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Enhancing Hungarian students' English language skills on the basis of literary texts in the three-dimensional space*

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Abstract. In our paper we introduce a bilingual language learning material developed in the framework of the so-called three dimensional virtual library model (3DVLM). This model inspired by the history and organization of the famous ancient Library of Alexandria forms the basis of the virtual library project which started about eight years ago as part of the Cognitive Infocommunications (CogInfoCom) research. The current version of the 3DVLM uses the excellent 3D features of the MaxWhere Seminar System which makes it suitable for both individual learning and classroom use. In the following, we would like to introduce first the basic framework of our development, then describe in detail the data structure and organization of the developed bilingual language learning material. The basic idea of the material is to present selected phrases and contexts from classical literary works in English and from their parallel translations in Hungarian in order to improve both the language skills and background knowledge of Hungarian language learners at an advanced level. We found that using web technology was especially useful for developing the language learning material and the developed hypertext structure formed a scale-free network of interconnected nodes.

Keywords: second language learning, three-dimensional virtual library model (3DVLM), MaxWhere Seminar System, bilingual language learning material

AMS Subject Classification: 68U05, 68U35, 68T05, 91E10, 91E40

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1. Introduction

In the year 2013 a *virtual library project* was initiated as part of the cognitive infocommunications (CogInfoCom) research [2, 3]. From the beginning, we have laid great stress on the mapping and visualization of the library content in the virtual 3D space the characteristics of which have been thoroughly investigated and analyzed by a lot of studies. We found especially useful for our project the presentation of virtual buildings in the 3D space [19, 27], the use of 3D VR as an effective virtual learning environment [20, 21], and the psychological aspects of the 3D environment [5, 6] but the number of such investigations is substantially increasing [15, 16]. The virtual library project was originally intended to bring together, arrange and show relevant verbal and multimedia materials in the 3D virtual space about the Great Library of Alexandria and Greek literary texts in English (e.g. preprocessed content about the work and life of Callimachus, English versions of chosen literary texts of remarkable ancient writers and poets etc.) [7, 9, 12], but later we significantly expanded the content of the virtual library in order that we can meet the requirements of the potential language learners. Though we think that the 3DVLM can be developed for different applications and purposes, *language learning* has seemed to be the most useful application of the virtual library material [10, 11] because, among others, of the increasing significance of the advanced English language competence and skills in the so-called information society. Moreover, the basic concept of the virtual library project includes to convey the message of ancient and classical cultures to the present-day culture through literature and we are convinced that with a carefully elaborated way and methodology the eternal values and thoughts of classical literary works can be precisely and eloquently expressed for the young members of the generations CE [15].

The current implementation of the 3D virtual library model exploits the spectacular 3D features of the MaxWhere Seminar System [26] especially because the arranged web browsers (called smartboards) fully support web technology and therefore enable the hypertext-based implementation of the basic concepts of the 3DVLM [8, 13, 15, 17].

In the following section we give an overview on the basic concepts and overall organization of the 3DVLM as a virtual learning environment where the selected and carefully preprocessed library content of the knowledge base of the virtual library will be presented for the potential language learners.

2. A brief overview of the 3DVLM as a virtual learning environment

As discussed before, the current implementation of the 3DVLM uses the innovative and spectacular 3D features of the MaxWhere Seminar System. We emphasize primarily the embedded *smartboards* in a selected ready-made 3D virtual space where the core content (e.g. texts about Callimachus or the Library of Alexandria, selected

parts of classical literary works etc.) and various navigation devices (thesaurus, index, concordance map, reference etc. *pages*) of the virtual library [13, 15, 17] can be displayed. A number of excellent and well-designed 3D virtual spaces can be found on the MaxWhere site [26] and they can be applied to almost every context, although each space shows its distinguished and unique characteristics. In our previous publications [13, 14, 16, 17] we selected the *3D Castle* virtual space for the presentation and arrangement of the virtual library content. But, owing to the flexibility of the 3DVLM, we can utilize other 3D spaces as well. Therefore we chose the *3D Library* virtual space for the new implementation of the virtual library model which provides a lot of smartboards in a virtual two-storey library building. In the following, we are going to show some screenshots and explanatory notes so as to illustrate how to have easy access to the preprocessed verbal and multimedia content in the 3D Library space.

