

Developing an E-Learning Application for Teaching Phraseology in Foreign Languages: Lessons Learned from EPHRAS Project

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Abstract - The main goal of the Ephras project funded by the EU Commission was development of an E-Learning application to support self-initiated learning of phrases in a foreign language. The application consists of two components – a multilingual database of 4000 phrases in 4 different European languages and a collection of interactive exercises structured according to language, difficulty level and particular pedagogical approach. In this paper the technical and pedagogical experience collected during development of this application is presented. For example, the data model used to represent the phrases from the database; data searching facilities, as well as user interface issues are discussed. Further, the complete development process of the interactive component is discussed. Thus, the paper reports about the process of collecting and analyzing pedagogical requirements for this component; design, model, and development of interactive exercises; and last but not least user interface of the component. In addition, the paper presents the typical problems that have been encountered in the development process, solutions to those problems, and finally lists and summarizes lessons that have been learned in this project.

I. INTRODUCTION

The Ephras project (117024-CP-1-2004-1-SI-LINGUA-L2) was a project funded by the European Commission under the Socrates/Lingua2 programme. The goal of the project was to develop a computer supported phraseology learning material for students of foreign languages for four European languages - German, Slovak, Slovenian and Hungarian language. The project aimed at eliminating the lack of such phraseology learning material, as well as at meeting the demands for multilingual learning material in the enlarged European Union.

The developed Ephras learning material is composed of a searchable database of 4x1000 phraseology data items in four languages (i.e. 1000 data items in each of the languages) accompanied with about 150 interactive tests to selected phrases in four languages. These questions and tests serve to check understanding and knowledge of the phrases in question, as well as for improvement of skills for producing these phrases in a written and spoken foreign language. As such they follow a sound didactic approach developed within the project in the form of an exercise typology. Moreover, the questions and tests are aligned according to language, topic, knowledge, and skill level of the students.

This paper provides an overview of the project results by presenting both of the project components in details. Apart from the technical issues related to the project, pedagogical aspects of the developed E-Learning application are presented. Additionally, the paper discusses problems that occurred during the project and lessons that

were learned. Furthermore, the paper provides a number of suggestions for the future work in development of E-Learning applications for language teaching.

II. PHRASEOLOGY DATABASE

This section concentrates on the first component of the Ephras learning material – the phraseology database - by discussing its requirements and features, as well as a number of important technical issues related to that component. The most important requirements and features of the database can be summarized as following.

Firstly, the source language is German with 1000 phraseology data items, where each of these data items is a single phrase in German with one or more meanings. Additionally, each German phrase is involved in a so-called equivalence relation with data items from other three languages (target languages). The equivalence relation expresses rather complex phraseology relationships between different data items. It can represent one of the following:

- A one-to-one relation between a single-meaning German phrase and a single meaning phrase from any of the target languages.
- A one-to-many relation between a single-meaning German phrase and a number of different single-meaning phrases from any of the target languages.
- A one-to-one relation between a multiple-meaning German phrase and a multiple-meaning phrase from any of the target languages.
- A one-to-many relation between a multiple-meaning German phrase and a number of different single-meaning or multiple-meaning phrases from any of the target languages.
- In some cases there is no direct phraseology equivalent for a German phrase in the target languages. The equivalents in that case are non-phraseology data items, i.e., a single word or a free collocation. Thus, the equivalence relation in such a case is a one-to-one relation between the German phrase and its corresponding free collocation.

Thus, the equivalence relation is 2-dimensional, where the first dimension denotes a one-to-one or a one-to-many relation between a German data item and the corresponding data items in the target languages. Orthogonal to that relation there is a relation between meanings of different data items, which can be either single-meaning or multiple-meaning data items, i.e., this relation is a typical many-to-many relation.

Another important feature of the phraseology database is a so-called description model. The description model for phrases in all four languages has been developed according

to the latest phraseology principles and includes the following: basic form (i.e., the content of a phrase), meanings, style, grammar, collocation, pragmatics, examples, variants, keywords, synonyms, categories and multilingual comment.

