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ÚSTAV JAZYKŮ

**DESIGN OF AN E-LEARNING APPLICATION
FOR THE COURSE ENGLISH FOR IT**

TVORBA E-LEARNINGOVÉ APLIKACE PRO KURZ ANGLIČTINA PRO IT

BACHELOR'S THESIS

BAKALÁŘSKÁ PRÁCE

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DOPORUČENÁ LITERATURA:

- 1) Computer Desktop Encyclopedia. Point Pleasant: The Computer Language Company Inc. Retrieved from <http://www.computerlanguage.com/>
- 2) Schildt, H. (2014). Java: The Complete Reference (9th ed.). New York: McGraw-Hill.
- 3) Oracle Java SE Embedded: Developer's Guide. (2014). Retrieved from <https://docs.oracle.com/javase/8/embedded/develop-apps-platforms/>

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Abstract

The aim of this bachelor's thesis was to develop an e-learning application that would be used as a supplementary tool for the course English for IT. First, the thesis examines existing applications used for English vocabulary learning along with the consideration of what elements could be derived from them. Next, it focuses on the design and implementation of the application as well as the presentation of technologies used. The thesis also provides the theoretical framework of vocabulary teaching and learning which is followed by an analysis of various vocabulary testing exercises employed in the program. Finally, a guide for students and teachers is developed to assist them with using the application. The result of the thesis is the functional application for the students of the course which will enable them interactive vocabulary learning and preparation for lessons.

Key words

e-learning application, Java, JavaFX, GUI, SQL, user, database, toolbar, vocabulary acquisition

Abstrakt

Cílem této bakalářské práce bylo vytvořit program, který bude sloužit jako výukový doplněk pro kurz Angličtina pro Informační Technologie. Práce nejdříve zkoumá existující aplikace, které jsou vytvářenému programu podobné včetně prvků, které mohou být v programu využity. Následně se zaměřuje na návrh a implementaci aplikace spolu s představením použitých technologií. Práce dále zkoumá teorii výuky nové slovní zásoby, po které následuje rozbor jednotlivých cvičení, které jsou v programu použity pro zkoušení nabyté slovní zásoby. Závěrem je zpracován návod pro studenty i učitele, jehož cílem je pomoci s používáním programu. Výstupem práce je funkční aplikace pro studenty výše zmíněného kurzu k interaktivnímu studiu slovíček a přípravě na hodiny.

Klíčová slova

e-learningová aplikace, Java, JavaFX, GUI, SQL, uživatel, databáze, panel nástrojů, osvojování slovní zásoby

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V Brně dne

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Tomáš Hotový

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Tímto děkuji paní Mgr. Ing. Evě Ellederové za podnětné rady a připomínky při tvorbě bakalářské práce.

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1 Introduction

English is commonly said to be the lingua franca of the computer world. A large number of technical terms in the Czech language that are derived from English clearly demonstrate the point. A thorough knowledge of technical vocabulary in this fast-growing field is therefore essential not only for the professionals, but also for the general public. The rapid growth of this field brings another aspect into attention – computer learning. Computers are gradually becoming the prevalent way of learning a new vocabulary as a result of having several advantages over more traditional ways of vocabulary memorizing and testing.

This thesis aims to develop an easy-to-use and portable application in a Java programming language. The application will be used by students of the course English for Information Technology to train the vocabulary acquired during the course and also to prepare for the final test. Several exercises will be contained in the application with the aim of testing the various aspects of vocabulary, such as correct spelling, translating and meaning of words. The vocabulary focuses on twelve different topics that broadly cover the fundamentals in the field of information and communication technology in addition to extra vocabulary regarding the history of a personal computer and the Internet. All of the topics correlate with those taught in the course. In order to describe the ways of using the basic functionality of the application, the guide is to be created for both students and a teacher.

The second chapter deals, as previously mentioned, with the comparison of different e-learning tools used for teaching vocabulary to foreign language learners. The Chapter Three then goes into detail of designing the application. It contains information about the programming language used for the development, data management of vocabulary and the graphical design of the application. This is followed by a theoretical framework which focuses on acquiring, teaching and testing the vocabulary. This serves as a foundation for the fourth chapter dealing with the various exercises used in the application and their function for testing of the vocabulary. The Chapter Six presents a guide for using the application which is separated into *User's Manual* for students and *Administrator's Manual* for a teacher. The conclusion of the Bachelor's thesis is drawn in the final chapter detailing the result of the development and the contribution of the thesis to both the author and the users of the application.

2 Current Applications

The chapter concentrates on four different applications used for learning technical vocabulary and its usage in sentences. It describes the exercises and teaching methods used by each application, before briefly examining the advantages and disadvantages each exercise and teaching method has to offer. The image of the application is also to be presented in order to evaluate the quality of the user interface. Lastly, all the programs are compared in the summary in order to determine what exercises could be considered in the application and which particular aspects of them could be improved.

2.1 Anki

This desktop program has an easy to use graphical interface as illustrated in Figure 1. Despite this fact, it is a rather powerful tool for learning nearly anything. It uses the system of flash cards in sets, which can either be downloaded from the official database, or created by the user. The cards are presented one by one with an option to flip them to the other side, in order to reveal the solution. Once flipped, the user decides how difficult it was for them to recall the answer on the back of the card, which then determines when it should appear again.

The number of cards studied each day, the number of new cards added, the display order and many more can easily be configured. The application is also accessible to users on many different platforms, including but not limited to, Android and Linux systems. The downside of the application is that despite the size of the database, there are no existing decks for learning Czech to English translations of computer vocabulary. Another point is that even though the card system is useful in learning pairs of words, it cannot present more than two pieces of information at once. This is a major bottleneck as our application has to display a word in English, Czech and, moreover, it has to be accompanied by its definition. Finally, it does not offer much in terms of interactivity, innovation or entertainment, so some users might be discouraged from using Anki.

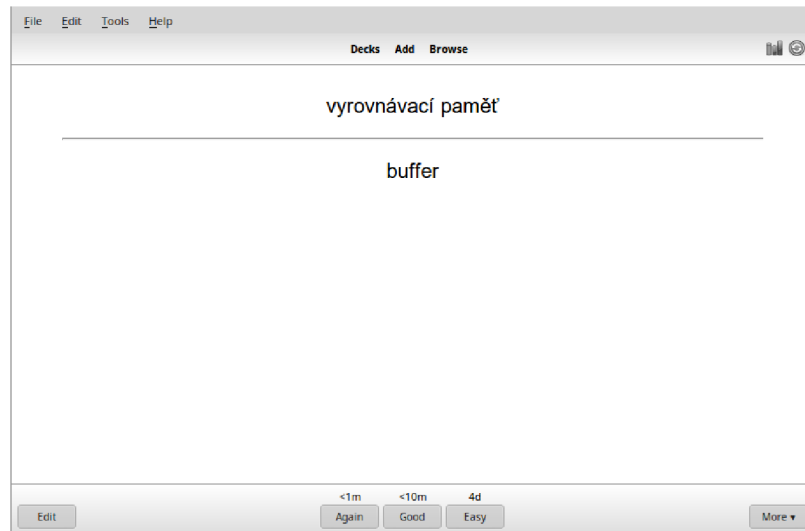


Figure 1. GUI of Anki.

2.2 Memrise

The website tool, which can be used to learn variety of different subjects in nearly all the languages, offers thousands of user-made courses. One such course is called “Mastering Computers”. It takes roughly two hours to finish, while taking the users through the basics of the computer world. It does so by first showing a word along with numerous different images of it. It is followed by testing which uses multiple choice exercises showcasing one of the presented images (see Figure 2). This is done for around 105 words, which demonstrates that the course is rather limited. There are, however, several alternatives to choose from, for instance “Learn Computer Science” which teaches over 1300 words as well as their definitions in twenty-two hours.

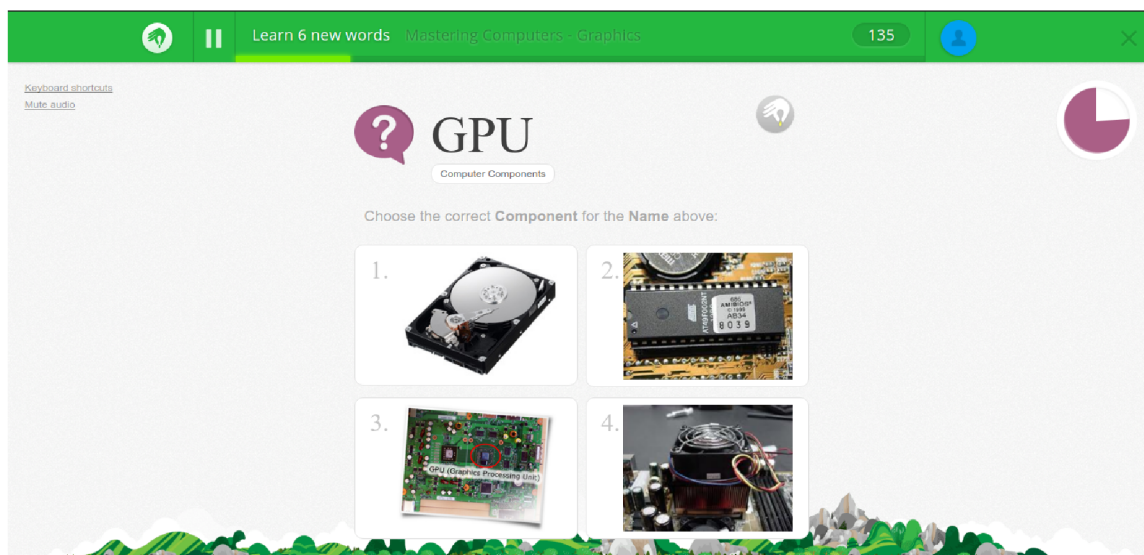


Figure 2. GUI of Memrise.