Let us use the navigation page as a starting point [15, 17] (Fig. 1).

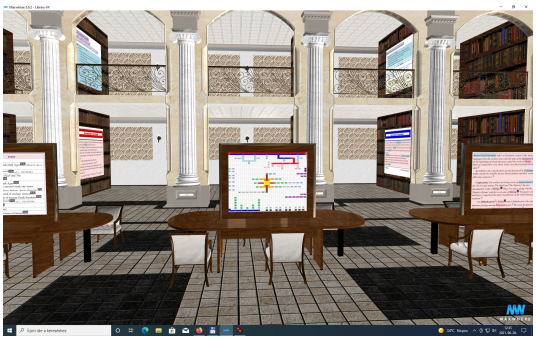


Figure 1. The *navigation page* of the virtual library content placed on the ground floor in the MaxWhere 3D Library space.

In the foreground of Fig. 1 there are three smartboards which jointly form an "information desk" of the 3D virtual library. These browser windows provide "smart" access to the main navigation devices of the virtual library:

- the *navigation page* is placed at the centre of the image;
- on the left side we can find a small part of the page providing a *timeline* of some historical events of the ancient era;
- on the right side a part of the *category page* [17] can be recognized which involves explanations of the main classification categories and presents their hierarchical structure.

In the background of the screenshot shown in Fig. 1 we can see some additional smartboards. Based on the content they contain we can distinguish two different types as follows:

- the smartboards located on the ground floor of the 3D library (the so-called *main cabinets*) show the core content of the virtual library including primary texts about Callimachus, the ancient Library of Alexandria etc. as well as selected parts of literary texts;
- the smartboards located on the first floor of the 3D library show, among others, the so-called *thesaurus pages* of the virtual library. These pages are intended to present additional linguistic knowledge which has been organized around certain keywords and collocations selected from the texts of the cabinets, and represented by a number of concordances or quotations which contain at least one of the keywords in the given collocation pattern.

Note that the developed bilingual language learning material can be considered as a supporting device for the language learners which contains designated keywords and selected contexts from classical and modern literary works. Therefore its place in the virtual 3D Library environment can be either on the ground floor (among literary texts which can directly refer to the material) or on the first floor (among the thesaurus pages which support e.g. vocabulary building).

The main function of the information desk is to enable the users to access relevant information, hence we located the content of the navigation pages also on the wall of the 3D library (see Fig. 2).

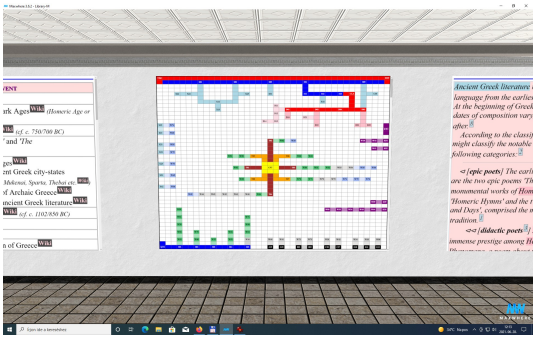


Figure 2. Three *navigation pages* of the virtual library placed on the wall in the MaxWhere 3D Library space.

The content of some of the main cabinets is organized around selected primary texts about the life and work of Callimachus (including the Pinakes, the ancient Library of Alexandria, the works of Callimachus etc. [13, 15–17] which, as we mentioned before, can be discovered on the ground floor of the 3D library just behind the information desk. The primary text about the ancient Library of Alexandria, and that about Callimachus can be observed in Fig. 3.

From a different view we can see the primary text about the Pinakes as well (Fig. 4).

