Deriving ontologies and assessment rubrics for electronic documents with human support for automatic assessment purposes

Master's Thesis

submitted by

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Automatische Leistungsermittlung durch Extraktion von Ontologien und Bewertungsrubriken aus elektronischen Dokumenten mithilfe menschlicher Unterstützung

Masterarbeit

vorgelegt von

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Abstract

Since there is information technology it is important to describe content and data in some way. That also applies to the educational sector. If a subject's learning matter is available in a structured way, for example, it can be easier to provide a standardized examination procedure. Such standards are important for a fair evaluation process. This can be achieved with the use of ontologies and the help of assessment rubrics.

Therefore this thesis addresses the topic of automatically deriving ontologies out of electronic text as well as making those derived ontologies modifiable by human support. Out of those ontologies rubrics are derived that can be used for automated assessment purposes and in particular for automated essay grading systems.

Thus, this thesis is divided into a research part, a part that describes the development of the prototype and finally the results of a case study in deriving ontologies and concept rubrics out of electronic documents are stated.

Thus, firstly some definitions and overall information about educational assessment techniques, assessment rubrics and ontologies will be mentioned and secondly a variety of systems that are working with rubrics will be presented. Thirdly, the semantic of rubrics for assessment purposes will be discussed and afterwards the prototype will be introduced. The section about Rubrico, the software prototype we have developed, contains the overall system specification and the system design. The system design includes mock-ups, UML class diagrams and the intention why this structure was chosen.

Finally the case study, the challenges that were met in developing the prototype, and the conclusions that were obtained will be stated.

Kurzfassung

Seit Beginn der Informationstechnologie ist es wichtig Daten und Inhalte zu beschreiben. Dies trifft auch auf den Bildungssektor zu. Wenn zum Beispiel Lernstoff in einer strukturierten Art und Weise zu Verfügung steht wäre es möglich standardisierte Bewertungsmechanismen zu entwickeln. Solche Mechanismen sind wichtig um eine faire Bewertung zu ermöglichen. Dies kann durch Ontologien und Bewertungsrubriken ermöglicht werden.

Diese Masterarbeit beschäftigt sich mit dem automatischen Extrahieren von Ontologien aus elektronischen Dokumenten. Diese Ontologien werden in weiterer Folge durch den Benutzer modifiziert. Aus jenen werden anschließend Bewertungsrubriken generiert, welche für das automatische Bewerten von Aufsätzen eingesetzt werden können.

Diese Arbeit ist in einen Forschungabschnitt, einen Abschnitt, welcher den Entwicklungsprozess des Prototyps darstellt, und einen Abschnitt, welcher eine Fallstudie, die sich mit der Genauigkeit automatisch extrahierter Konzepte beschäftigt, aufgeteilt.

Folgend werden Definitionen und allgemeine Informationen bezüglich Bewertungstechniken im Bildungssektor, Bewertungsrubriken und Ontologien aufgezeigt. Nachfolgend werden Systeme, welche mit Rubriken arbeiten, sowie die Semantik von Rubriken, präsentiert. Darauffolgend wird der Prototyp Rubrico vorgestellt, indem die allgemeine Spezifikation und anschließend das Design beschrieben werden. Das Design umfasst Mock-ups, UML Diagramme und eine Erklärung zur Wahl jener Struktur.

Abschließend werden die Fallstudie, sowie die Probleme, welche beim Erstellen des Prototyps entstanden sind, erwähnt und abschließend die weitere Vorgehensweise beschrieben.

Statutory declaration

I declare that I have authored this thesis independently, that I have not used other than the declared sources / resources, and that I have explicitly marked all material which has been quoted either literally or by content from the used sources.

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Graz am, 1.11.2010

(Emanuel Reiterer)

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Chapter 1

Introduction

1.1 Context and scope

A huge amount of information is available in electronic form nowadays. Therefore it is important to have a good, easy to use, computer processable, and portable standard for storing and describing this information. This can be solved with the help of ontologies. With ontologies arbitrary topics can be described in a way a computer can work with and therefore, for example, it is possible to use query languages for searching in such ontologies. An important part to create ontologies is the extraction of concepts out of the provided electronic data. Therefore one aim of the practical part was to extract the concepts automatically.