Despite the number of computer courses for English speakers, there is none to be found in Czech. Another point to be made is that the free version of the site has its limitations. Monthly subscription of about nine dollars has to be paid in order to access courses which offer learning from video and sound recordings. On the other hand, the site makes an outstanding job at keeping its users motivated by allowing them to set daily goals, leveling up their character with every few words learned, or keeping a leader board of the best people in each course. The statistics of the words learned are also kept, therefore the users know when and what to revise. Last but not least, the website facilitates social learning by making the progress of the users visible to their friends and followers.

2.3 ESOL Courses

ESOL Courses are an English learning website featuring multiple online lessons where one of them deals with the topic of computers and the Internet. Despite consisting of only about 100 basic words, the course really shines in its wide variety of exercises. To name a few: matching an image with the correct word in the multiple choice format, finding the terms in a word search, drag and drop exercises with images and definitions, or correcting the words with inaccurate spelling. The website even offers a reading comprehension exercises as well as several videos about the taught topics.

The major advantage is that the course is entirely free to use. The disadvantage, on the other hand, is that the website is rather hard to navigate through (see Figure 3) due to it being overly cluttered. To add even more, the courses do not support any other language and the lack of motivating elements and clear sense of progression can also be observed. That being said, the sheer variety in exercise types compensate well for this fact. Finally, with no other alternatives on the website, the previously mentioned course is far from satisfactory in terms of vocabulary learning.

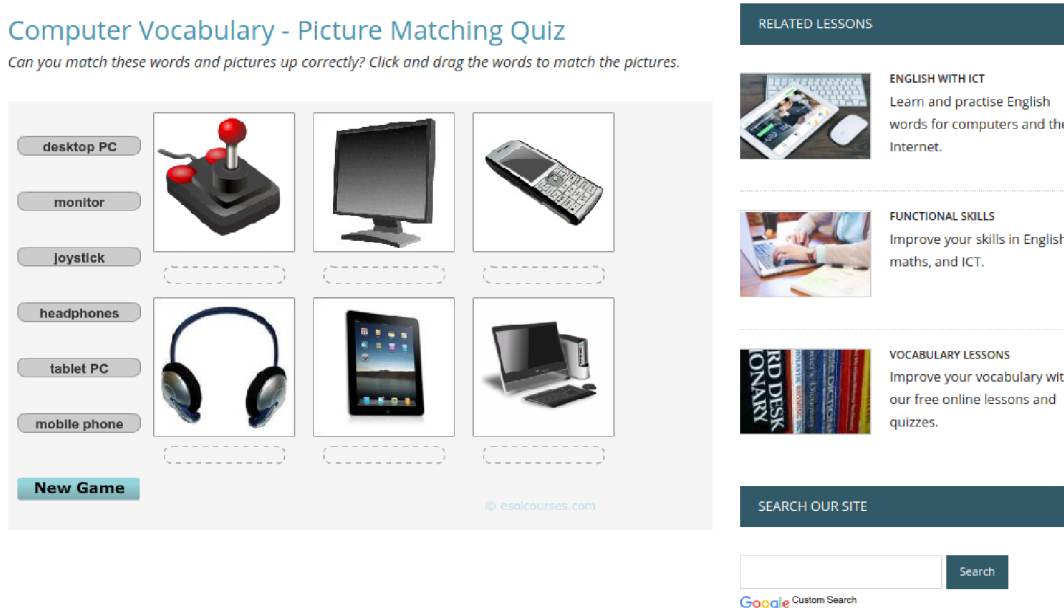


Figure 3. GUI of ESOL Courses.

2.4 Babel

The last website is unique among the others in one particular feature. It is said to have the best voice recognition on the market proving the fact by earning several rewards. The learning is done by linear series of task. First, four words are read to the user along with the written version and the pictures showcasing the words. The voice exercise follows, having the user repeat the words out loud to the microphone, learning the pronunciation. This part can be disabled for the users without access to a microphone. Next, a series of images is presented with the task of correctly spelling the word in the picture. Lastly, the user is asked to fill in the missing words in the sentences. The site offers, besides others, a computer technology course promising to teach about 150 words in fifteen lessons.

Figure 4 illustrates that Babbel offers a clean and simple interface which is easily navigated through. The variety of exercises is more than satisfactory with the voice relating ones being a clear selling point. The downfall of the website is, the same as in previous applications, no courses offered for learning Czech vocabulary. Furthermore, all the positive points come at a cost as only the first lesson of each course is accessible without paying a monthly subscription of about ten dollars.

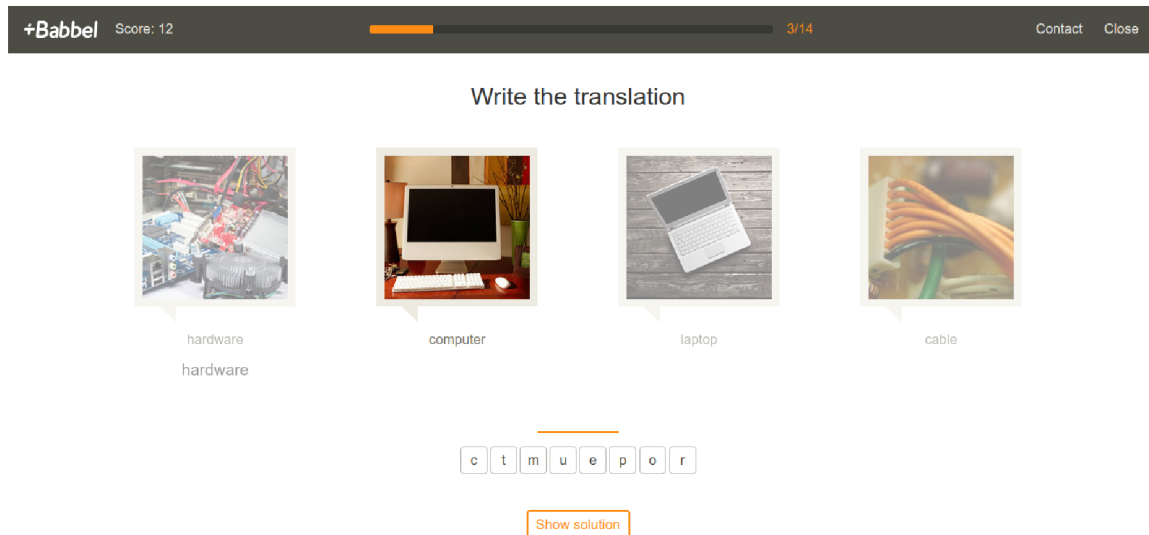


Figure 4. GUI of Babbel.

2.5 Conclusions Drawn

None of the above-mentioned e-learning tools offered learning of Czech technical vocabulary. Only one application, Anki, came close with the option to add custom-made lists of vocabulary. This process is, however, very tedious and does not allow for learning the definitions. Due to this absence on the market, our application has the potential to become an essential tool for many users.

The best variety in terms of exercises was clearly provided by the ESOL Courses with most of them being usable for the purposes of the application. For example, drag and drop exercises where the user has to match the definitions or the translations of words are bound to be used in a similar form which appeared in the course. Correctly spelling scrambled words can also be considered an innovative way of teaching and will be used as well. On

the other hand, several exercises are overly resource demanding to be usable. To match the words with its images would require, in case of one picture for each word, the database of over 800 images. This would make the software unreasonably large in size in order to be easily distributed. To add one more example, the voice recognition would either require months of programming or the use of external tool, which is not acceptable for the purposes of this application.

Finally, the use of motivational elements is to be considered. In this regard, the Memrise website was several steps ahead of the competition with numerous different tools to keep the user motivated. After comparing its results with the others, it seemed arguably the best one, though it is not suitable for our needs as the application has to work in an offline mode only. What could be considered is using the database file to store the information about the results for each exercise as well as more complex words. Thus, the user would see the improvements made and the words to which they should pay attention.

3 Design Methodology

The chapter provides comprehensive overview of design approaches used along with the description of chosen development tools that are best fitting for the purposes of developing the application. The first part covers in detail the programming language used to develop the software including the reasons behind the choice of it. The Graphical User Interface is the next topic where the look and feel of the program is dealt with. The chapter concludes with the in-depth analysis of the data manipulation.

3.1 Java Programming Language

Java was originally conceived by Sun Microsystems in 1991 with the primary goal of creating a platform-independent programming language that would be used for embedding software in consumer electronics, for instance microwave ovens (Oracle and/or its affiliates, 2014). At that time, however, another large area of development that required portability started to emerge – the World Wide Web. This new market significantly enhanced the usability of Java as it found the language to be the perfect solution for its portability issues. In 1995 Java released its first official version which shifted the primary focus on large-scale Internet programming instead of the original aim at consumer electronic devices (Schildt, 2014). Today, Java is extensively used in systems all around the world, in particular for the development of applications for Android mobiles, Web and large businesses (Stack Overflow Developer Survey, 2017).

Java language, due to the partial relation to C++, uses a model called object-oriented programming. This approach organizes parts of code into objects, rather than actions. Such a concept allows programmers, among many other benefits, to understand the code written easily, because humans are used to thinking in terms of objects in an everyday life. Probably the most renowned feature of Java is its principle first mentioned by Sun Microsystems called “Write once, run anywhere”, or in short WORA (Langley, 2002). Such portability is accomplished by compiling a source code into a bytecode, instead of the usual executable code. The bytecode is the same for every platform used, whereas the Java Virtual Machine (JVM), which it is fed into, differs from a system to a system. The JVM also establishes an additional layer of security, as it essentially creates an independent

space in which the code to be executed is contained and, to a certain extent, isolated from the remainder of the system (Schildt, 2014).