For those who would like to see the hypertext representation of the library content we have mentioned above, the current content of the virtual library project

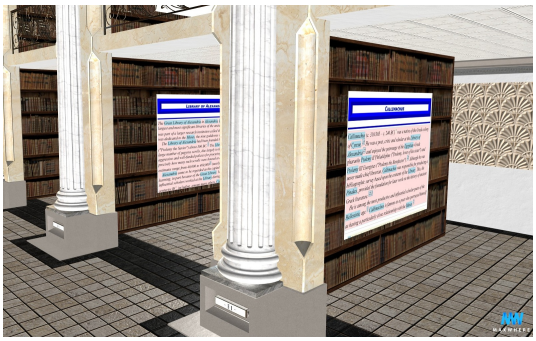


Figure 3. *Cabinets* which include primary texts about the Library of Alexandria and Callimachus placed on the ground floor in the MaxWhere 3D Library space.

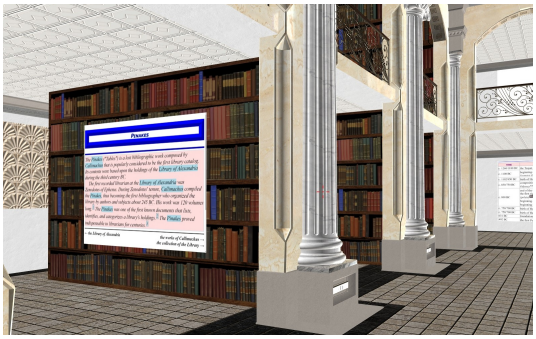


Figure 4. The *cabinet* which shows the primary text about the Pinakes placed on the ground floor in the MaxWhere 3D Library space.

can be accessed through the internet [23].

3. Introduction of a bilingual learning material for language learners

In the following, we would like to introduce the latest development of our virtual library project. We prepared a *bilingual language learning material* [25] aimed especially at Hungarian students who have an advanced level of English language proficiency (and who have great interest in literature as well). The basic idea of the material is to present carefully selected passages from literary works along with their parallel translations and organize them with the intention to prepare a more or less scale-free network of interconnected nodes in order to provide an efficient learning environment for language learners.

We'll have a ***swashing*** *and a* ***martial*** *outside* (I.3.120)

where the adjectives *'swashing'* and *'martial'* have several synonyms as well as rich connotations which we thought were worth elaborating. So we gathered two separate groups of semantically related words named as Part 1 and Part 2, respectively. Each of the groups had more than 60 items, e.g.

loud, noisy; hoarse, rough, harsh; ...; hectoring, boastful, cocky; *swaggering*, **swashing**, swashbuckling, square-jawed; ...; disdainful, contemptuous, scornful (Part 1)

active, energetic, vigorous, dynamic, alert; ...; **martial**, soldierly, militant, combative; *aggressive*, bellicose, belligerent, quarrelsome; ...; relentless, implacable (Part 2)

These words have been considered as keywords and *the primary aim of the developed bilingual learning material is to help language learners to enhance their vocabulary* as well as their language skills by learning these words and their contexts.

Although we gave Hungarian translations of the listed English words, we added selected bilingual phrases and sentences (either alone or with a broader context) to the material in order that the possible language learners could deepen, interconnect and then memorize the whole content. Moreover, we organized the content of the material by devising an inner hyperlink structure where

- the keywords serve as nodes and
- the selected contexts of the keywords contain hypertext links to the keywords that occurred in the contexts.

Metaphorically speaking, **we considered the bilingual learning material as a hypertext-based model for the long-term memory of the language learners.**

We selected 20 literary works in English (both from the English literature and from the world literature in English translations) with their parallel Hungarian translations as sources for the selected contexts that contain at least one of the keywords to be learned. As for the bilingual phrases, the available dictionaries proved to be a rich source in addition to the texts of the selected literary works. In some cases we also provided sentence examples, but this option could be switched on or off depending on the demands of the users of the learning material.

