to each other for comparison. (Fig. 1) shows the mechanism for a multiple choice exercise, where choices selected by the student are displayed as ticks, while the arrow indicates the (only) correct solution.

Mark the answer of the following question:

Почему Надин не хотела жить в общежитии?


- потому что она не говорит по-английски
- потому что там много иностранцев
-  потому что в России она хотела говорить только по-русски

Figure 1: Solution of a multiple choice exercise

This possibility of giving more or less direct feedback to learner decisions seems to be important as it will enhance learning in numerous ways. In fact, any type of feedback, be it positive or negative, can have this effect as long as it is the learner himself who can decide whether feedback is welcome or not. In the case of negative feedback adult learners usually begin reflecting on their errors, thus strongly stimulating language and learning awareness. This can be even more enhanced by giving learning hints and questions directed towards the learning process. On a more abstract level, it can be said that the direct feedback option widens the degree of interactivity of the tool and therefore opens up a wider range of additional processing activities in the learners that will help consciousness rising. After the user has completed all exercises of a learning unit, the solutions are sent to the server which saves the results and generates the statistics.

The following types of interactive exercises are available in the platform:

- **Grouping exercise.** In this exercise, the student must assign different terms to groups. The user interface shows both the available groups and the available terms as a list. The terms may then be moved to a group using a "drag & drop" interface. This exercise is suitable for, e.g., sorting terms of different topics, such as kindergarten, elementary school, high school and university to their corresponding groups or, as another example, for differentiating the grammatical forms of words ("Group these verbs according to tense: past, present, future"). It is also possible to add some "dummy" answers, which then may not be assigned to any group by the student, which allows further variation in the usage of this exercise type.
- **Sequencing exercise.** In this exercise type, an array of numbered gaps and an array of mixed words or collocations are given. The students must fill the available gaps in the correct sequence. This exercise can be used to train the reading of "procedural" texts, such as recipes, as the student can be trained to reproduce the most important points of a text in correct order.
- **Gap text exercise.** In this exercise, some words of a text are replaced by gaps that must be filled in by the student. The tutor may decide to make the missing words available as a list next to the text so the student can use drag & drop to fill the gaps. Alternatively, the student can be forced to type in the correct word for each gap him- or herself without further aid. This exercise is suitable to learn collocations or to find short answers.
- **Gap picture exercise.** As a logical extension of the gap text, this exercise allows to position gaps freely on a background image. Only drag & drop of provided answer possibilities is allowed here, but the possibilities may either consist of text (e.g., names of cities or rivers that must be placed on a map) or images. The exercise may be used to train vocabulary skills by naming various items (cf. (Fig. 2)) or to simulate the "filling out" of official forms.

Do you know, what are the names of the below painted things in Russian language?
Fill the spaces below the pictures with names from the right column:

(Klicken für Übersetzung)

купальник
плавки
шуба
солнечные очки
спрей от комаров
зонтик
шорты
солнцезащитный крем
босоножки
тёплое бельё
сапоги
шарф
шапка
льжжные ботинки
варежки
ветровка

Figure 2: Gap Picture Exercise in Player

- **Text input with and without automatic evaluation.** In these two very similar kinds of exercises, the student is supposed to write a short text. The system is able to automatically compare the student's answer to a sample solution provided by the tutor but as only exact matches can be counted as correct, use of this automatism is obviously limited to very short answers. For longer answers, e.g., short essays, the system can be configured to simply store these answers on the server upon completion of the learning unit. Later, a

tutor personally corrects these exercises and may assign points manually. Students can access the reports about these exercises via the web platform.

- **Multiple choice exercise.** In this exercise a user can choose one or more answers from several provided possibilities (cf. (Fig. 1)). This exercise is suited for questions that ask for concepts or ideas mentioned in a previously read text.
- **Marking exercise.** Somewhat similar to a multiple choice exercise, here the user again has to mark correct answers. However, these “answers” are in fact single words or whole sentences embedded in a longer text. The marking exercise is important for spotting key words, i.e. names of politicians in a text about politics. Marking exercises can also be used when learning grammatical forms. Here, a student should mark only words in a given grammatical form (i.e., verbs in past tense). The author has different options to choose how the player visualizes these markings, e.g., by changing the font color, underlining or erasing the marked words.