Java programming language, or to be more specific Java 8, was adopted to design the program mainly for two different reasons. Firstly, the author of the thesis is most experienced in Java, along with its related development tools. The second and more important reason is that the language offers, as mentioned earlier, great portability and cross-functionality. As a result, the application can run on a variety of desktops without any major difficulties, as long as it has a Java Runtime Environment (JRE) installed on it. This Java feature also allows for an easier development without the need to focus on the specific platform requirements.

3.2 GUI

For the design of the Graphical User Interface (GUI) of the application, the JavaFX graphics platform was used. The decision was made because of the fact that it offers a lightweight, powerful and modern solution while having its libraries built into a Java SE (Pawlan, 2013). Oracle also stated their intention of continual support of JavaFX in the foreseeable future (Oracle, 2017), thus eliminating the need of rewriting the application to use another framework later on.

The design of the application was kept simple and united across the entirety of exercises and menus. All the parts of the program can be accessed through a main menu with the use of the buttons. Upon clicking on one of the buttons a dialog is presented to the user with the choice of, depending on the exercise type, unit, language, difficulty and a variety of other options. Dialogs are common in the application since they offer a simple approach for informing, warning about an error or obtaining a confirmation from the user. However, one of the main GUI elements of the application is a toolbar displayed at the top of the screen during the entirety of exercise solving. The toolbar holds various elements which can be used to interact with the application. These can range from a main menu button to a filter for the table and their presence is determined by the exercise currently opened along with other factors, for instance whether the user is an administrator or not. The cutting-edge technology of JavaFX turned out to be specifically useful while designing drag-and-drop exercises, as they are easy to do, while at the same time being refreshing and

innovative. The support for managing and manipulating tables also turned out to be outstanding, allowing for the creation of a user-friendly table of words.

A number of different keyboard shortcuts were added to the application in order to interact with its various elements. The motivation was to allow users to successfully interact with the program at the basic level without a pointing device. Among the customary one-key shortcuts is an interaction of the Enter key to confirm and the Escape key to cancel any dialog window. These two keys can also be used respectively to submit/repeat an exercise and go back to the main menu. All the buttons can also be navigated using the Tab key and then pressed by the Space key. Among the more unconventional shortcuts is a Ctrl + D combination that enables administrator tools, which are described comprehensively in Chapter 3.4, across the application. All the shortcuts, along with their functions, are discussed in the corresponding sections of the user's manual.

For the theming of the application the CSS technology was used since it is deeply integrated into JavaFX. The created theme uses a light blue and white color palette for most of its elements. This color combination was inspired from the Microsoft's Aero theme which is used in Windows operating systems. All of the buttons that appear in the application are of a modern semicircular shape while most of the other elements have slightly rounded borders. Furthermore, shadows were extensively used for all elements since they help the user understand its function. For instance, an outer shadow was generated around each button giving it a 3D look of an elevated object on the screen, thus indicating that it is clickable. On the other hand, an inner shadow was generated in each text entry field to suggest an element is indented into the screen and to indicate that a text can be filled in.

3.3 Data Saving and Loading

The original intention was to store words inside a text file using a technique called comma-separated values (CSV). Pieces of information about each word (English, Czech and its definition) would be delimited by a vertical bar '|', while each new line would represent a different word. Such an approach might be appropriate for small applications that do not require storing more complex data. However, it was dismissed mainly because of the lack of easy scalability. Since the program requires data to be modified and written back to the

source, it cannot be embedded into a JAR file, or in other words placed directly inside the file the user executes. Therefore, every single data file has to be placed onto the users system. Using CSV would involve either placing all the data into a single file, resulting in a chaos from a programmer's perspective, or creating over fifteen different files, preventing an easy deployment of the software to students. None of the approaches were found reasonable, therefore a different technique had to be used. Fortunately SQLite could be employed as it resolves all previously mentioned problems while adding several valuable features. Additionally, according to the official website, the SQLite database engine is self-contained, transactional and server-less, which makes it perfectly suitable for the application (SQLite, 2017).

The database stores each of its tables inside a single file which is by default placed inside the JAR file (internal database). This placement, however, does not allow for data modifications since, as mentioned previously, Java does not allow for modification of the JAR file during runtime¹. This means that in case the teacher wants to make any changes to words they have to store them in a database file placed inside the same folder the JAR file is located in (external database). The process of doing so is further explained in the following chapter. The external database file then has to be sent along with the application so that it can be loaded on the user's computer. This approach was employed as it allows for an easier deployment by the teacher if no changes were made to words since they only have to send the JAR file to the students. In case the application fails to load an external or internal database, an error message is displayed and the program is terminated. This would usually indicate an error in the data structure of the internal database that would have to be fixed by the software developer. Data can be manipulated using SQL (Structured Query Language), by writing select and action queries which offer a complex but fast and effective way of accessing and modifying the database. The application data is loaded whenever it is needed and remains in the memory for the remainder of the program runtime. This allows for a faster load time of subsequently launched exercises while taking up approximately 100 MB of computer RAM. The database file itself takes up less than 1 MB on a computer hard drive as it only stores text and a couple of images.

Two tables are located inside the database. The first is the table of words where every word contains information about its ID, which is automatically generated upon its creation, unit

¹ The time when the program is running, starting from opening the program and ending upon closing it.

number it belongs to, its English and Czech version, definition and example sentence. Additionally, English and Czech translations might contain semicolon ‘;’ which serves as a delimiter for synonyms. The semicolon may also be used for example sentences to separate multiple sentences from each other. When accessing a specific unit, its number is passed in as an argument to a query which then returns all of its words. For this reason, words belonging to an “Extra Reading” part, even though it is not technically speaking a unit, are assigned a number 13. The second table is more straightforward as it only contains data for the application guides. Each entry in this table includes the name of the section it belongs to, text contained within the part of the manual and images to be displayed.

4 Vocabulary Teaching and Learning

The chapter begins by introducing the theory of how vocabulary can be acquired. Then it describes various ways of presenting new vocabulary to language learners. The final subchapter deals with testing and practicing vocabulary along with the description of several types of exercises used for this purpose. Some of the mentioned exercises are later employed in the application.

4.1 Vocabulary Acquisition

Generally speaking, vocabulary is the most important part of the language for communication purposes. Thornbury (2002) points this out when he states that very little information can be expressed using grammar only. With the good knowledge of vocabulary on the other hand one can express significantly more. As Thornbury (2002) further states each word has two parts that are necessary to know in order to acquire a new word. Those two parts are the form of the word and its meaning. The form is how the word is written and what its pronunciation is, whereas the meaning is much more complex. It involves not only the definition of the word, but also what other words it commonly collocates with, or what register and cultural context it belongs to. Thornbury (2002) also makes a distinction between the productive and receptive knowledge of the word. The productive knowledge of the word means the person is comfortable with using the word in spoken or written discourse, while the receptive knowledge allows the person to merely understand the two mentioned discourses. The productive knowledge is most of the time acquired after the receptive knowledge, since we usually first understand words before we are able to use them properly. According to Chomsky (as cited in Nunan, 2000, p. 129-130) the word can be considered fully acquired only if the person has good understanding of both the productive and the receptive knowledge.

A learning process of new vocabulary is a process that can be separated into several stages (Thornbury, 2002). The first stage is *labeling* when a concept or an object is connected to the word. For instance, when a person learns the word “computer”, the brain assigns the concept to the computer object. The next stage is *categorizing* in which the person

categorizes the word so that it refers not only to the computer itself but also to other types of computers, pictures of computers and more abstract terms. The last stage of the vocabulary learning is the *network building*. In this stage the person realizes the connections to other words that are for instance its synonyms, homonyms, antonyms, superordinates or subordinates. The person then links all these words together creating a web interconnecting the vocabulary. It is important to note that during the second language learning people tend to reuse already created networks and simply map the word to its translation in the first language. This is a problem as it skips all the stages causing the word to have the same connections as the translation even though they might not be precisely synonymous.

In order to understand how words are remembered, the basic work of memory has to be understood. Thornbury (2002) explains that three memory systems exist in our brain: *short-term store*, *working memory* and *long-term memory*. Short-term store is the memory heavily limited by time. It can hold information for several seconds, usually with the use of vocal repetition. Items are usually stored into this memory when we need to use them right away and they become obsolete after its usage. One example may be repeating a spoken promise after someone. In case the information has to be learned or understood it is transferred to the working memory. This section is capable of holding the phonetic representation of the information for about twenty seconds, which is possible due to the sub-vocal repetition inside a mind. This process is often called the *articulatory loop*. The incoming information can either be received from the short-term store or from the long-term memory if the need of using or changing the word in memory arises. The section can hold very limited amount of information that is dependent on the size of the loop. The long-term memory, on the other hand, can hold extensive amount of information. The amount of time the long-term memory is capable of holding the information varies from several minutes to being permanently stored. Items are stored for longer if they are frequently repeated and retrieved from the long-term memory to working memory. Another important aspect of storing information is that only a certain amount of information should be tried to remember in a short time period. Finally, if the information has an emotional effect on the person or if it is of high importance it is more likely to be stored permanently. Nevertheless, scientists estimate that only about 20 % of newly acquired information is

stored for longer than a single day.