A. Data Representation

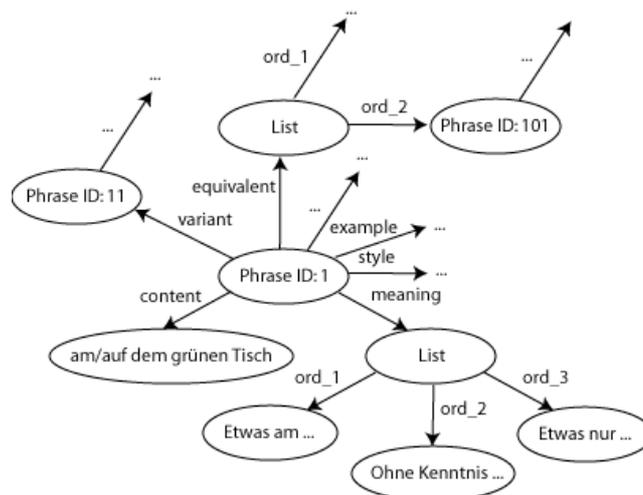
To efficiently represent the phraseology data it was necessary to look closely on some of its features. Here is a list of some specific properties of the phraseology data:

- Data is structured only to a certain extent, i.e., there are data fields that have a different structure for different data items. For example, the meanings field contains typically textual content that possesses a varying internal structure - a single meaning or a list of meanings. Another example includes the multilingual comment field, where the content can be decorated, thus including text in bold or in italics.
- Whenever a data field has an internal structure as it is the case with the meanings or multilingual comment field, the ordering of elements within this internal structure is important and embodies semantic significance. For example, if a meanings field contains a list of meanings then the ordering of these meanings within the list possesses a certain denotation and needs to be maintained.
- Data items are interrelated by means of typed relations such as the equivalence relation discussed above. The equivalence relation is an ordered relation with varying arity and dimensions, e.g., the relation can be a one-to-one, an arbitrary one-to-many relation or even a many-to-many relation between meanings of data items. Additionally, data items can be involved in a so-called variance relation (e.g., a phrase is a variant of another phrase in the same language).

From the data modeling point of view, data with such properties is referred to as semi-structured data. Typically, semi-structured data is irregularly, partially or implicitly structured. Further, for such data there is no a-priori or rigid database schema but only a so-called a-posteriori data guide can be identified [1, 2]. Obviously, the phraseology data in question can be classified as semi-structured data.

Generally, semi-structured data is modeled as a labeled graph [1]. The nodes represent data items, have unique identifiers and can be either atomic or composite. Composite data items are related with other data items by means of labeled edges, where labels represent the relation types. A simple model representing a couple of phraseology data items can be seen in Fig.1.

Recently, through the emergence of the Web and the related mark-up technologies, such as eXtensible Markup Language (XML), the latter evolved to a de-facto standard for managing semi-structured data [3, 4]. An XML document is a hierarchy of elements with ordered sub-elements. Each element has a name (also referred to as label or tag). The basic XML model is a labeled ordered tree where labels represent node names. Edges are always directed (to preserve the tree order) and do not have labels. Additionally, XML supports a referencing mechanism between nodes, which basically facilitates modeling of arbitrary graphs. In this way semi-structured data might be represented by means of XML documents. An excerpt



from XML-based representation of phraseology data is shown in Listing 1.

Fig.1. Model of semi-structured phraseology data

```
<phrase id="1">
  <content>am/ auf dem grünen Tisch</content>
  <meanings>
    <meaning>Etwas am ... </ meaning>
    <meaning>...Kenntnis ... </ meaning>
    <meaning>Etwas nur ... </ meaning>
  </meanings>
  <style >... </style>
  <examples>
    <example >... </ example>
  </examples>
  ...
</phrase>
<phrase id="11" variant="1">
  ...
</phrase>
<phrase id="101" equivalent="1">
  ...
</phrase>
```

Listing 1. XML Representation of Phraseology Data Items

B. User Interface

The user interface of the phraseology database is rather simple. The user can search within the database using any of four languages as the starting language. The search results are presented in a list and the user can click on a particular search result and obtain the full description of the data item. The links to the related data items (e.g., equivalents) are included in the data item description. In addition, the user can define a number of filters to further refine the search query (see Fig.2).