The literary works include English classics such as William Shakespeare's *As You Like It*, Jane Austen's *Pride and Prejudice*, Charlotte Bronte's *Jane Eyre*, Sir Arthur Conan Doyle's *The Adventures of Sherlock Holmes* etc. Works from the world literature in English translations include Victor Hugo's *Les Miserables*, Rafael Sabatini's *Captain Blood*, Leo Tolstoy's *War and Peace* etc. We would like to add some present-day literature works, too; so we selected short passages from J. K. Rowling's famous Harry Potter series, Stephenie Meyer's Twilight saga etc.

4. The data and link structure of the bilingual learning material

As we mentioned above, we had gathered more than 120 keywords which formed separate nodes in the hypertext structure. We attached carefully selected bilingual phrases, sentences and contexts to almost all nodes. (Note that each context established an individual node as well). We were aware that in the contexts which came from literary works there could be unknown, rare or difficult words or phrases, so we added separate vocabulary entries to each context in a separate section called 'Comments'. We also added further vocabulary entries to every keyword that occurred in a specific context and then, in each vocabulary entry, established hypertext links from each keyword to the corresponding node. For example, in Fig. 5 there is a node of the keyword 'hoarse', a short passage (in fact, a sentence in this case) from J. K. Rowling's Harry Potter and the Chamber of Secrets, and a short 'Comments' section including the vocabulary entry 'shout oneself *hoarse*' which contains a hypertext link (represented by an asterisk) to the same node to which the context belongs, i.e. to the node of 'hoarse'. There are two other links in the attached context (represented by a double arrow in superscript position, just at the end of the context) which point to the bibliographic description of the sources of the context (i.e. J. K. Rowling's corresponding work and its Hungarian translation) which can be found in the Reference page.

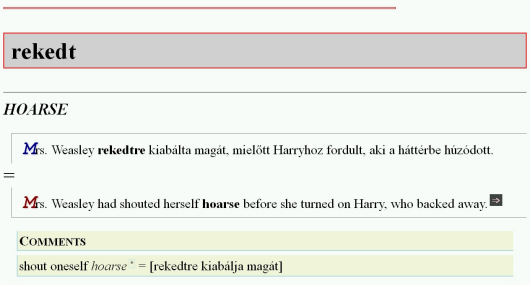


Figure 5. *The node of the keyword 'hoarse' with a bilingual context and its 'Comments' section.*

Apart from the nodes of keywords and the hypertext links in the vocabulary entries which point to them, we created specific navigation sections within the learning material each of which contains a dedicated group of hypertext links to specific parts of the material. In the following we would like to present them one by one.

First, the 'Sources' section lists a characteristic part (e.g. the first few words) of every context which occurs in the material. We grouped the items by the corresponding works of literature where the contexts occur and added several hypertext links to the items, which point to

- the bibliographic description of the corresponding literary work written (or translated) in English,
- the bibliographic description of the Hungarian translation of the corresponding literary work,
- the corresponding context (in English).

In case there are more than one context from a selected literary work, the referenced contexts are arranged according to their order of occurrence in the original work (Fig. 6).

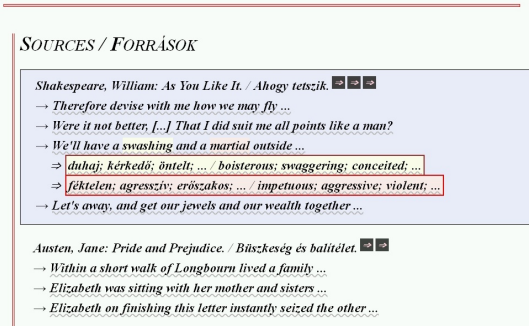


Figure 6. *The 'Sources' section containing references to the selected literature works and their contexts. Note that after the double arrows there are links to the two other navigation sections (i.e. Part 1 and Part 2, see below).*

Second, we created two other navigation sections which point to the group of keywords listed above as Part 1 and Part 2 (which are also the name of the sections themselves). The words are presented in two separate columns of a table where the second column contains the listed English words and the first one is their Hungarian equivalents. Moreover, we assigned a hypertext link to those keywords which are presented as individual nodes in the learning material (Fig. 7).