4.2 Approaches to Vocabulary Teaching

When teaching students new vocabulary, several factors have to be considered. These factors are considered by Thornbury (2002). They include the language capability of a student (whether the student is a beginner, intermediate or advanced), how well the student can already know the word, difficulty of the word, how difficult it is to explain the word and the reason for learning the word (production or reception). Thornbury (2002) further explains various choices that have to be decided when teaching vocabulary. First, it is the amount of items to be taught at a time. Most of the textbooks teach dozen items in a single session, however, some new techniques such as accelerated learning try to teach hundreds of words at once. When presenting the words to learn, one can choose to present the form first and the meaning second or vice versa. As to which of the two ways is best depends on whether there is a context involved when presenting the words. Probably the most important decision is the way of presenting the vocabulary. This may be by translation, which is simply saying or writing the word and assigning an equivalent to it, usually in a native language. This is the most common approach as the equivalent directly points to the word thus being very efficient, however, it may not be the best approach as described in the previous chapter. The second approach is presenting a picture of the object or the object itself and assigning the word to it. Other approaches include presenting definition, situation in which the word is involved or describing it by gestures. Every approach has its certain advantages and disadvantages and none should be used universally. Finally, the engagement of students during the learning process can be varied. Students can either be provided with the meaning and the form of the word, or they can be left to deduce one of the parts themselves, which is usually better for remembering the word. The repetition of the word can also be employed to further improve the memorability of the word.

The courses of English for Information Technology are focused on the *lexical approach* of teaching vocabulary. Thornbury (2002) describes its basic principles as having a syllabus that is organized based on meanings (also called semantic syllabus), words being typically placed alongside similar words while often forming combinations and the most frequent

meanings being represented by the most frequent words. *The semantic syllabus* completely disregards the grammar side of language and only focuses on the meanings and definitions of the words. It is popular arguably because the words themselves carry the meaning, not the structures of the sentences. Ur (1996) proves the importance of grouping similar words together in her research. She states that “[...] it is much easier to learn words in groups, where one can be associated with, or ‘hung onto’ another” (p.67). Another major part of the lexical approach are *chunks*. Chunks are multiple words that are commonly combined together to form a phrase or collocation. Learning these chunks manually is considered much faster than forming them from the grammatical rules. The chunks are especially beneficial to language learner as new chunks might be created from the rules of already established ones. Essentially, the lexical approach considers learning a new language as memorizing a set of items that are then combined together to form a sentence. Only after forming the sentence it is adjusted according to grammatical rules. It therefore does not consider learning these rules a major priority. The lexical approach was chosen for the course because students are already supposed to be familiar with grammatical rules and the course should only teach them the professional discourse used in the field of information and communication technology.

4.3 Vocabulary Practice and Testing

Practicing and testing vocabulary is an essential part of learning it. There are several reasons why testing the vocabulary is advantageous for learners as described by Thornbury (2002). The first reason is that it offers a valuable feedback for both the teacher and the student. Many students tend to be motivated if they acquire good results or are forced to improve themselves in the case of bad results. This correlates with the next reason: Students are motivated to learn and revise the vocabulary prior to testing in order to achieve good results. It is therefore a form of recycling of the vocabulary which is important for storing it inside the long-term memory, as described in the previous chapter. Most of the points also hold true for the vocabulary practice since it only differs in that it is not marked by the teacher. Scrivener (2005) adds that the primary reason for practicing vocabulary is to become familiar with it and learn how to recognize, manipulate and use it. Thornbury (2002) further examines what the test should look like. He states that a good

test exercise should focus on several aspects of the word. These might for instance be its meaning, collocations, spelling, grammatical characteristics, etc. Most of the types of exercises focus on one or two of the aspects. For instance, the gap filling with multiple-choice cloze will only test the ability to correctly assign collocations. Furthermore, it will not test the ability to produce words since they are already written in the options. Scrivener (2005) lists several practice exercises. These include matching lexical items together or to synonyms and collocations, filling gaps in sentences, classifying items into lists and others. It can be observed that most of these exercises can be used for testing purposes as well, which further supports the similarity of testing and practicing outlined in the previous paragraph. The exercises used in the application are meant for the practice+ however, since they provide the score at the end of the exercise, they can also be used for the testing purposes. All of the exercises used along with its detailed descriptions are examined in the following chapter.

5 Types of Exercises Used in the Application

The application offers various techniques for vocabulary teaching and learning with the main emphasis put on the testing and revision to support vocabulary acquisition. This is because students are supposed to acquire quite a large professional vocabulary in the course English for IT, therefore the application is intended to be used as a supplementary tool in particular. All the techniques for vocabulary teaching and testing used in the application are dealt with in this chapter. For each technique, its importance, a brief description of its functioning and the level of difficulty are discussed. Moreover, the advantages of doing the particular exercise with the help of a computer are described.

5.1 Multiple-Choice Cloze

The multiple-choice cloze exercise was employed for testing the student's knowledge of word meanings as well as an ability to fill gaps in sentences. Ur (1996) points out that the student does not have to know how to spell the word, pronounce it or use it grammatically or contextually correctly in order to succeed in this exercise. Additionally, the student has 25 % chance of succeeding if guessing. This qualifies multiple-choice cloze as the easiest exercise in the application. The creation of such exercises can be particularly time consuming (Ur, 1996). However, this problem can be solved by the use of a computer as it can generate the exercises in milliseconds. Furthermore, since the application generates each question of the exercise from four random words with one of them selected to display its definition or example sentence, the amount of possible combinations of questions appears to be nearly infinite². This is especially important as it ensures the exercise will not become repetitive over a longer period of usage.

In order to make the exercise slightly more difficult, a technique of detecting word classes was employed. The technique examines and searches parts of definitions and words for the expressions common to a certain part of speech. For instance, most of the verb definitions start with "to" as they are in an infinitive. Words in the same classes are then grouped and used to form questions together. It is important to note that this technique does not work perfectly as there are exceptions to several rules employed to match the word classes.

² The exact amount of combinations is so large that the user has very little chance of encountering the two same assignments.

Moreover, it is not common for the units to have enough words to form the exercise from the groups, thus having to mix the words.

5.2 Word Matching

The term vocabulary often refers to single words as well as a tightly linked word combinations (Scrivener, 2005). In the field of information technology, combinations of several words are very common. An exercise in which the student directly writes words would therefore be unreasonably difficult. For this reason a drag-and-drop exercise was employed to translate, match definitions and fill the gaps in sentences.

It allows students to “pick up” a word and match it directly to its counterpart. This technique has several advantages. Firstly, an exercise is perfectly suited for students with photographic memory as the connected words get visually matched together on the screen. Secondly, students are encouraged to think about the various connections they can make and to use the method of elimination as there is only a limited amount of possible combinations. This implies that the exercise is of moderate difficulty because if the student remembers the word indistinctly, it is possible to guess the correct match out of ten options. Lastly, the exercise is particularly efficient and entertaining. If the student knows the correct answer, the exercise will take no longer than one minute, whereas the writing exercise would take several minutes to complete. The main disadvantage of this exercise is that students usually have no easy way of changing their minds about the words they have already matched. The word has to be erased and then rewritten which, if done frequently, leads to confusion as to which words belong together. The use of computers completely eliminates this issue as words can be disconnected and then reconnected instantly and an already connected word can even be directly overridden by another word. Furthermore, an immediate access to both the results and the correct solution is possible.

5.3 Correct Spelling

The knowledge of correct spelling of words is essential in order to succeed in the written communication. This is the reason why an exercise with the main focus on testing spelling was employed. It randomly selects ten words from the unit of choice and then displays

them to the user with the task of writing their translations. Since this can be a substantially difficult task, scrambled letters of the correct translation are displayed in addition to the word to translate at the lower difficulty level. These scrambled letters are displayed next to the text field to which the correct translation is to be filled in. The exercise forces students into thinking about all the words they already know along with their correct spelling and translation, which might be its greatest advantage. A disadvantage, on the other hand, is that some students may be discouraged from completing the exercise as it requires a considerable amount of time to finish. Second disadvantage is that the exercise might be too difficult for some students, especially since certain words are formed from multiple words. It also requires the knowledge of both the translation and correct spelling which further contributes to the fact that this is the most difficult exercise in the application. This problem is partially solved by giving students the ability to choose from two levels of difficulty. The use of computers for this type of exercise is important due to the fact that it allows us to generate a different set of words with, on lower difficulty, differently scrambled letters each time it is launched, thus preventing repetition.

6 Application Guides

6.1 User's Manual

This chapter focuses on creating a manual for standard users or, in other words, students. The requirements for the manual are to be short and easy to understand while enabling the user to discover all the features of the application. The chapter is separated into several sections which correspond to those in the application. Using the Help button displayed in the top left corner of the program will display the appropriate section of the user's manual. The main screen contains the section of its own with detailed information about the program, its creator and resources employed for the development of the application. The Vocabulary section describes the relation of the words to the English for IT course as well as provides the user with the resources from which the definitions and example sentences were adopted. Each of the other sections include the instructions on how to finish the particular exercise, the differences between the two levels of difficulty, and what can be learned by doing the exercise.

6.1.1 Main Section

The application was developed by Tomáš Hotový as a part of the Bachelor's thesis. Its main purpose is to be a supplementary learning tool for the students of the course English for Information Technology taught at the Faculty of Information Technology and the Faculty of Electrical Engineering and Communication of Brno, University of Technology.

The entire program was created in a Java programming language, version 8. Having it installed on the system is therefore a prerequisite to running the application. JavaFX was used as a platform for creating a Graphical User Interface with styling done in CSS. For the purposes of storing and managing data, an SQLite database management system was adopted. All the above mentioned technologies allow for the portability, meaning that the application can be used across a variety of the desktop operating systems including Windows, Mac and Linux.

Sources used for the development of the application are as follows:

Oracle and/or its affiliates (2014), Oracle (2017), SQLite.(2017) and Schildt (2014).

This software was created for the academic purposes only. It is free to distribute or make changes to as long as it is not used for the commercial purposes.