Thus, we decided to use ontologies for our purposes in the field of automated essay grading and to build a software that is capable of deriving and visualizing ontologies as well as providing the functionality to manage and work with them. As a result the derived ontology is adaptable by the user, assessment rubrics can be calculated out of it, and the ontology can be stored for reuse in other programs. Therefore we decided to use the OWL Syntax (W3C, 2009a) to store the ontology. For calculating the ontology itself the Text2Onto (Cimiano

& Voelker, 2005) toolkit is used and the prototype was developed with Eclipse (Eclipse Foundation, 2009a)as a Rich Client Platform (RCP) (Eclipse Foundation, 2009b) application.

1.2 Motivation

The work on this project was motivated by the emerging need of structuring massive amount of electronic data and the facilitation for lecturers in grading essays. Because our field of research is the educational sector and for grading purposes the use of assessment rubrics can be very helpful and thus we decided to work with them. Assessment rubrics became popular in the last years and they are applied to provide a fair evaluation process. They are divided into categories where each category consists of the required concepts that have to be mentioned in the exam to reach a specific level. Such a rubric can be translated into an ontology as well as the other way round. Because of the possibility to translate ontologies into rubrics and the power of describing topics by using ontologies we decided to adapt them.

1.3 Structure

This thesis is divided into a research part, a part that describes the development of the prototype and one that deals with the result of a study in deriving ontologies and concept rubrics out of electronic documents.

Firstly, the motivation to develop this prototype, some definitions and general information about educational assessment techniques, assessment rubrics and ontologies will be mentioned. After that the research we have done will be illustrated. This section handles the topic of assessments in general, the definition of assessment rubrics and how they are structured and the role rubrics take up in the different assessment phases. Also, systems that work with rubrics will be mentioned as well as the semantics on rubrics, the state of the art of content and concept retrieval, ontology creation and how rubrics are extracted out of an ontology. Finally, the research regarding user interfaces and available tools to achieve our goals will be discussed.

After the research section the prototype will be described. That includes the system specification, system design, challenges that were met and further tasks for the future. The system design includes mock-ups, UML class and activity diagrams and an explanation of the intention of the chosen structure.

Last but not least the case study that was made to figure out necessary improvements to our prototype will be stated. That section consists of the setup of the case study, the results and interpretations of that results.

Chapter 2

Background

In this chapter some definitions regarding assessment rubrics and ontologies are introduced. Firstly, the term academic rubric will be outlined, secondly formal concept analysis will be introduced, thirdly ontologies will be described. Thereafter current ontology description languages will be outlined, and finally the Eclipse platform followed by the NeOn toolkit and the Text2Onto toolkit will be stated.

2.1 Rubric (academic)

Rubrics that are used for assessment purposes (Assessment Rubrics) are defined as a scoring tool for subjective assessments (Nationmaster, 2009; Wikipedia, 2009c).

They are used for assessments on papers, projects, essays and other kinds of assessments.

A scoring rubric consists of one or more dimensions - also called criteria - where each dimension has a definition (descriptor) and a rating scale (levels). Scoring rubrics include one or more dimensions on which performance is rated.

With the help of rubrics standardized evaluation can be provided, which also makes self reflection and peer review easier.

A rubric is also a tool to enforce authentic assessment (Pickett & Dodge, 2009). Thus, it is designed to simulate the real life learning process and follows the principle of evaluating real work.

2.2 Formal concept analysis

Formal Concept Analysis (FCA) (Priss, 2006) is a method that can be used to derive ontologies automatically. Therefore a collection of objects and attributes is used. This method was introduced by Rudolf Wille in 1984 and uses lattice and order theory which was invented by Birkhoff and others in 1930.

The aim is to find natural clusters of attributes or natural clusters of objects. One natural cluster of attributes corresponds to one natural cluster of objects. Such a constellation is named concept. Out of those concepts it is possible to build a concept lattice.

