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LANGUAGE-INDEPENDENT VIRTUAL BIOLOGY EXERCISE FOR THE DEVELOPMENT OF KEY COMPETENCES FOR LIFELONG LEARNING

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Abstract

Natural sciences in Slovenia are not as popular as we would like them to be. Biology teaching and learning in great part consist of memorizing the facts and not so much of developing competences. Laboratory and field work are recognized as methods where students can achieve subject specific and generic competences, as recommended by different international organizations. Such key competences are mathematical competence and competences in science and technology, and digital competences. Although competences cannot be learned but have to be achieved, the task seems epical when students can hardly find computer supported didactical tools in their own language.
On the Faculty of Natural Sciences and Mathematics virtual biology exercise Mendelian Genetics with a translational tool was developed. Teachers have the possibility to translate it into desired foreign language. Virtual exercise is interactive and encourages the critical thinking approach to reach the high level cognitive skills and development of different competences.
Key words: *Mendelian Genetics, virtual laboratory, simulations, competences.*

Introduction

European parliament has published a framework of eight key competences for lifelong learning (Recommendation of European Parliament, 2006). This framework describes the essential knowledge, skills and attitudes related to each of these competences. Even if all competences are recognized as equal they cannot be developed equally in a framework of each school subjects. Starting from this point of view the most important competences in the natural sciences are mathematical competence and basic competences in science and technology, and digital competence (Špernjak and Šorgo, 2009 b). The mathematical competence includes knowledge of basic laws of mathematics and numbers, the competences in science and technology introduce the usage of scientific methods for explanation of natural phenomenon and critical thinking. The digital competence stands for the unavoidable importance of the usage of technology.

The competences cannot be transferred, but must be developed and the best way to assure that in the education process is to include activities, where critical thinking, solving problems and active participation of the students is encouraged (Prince, 2004; Savery, 2006). Practical work, such as usually found in laboratory and field work, is recognized as the method

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where students can achieve subject specific and generic competences as it is recommended by different international organizations (UNESCO, 2008; European Parliament, 2006). The development of competences in science and technology are also encouraged through the computer supported laboratory work (Špernjak and Šorgo, 2009 a) and multimedia (Starbek et al., 2010). The tool used for learning purposes has to be not only educational, but also interesting, because then it attracts students and develops their desire to learn (Fancovicová, 2010).

The society is dealing with rising globalization, which makes the competence of communication in a foreign language even more important. On the other hand, the roots of an individual should not be forgotten or ignored, or in other words, the importance of the competence of being able to communicate in the mother tongue should not be diminished. This competence can be harder to develop especially in the educational systems of nations with smaller groups of native speakers, because they have to include literature that is written in for them foreign language. The language problems can be solved in different ways. One of it is the usage of translating tools and dictionaries (Schloman, 2000), or the usage of materials without text (pictures, silent movies, animations without text), where language does not play a key role (Puhek and Šorgo, 2009). The simulation Mendelian Genetics was developed in Slovenian to enable students to learn and inquire genetics in their mother tongue. In the other hand it is also enabled to translate the simulation into any foreign language, including English.

Simulation Mendelian Genetics was developed to engage students' critical thinking. The virtual exercise presents an interactive environment where salvations of problems from the real world are enabled – in our case the colour of Labradors. The students practice basic mathematical competence when dealing with variance and calculating the numbers of specific offspring. To reach the high level cognitive skills, they have to predict the colour and the genotype of the animal and after that check their results with the simulation. The exercise increases critical thinking, because the student is able to continue to the next level only if the problem is solved. The digital competences are encouraged by managing the simulation itself. Finally, for the simulation to be available for different nations, menu for translations to other languages is included. Teachers now have the possibility to translate the simulation and use it in "mother" language of students (competence of communicating in mother tongue) without further obstacles or they can even use it in multi-cultural classes (competence to communicate in foreign languages).