6.1.2 Vocabulary

The vocabulary section allows you to view all the words contained within the chosen unit and can therefore be used for learning. For each word its English translation, Czech translation and definition are displayed in separate columns. If the revision was selected in a selection screen, an additional column with the unit number will be visible. Columns can be reordered by dragging and dropping its header or resized by clicking on the edge of the header and dragging it in either direction. Additionally, a header can be clicked to sort all the words by the column of the header in an ascending or descending order. The filter text field in the central part of the toolbar can be used to filter the words based on the English or Czech translation, or based on the unit number if the words from the revision are currently displayed.

The unit numbers and names correspond to the ones in the course English for Information Technology and to the e-coursebook of the same name by Ellederová (2016). Additionally, the revision section contains all the words from units one to twelve for the purpose of studying for the final test. The section Extra Reading relates to the chapters “History of a Computer” and “History of the Internet” of the above mentioned book. In case any changes are made to the units, you will need to have the database file distributed by the teacher in the same folder as the application file. Otherwise the default vocabulary will be loaded.

All definitions and example sentences used in the application were taken from the following sources:

Collins (2018), The Computer Language Company Inc. (2017), Datamuse (2018), Dictionary.com, LLC (2018), Horak (2007), LoveToKnow, Corp. (2017), Oxford University Press (2017), Schell and Clemens (2006), WebFinance Inc. (2018), Wiktionary (n.d.).

6.1.3 Definition Matching

This exercise is focused on broadening the knowledge of the word meaning. It does so by

using the definitions assigned to each word. Since the exercise is randomly generated it can be repeated numerous times. You can choose the language (English or Czech) that will be used for the words that are to be assigned as well as the difficulty level which will determine the type of the exercise.

The definition along with four options is presented at the lower difficulty level. Your goal is to choose the correct option for each of them. There should always be a total number of ten questions unless there are not enough words that contain the definition in the selected unit. Upon submitting, the screen with the final score will be displayed. Incorrectly selected options will be highlighted in red, while the correct answers will be highlighted in green. If no selection is made for the particular question, only the correct answer will be highlighted, but the answer will still be considered as incorrect. The example of a result screen can be seen in Figure 5.

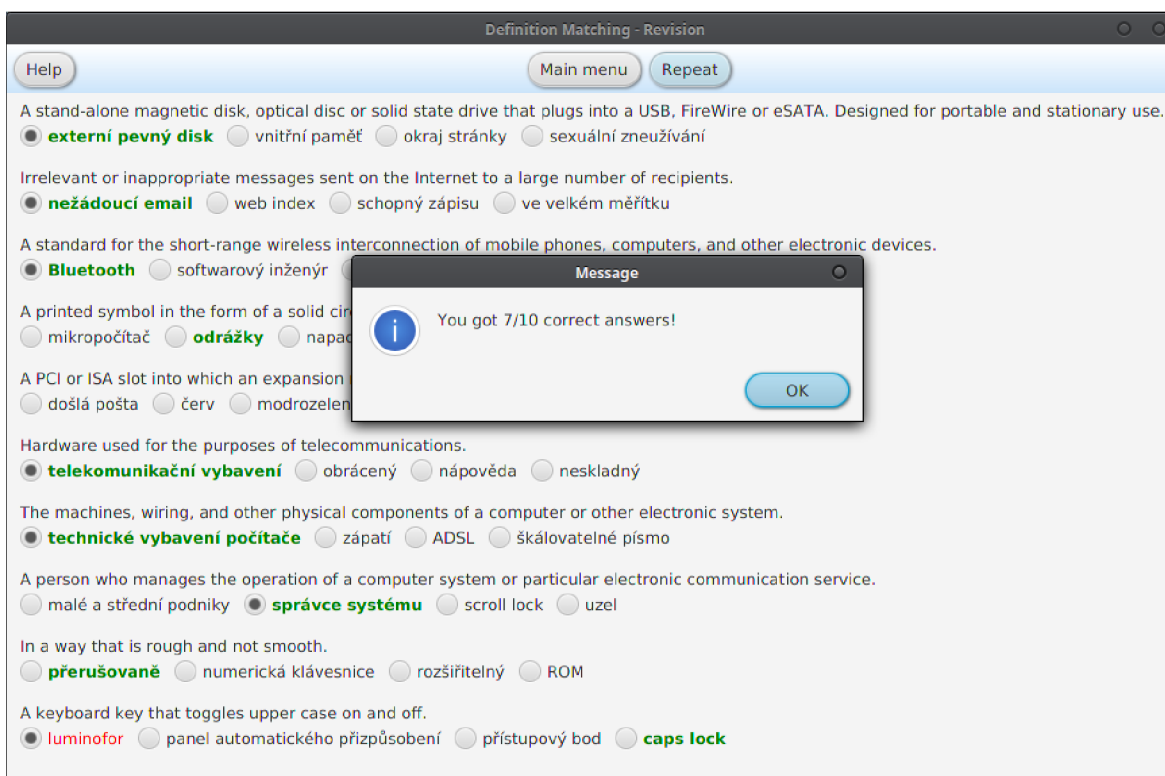


Figure 5. Example of a definition matching result screen at the low difficulty level.

Ten random definitions are chosen for the higher difficulty level and displayed on the left side (see Figure 6). These form a pair with the words on the right side. The goal is to correctly assign each word to its definition. This can be achieved by clicking on the word

and dragging it onto the definition. Once the definition has a word assigned to it, its background becomes grey. The words can be assigned to already matched definitions to override the previous pair or dropped anywhere else in order to reset them. When submitted, the screen with your score will be displayed and all the words will be assigned into correct pairs. Those that were paired correctly will be highlighted in green while the rest will be red. The definitions that had a word assigned to them will still have a grey background.

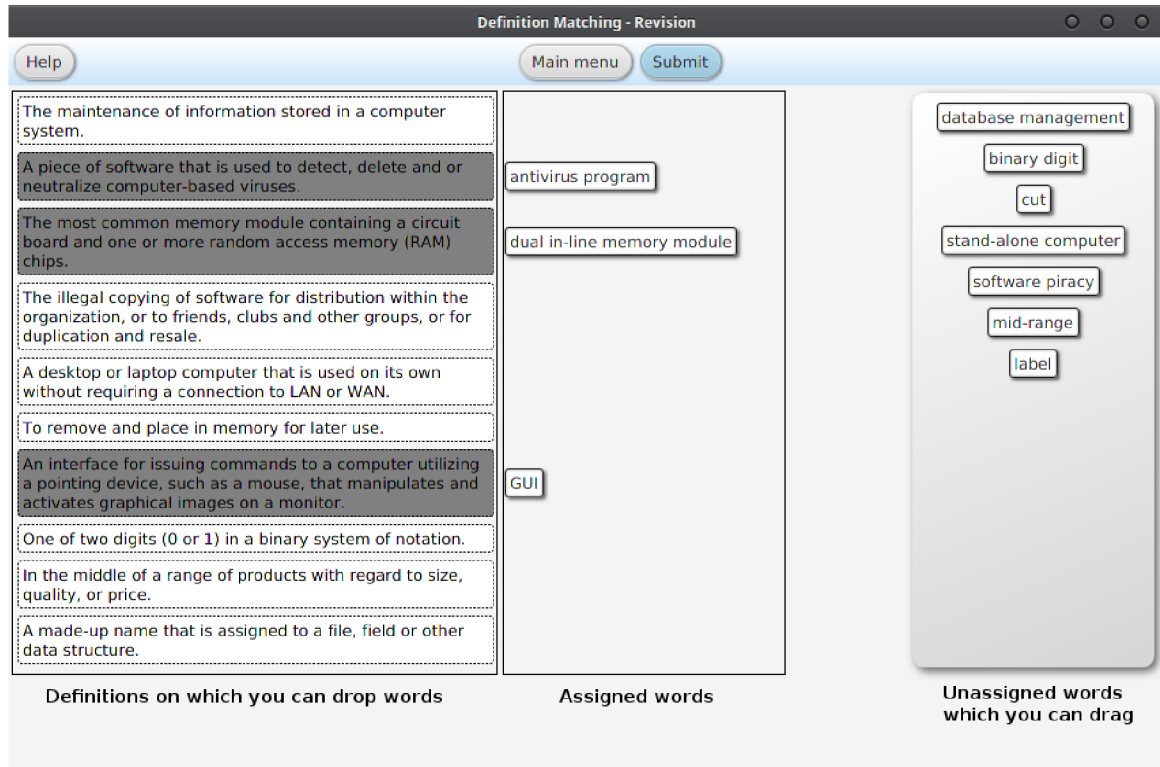


Figure 6. Layout of definition matching at the higher difficulty level.

The results can be displayed by clicking on the Submit button located in the central part of the toolbar, or by pressing the Enter key. Please do note that unless all of the questions are answered, a confirmation dialog will be displayed. After the submission, the Submit button gets replaced with the Repeat button, which can be used to generate new exercise with the same options. You can return to the Main Page by either using the Main menu button, which is displayed on the toolbar next to the Submit button, or by pressing the Escape key on your keyboard.³

³ The instructions for displaying the results and returning to the Main Page apply to all types of exercises in the application.

6.1.4 Word Translation

Translation skills along with correct spelling are tested in this exercise. Both the language you will be translating into and the difficulty level can be chosen in the selection screen. The difficulty level will determine whether a hint is displayed for each word. Ten words are presented for both difficulties with the goal of writing their translation into the text-entry fields.