In real life, mark-up exercises are quite different from computer-based mark-up. There is in fact no sharp border in real life. You will feel that any marked-up passage will immediately strike your attention, be it underlined in a precise or, on the contrary, imprecise manner. In other words, the exact beginning or end of the mark-up line doesn't really matter. This, of course, leads to a big problem in computer-based exercises, as mark-up borders usually have to be assigned in an absolutely precise manner, following a strictly binary logic. We have therefore spent some time on dealing with this problem and have come up with a solution that allows imprecise mark-up even in computer based exercises, at least to some extent. We have decided to use an “ambiguous” marking, which is always evaluated as a correct answer regardless whether the student marked the corresponding text as a solution for this problem or not. Ambiguous text fragments can be indicated by tutor and provide for the desired fuzziness of marking as mentioned above.

- **Marking with multiple colors.** This exercise practically combines several marking exercises into one. Based on the same text, the student has to mark the answers to different questions in different colors. As an example, consider the description of a journey, in which a student should mark in red color if someone was flying, green if someone went by train and blue if by ship.

Other Features of the E-Learning Platform

Another important feature that can be used to specifically train some kinds of reading strategies is *limiting the time* in which reading the text or working on the exercise must be completed. For some reading strategies it is important that the student reads fast or that he or she works on an exercise without thinking about it too much. Setting a time limit is a practical way to enforce the use of certain reading techniques, e.g., cursory reading, of a text that would be hard to practice otherwise. Furthermore, practicing how to work under time pressure also has its advantages when preparing for exams.

To widen the scope of the e-learning platform somewhat beyond reading comprehension, each text page or exercise may be enhanced with an *audio file* in MP3 format. In particular for a language like Russian that uses its own specific alphabet, the reception of new vocabulary in a text can be greatly improved by hearing the pronunciation of the new words at the same time. Additionally, the tutors may choose to give the task description *only* as an MP3 to further intermix listening comprehension and reading comprehension training.

Some of the learning units in the presented platform currently are composed of more than 50 exercises with associated text material. Completing an entire learning unit during a single uninterrupted work session is therefore not feasible anymore. Therefore, the platform allows to temporarily *suspend* the execution of a learning unit and to resume working on the exercises at a later time. As the results are stored on the server in between, it is not necessary to work at the same PC when resuming.

The platform also provides functions of a *vocabulary book*, in which a student can store his or her notes on particular words of the foreign language. The vocabulary book is available across all learning units from within the player application. Currently, each student can individually store those words that are difficult or important for him or her. However, we are considering additional features like sharing of vocabulary entries or providing pronunciation aids via audio files. In the *Russian Online* version of the e-learning platform, the vocabulary book is optimized for the specifics of the Russian language. Apart from the “classical” two column layout to display corresponding words in the native and foreign languages, it is also possible to store specific features of particular word classes, e.g., gender for substantives, aspect, conjugation and past forms for verbs, etc. These additional features are adapted to the specifics of other languages as needed.

Finally, to allow students to work on the course material when not having a PC available or being connected to the internet, the platform supports a print function, which provides PDF files to the students that can easily be printed out. While the printouts obviously do not contain interactivity functions, we have taken great care to provide a look and feel that is similar to common “work books” which also contain many of the exercise types that our platform supports.

Authoring Tool

We have designed a comprehensive and user-friendly authoring tool that allows teachers to create and maintain both texts and exercises by themselves. The authoring tool retains the look and feel of the player application as far as possible, only adding a few user interface components to allow for modifications of the exercise. A preview function is included to provide true WYSIWYG inspection if necessary. (Fig. 3) illustrates this concept by showing the same gap picture exercise both in the player (left side) and the editor (right side). The texts are at their correct positions in the editor while they are arranged in a random order next to the picture in the player. Furthermore, a few additional menu bars are introduced to allow, e.g., editing of the question text, time limit, difficulty etc.

Providing an integrated user-friendly editor has the advantage that the learning content may be edited directly by the tutors of the language centre. No programming skills are needed to use the many different exercise types to create learning content. Instead, teachers may directly implement their educational ideas within the framework that the platform provides, without having to relay their thoughts to specialized authors or even programmers. Simplicity and intuitiveness of authoring comprise one of the major benefits of our platform, as this is a cornerstone for the creation of high quality learning content.