Methodology of Research

General Background of Research

One of the eight basic competences, presented by the European commission, is the communication in the mother tongue. When dealing with the education, things are not equal anymore and (usually non-English) students have to satisfy with materials only in the official language. The problem reaches even further, when students try to find a topic through internet. Sometimes they manage to get only a few (probably outdated) hits that cover the topic or there are no hits at all. Since internet is becoming more and more important educational tool (Fancovicova et al., 2010) and students find it more useful than printed resources (Mayfield and Ali, 1996), it is crucial for them to have good chances to find appropriate learning materials.

Data Collecting

In the first part of the research a comparison between hits from Google in different languages was made. Words were chosen decreasingly from general words like "Biology" to specific ones like "Eustachian tube". The search was repeated for translated word phrases in

different languages, with the help of advanced searching mode (language setting).

When searching for a clue in Google, the searching results almost always include the hits from Wikipedia. In the second part of the research a comparison between the articles in different languages in Wikipedia was made. Firstly, the total number of articles in different languages was counted. The numbers of articles were provided by the administrator of the encyclopaedia. Later the articles were copied into Microsoft Word and the words and characters were counted.

Language-Independent Computer Simulations

In the simulation Mendelian Genetics the students are put into the role of modern Gregor Mendel. Mendel was an Austrian priest who was breeding "famous" peas. During his experiments the core of classical genetics, with the first and second Mendel's law, was born. The simulation is build interactively to support critical thinking and active learning approach – students have to be active to pass to the next level of the exercise. Instead of peas the Labradors were used to show students that in the real world science is present everywhere.

The simulation is an independent (self-running) application with no need of special preparation to run it. It was developed in Lazarus (Free Pascal) that emulates Delphi. Because Lazarus is an open source software (GPL licence), its usage is for free and like that easier to spread among users. For usage of the simulation, students need the basic knowledge of computers. In case of some schools (for example vocational school for Computer science), even simple exercises can be developed. Unlike Java, which works as "written once and run anywhere", Lazarus is "written once and compiled anywhere". The problems with previous installation of application and importance to have internet to run it were avoided. The simulation was tested on different Windows operating systems (XP, Vista, Windows 7) and is supposed to work also (probably with some modifications or emulators) on Linux systems and Mac OS.

Results of Research

Searching for Information with Google

Approximately 85% of the users make Google the most visited webpage in Slovenia (Brečko, 2010). In the first part of the research a comparison between hits from Google in different languages was made, because it is probably the first choice of Slovenian students when they are dealing with problems they come across. Table 1 presents the results of searches for different years (Šorgo, 2003; Puhek and Šorgo, 2009; Puhek and Šorgo, 2010).

Table 1. Google hits of the words in different languages for different years (Šorgo, 2003; Puhek and Šorgo, 2009; Puhek and Šorgo, 2010).

WORD	LANGUAGE	HITS (2003)	HITS (2009)	HITS (2010)
Biology	English	4.780.000	166.000.000	192.000.000
biología	Spanish	/	6.950.000	9.020.000
Biologie	German	/	5.670.000	4.440.000
biyoloji	Turkish	/	2.310.000	3.520.000
bioloĕija	Latvian	/	216.000	182.000
biologija	**Slovenian**	**10.800**	**178.000**	238.000
Heart attack	English	667.000	47.200.000	58.900.000
ataque al corazón	Spanish	/	4.130.000	5.350.00

Herzinfarkt	German	/	1.080.000	1.110.000
kalp krizi	Turkish	/	1.320.000	1.740.000
sirdslçkme	Latvian	/	51.300	65.600
srčni infarkt	**Slovenian**	**137**	**52.600**	127.000
Eustachian tube	English	10.600	806.000	332.000
trompa de Eustaquio	Spanish	/	30.400	118.000
Eustachi Röhre	German	/	8.070	11.300
östaki borusu	Turkish	/	11.700	58.000
eistâhija kanâla	Latvian	/	5.220	6.230
evstahijeva cev	**Slovenian**	**5**	**5.430**	7.670

The Case of "Stumps" in Wikipedia

Wikipedia is another popular page in Slovenia (Brečko, 2010) and is often cited in the student papers. In the Table 2 are presented the results of searching word phrases for articles in different languages with the numbers of words (and characters without spaces) in them. The character * next to some Slovenian and Turkish searching words means that the article was defined as a "stump". For two Latvian words there were no articles found at all. Finally, the total number of articles in Wikipedia in different languages is presented in Table 3.