III. EXERCISE MODULE

The basis for development of the interactive tests in the Ephras project is a sound and successful pedagogical approach for teaching phrases in foreign languages. This approach includes learning activities such as phrase

recognition, phrase meaning or phrase pragmatics
identification, phrase form and grammar understanding,

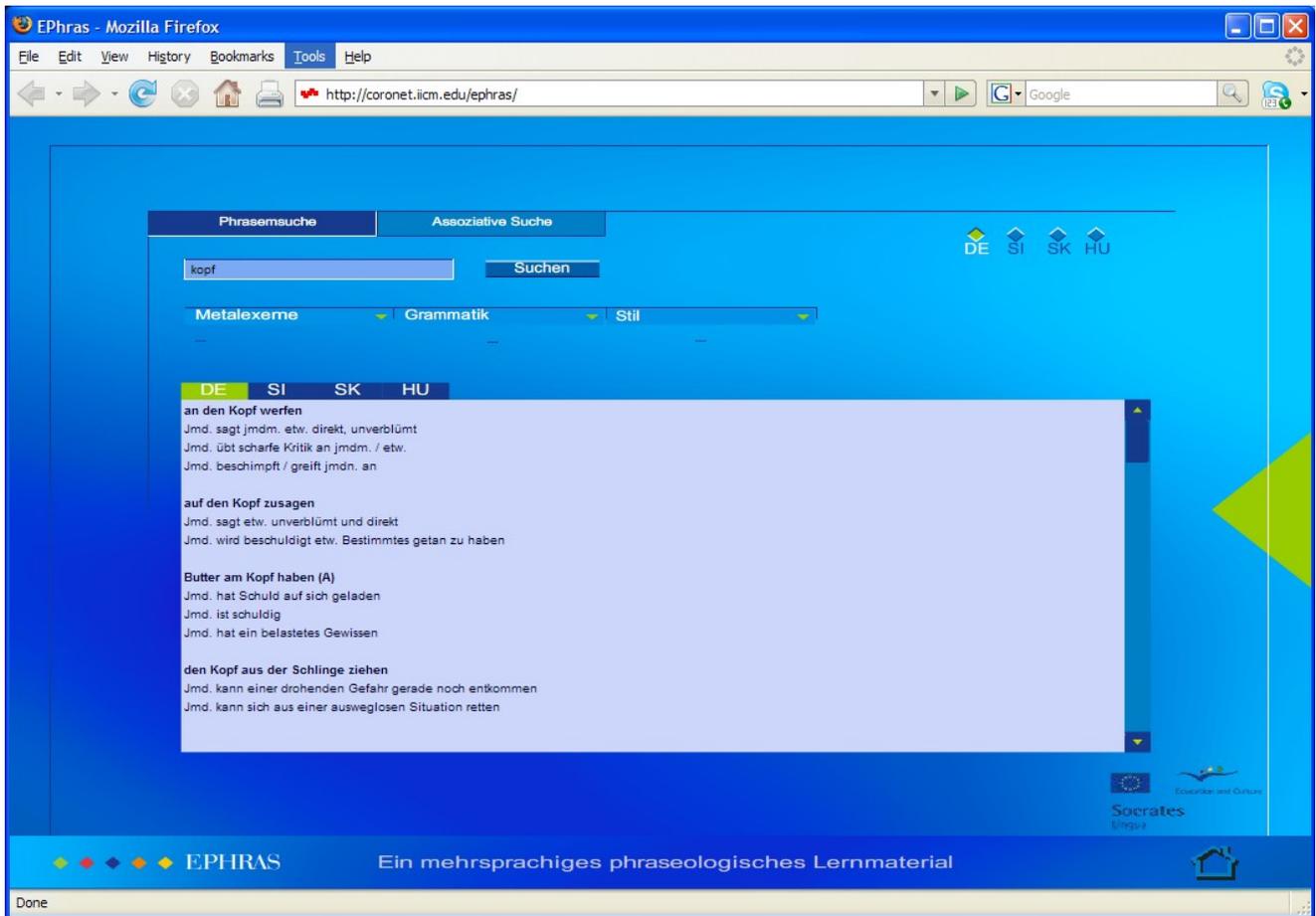


Fig.2. Graphical User Interface of the Phraseology Database

consolidation and reflection. Each of these activities is typically represented by a number of exercise types which are used in accordance with the current context, as well as the student's knowledge and skill level.

