

DISCUSSION FORUMS AS LEARNING RESOURCES IN WEB-BASED EDUCATION

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Abstract

Discussion forums are very popular and widely applied tools in Web-based education (WBE) systems. Usually, discussion forums are used by learners to discuss topics related to courseware, their current learning task, or the learning project they are working on. These discussion forums contain tremendous educational potential for future learners, since they contain question and answer dialogues, discussions, or examples made by previous learners. Thus, by simply reusing these discussion forums as new learning resources in WBE systems future learners would have very valuable learning information based on the hands-on experience of previous learners. However, implementing such a simple yet powerful idea in WBE systems is not a trivial task. Finding relevant information in discussion forums might be seen as a rather tedious task and the results of such process leave much to be desired. In this paper we present a simple tool that solves problems related to information retrieval in discussion forums and thus allows reuse of the forum content as new learning resources in WBE systems.

Key Words

WBE Systems, Discussion Forums, Reuse, Learning Resources, Semantic Modelling, Information Retrieval

1. Introduction

Nowadays, discussion forums are applied extensively as an easy-to-use and yet powerful communication tool in numerous Web-based applications.

For example, in Web-based scientific digital journals and digital libraries discussion forums are commonly used for discussing published articles, commenting ideas presented in these articles, or simply for writing “letters to the editor”. Another example constitute

discussion forums dedicated to software development and programming where programmers come together to exchange their views on different programming techniques, software design methods, project management concepts, etc. Moreover, the existence of numerous Web-based communities, communities of practice, and most notably Open Source communities relies mostly on discussion forums, which are usually the essence of such communities.

Similarly to general Web-based applications, in Web-based education (WBE) systems discussion forums are deployed for many different purposes with a huge success. For instance, each WBE course is associated with a special discussion forum that provides a place for context-dependent discussion on issues related to that course [1]. Thus, learners participating in a particular WBE course utilize the associated discussion forum for asking questions about the subject matter, discussing topics from the course, publishing their examples, etc. Furthermore, in a problem-solving or project-oriented WBE course the associated discussion forum is the first place where learners go to discuss actions they need to take to accomplish their tasks [2]. And last but not least, in collaborative WBE learning sessions [3] discussion forums are applied as primary collaboration tools [4] because discussion constitutes the first step of any collaboration.

Regardless of the application area discussion forums are always used extensively by the huge majority of users of a particular system. Consequently, discussion forums have a large success among numerous Web-based applications. One of the main reasons for this success is the simple and intuitive nature of these tools. Usually, discussion forums have a very simple and highly usable user interface which can be easily operated by a wide range of users

with very different and even non-technical backgrounds. Hence, users simply read through contributions arranged in a tree or a list and reply to those contributions by simply activating a special reply button. Structurally, discussion forums utilize a very simple and concise structure. Contributions to discussion forums are arranged into a tree, where non-leaf nodes represent so-called threads, i.e. contributions that have replies. Therefore, visualizing and providing a simple Web-based user interface for this simple tree-based structure is technically very easy task to accomplish.

Although discussion forums are primarily used as communication tools, we believe that they have even larger application potential, which goes far beyond a simple communication tool. Particularly, we believe that discussion forums in WBE systems contain tremendous educational potential. For example, these discussion forums contain question and answer dialogues, discussions, or examples made by previous learners. This of course is very valuable learning information for future learners. Such huge potential might be exploited by reusing discussion forums as new learning resources in WBE systems.

Generally, reuse of discussion forums as new learning resources might be seen as a three-step process. Firstly, discussion forums need to be applied for extracting knowledge about certain subject matter from people who possess that knowledge. At the next step the extracted knowledge is transformed into an adequate digital form. Finally, the extracted and “digitalized” knowledge might be reused in WBE systems as valuable new learning resources.