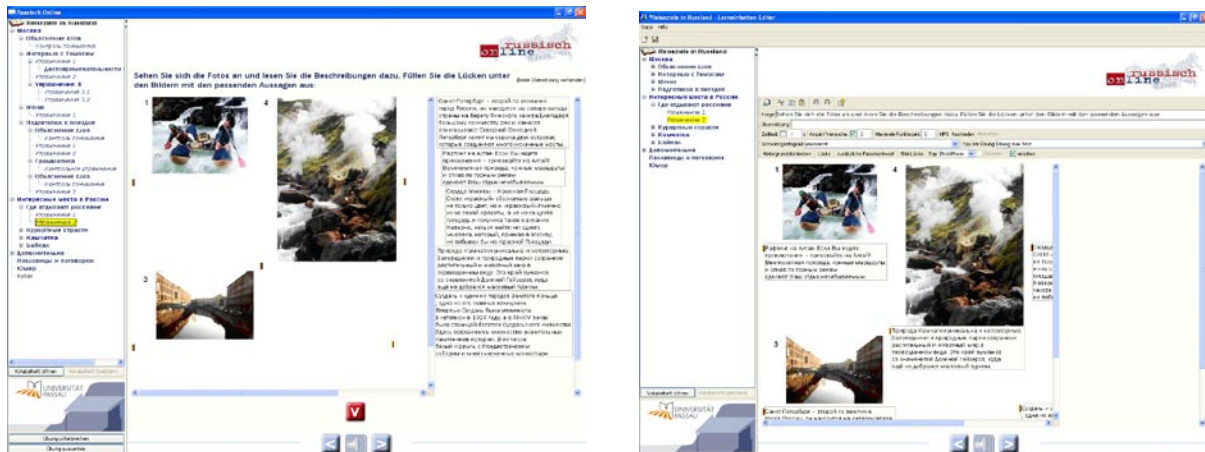


Figure 3: Screenshot of an exercise in the player application (left) and in the editor (right)

Related Work

It is difficult to compare the platform *Language Training Online* with common commercial suppliers, as those systems usually have different goals. The goal of common commercial solutions, e.g., Saba Learning Suite (Saba 2007), is to provide learning material as easy and quickly as possible without giving too much thought to the didactical concepts. In contrast, the concept of *Language Training Online* Platform is based primarily on a didactical framework, extending common exercise types by a number of new types. Furthermore, offering optional answers may go against trends in commercial e-learning systems, which only provide sharp, easily computable answers. Our platform implements optional answers, which is, as mentioned, essential for language learning.

Another system which was developed for e-learning of foreign languages is SZBrowser (Sprachenzentrum 2007) from the Language Centre of Friedrich-Alexander-University of Erlangen-Nuremberg. This software provides technically similar concepts as our system, but does not seem to include a didactical concept based on pre-reading and post-reading tasks as described in (Radde et al. 2006) for our platform. The authors of the SZBrowser claim an advanced system of statistics for tutors as the greatest didactical advantage of their platform. Furthermore, they do not support the student’s own learning process with statistics, as our platform does.

Usability for other purposes

As mentioned, our platform has been developed having in mind a didactical concept for reading comprehension in a foreign language. However, since the system has been designed in a modular and configurable way, from a technical point of view it is easily possible to use the system for other kinds of content as well. As an example, we consider a university course for freshmen, which confronts students with the scientific language for the first time. Being only familiar with rather simplified school text books, now having to deal with exact and concise scientific texts is similar to use a foreign language. The new students do not have much previous knowledge in their field of study and are not yet accustomed to this kind of language. Therefore, this application has similarities to the above mentioned features of reading comprehension in a foreign language. From this point of view it is reasonable to not only use our software platform for this course, but to build it along similar didactical concepts as well.

To give an example of the technical extensibility of the software, we can use the platform to extend electronic lecture notes by interactive exercises to verify the student's understanding of the provided text. The current version displays "only" the number of errors and the correct solution if a student made mistakes within an exercise. At this point, the feedback can be extended to provide a hyperlink to the corresponding chapter in the lecture notes to lead the student to reading more details about the necessary parts of the lesson. This example shows a possible combination of the platform with externally stored lecture notes that leads to a deepened acquisition of knowledge in many fields of teaching.