On the technical side, IMS Question & Test Interoperability (QTI) [5] specification has been applied to develop the exercise module. The QTI is a de facto standard for cross-platform representation of questions and tests in Learning Management Systems (LMS) and there are freely available tools for authoring, running, or result processing for QTI tests in an XML format.

During development of the exercise module we have experienced the following problems caused by a so-called "impedance mismatch" between the QTI standard and its concrete application in a specific subject area such as foreign language teaching. The mismatch is visible at three levels.

Firstly, the QTI standard is a technical specification which supports development of questions and tests for various subject domains where questions and tests are interoperable at the level of authoring tools, question/test databases or LMS. As such the standard defines a number of general question types that might be applied in a number of areas and does not take into account specific question and test types of a particular domain [6]. However, there exist a number of specific question types which are commonly used in foreign language teaching but are not reflected in the QTI standard, with crossword puzzles being only one typical example.

Secondly, the QTI standard is not concerned with pedagogical issues and, as a matter of fact, it tries to be as pedagogy neutral as possible [7]. Yet the basis for development of the interactive tests in the Ephras project is a well-defined pedagogical approach mentioned above.

Thirdly, there is a variety of technical possibilities for realizing the pedagogical aspects in QTI and very often it is difficult to estimate an optimal solution. For example, identifying phrase meaning can be realized with a multiple choice question where the student needs to select the correct meaning of a phrase from a number of possible answers, with a short text essay where the student needs to write down the meaning of the phrase, with a combination of these two question types, or with a simple drag-and-drop exercise where the student needs to correlate the phrase meaning with a graphical representation of that phrase (see Fig.3).

A. Development process

Basically, development of exercises was an iterative process with a number of repeating steps. The whole process required collaborative efforts on the side of the system developers and the teachers. The iteration steps of this development process included:

- Initial discussion between the system developers and teachers. The main goal of this session was to achieve a better understanding of both the pedagogical requirements for questions and tests and the technical

possibilities offered by the QTI standard. Thus, the teachers explained the types of questions and tests that are needed, whereas the system developers explained the features of the QTI standard.

- Preparation of several QTI samples to illustrate the possibilities of the QTI standard. The prepared samples already dealt with the questions and tests from the subject matter.

- Agreement on a text-based informal format for defining the questions and tests by the teachers. Such an informal format was needed because the teachers were not familiar with creation of formal specifications, i.e. they had a non-technical background.
- Realization of scenarios by means of QTI standard.
- Test and improvement phase.



Fig.3. Correlating phrase meaning and graphical representation

Note that some of the steps have been repeated a couple of times to obtain optimal results. Thus, the sheer amount of the development steps, as well as the amount of the work needed for communication, testing or improvement resulted in tedious work. Moreover, because of misunderstandings, communication problems, or implementation difficulties the whole development process was error-prone.

The difficulties of the development process can be summarized as follows:

- Learning curve for the QTI standard for the teachers was very steep. There are no sufficient manuals, help files, tutorials or tools that would decrease the time needed to learn the standard.
- Informal nature of format for defining the needed exercises leads to misunderstanding problems between the teachers themselves. The consequences of such problems become even more serious with an increasing number of teachers, because format disparity between different teachers also increases.
- Realization of exercises using such an informal format is also very difficult because of misunderstanding

problems between the authors and the systems developers. Again, the disadvantages become more visible as the number of teachers increases.

B. A Template-based Solution

To resolve the impedance mismatch and tackle the problems caused by that mismatch a template-based solution has been applied. Thus, a number of question and test templates have been developed. Each of these templates bridges a single gap between the features from the Ephras tests and the features offered by the QTI standard.

For example, a crossword puzzle template has been developed to support creation of typical crossword tests. To create a crossword puzzle a number of parameters need to be defined including the number of rows, the number of columns, the row questions, and the solution of the crossword puzzle. These parameters are defined by operating a QTI compliant editor (see Fig.4). In the Ephras project we used the Author from the Canvas Learning (<http://www.canvaslearning.com/>).