Let us look on few examples of how discussion forums might be applied for knowledge extraction. For instance, in a particular discussion forum associated with a WBE course learners usually ask a lot of questions about the course and subject matter. Normally, teachers and tutors answer these questions in the discussion forum. Thus, we can observe knowledge extraction from teachers and tutors when they answer learners’ questions. Another example includes a discussion forum attached to a problem-solving or project-oriented course. This discussion forum contains all the steps of learners’ progress in achieving their learning goal combined with the feedback they

got from teachers and tutors on each particular step of the course. This feedback represents the expert knowledge extracted in an electronic form. Moreover, teachers and tutors often discuss their WBE sessions in especially assigned discussion forums. There they are exchanging their knowledge and experience in a particular subject matter, thus such expert discussion results in extracted knowledge.

Now, to reuse the extracted knowledge as new learning resources some post-processing of discussion forums is required. Thus, a single document in the form of frequently asked questions (FAQ) might be created containing only the relevant question and answers from a particular discussion forum. Usually, this post-processing is done manually and this can be a very tedious task to say at least.

The best way to reuse the extracted knowledge would be of course to reuse discussion forums directly without any manual post-processing. However, reusing discussion forums directly, especially in WBE systems is related to a number of problems. The main problem might be stated as follows. Although discussion forums are highly usable as communication or even as knowledge extraction tool, support for information retrieval in discussion forums is very bad. Besides full-text search there is literally no other support for information retrieval in discussion forums. Search in context, or comprehensive navigational support is hardly available. For example, threads are organized in a simple temporal sequence, i.e. they are shown in a list sorted by time when they have been started. This means that older contributions are not easily accessible. Usually, the older threads become completely ignored, or even removed because they expire. Further, in each thread replies start usually with a simple “RE:” (abbreviation for “Reply”) followed by the title of the main contribution in that thread. If there is more than one level of reply all of these contributions start with as many “Reply” abbreviations as there are reply levels. This of course has as the result discussion forums that are completely unreadable, and it is almost impossible to find a certain contribution by navigation.

The reason for this problem lies in complete lack of any semantic model of threads and contributions in a discussion forum. Semantic model of contributions would involve

classifying and categorizing contributions around a number of interrelated concepts, i.e. assigning contributions to these concepts, and thus providing them with an explicit semantics. Information retrieval from such semantic model would be very easy: accessing a particular contribution might be accomplished through searching for contributions belonging to a certain concept or by simple navigating through concepts. The resulting discussion forum would be very concise and clear for its readers and could be easily reused as a new learning resource.

In this paper we present a possible approach to support semantic modelling of discussion forums. Further, we define the requirements for a tool that could support this process. In addition, the tool that we implemented following to the defined requirements is presented. This tool is a part of a WBE system called WBT-Master [5] and provides for creating, managing and reusing of semantically modelled discussion forums.

2. Semantic Modelling of Discussion Forums

Generally, semantic modelling of a particular domain involves identifying a number of concepts and relations between these concepts. Applications might use this semantic model as a part of their operations. These operations might range from a simple search in the model, navigation over the model, inference over the model, etc.

There are few different forms of semantic models, with ontology being the most general case of such models. Ontology defines a number of concepts, relations, rules and constraints on the relations [6], i.e., it specifies exactly the way how concepts might be related to each other. In a simpler case ontology might only identify concepts and their relations [6], without defining any constraints. Another type of semantic models is so-called taxonomy [7]. Taxonomy defines a number of concepts related by means of a single relation type: “is-part-of” or “parent-child” relation [7]. In other words taxonomy defines a hierarchy of concepts and sub-concepts.

Particularly, a semantic model of a discussion forum might define concepts and relations, which are inherent in the discussion domain. In WBE systems a discussion forum is usually attached to a WBE course. Each WBE course deals with a particular subject matter and therefore the discussion framework is already known. That means that the semantic model of this particular subject matter might be easily identified even before any discussion starts.

For example, let us consider a WBE course on databases. Suppose that we want to create a semantic model in the form of a hierarchy of concepts (taxonomy) for the discussion forum attached to this course. The top concept in the hierarchy might be called simply “Databases”. Sub-concepts can be “Data Model”, “Database Management Systems” and “Distributed Databases”. Sub-concepts of the “Data Model” concept might be “Network Data Model”, “Relational Data Model”, “Object-Oriented Data Model”, etc. (see Fig. 1.).