Table 2. Words in different languages counted from articles in Wikipedia.

WORD	LANGUAGE	WORDS	CHARACTERS (WITHOUT SPACES)
Biology	English	6.386	37.068
biología	Spanish	4.736	25.985
Biologie	German	3.306	22.731
biyoloji	Turkish	2.588	18.727
bioloĕija	Latvian	1.760	11.406
biologija	**Slovenian**	**792**	**4.930**
Heart attack	English	13.115	78.358
ataque al corazón	Spanish	7.712	43.011
Herzinfarkt	German	6.018	41.298
kalp krizi*	Turkish	359	2433
sirdslçkme	Latvian	/	/
srčni infarct*	**Slovenian**	**293**	**1908**
Eustachian tube	English	1.328	7.347
trompa de Eustaquio	Spanish	337	1.858
Eustachi Röhre	German	525	3.454
östaki borusu*	Turkish	112	818
eistâhija kanâla	Latvian	/	/
evstahijeva cev*	**Slovenian**	**73**	**475**

Table 3. Total number of articles found in Wikipedia in different languages.

LANGUAGE	ARTICLES
English	3.414.353
Spanish	647.547
German	1.122.285
Turkish	149.957
Latvian	29.940
Slovenian	**116.000**

Simulation Mendelian Genetics

The basic view of the simulation Mendelian Genetics is presented in the Figure 1. First students have to choose which type of breading they would like to test. In the menu on the right they can choose between "Monohibridno križanje" (Law of Segregation) and "Dihibridno križanje" (Low of Independent Assortment). Basically the difference between them is in the number of alleles. The meaning of alleles is explained in the special legend under the menu.

Simulation Menedelian Genetics is programmed to encourage student to be active when gaining the feedback. It works based on the following principle: firstly, the student tries to solve the problem and afterwards, if he/she is right, the result in the form of a picture appears on the screen, with which the next stage is enabled. At the beginning the genotype and the colour of each parent should be linked together. If both answers are correct, student can breed the dogs with click on the button "križaj" (breed). The genotype of the offspring fills the Punnett's square. The next exercise is to choose the showed genotype with the right phenotype from the drop-down list. The genotype is marked randomly and is different every time. Again, if the answer is correct, the picture of chosen Labrador is shown.

The simulation is also supported by the menu for translation into other languages – menu "Jezik" (language). If the user pushes the button "prevedi" (translate), the text inputs are activated and appear on the screen. This application enables the user to translate all words into the desired language (Figure 2). When the translation is inserted, it can be confirmed with the button "OK". The new language can be saved into the text file, which can be reached through menu "Datoteka" (File) and "Shrani jezik" (save language). We also included the "safety" button to return to the basic language, if mistakes in the translations appear and the meaning of simulation gets lost.

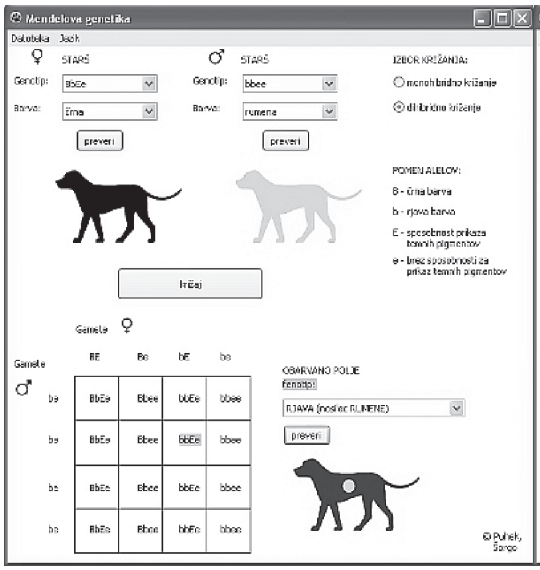

Figure 1. The basic view of the simulation Mendelian Genetics.