To be able to recover the original context a Hasse diagram (also called line diagram) can be used (Wikipedia, 2009a).

More about FCA will be mentioned in the chapter about concept extraction.

2.3 Ontology

An ontology is a computer processable model of a specific domain. It is a formal representation that consists of a set of concepts within a domain. The concepts may stay in relation to each other.

Ontologies itself can be divided into formal and informal ontologies. An informal ontology is specified by a catalog of types that are undefined or defined only by statements in a natural language. A formal ontology by contrast is specified by a collection of names for concept and relation types organized in a partial order.

An ontology consists of components like individuals, classes, attributes, relations, function terms, restrictions, rules, axioms and events. (Katifori, Halatsis, Lepouras, Vassilakis, & Giannopoulou, 2007)

Ontologies can also be divided into frame-based, first-order logic based and description based ontologies.

Frame-based ontologies are focused on objects and classes. Such ontologies consist of a set of classes organized in a hierarchy and a set of lots that are associated to classes as well as a set of instances. First-order logic-based ontologies on the other hand support first-order logic expressions. Description based ontologies are an extension to the frame-based ontologies but are not including features out of the first-order logic-based ontologies.

2.4 Ontology description languages

In this chapter RDF (Resource Description Framework)(W3C, 2009b), OWL (Web Ontology Language)(W3C, 2009a)and F-logic (Michael Kifer, 1995) will be described. RDF and OWL were invented by W3C (World Wide Web Consortium). OWL is the successor of RDF and both are description based ontologies. To mention a frame-based ontology representation as well, the F-logic representation will be depicted shortly.

2.4.1 RDF

With the Resource Description Framework (RDF) it is possible to describe ontologies that are exchangeable with other systems (Lux, Schleir, Tochtermann, & Granitzer, 2008). It is a W3C specification, designed as a meta model and now used for conceptual modeling. It is a general purpose language for representing information in the web. (W3C, 2009b) It has a variety of syntax formats. RDF uses object oriented concepts described as classes, which may have properties. RDF uses XML as an interchange syntax.

2.4.2 OWL

The OWL (W3C, 2009a) or 'Web Ontology Language' is the successor of RDF. The main advantage of OWL is the better computer processability. Therefore three different kinds of sublanguages were developed: OWL Lite, OWL DL and OWL Full.

If there is only the need of subclass-of relations and simple constraints the OWL Lite language is feasible to use while the OWL DL language stands for maximum expressiveness while retaining the computational completeness. The third sublanguage is the OWL full language, which is compatible to the RDF Schema and thus not easily computer processable.

2.4.3 F-logic

This representation was developed by Michael Kifer and Georg Lausen (Michael Kifer, 1995) and is focused on objects and classes. Relations are secondary in this representation. Features of F-logic include object identity, complex objects, inheritance, polymorphism, query methods, and encapsulation.

2.5 Eclipse

Eclipse (Eclipse Foundation, 2009a) was originally developed by IBM (IBM, 2010) and is used as an IDE (Integrated Development Environment) for programming in Java. In 2004 a not-for-profit corporation called Eclipse Foundation was founded to direct the Eclipse community. Since then, several applications have been developed. Some are stand alone applications where Eclipse is used as a RCP (Rich Client Platform) and others are plugins that are added to the Eclipse IDE itself. An example of an RCP application is the NeOn toolkit that is mentioned in the next chapter.

2.6 NeOn toolkit

The NeOn toolkit (NeOn, 2009) was developed to provide tools for creating and working with ontologies or semantic applications. This toolkit was developed as an Eclipse rich client platform application and invites everybody to participate with a plug-in. Currently 45 plug-ins are developed especially for this toolkit. Because our prototype has to handle ontologies as well we took into account to contribute to it by developing a plug-in.