Another possible direction of further development of the platform is the usage of a dynamic navigation within the learning unit based on the results of the exercises. This way, a student having given wrong answers can be re-directed to the former text or be sent to another similar exercise, whereas a student with correct results would be forwarded to the next chapter directly. So we move away from the concept where the choice of the exercises is recommended by the tutor towards a model, where the system itself determines the suitable exercises for the user. Although the tutor still sets rules based on which the system chooses the exercises, the role of the tutor is reduced in its importance. Such a concept is not anymore suited for teaching foreign languages ideally, but it may be appropriate in other pedagogical areas.

Experiences

Extensive practical evaluations within the Russian courses of the language centre have shown that the platform is widely accepted and rated as a valuable extension to traditional courses amongst the students. Acceptance and motivation were surprisingly high right from the start of the project, and students requested to continue treating the texts and exercises of the platform during the classroom lessons that are normally focused on completely different topics and content. Carefully interleaving content and methods of the concepts of *Language Training Online* and the classroom course modules to cover all kinds of language skills will lead to a new level of quality in the language teaching at our university in the form of a true blended learning arrangement. The *Language Training Online* platform will then serve to extend and supplement our course concept and will also be made available to individual learners that are particularly interested in developing their skills by self-study.

Apart from the authoring tool, having access to detailed statistics down to the question level is a valuable tool for tutors. These statistics allow spotting students' misconceptions about the exact intentions of particular questions, for example. Our tutors use these statistics to identify special issues and address them during the classroom lessons and to improve questions when the statistics indicate that their wording is probably unclear to students.

Technical Aspects

Modeling of the Exercises

The software architecture of the platform is based on the Model-View-Controller concept that is well-known in software engineering (cf., e.g., (Gamma 2000)). Using this pattern, the internal data of the exercises are independent of the technology that is used to actually display them. This design allows, for instance, to use different visual representations for marking a word (i.e. underlining or coloring). Another example for its usefulness is the relative

simplicity of the authoring tool that works on the same data structures as the player application but, as mentioned, uses editable GUI components.

We use inheritance (Gamma 2000) to take advantage of the fact that many exercises are similar or share a core of common functionality. (Fig. 4) shows the inheritance tree for our exercise model.

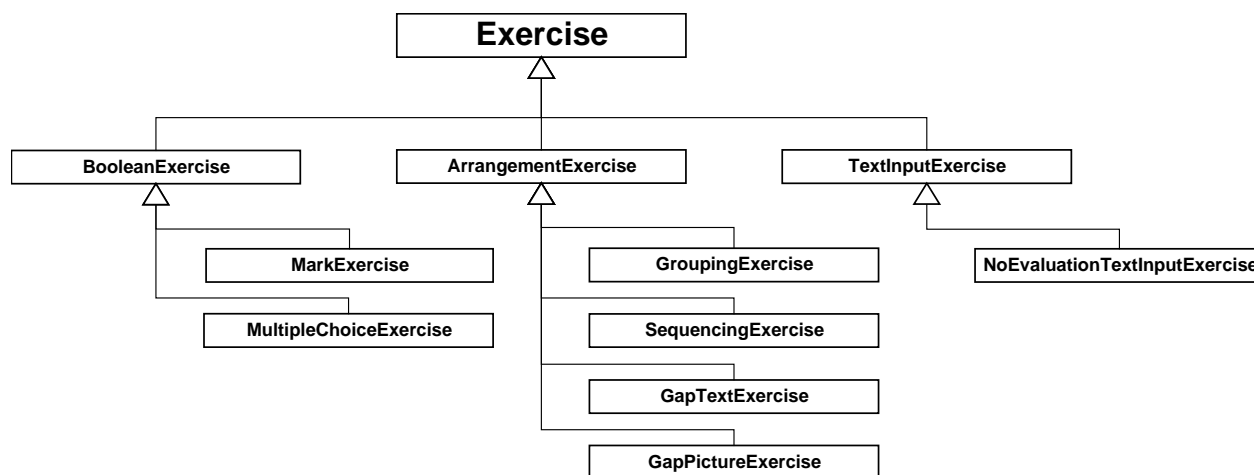


Figure 4: UML Diagram of Exercise model hierarchy

The advantages of this construction become evident from an example of the internal data structures of the marking exercises which are very similar to a multiple choice exercise. Their common "parent" class **BooleanExercise** uses a general algorithm to correct both types of exercises – eliminating unnecessarily redundant program code. All children of the class **ArrangementExercise** similarly share a common internal representation and correction functionalities.