Now, the defined semantic model might be used in the following way. Whenever a user writes a new contribution in the discussion forum, the new contribution might be assigned to one or more concepts from the semantic model. For example, if the user writes a new question about relational calculus, this contribution might be assigned to both concepts: “Data Model” and “Relational Data Model”.

In this way, each contribution is provided with an explicit semantics, which can be processed to improve information retrieval facilities of the discussion forum. For instance, simple semantic search might be easily implemented. Such search could involve searching for all contributions, which belong to a certain concept from the semantic model, or searching for all contributions which are related to a particular concept by means of a specific relation. For example, a user might search for all contributions belonging to all other concepts related by means of “parent-child” relation with the “Data Model” concept. The results of this search would include all contributions from all sub-concepts of the “Data Model” concept, i.e. all contributions from “Network Data Model”, “Relational Data Model”, etc. will be a part of the result.

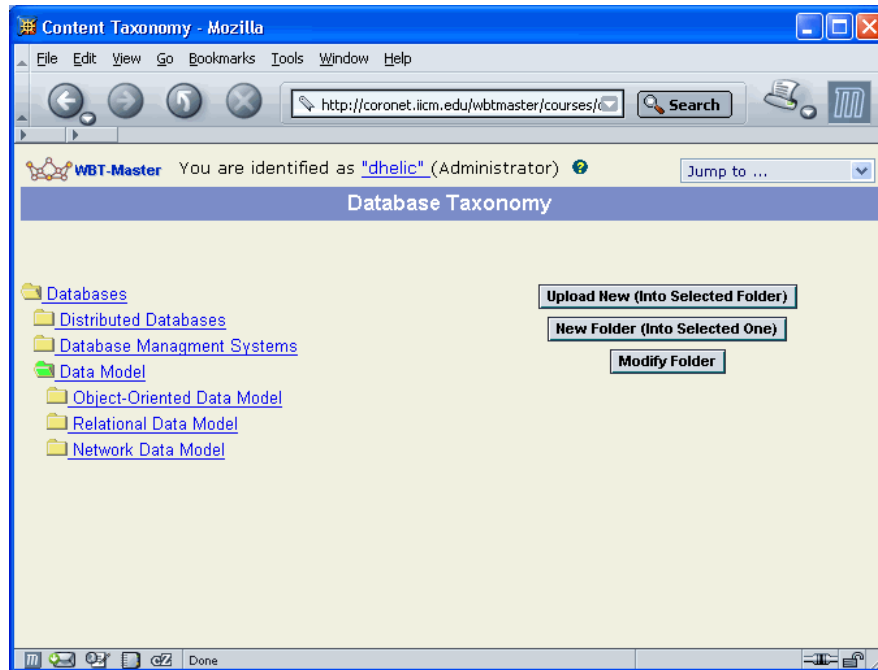


Figure 1: Example of database taxonomy

Further, the semantic model can provide navigational support. For example, each concept from the model might be represented as a link. Clicking on such a link might present the list of all contributions belonging to that concept, as well as links to related concepts.

Obviously, providing such semantic modelling possibilities in discussion forums requires an extension of their functionality. The functionality must be extended in a number of ways. Firstly, there should be a possibility to combine discussion forums with the corresponding semantic models. Secondly, a mechanism that supports assigning of contributions to concepts from the semantic model must be added to discussion forums. Finally, facilities processing the semantic model to improve information retrieval should be also implemented in these new discussion forums.

3. Implementing Semantic Modelling in Discussion Forums

Extending the functionality of discussion forums to support semantic modelling of contribution might be achieved in a number of different ways. Depending on the environment the requirements for such a new tool may vary. However, we are interested in such requirements considering a

WBE environment. Identifying these requirements should be guided by the basic idea that discussion forums in WBE systems might be easily used to extract and transform knowledge from people into an electronic form. At the next step, the extracted knowledge should be reused as a new learning resource in the system.