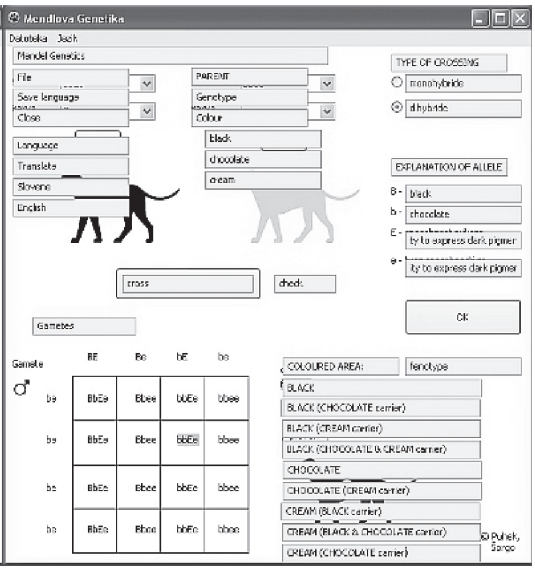

Figure 2. The translated version of simulation Mendelian Genetics (target language: English).

Discussion

Manten (1974) reported the rise of scientific articles in English and the fall of scientific works in German and in French. Phillipson (2006) has characterized English as an invasive, imperialist language in Europe. Goodman (2008) found out that Spanish students more likely saw the language as a barrier than their English colleagues. Šorgo (2003) declared that the problems of not understanding the foreign language increases with the student's youthness and can get in primary school even to the level that the problems of understanding can get insurmountable (Puhek and Šorgo, 2009).

As it was expected (with spread of technology and internet), the number of hits in Google is increasing in all languages. It is true that the quantity is not everything, but if there are just a few sources, you will more probably not find what you are looking for. Many hits are actually fake and are presenting different blogs, forums, subpages, hits in similar languages etc. With more than 500 million users or 27, 3% of total world internet users (Miniwatts Marketing Group, 2010), official internet language is still English (Šorgo, 2003). For example Spanish, as the third most spoken language that present 7,8% of the world's internet users or even the remaining world's languages (without top 10 languages) that presents 17,8% of the world's languages, cannot be compared to the expand of English.

Similar results were obtained when searching for articles in Wikipedia. Not only that there are more articles in English, but they are even longer than articles written in other languages. It is not a rule that longer articles are better, but again, if users cannot get the inquired information in the articles in their own language, they are forced to use references in foreign language or choose a different source. When searching for word phrases in languages with smaller number of speakers than English it was often the case that the article was marked as a "stump" or there were no articles found at all (like in some Latvian searches).

Conclusion

Many researchers from different disciplines already dealt with the problem of effectiveness in teaching. One of the main conclusions was that the students have to be active during the class. If this is illustrated on the case of orchestra, then the students have to play the instruments instead of just sit and listen like the audience.

When designing didactical tools, these findings have to be taken into consideration. If students are supposed just to click through the exercises, they will soon get bored and focus their attention somewhere else. Although it is almost impossible to develop a special tool that can be used in every situation and in every language, the presented simulation defines a good approach that could be useful for many teachers. One of the basic competences in the area of education - the communication in mother tongue - represents also one of problems, which was discussed earlier about the difficulties the majority of students around the world faces when searching for the didactical tools in their own language.

The language-independent simulation can be translated into the desired language and then used on different occasions. Despite some disadvantages of that procedure, as the fact that somebody still needs to know the basic language and translate it into desired one, we created an option for more users to use the simulations as if the simulations were only in English. The idea of our work is to develop a product that can be dispatched through the World Wide Web (or with other media like USB sticks) and can then be used by everyone, especially by the users that can hardly find educational tools in their non-English languages. The simulations are designed like self-running programs, so they do not need internet connection and can run almost everywhere.

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