The design of the lower difficulty level should aid you in case of uncertainties regarding the correct spelling of the word. The word to translate is displayed in grey color as a hint inside the text-entry field. This hint disappears once the text-entry field is focused (e.g. if you click inside it) or text is entered. Furthermore, scrambled letters of the correct translation can be seen next to the text-entry field. Those letters are separated into words using spaces and are always in a lower case. The layout is illustrated in Figure 7. Upon submitting, the correct answers are displayed in the text-entry fields. If your answer is correct, the entered text will be displayed in green, otherwise it will be highlighted in red.

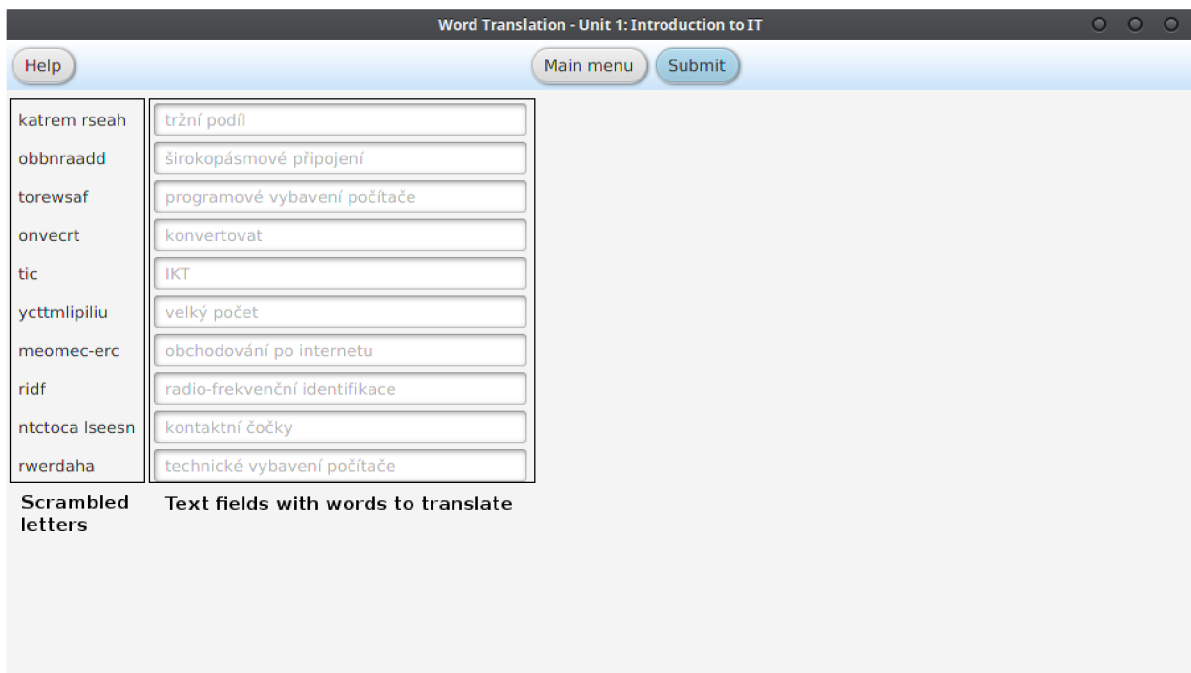


Figure 7. Layout of a word translation exercise at the lower difficulty level.

The higher difficulty level removes the scrambled letters completely and only leaves the word to translate. This fact makes this exercise the most difficult of the entire application

as not only translation skills but also correct spelling has to be demonstrated. It is therefore recommended to train at the lower difficulty level before moving forward to the higher one. The position of the word to translate has been changed when compared to the lower difficulty level, so now it is to the left of the text-entry field where the answer is supposed to be entered. Figure 8 shows the layout of the exercise. The resulting answers are highlighted in green if they are correct and in red if they are incorrect, which is identical to the low difficulty level described above.

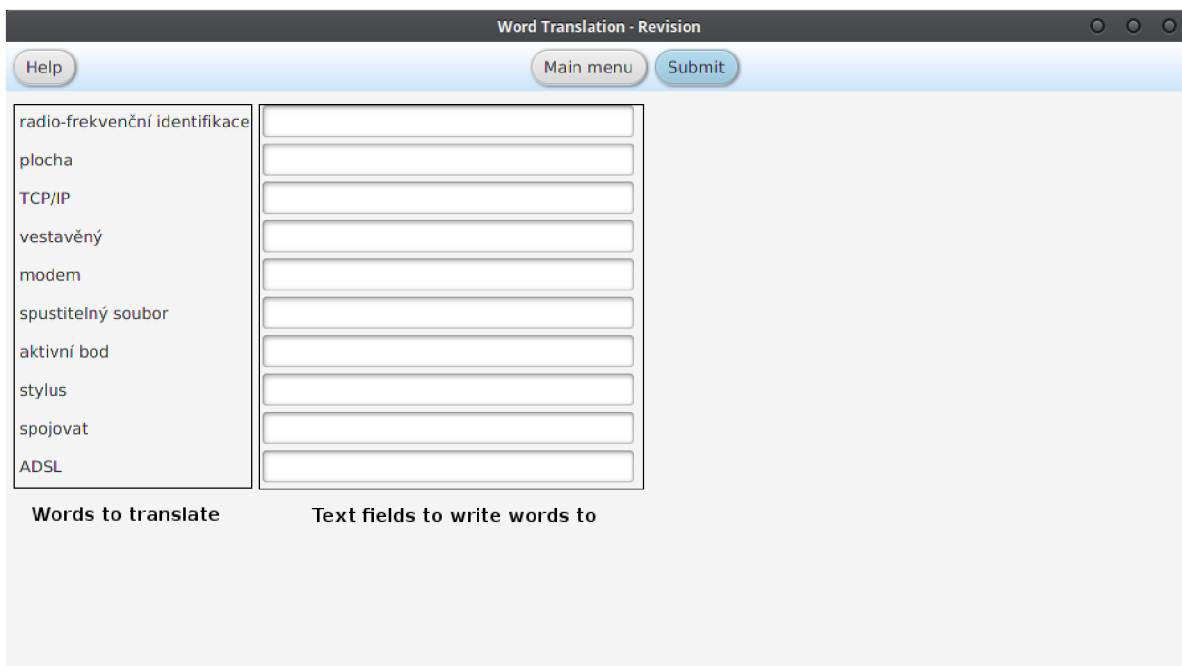


Figure 8. Layout of a word translation exercise at the higher difficulty level.

6.1.5 Word Matching

Word matching exercise test the ability to translate words correctly. Since it uses the technique of matching the word to its translation, it is essentially an easier version of the exercise “Word Translation”. Students with visual memory may learn faster using this exercise due to its graphical character. The only difference between the difficulty levels in this exercise is in the amount of words to match. While at the lower level your task is to match ten words, at the higher one it is a total of fifteen words.

Your task is to correctly assign each word on the right with its translation on the left, thus creating a pair. This goal can be accomplished by clicking on the word, dragging it onto its counterpart on the left and then releasing the mouse button which will “drop” the word

causing it to be matched. In case there is already an existing connection, it will be overridden by the new word. You can also choose to remove the connection by dragging and dropping the word anywhere else on the screen. Every translation with a word connected to it will have its background colored grey. The layout of the exercise is illustrated in Figure 9. Upon submission all the words will be matched correctly and highlighted in one of the two possible colors. Those highlighted in green are in correct pairs, while those highlighted in red are incorrect. In case the translation on the left was not assigned any word its background will be white and its correct word will be highlighted in red.

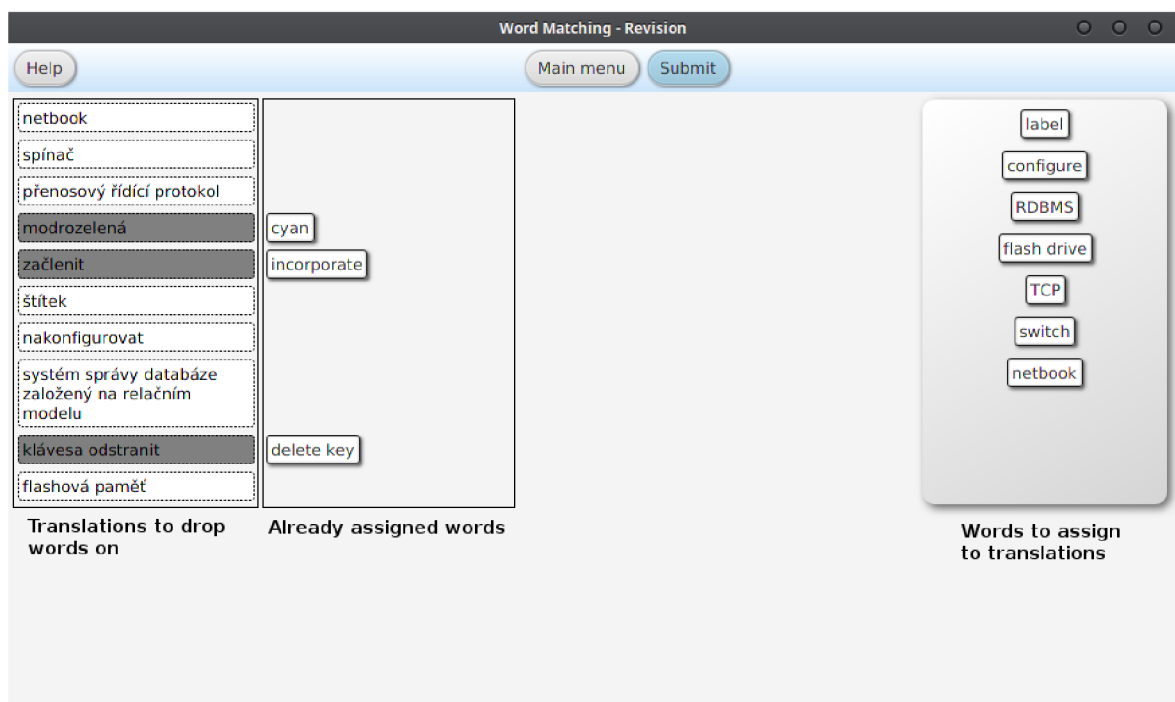


Figure 9. Layout of a word matching exercise.