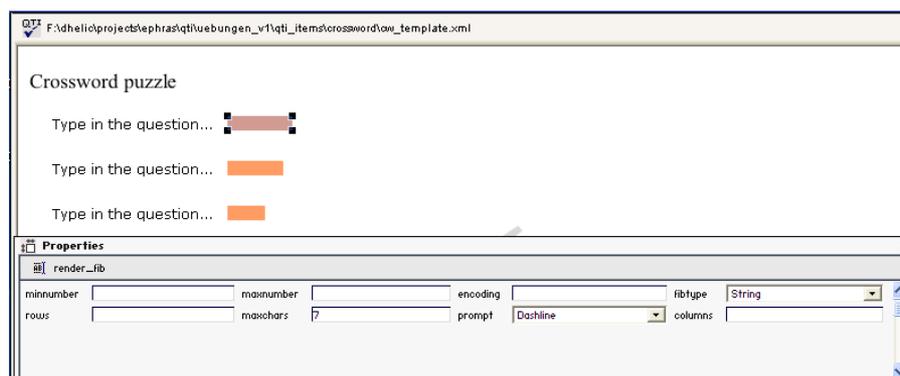


Fig.4. Editing the crossword puzzle template

Internally, the crossword puzzle is mapped onto QTI questions, such as single and multiple fill-in-gap questions with appropriate layout. However, through the abstraction offered by the crossword puzzle template the authors do not need to deal with the underlying low-level QTI solution.

The same template-based solution has been applied to resolve the impedance mismatch problem at the pedagogical level. Thus, for each learning activity mentioned above several templates have been developed. Each of these templates reflects a single possibility for supporting a particular activity. For example, to support phrase meaning identification activity three templates have been developed. The first template comprises a multiple choice question and a number of possible answers where only one single answer is correct. The second template includes a short essay question, where students need to type in their own textual explanation of the phrase meaning. The third template combines the first two, i.e., it includes a multiple choice question together with a short essay question.

Again, the teachers do not need to be concerned with the internals of the QTI standard. Rather they work with the QTI editor and only define a couple of parameters to create a working template instance (see Fig.5).

It is important to note here that the applied template-based solution is a general one, i.e. this solution is not limited only to an application in foreign language teaching. In fact, such a template-based solution might be easily applied in any other subject area. Basically, this solution hides the underlying QTI-based implementation and works at a higher abstraction level. That abstraction level is much closer to the subject area in question. Thus, the authors deal only with entities from the subject domain that they are already familiar with.

The benefits of this approach in the Ephras project resulted in efficiency and productivity increase during the development of the interactive tests. However, to achieve that increase in productivity some additional efforts have been needed to produce the templates themselves.

IV. PROBLEMS AND LESSONS LEARNED

The last difficulty that the system developers have been confronted with is not directly related to the presented approach but to the QTI standard and the way the presentation of questions is defined in QTI. Basically, QTI XML files mix together the content and its presentation.