Here is a list of the most important requirements that new discussion forums must meet:

- Usability. The main reason for the large success of discussion forums is their highly simple and usable user interface. If the new discussion forum introduces any additional complexity in the user interface, or if it breaks the simplicity or intuitiveness of the original tool, then it is largely predestined to become a failure. On the other hand, since we need to attach a semantic model to the tool, it is obvious that we need to introduce some modifications in the user interface. One possible solution to this problem would be to put restrictions on the type of semantic models that can be used. In this way we lose some expressional power of more advanced types of semantic models, but try to keep the new tool as intuitive and simple as possible. Moreover, even the simplest type of semantic models usually has enough expressive power to meet our requirements for improving information retrieval in discussion forums. Hence, we can permit only the simplest type of

semantic models – taxonomy. Permitting only taxonomy as a semantic model type has another very interesting and promising property. Structurally, taxonomy is a hierarchy (tree) of concepts. This structure is identical to the structure of contributions and threads in discussion forums. That means that we can use the same user interface for working with taxonomy or threads and contributions. We only need to introduce one new button for switching between taxonomy and the original discussion forum. In this way we preserve the simplicity, intuitivism and usability of the original user interface.

- Flexible taxonomy. Taxonomy is created before users start to work with the tool by identifying concepts and their sub-concepts in a particular subject matter. Thus, there exists a problem that this taxonomy will not introduce all relevant concepts for a particular discussion. Also, new concepts might be identified as the results of a fruitful discussion. Obviously, there should be a possibility to modify the taxonomy on-the-fly. However, modification of the taxonomy should be allowed only for few designated users – moderators, in order to keep it as simple and precise as possible. Of course, modification of the taxonomy may happen upon users' request or as a result of some discussion in the forum.

- Reliability of assignment. Our approach is based on assigning contribution from the discussion forum to concepts from the taxonomy. Obviously, the final assignment must be reliable since we want to reuse the discussion forum as a new learning resource in the system. If we have contributions assigned to concepts that they actually do not belong we did not achieve much with this approach. Let us now first consider an automatic assignment of contributions to concepts from the taxonomy. This approach usually involves so-called text mining [8] or in some special cases even Web mining [9]. Text mining tries to extract keywords from the text and identify concepts to which these keywords refer. In the simplest case a text mining tool might assign documents to the taxonomy by comparing keywords and concepts. Although results of such categorization mechanisms may be surprisingly good they have also a number of disadvantages [10]. Firstly, text mining processing is dependent on the language, and requires a special processor for each particular language. Thus, such mechanism is not universal enough, and we need to have different processors for different languages. Further, good

results in text mining have been achieved only for English language, processing of other languages leaves much to be desired. Also, having a multi-lingual discussion forum could lead to serious problems in implementing this approach. Finally, text mining is very computationally expensive and does not scale well enough for larger collections of documents. This, of course, may constitute a serious problem for many WBE systems. Moreover, some contributions include also multimedia objects, such as graphics, sounds, etc. In this case categorizing such contribution requires also Web mining, i.e., text mining must be extended to investigate multimedia objects as well. This process however is not so well developed and is computationally even more expensive than text mining. Therefore, we need to take some other approach. Obviously, we can let users of the discussion forum manually assign contributions to the taxonomy. Since we already guarantee a high usability of the new tool this want constitute a serious problem for users. To further improve reliability of our approach we may introduce a simple voting system that will allow users to agree or disagree with a certain assignment. Thus, the author of a contribution would assign this contribution to a particular concept and other users may agree or disagree with this assignment. If the contribution gets more disagreement than agreement then this contribution is removed from that concept.