Integrating the Platform into a Campus Management System

As we already discussed in the didactical aspects session, *Language Training Online* is a suitable platform to support the acquisition of reading comprehension skills. Reading comprehension is an important building block for language courses, in particular for learners that want to study original texts. However, it would be advantageous to embed *Language Training Online* into a platform that supports more kinds of learning material (e.g., printable scripts for applied geography lessons) to achieve our goal of approaching a blended learning arrangement.

Our university has recently introduced a complete learning management system (LMS), in our case the German open source software Stud.IP (Data-quest 2007), which is intended to serve as a central portal for students to access all material and information related to their studies, including lecture notes and exercises management. Integrating *Language Training Online* into this system therefore presents itself as an ideal opportunity to blend the online learning units with the more traditional teaching techniques. Furthermore, this integration would allow us to reduce redundancies particularly with user management, course enrollment and similar general functionalities. In the near future a number of web services will be implemented for *Language Training Online* that provide functionality like listing available learning units for a student or launching a particular learning unit. With the integration aimed at, the learning units would be launched directly from within the LMS, without invoking the web portal of *Language Training Online* at all. The usage of standardized web services will allow easy interfacing with other portal applications or campus management systems as well.

Only tutors would have to access the portal to obtain information that cannot easily be exposed to external access by a LMS, i.e. the fine-grained statistics which give much more detailed information, e.g., about single questions within the exercises, than the course-based level that the LMS "sees" of *Language Training Online*.

Technology Review

While it may be possible to realize the display of our learning units using the AJAX technology (Garrett 2005), particularly its Java binding in form of the Google Web Toolkit (Google 2007), we decided to "leave" the browser

by packaging the display technology into a dedicated Java application that is delivered to the users via the Java WebStart (Sun 2006) technology (see (Radde et al. 2006) for a detailed description of the process).

The advantage of an AJAX based web application is that it does not require the installation of particular software apart from a web browser (and, possibly, required plug-ins like Flash), whereas our approach makes it necessary to install a Java Runtime Environment prior to running a learning unit. However, all computer labs at our campus are already equipped with this required software and we provide extensive installation help to students that want to do the exercises at home. Note that the player application itself does not need explicit installation.

As another aspect, using AJAX requires to carefully consider security implications. Cheating our closed player application is technically difficult but may become significantly easier when changing to the “open” architecture of an AJAX application that relies on HTML and JavaScript (see, e.g., (Chess et. al 2007) for a description of an eavesdropping attack on many common AJAX frameworks). Of course, this issue becomes more pressing if we decide to also run *exams* within the platform instead of mere lessons and homework. Securing an AJAX platform in any case requires moving more functionality to the “trusted” server environment, placing additional performance burdens on the server, thereby possibly increasing operating costs of the platform.

The mentioned moving of functionality from the client to the server also has implications concerning the offline-capabilities of the player application. An AJAX based implementation would practically require permanent online access, whereas the current player application requires an active internet connection only when downloading the learning unit at the beginning and when transmitting the results back to the server at the end. In between, students can work on the exercises without being connected to the internet. Furthermore, the current player application may be adapted to run fully offline, i.e. from a CD-ROM, whereas an AJAX based implementation would require a major redesign to achieve offline capability.

Summarizing, the Java-based player application is appropriate for our intended fields of use. To improve distance teaching support and to accommodate users who prefer a pure browser-based access, an AJAX-version of the player application is under development.

Conclusion and Outlook

We have presented the design and properties of an e-learning system that is devoted to the training of reading comprehension skills. Using authentic texts and a multitude of exercise types, the learner is prompted to actively apply a wide range of different reading skills and strategies to solve tasks such as the acquisition of new vocabulary or new cultural knowledge. The learner is supported by helpful tools, e.g., a personal vocabulary book, pronunciation aids and printing facility. Authors are supported by a comprehensive editing tool that enables efficient, WYSIWYG-style creation and maintenance of the content of the platform. Furthermore, we presented facets of our technical platform that realizes the described design goals and discussed our implementation decisions. Following its successful start with the Russian language, we are currently extending the contents of our platform to encompass lessons for more of the languages that are offered to students by the Language Centre of our university. We furthermore aim to extend the scope of the platform to provide its services not only to the University of Passau but also to a broader audience.

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