As we can see in the figure, in both columns of the table certain words are separated by horizontal lines to form subgroups of synonymous words. Where it seemed to be useful, we presented the pronunciation of some English words as well (that is, when pronouncing a word may be difficult for a Hungarian learner).

Third, we listed all the keywords and their Hungarian translations which occur in the learning material (either in a bilingual phrase or in a specific context) using a simple JavaScript program. We arranged the English keywords alphabetically and inserted a hypertext link to the exact place in the learning material where the presented keyword occurs (represented by an arrow in the third column of the table in Fig. 8). Note that we omitted from the table the occurrence of keywords in the sentence examples because their display is optional (as mentioned above).

Figure 7. *The beginning of the table containing English keywords and their Hungarian equivalents from the group of words named Part 1.*

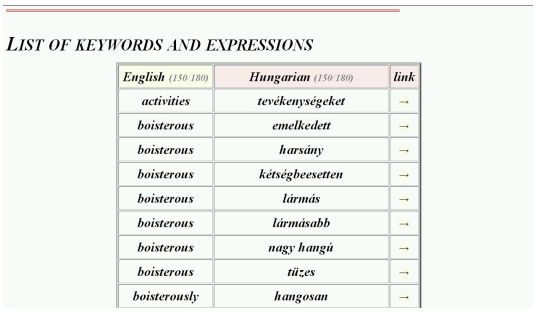
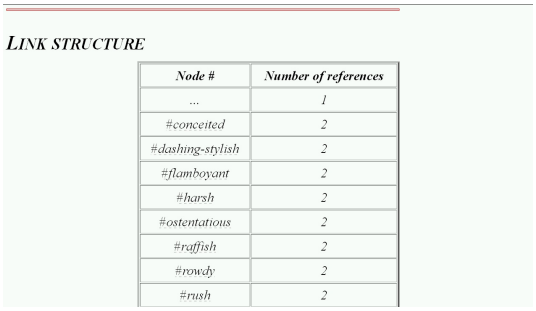


Figure 8. *The beginning of the 'List of keywords' section containing English keywords and their Hungarian translations arranged alphabetically. There are also links to the occurrence of each of them.*

Currently there are 150 occurrences of the listed keywords in the learning material (see Fig. 8).

Fourth, we listed all the English keywords which occur as separate nodes in the learning material (identified by their name after a hash mark like #conceited, #harsh etc.) using also a simple JavaScript program. We arranged the keywords by the *number of links* (called either 'Number of references' or 'Link strength') that point to the node of the respective keyword in the learning material, and inserted a hypertext link to each node represented by a gray dotted line which underlines each keyword in the first column of the table (Fig. 9). Note that we omitted those keywords the link strength of which is only 1 because of their number (actually, there are currently more than 200 such nodes).

Finally, we summarized the basic features of the *network* of nodes and hypertext links established in the bilingual language learning material. Using a JavaScript program we divided all referenced nodes of the learning material into separate groups according to the number of references which each node has (called 'Link strength') and determined the number of nodes in each group (called 'Strength



LINK STRUCTURE

Node #	Number of references
...	1
#conceited	2
#dashing-stylish	2
#flamboyant	2
#harsh	2
#ostentatious	2
#raffish	2
#rowdy	2
#rush	2

Figure 9. *The beginning of the 'Link structure' section containing the keywords (in the 'Node #' column) and the number of hypertext links that point to them (in the 'Number of references' column).*

frequency'). In the table shown in Fig. 10 we presented for each group of nodes the link strength value in the first column, and the number of nodes in the second column.

5. Evaluation and further use

In the science of networks the degree distribution of the so-called scale-free networks can be displayed by a curve that follows the power law and can therefore be described by the formula

$$N(k) = c * k^{-}\gamma \tag{5.1}$$

where N(k) is the degree or frequency of nodes that have exactly 'k' links. In other words, formula (5.1) describes the number of those nodes the "link strength" of which is exactly 'k' (see the first and second column of the table in Fig. 10). The parameters denoted by 'c' and γ are fixed parameters that characterize the specific network.