- Users' motivation. Since the discussed approach relies on users who manually assign their contribution to concepts a proper motivation of users might be needed. In WBE systems a high level of users' motivation may be achieved as follows. Usually, tutors, teachers and authors need to prepare courseware in WBE systems anyway. Since, a discussion forum enhanced with taxonomy and a proper assignment of contributions to concepts from the taxonomy is already a new learning resource motivating tutors, authors or teachers won't constitute a problem. Basically, they need to conduct a WBE training session using the tool, moderate the discussion and make sure that the quality of contributions is on an acceptable level. In that way they won't have much of work (if any) on their local sites in order to prepare the courseware. On the other hand, motivating learners may be easily achieved by providing them with additional points for their final note for each useful contribution and assignment that they make.

- Flexible assignment policy. Sometimes a contribution may belong to a number of concepts. Thus, it should be possible to assign contributions to a number of concepts.

Following to the presented requirements we implemented a tool called Virtual Discussion Room in WBT-Master system. The next chapter presents this tool in more details.

4. Virtual Discussion Room in WBT-Master

Virtual discussion room is composed of two components: discussion forum and taxonomy. Usually, taxonomy reflects concepts that are inherent in the discussion domain.

A virtual discussion room can be attached to a WBE course in the same way as a normal discussion forum would be attached. However, a room might be created and published in the system completely independently of any WBE course. An especially designated user, which will be a moderator of the discussion creates a room

and publishes it in the system. Further, the moderator creates an initial taxonomy and attaches it to the room. Note, that the moderator may modify the taxonomy on-the-fly, whenever there is a need to introduce a new concept.

Initially, users access the room and work mainly with the discussion forum. The discussion forum provides the standard functionality, allowing users to read contributions and post replies to those contributions. Note that virtual discussion room provides a simple tree-like graphical user interface to the discussion forum (see Fig. 2.). At the next step, users may assign contributions to concepts from the taxonomy. To do so users activate a special button. The system visualizes the taxonomy, allowing users to navigate through its concepts until the desired concept is reached. Note, that the visualization mechanism is again based on a tree-like graphical user interface. This insures high usability of the tool since users are already comfortable with this user interface from the discussion forum (see Fig. 3.). Note also that one contribution may be assigned to a number of concepts.

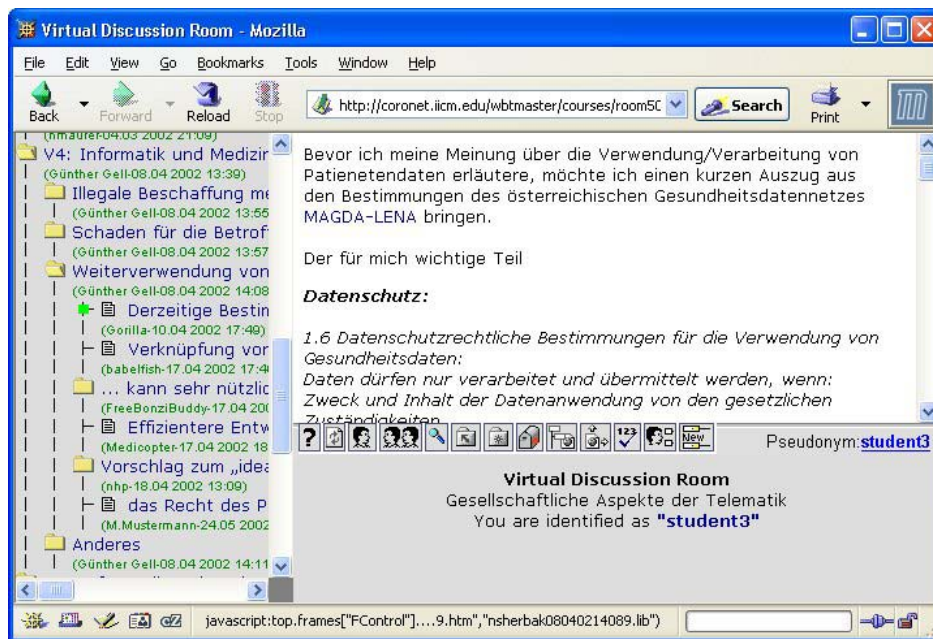


Figure 2: Working with discussion forum

Further, users may work directly with the resulting assignment of contributions by activating another special button. The system

again visualizes the taxonomy with assigned contributions in the same way as in the discussion forum.