2.7 Text2Onto toolkit

The Text2Onto toolkit (Cimiano & Voelker, 2005) was developed by the University of Karlsruhe and provides algorithms for extracting concepts out of electronic documents. This toolkit uses a corpus containing the documents to be evaluated and gets a set of algorithms to work with. This set can be extended with new algorithms quite easily. Also, it was developed as open source and by studying the source code we found out that it has some shortcomings when working with other operating systems than Windows. Thus, we decided that it could be a perfect starting point for our prototype, of course after the necessary adaption took place.

2.8 Conclusions

In this chapter terms used in this thesis were explained as well as some tools we considered to work with. We have started with the definition of academic rubrics because it was planned to use the prototype in automated essay grading by developing content criteria for such rubrics. Also, formal concept analysis was mentioned, which would be interesting to implement for a better extraction of concepts in the further development of our prototype. This was then followed by describing some application and toolkits we want to work with or contribute to as Eclipse, the NeOn toolkit, and the Text2Onto toolkit.

Chapter 3

Research

The aim of this chapter was to gain profound knowledge in the assessment design process, content and concept retrieval technologies and visualization techniques for our prototype. But also research regarding the creation of rubrics is stated.

Thus, the literature research work will be outlined, which is divided into a content and concept retrieval, an ontology creation, a rubric extraction and a visualization section.

But first the design process of assessments will be described and how those techniques used in that process can be deployed into our prototype. In the content retrieval section some tools and algorithms to retrieve reliable and relevant concepts will be discussed. The ontology creation section will handle the task on how an ontology can be stored, and what representation for exchange with other software can be chosen. Then we will proceed with the rubric extraction. This extraction should be achieved with an algorithm that will be applied on the extracted ontology. Finally a look on how ontologies can be visualized will be taken.

3.1 Ten steps as part of the assessment design process

To retrieve valuable concepts or subsequently rubrics it is helpful to get a better understanding of the assessment design process. Herman, Aschbacher and Winters mentioned ten steps in their paper "A Practical Guide to Alternative Assessment". (Herman, Ashbacher, & Winters, 1992). Those steps will then be analyzed in connection with our work on retrieving concepts for automated assessment.

1. Clearly state the purpose for the assessment, and do not expect the assessment to meet purposes for which it was not designed.
2. Clearly define what it is you want to assess (the achievement target).
3. Match the assessment method to the achievement purpose and target defined in step 2.
4. Specify illustrative tasks that require students to demonstrate certain skills and accomplishments. Avoid tasks that may be merely interesting activities for students, but may not yield evidence of a student's mastery of the desired outcomes.
5. Specify the criteria and standards for judging student performance on the tasks selected in step 4. Be as specific as possible, and provide samples of student work that exemplify each of the standards.
6. Develop a reliable rating process that allows different raters at different points in time to obtain the same - or nearly the same - results, or allows a single teacher in a classroom to assess each student using the same criteria.
7. Avoid the pitfalls that threaten reliability and validity and can lead to mismeasurement of students.

8. Collect evidence/data showing that the assessment is reliable (yields consistent results) and valid (yields useful data for the decisions being made).

9. Ensure "consequential validity." That is, the assessment should have a maximum of positive effects and a minimum of negative ones.

10. Use test results to refine assessment and improve curriculum and instruction; provide feedback to students, parents, and the community.

3.1.1 Application of those steps in the field of automated assessment

It is beneficial to understand the assessment process in order to automate the scoring process. Thus, we used those ten steps to adapt or specify our system in a way that makes it most useful for the user for developing concept rubrics as well as for the student to be able to improve his or her work with this tool for formative assessment purposes.

Step 1: With the application of rubrics the purpose is stated clearly, and students can get a better understanding of the taught topic. Because we are working particularly on content rubric criteria it is intended to adapt our prototype to provide the functionality to choose the detailedness of the shown rubric criteria. As a result the lecturer can then choose which of the automatically retrieved rubric criteria the student should see. But the detailedness of the criteria has to be good enough for the students to know what they have to internalize.

Step 2: The achievement target can be split up into a main objective and the level of immersion into a specific topic. The level of immersion can be put on a level with complexity and therefore the lecturer has to be able to specify that. But the main objective has to be clearly defined no matter how low the complexity level is. For example, if the level of complexity will be decreased to a very low level the only available concept could be the name of the topic in the lecture. But this may not be enough because sometimes not the whole topic is meant to be assessed, rather only a specific part of the whole topic.