6.1.6 Gap Filling

The Gap filling exercise strengthens the knowledge of the use of words in sentences. It does so by enabling you to fill the gaps in the sentences with words. The only option available in the selection screen for the exercise is the difficulty option which determines how will the words be filled in.

At the lower difficulty level ten sentences (unless there are not enough words in the unit) are displayed with the gaps inside them represented as a series of periods. Each of the

sentences has four options below to choose from. The goal is to select the one that fits best into the sentence. Figure 10 shows the layout along with the description. Once you submit the exercise, the correct options will be highlighted in green, whereas those selected incorrectly will be highlighted in red. Only the correct option will be highlighted for the selections with a missing answer.

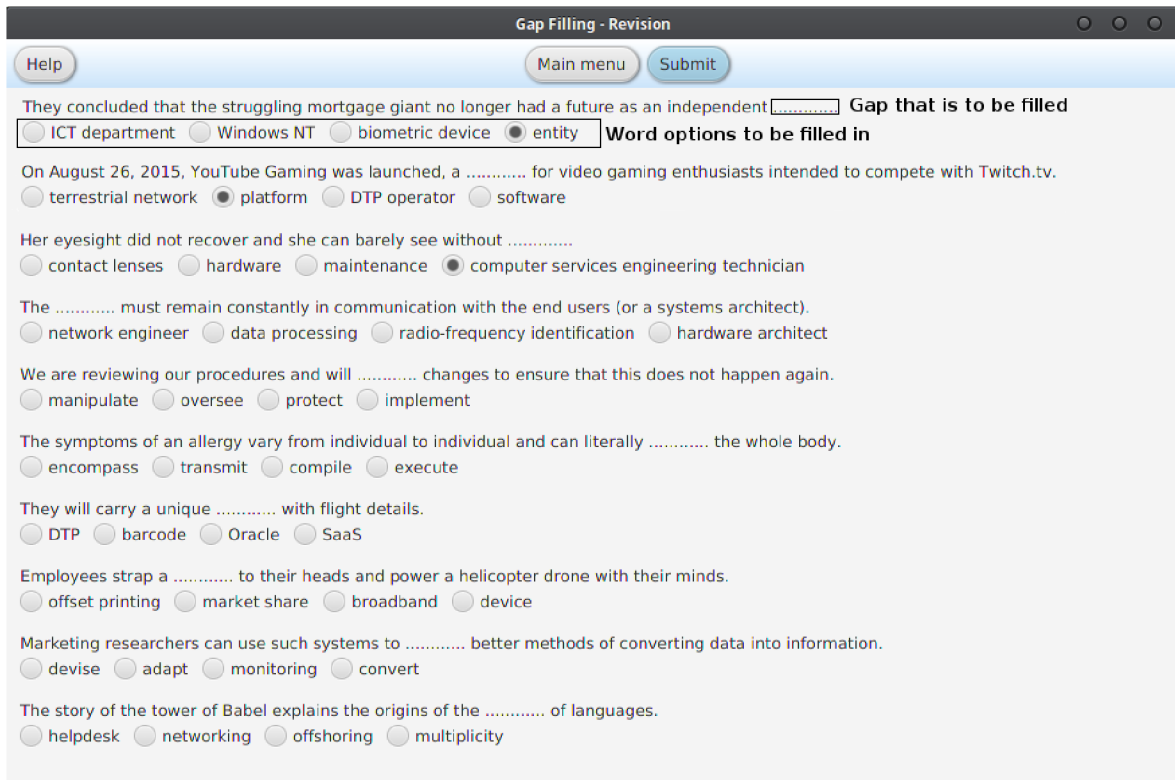


Figure 10. Layout of a gap filling exercise at the lower difficulty level.

The higher difficulty level features the sentences on the left side and words to fill in on the right side. The task remains the same as at the lower difficulty level – to correctly fill in the gap in each sentence with a single word. This can be achieved by picking up the words on the right by clicking and holding the mouse button and then releasing it once the cursor is above one of the sentences. This action is further referred to as drag-and-drop. With the use of drag-and-drop you can connect each word to the appropriate sentence based on where the word might fit in. The drag-and-drop function can also be used in the sentence that has already been connected to one of the words, which will cause the previous action to be overridden. Furthermore, whenever a word is dropped anywhere else on the screen (except for the toolbar) its connection is reset. Every sentence with a word connected to it will

have a grey background until the exercise is finished. This can indicate which sentences do not have their gaps filled in and it is illustrated in Figure 11. Besides the background color, the words in the result screen are highlighted as well. The red color indicates an incorrect connection while the green indicates the correct one.

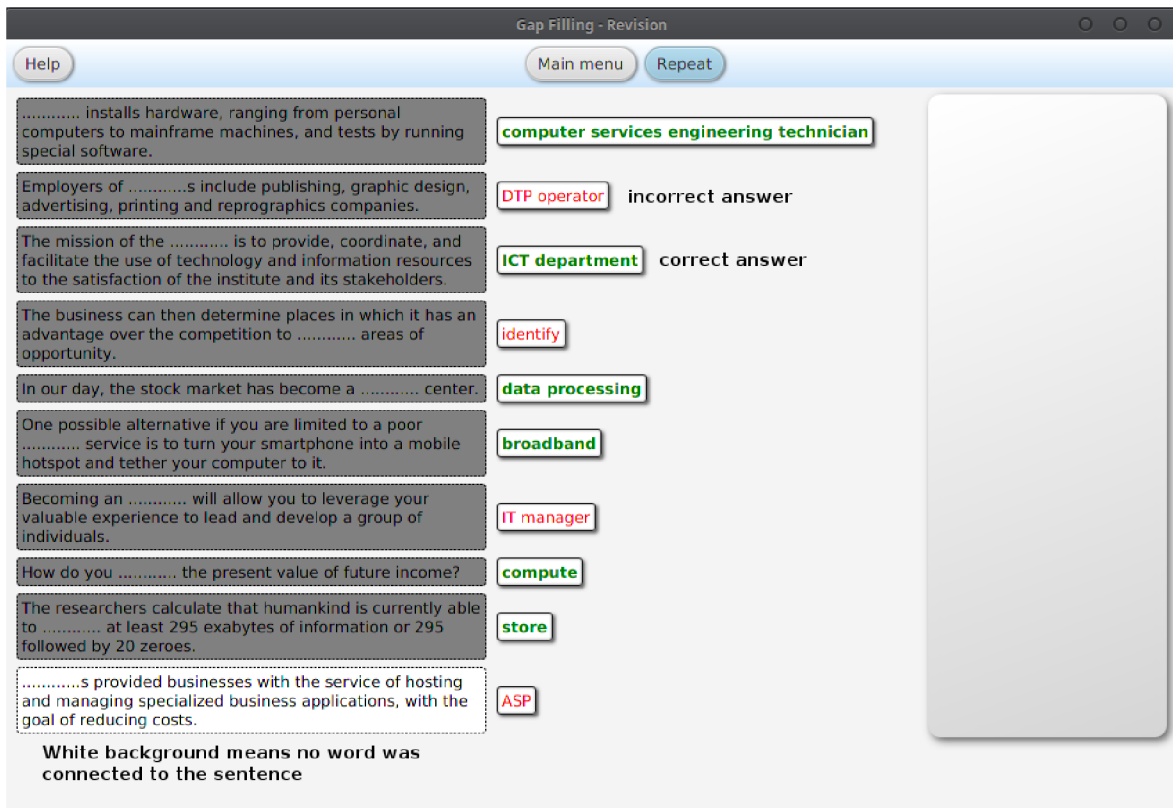


Figure 11. Example of the result of a gap filling exercise at the higher difficulty level.

6.2 Administrator's Manual

The Administrator's Manual chapter provides the teacher with two additional sections of help pages that are displayed on the screen once the Help button is pressed. If the administrator mode is activated, which can be done by pressing the CTRL + D keys simultaneously, the corresponding sections of the user's manual will be replaced with these in the administrator's manual. The main section gives information on how the application supplements the course, what the students should use it for and the way to access the administrator mode. The vocabulary section forms a reference guide on how the program can be extended by adding new words or changing the existing ones.

6.2.1 Main Section

The application supplements the course English for Information Technology and the book of the same name. It was created so that students can practice the vocabulary of each unit and prepare for the final test. Additionally, the revision contains the vocabulary from all units thus allowing students to learn and revise vocabulary for the final test. Students should be distributed the software and encouraged to use it in order to increase their chances of successfully completing the course.

The administrator mode can be activated by pressing CTRL + D keys on your keyboard. This will present the dialog with the information of successful activation as shown in Figure 12. The administrator mode will be deactivated upon pressing the shortcut again.

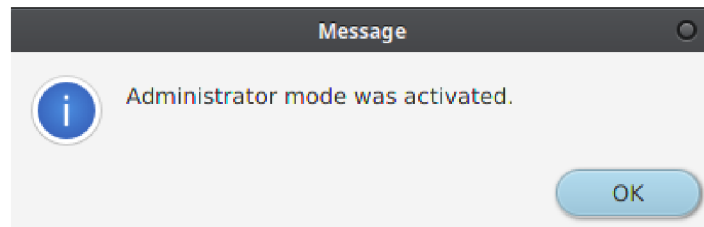


Figure 12. Administrator mode dialog.