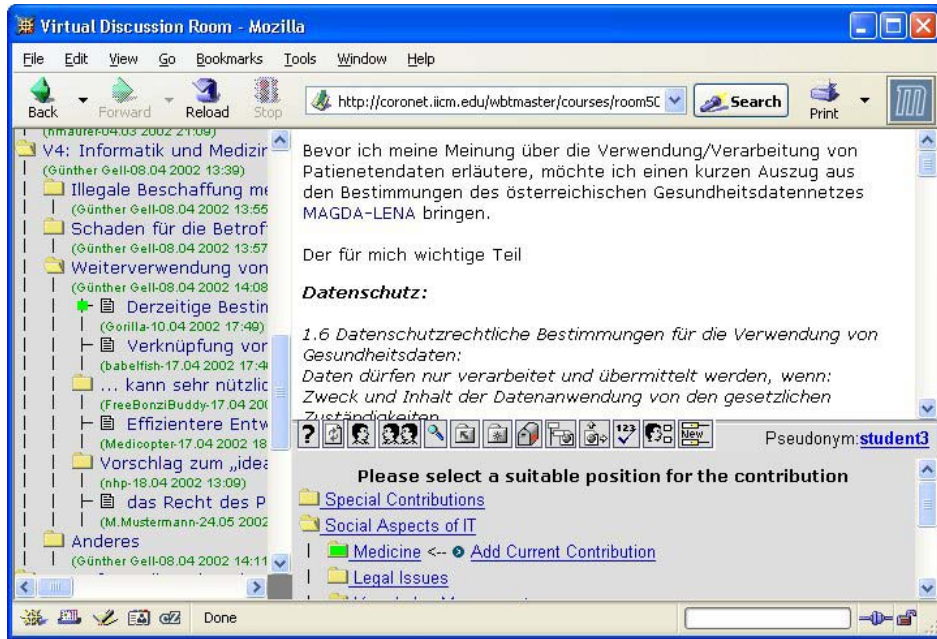


Figure 3: Assigning a contribution to a concept

Now, users may vote for or against assignments made by other users (see Fig. 4.). Each positive vote increases the “weight” of an assignment, thus making it more reliable. On

contrary, each negative vote decreases this “reliability”. If a particular assignment reaches a negative “weight”, then this assignment is automatically removed from the concept.



Figure 4: Working with assignment

Note that during their work with the assignment the original context of a particular contribution is visible and users may at any time switch back to the discussion forum by simply clicking a button. This can be very useful for voting for or against a particular assignment,

since users may see what the context of that contribution is.

When the discussion is over the moderator may close the room. Now, the resulting assignment might be reused as a new learning

resource in the system. That means that other users may work with the room using the resulting assignment as their access point. In other words, users may navigate through concepts and in that way reach contributions. Further, they may use a special search mechanism to search in contributions using different search criteria. For instance, they can search for contributions belonging to a certain concept, or for contributions related to a particular concept. Thus, the room now resolves information retrieval problem of discussion forums by providing two sophisticated information retrieval techniques.

5. Virtual Discussion Room in Practice

We applied the virtual discussion room tool for conducting the 2002 summer term course in Social Aspects of Information Technology (IT) at the University of Technology in Graz. More than 200 students participated in the course [11]. This course consisted of:

- 12 lectures on different social aspects of IT, such as legal issues of IT, IT and medicine, knowledge management, etc.
- An especially for this course prepared virtual discussion room where students, tutors and the teacher discussed the topics from the lectures. Before the discussion started the teacher prepared the domain taxonomy by arranging 36 concepts into a tree of concepts.

Students needed to take an active part in the discussion by writing, reading and replying to contributions. Further, they were asked to assign contributions to concepts from the taxonomy and to vote for or against particular assignments made by other participants of the discussion. There was no final examination for students; they were graded only by evaluating their participation in the discussion. Thus, grading of students was based on the number and quality of written and read contributions, the number of assignments they made and the number of votes.