Note that the empirical value of the parameter γ (i.e. the degree exponent of the curve) for a lot of well-known scale-free networks is typically $2<\gamma<3$, e.g. $\gamma=2.5$ [1].

The JavaScript program we created fits a curve following the power law distribution of the number of nodes having exactly 'k' links described in formula (5.1) according to the series of data points presented in the first and second columns of the table in Fig. 10. The *estimated frequency values* that the fitted curve provides are presented in the third column of the table.

We found that in the current stage of the development of the learning material the value of the parameter γ is about 4 and the square root of the residual sum of squares (which, using the least squares fitting method, characterizes the deviation of the calculated values from the actual ones) is relatively high ($\Delta \approxeq 5.564$; see Fig. 10).

Link strength	*Strength frequency*	*Estimated value* (γ=4.188, Δ≈5.564)
1	*242*	*241.97*
2	*12*	*13.28*
3	*5*	*2.43*
4	*4*	*0.73*
5	*2*	*0.29*
6	*3*	*0.13*
7	*1*	*0.07*
Number of links: 332		

Figure 10. *The basic features of the network structure of the nodes of keywords and hypertext links. For example, there are 242 nodes that have 1 reference, 12 nodes that have 2 references etc.*

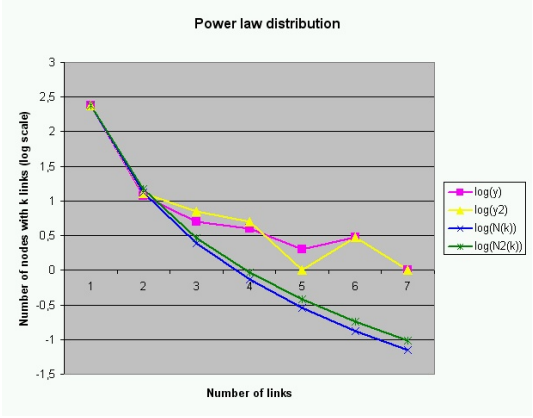


Figure 11. *The distribution of the strength frequency of nodes having exactly 'k' links on a logarithmic scale according to the data presented in Fig. 10 (first curve), and to the improved data after two weeks (second curve). The third and fourth curves have been fitted to the data in Fig. 10 and the improved data, respectively.*

However, we experienced in the content development process that during the elaboration of the language learning material the parameter γ tends to be gradually decreasing. For example, after two weeks' development of the content of the learning material, we calculated a somewhat lesser value for the parameter γ compared to the value presented in Fig. 10 (i.e. $\gamma \approxeq 4.014$ instead of $\gamma \approxeq 4.188$). So we guess that further elaboration of the material (for example inserting even more contexts

etc.) will result in an effect that the value for the exponent will be between the 'experimental' boundaries (i.e. between 2 and 3) and the deviation of the actual values from the calculated ones will be considerably less.

As for the effectiveness of the language learning material we intend to make it available freely through the internet. Both the usage statistics for a given period of time and the comments of the users can help us evaluate and improve the learning material. Note that the bilingual language learning material is also an inherent part of the 3DVLM which uses the MaxWhere Seminar System. Note that MaxWhere, on the one hand, is a desktop virtual environment for education and learning [4] which can provide, among other things, personalized, customizable learning environment and paths [22] for the learners, and, on the other hand, MaxWhere can be considered as a possible candidate for next generation 3D operation systems [24]. Besides, there are two firm pillars on which our work is founded: the 3D virtual environment might enhance the effective use of our long term memory serving as a kind of memory palace [18] and, supposing that the organization of the content elements to be memorized is more or less adequately reflected in the mental image created in the memory during the learning process, *establishing the learning material as a scale-free network of content elements* might transfer the network's high degree of robustness [1] against "memory failures" (e.g. oblivion) to the "network of knowledge" that the learners had successfully built using our learning material.

As a conclusion of those considerations we can plausibly expect that advanced (as well as enthusiastic and interested) language learners can use our learning material effectively either for self-study or in language classrooms for advanced language courses.

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