6.2.2 Vocabulary Section

All of the vocabulary in the application is stored in the database file. This file is a part of the application internal files which are read-only, meaning that it is not possible to write into them. It is therefore essential to have an external database if you want to change any word. This can automatically be created by the program if you confirm the dialog (see Figure 13) presented upon attempting to make changes to words while using the internal database.

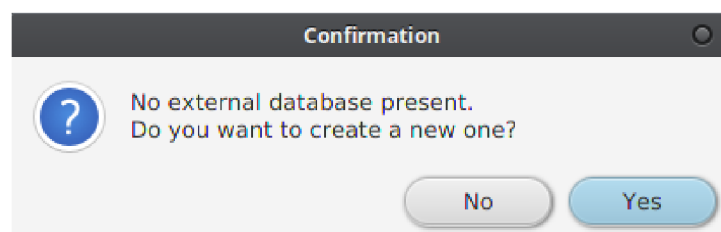


Figure 13. External database confirmation dialog.

The toolbar at the top of the screen contains new buttons which can be used to make changes to the vocabulary. In the respective order from the left to right the Add, Delete, Edit and Copy button are displayed. Each represents a separate operation which, except for the Add button, requires a word to be selected. The Add button allows you to create a new word and add it to the existing unit. The Delete button enables removal of the word. This operation cannot be reverted and the confirmation dialog is displayed to protect against a random deletion. Any changes to the existing words can be made with the Edit button, and a copy of a word can be made with the use of the Copy button. The Add, Edit and Copy buttons present the following dialog (see Figure 14) upon clicking them, which can be used to determine the properties of the word.

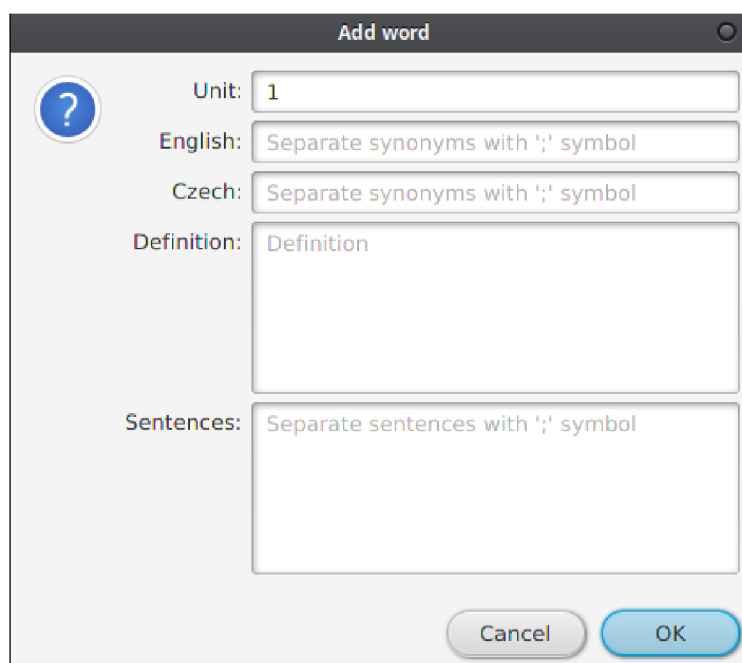


Figure 14. Dialog for editing words.

The dialog contains a total of five fields. In case you edit or copy a word, the fields are automatically predefined with the data from the word. All the fields implement the basic keyboard shortcuts such as copy (CTRL + C), paste (CTRL + V) or undo (CTRL + Z). The drag-and-drop function is also enabled, meaning that you can pick a text from anywhere else and drop it onto the field to paste its content inside it. The field marked as Unit represents the unit number the word belongs to. This field must never be empty; otherwise the requested operation will fail. It is automatically filled with the unit the dialog was

invoked from in case of adding a word. The extra reading exercise is considered as the unit number thirteen. The English and Czech fields represent the translations of the word. As in the case of the unit, these fields are required to have values filled in. Therefore multiple synonyms of each translation can be added as long as they are separated with a semicolon. The definition field contains the definition of the word that describes it most accurately. This field is optional and its value is used in the Definition Matching exercise. The field marked as Sentences allows you to add example sentences in which the word is used. The field is optional but in case the sentence is added, it is required to contain the word; otherwise the invoked operation fails. Multiple sentences can be added with the use of a semicolon as a separator. After submission the dialog informing about the result of the operation is displayed. This dialog contains the description of the problem in case the operation was unsuccessful.

7 Conclusion

The aim of the thesis was to develop a portable e-learning application that would complement the course English for Information Technology. The application was to test and reinforce student's knowledge of vocabulary in interactive and unique ways.

First of all, a variety of different applications were tested in order to find out which exercise would fit the program best and what should the implementation look like. It was found that the market contains a noticeably small amount of Czech to English applications that teach the vocabulary in the field of information technology.

Secondly, a design of the software was to be considered. The Java programming language along with the JavaFX graphics platform were used to develop the software mainly because of the portability offered. With that said, the application was tested on various operating systems, including, but not limited to, Windows 10, Linux Mint and Mac OS X. An SQLite database system was employed to store the words on a user's computer as it was found the most suitable for the deployment of the application.

Next, the theoretical framework of vocabulary acquisition, teaching and testing was established. This framework allowed the author to decide on the right types of exercises to be used in the application. The exercises were described in the following chapter with the focus on the theoretical aspects of each testing technique, the advantages of using it on a computer and its implementation in the application. It was discovered that using computers for vocabulary teaching and testing is highly advantageous in comparison with drilling or translating activities in ordinary lessons. Moreover, the application is extremely useful for self study providing students with correct answer feedback.

Lastly, the manual for using the application was designed. *User's Manual* provides students with the information on how to complete each exercise as well as the basic information about the application. *Administrator's Manual* was designed for the teacher with the purpose of presenting various ways of modifying vocabulary within the application.

Working on the thesis, the author has acquired experience in the development of GUI using JavaFX. The knowledge of the Java language and subsequently object oriented programming was also extended along with understanding data management using SQL. Finally, the author has gained an insight into vocabulary teaching and testing techniques.

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9 List of References

- *⁴Collins (2018). *Collins English Dictionary*. Retrieved from <https://www.collinsdictionary.com/>
- *The Computer Language Company Inc. (2017). *Computer desktop encyclopedia*. Retrieved from <http://www.computerlanguage.com/>
- *Datamuse (2018). *RhymeZone*. Retrieved from <https://www.rhymezone.com/>
- *DeepL GmbH (2018). *Linguee*. Retrieved from <https://www.linguee.com/>
- Detre, G., Cooke, E., & Whately, B. (2005). *Memrise* [Language Learning Platform]. London: Memrise Limited. Retrieved from <https://www.memrise.com/home/>
- *Dictionary.com, LLC. (2018). *Dictionary.com*. Retrieved from <http://www.dictionary.com/>
- Ellederová, E. (2016). *English for information technology*. Brno: VUT – FEKT.
- Elmes, D. (2017). *Anki* [Cross-Platform]. Retrieved from <https://apps.ankiweb.net/>
- *Horak, R. (2007). *Webster's new world telecom dictionary*. Hoboken: Wiley.
- Jones, A., & Lyon-Jones, S. (2011). *ESOL Courses*. London: ESOL Courses Ltd. Retrieved from <https://www.esolcourses.com/topics/computers.html>
- Langley, N. (2002). *Write once, run anywhere? Computer Weekly*. Retrieved from <http://www.computerweekly.com/feature/Write-once-run-anywhere>
- *LoveToKnow, Corp. (2017). *YourDictionary*. Retrieved from <http://definitions.yourdictionary.com/>
- Nunan, D. (2000). *Language teaching methodology: A textbook for teachers*. New York: Prentice Hall.
- Oracle and/or its affiliates. (2014). *Oracle Java SE Embedded: Developer's guide*. Retrieved from <https://docs.oracle.com/javase/8/embedded/develop-apps-platforms/>
- Oracle. (2017). *JavaFX FAQ*. Retrieved from <http://www.oracle.com/technetwork/java/javafx/overview/faq-1446554.html#6>

4 References marked with * indicate works used for designing exercises in the application.

- *Oxford University Press. (2017). *Oxford dictionaries: English dictionary, thesaurus, & grammar help*. Retrieved from <https://en.oxforddictionaries.com/>
- Pawlan, M. (2013). *What is JavaFX?*. Retrieved from <https://docs.oracle.com/javafx/2/overview/jfxpub-overview.htm>
- *Schell, B., & Clemens, M. (2006). *Webster's new world hacker dictionary*. Indianapolis: Wiley.
- Scrivener, J. (2005). *Learning teaching. A guidebook for English language teachers*. Oxford: Macmillan.
- Schildt, H. (2014). *Java: The complete reference* (9th ed.). New York: McGraw-Hill.
- SQLite. (2017). *About SQLite*. Retrieved from <https://www.sqlite.org/about.html>
- Stack Overflow Developer Survey 2017 Results. (2017). Retrieved from <https://insights.stackoverflow.com/survey/2017>
- Thornbury, S. (2002). *How to teach vocabulary*. Harlow: Pearson.
- Ur, P. (1996). *A Course in language teaching. Practice and theory*. Cambridge: Cambridge University Press.
- *WebFinance Inc. (2018). *Online Business Dictionary*. Retrieved from <http://www.businessdictionary.com/>
- *Wiktionary. (n.d.). Retrieved from <https://www.wiktionary.org/>
- Witte, M., Holl, T., & Hansen, J. (2007). *Babbel* [E-Learning Platform]. Berlin: Lesson Nine GmbH. Retrieved from <https://www.babbel.com/>