Here are some highlights of the results we had with this virtual discussion room. On average, students wrote 10 and read 45 contributions. They made 3 assignments and voted 2.5 times. Thus, the final discussion room had 2000 contributions, 600 assignments (450 different contributions were assigned) arranged into 36 concepts. The average “reliability” (how

many students agreed to a particular assignment) of assignments was 2.3. The teacher and tutors moderated the discussion, by starting new threads, and providing an initial direction for the discussion. Further, they actively participated in the discussion by replying to students’ contributions and clarifying certain topics for students. Finally, they made sure that the resulting assignment of contributions, as well as contributions themselves was of an acceptable quality. For example, they deleted some assignments from the resulting assignment whenever the quality of the assigned contribution was not satisfactory. This was necessary, since the teacher wanted to reuse this discussion room for the same course in the next year.

After the course students were asked to fill in a simple evaluation form. Here we wanted to get answers on questions such as:

- Did students like the idea to have a discussion-based course?
- Did students see any advantages in learning by using such communicational tool?
- Were they able to acquire new knowledge and skills by participating in discussion with other people?
- How much of an additional effort was to work with the taxonomy and to assign and vote for contributions?

Here are some of the results of this evaluation. Students generally liked the idea of having a course based solely on discussion with other students and the teacher. Most of the answers show that they liked this idea since in this way they were actively participating in the course all the time. 80% of students saw tremendous advantages in using such communicational tool to work together on a certain subject matter. They were able to get to know their fellow students and exchange their views and ideas on certain topics much better than in a more traditional course, where they tend to work alone or in small groups. Similarly, they also got more acquainted with the teacher and tutors since in a traditional course there is not so many communications going on between students and the teacher. 85% of students answered that they acquired additional knowledge and skills during the course in a very simple manner, i.e., by simply taking a part in a discussion. Also, 65% of students answered that they acquired additional knowledge by working with the taxonomy and trying to assign contributions or vote for particular assignments.

By doing so they were able to grasp the concepts and sub-concepts from the domain in more depth, thus this provided them with more overview of the subject matter. Further, assigning and voting for contributions represented a practical test of how well they understood topics from the subject matter and how able they were to relate ideas presented in contributions to concepts from the taxonomy. 90% of students were satisfied with the user interface of the tool, and answered that they did not need to put any additional effort to work with the taxonomy and assignments. For 70% of these students working with the taxonomy did not represent a problem because the taxonomy had the same user interface as the discussion part of the tool. Finally, the overall assessment of the course and the tool was 1.9, where 1 is the best mark on the scale from 1 to 5. The average assessment of courses in our university is 2.5, and on our institute 2.

6. Conclusion

The first results of applying virtual discussion room tool in WBT-Master were quite successful. Thus, the tool supports the standard functionality of a Web-based discussion forum, but further it provides means for semantic modelling of contributions from that discussion forum. The efforts on the users' side to create and manage this semantic model might be seen as minimal due to no additional complexity in the user interface of the tool.

The tool provides means for an easy extraction of knowledge from people participating in the discussion. The extracted knowledge is enhanced with the semantic model, which provides facilities for improving information retrieval in the final discussion forum. Thus, the benefits of having a discussion forum structured according to the semantic model are numerous. Retrieving useful information by simple navigating or searching by using concepts from the model is easily accomplished by a wide range of users. This, of course, allows us to reuse the final discussion forum as a new learning resource in WBE systems, where advanced information retrieval techniques are of the primary importance.

Moreover, we believe that this tool has even more potential than it might be visible on

the first look. For example, the tool might be easily applied as a general knowledge extraction tool in a wide range of other applications. For instance, let us imagine a situation where a number of experts in a particular subject matter come together to discuss certain topics in an especially prepared virtual discussion room. The result of this discussion and the attached semantic model might be seen as a structured excerpt of the knowledge that these experts possess. This knowledge might be reused not only in a WBE system in a university, but also in a corporate environment for training of the workforce.

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