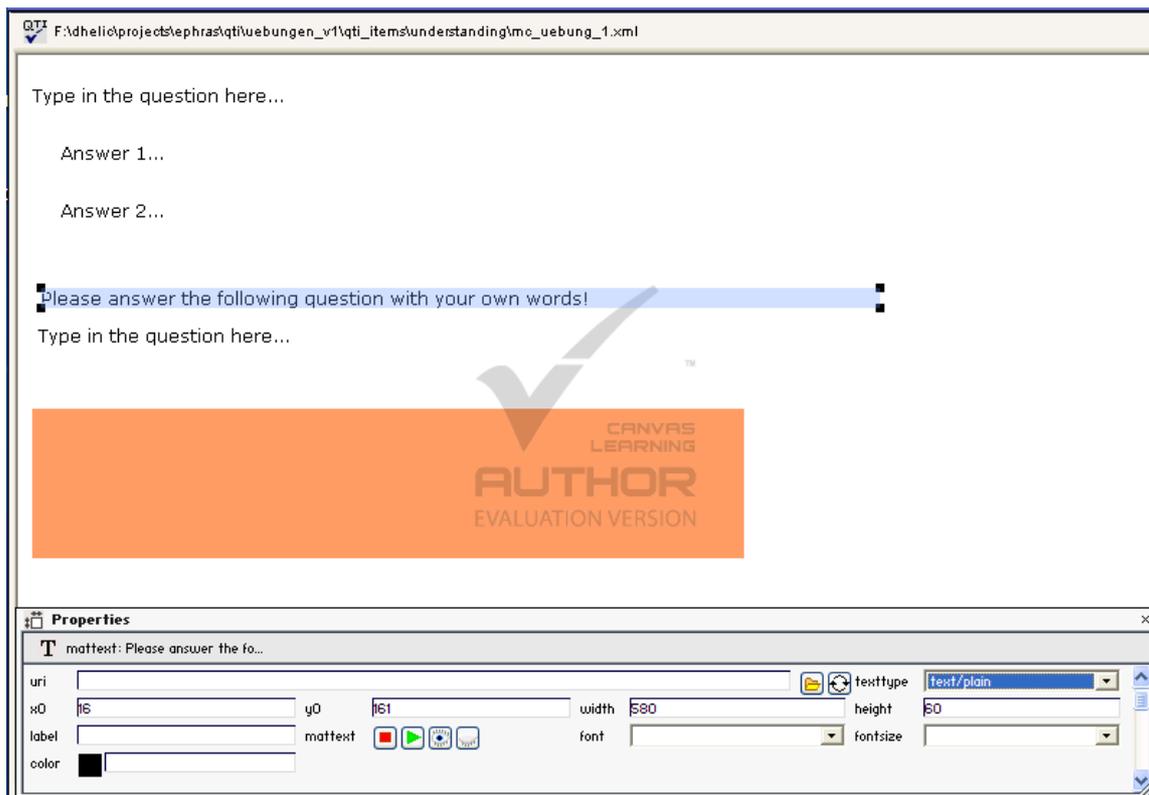


Fig.5. Editing the phrase understanding template

For each question apart from its actual content the developer needs to define its presentation, e.g. the coordinates on the screen where the question will be presented. This is a serious design flaw since it violates a well-known principle in software development called separation of concerns. Consequently, whenever the developer modifies the content of a question its presentation has to be modified as well because the spatial

relations within the question need to be updated. Especially, creating template instances can be very tedious because of this difficulty.

For example, one combination that has been very frequently used was a combination of a larger text where a number of sentences might be selected with a single correct selection. In addition, there is a multiple-choice question where a single answer can be selected to replace

the selected a sentence from the text. The replacement itself is achieved by means of dragging-and-dropping the selected answer from the multiple-choice question. Technically, this is a very complex combination, that includes a hot-spot area question for selecting a sentence from the text (using hot-spot in this particular case is actually a workaround since QTI does not define a question type “select a text”), a multiple-choice question, and a drag-and-drop question. Note that hot-spot area and drag-and-drop questions include also a spatial component, i.e., the developer needs to define positions on the screen where the answers are located or might be dropped with the mouse. Now, suppose that the text (from which sentences might be selected) is modified. This means that the developer needs to update the positions of hot-spot areas as well as position of areas where replacement sentences might be dropped. The only way to achieve this when using QTI is to update the template instance manually either by using a QTI editor or by editing QTI XML files with an XML editor.

Here are some of the lessons learned in the Ephras project. An analysis of these lessons might help to achieve certain improvements in similar projects in the future.

Firstly, templates in the Ephras project have been defined in isolation from each other, i.e. each template is defined independently of all other templates. However, questions are typically related to each other. For example, they are organized into larger units such as tests, which define how the questions should be sequenced at the run-time. Therefore, a possibility to define how templates and the questions created by applying them should be sequenced and organized into larger units would be a very welcome feature. Thus, our future work in this area will include development of such a possibility.

Secondly, it is very important that teachers obtain certain knowledge of the technical solution that is applied, i.e. knowledge about QTI in the Ephras project. For example, a simple support tool that can be used by the teachers to deepen their knowledge about the technical details could prove very helpful. By operating such a tool and learning about the technical solution in question the teachers can more easily understand what can be expected from the technical realization of their ideas. For example, this can influence the way how the teachers design their exercises

from the pedagogical point of view. Basically, they can focus more on such exercises which are indeed technically feasible.

Lastly, the system developers need to get a good understanding of the pedagogical requirements within a project. One possible way to achieve this understanding is to analyze the quizzes, question types, and questions. Such an analysis should answer the questions such as: which question types are the most important for the teachers and what are the combinations of the questions which are typically used. This in turn, can help developers in recognizing patterns typically used in question and tests. Knowledge of such patterns can improve to a great extent the development process of question and test templates.

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