Step 3: Because the prototype is designed for essay grading it is recommended to choose the correct assessment method beforehand. On the other hand a retrieved ontology of the topic to be assessed can be helpful with any assessment method.

Step 4: Illustrative tasks that yield into a student's mastery of a desired outcome could be achieved through the work on a specific criterion of an assessment rubric. Students can so be encouraged to work on interesting topics that are applicable to a specific domain.

Step 5 and 6: Specifying criteria and developing a reliable rating scale represent important functions of our prototype. The lecturer gets a set of automatically retrieved concepts that can be seen as a content criterion. Those concepts will be split up into more or less relevant concepts for each grading level. The more relevant concepts have to be mentioned in the exam for passing it while the less relevant concepts have only to be mentioned in the exam if the student wants to get a better mark rather than just passing the test.
To assure a reliable rating process the gathered concepts and the retrieved relevance values thereof can be used.

Step 7: With the use of a computer system and a fixed ontology and content criterion pitfalls that threaten reliability and validity can be avoided. Reliability and validity can be established through the transparency in the connection between retrieved concepts and the text were the concepts are extracted from as well as of standardized rubric extraction procedures that provide clearly defined rubrics for students to work with.

Step 8: To collect the evidence the retrieved concepts and the connection to the electronic data is stored and secondly the assignment can then be matched against those retrieved concepts for proofing the decision made by the computer.

Step 9: A maximum of positive effects can be achieved with a proper selection of concepts for a rubric's content criterion. Therefore the set of concepts that have to be mentioned in a test, should neither be too hard nor too easy but such decisions have to be made by the lecturers or the responsible committee. Thus, a semi-automatic process can be beneficial because a computer system is not able to derive rubrics that extract an equilibrated set of concepts used for the content criterion.

Step 10: With the test results the concepts of a rubric's concept criterion can be adjusted. As a result it is feasible, in a semi-automatic process, to improve the exam for the next time.

3.2 General features of rubrics

In this section the general features of rubrics will be stated. According to Bernie Dodge and Nancy Pickett (Pickett & Dodge, 2009) those features are:

- Rubrics focus on measuring a stated objective (performance, behavior, or quality)
- Rubrics use a range to rate performance
- Rubrics contain specific performance characteristics arranged in levels indicating the degree to which a standard has been met

Our interests lie in measuring the correctness of the content of an essay. Therefore we want to create a rubric's content criterion. Other rubric criteria as criteria for spellchecking, analyzing sentence structures, etc. can be easily added

to our rubric representation afterwards because the data structure, in which a rubric will be represented in our prototype, is an OWL DL structure, where new criteria, stored as new main concepts, can be easily added.
As a range to rate performance we chose to use relevance values of a rubric's content criterion, which are stored in a probabilistic ontology model that was created beforehand.

3.3 Different roles in different phases

According to R. Sabetiashraf (Nationmaster, 2009) rubrics serve different roles in different phases of an assessment.

During the pre-assessment phase, rubrics are used to clarify expectations and grading methods with learners. Also learners can perform a self-assessment prior the real assessment.

In the assessment phase, rubrics can help evaluators to remain focused on the preset standards of excellence and enforce them to objectively assess the learner.

In the post-assessment phase learners get a scored rubric with clear explanation of their grade and they are made aware of their weaknesses and strengths.

With this information we then deduced that ontologies and subsequently created concept rubric criteria can be used for the whole assessment process. Advantages by using ontologies and rubrics in the different assessment phases are stated below.

Pre-assessment During pre-assessment the expectations can be clarified in providing the calculated concepts. Those retrieved concepts can then be mapped to the document corpus, which contains the electronic data on which the concept calculation is based, and shown in an arbitrary level of detail. Thus, the lecturer has the opportunity to choose the information that is handed over to students.

Assessment phase In the assessment phase the software prototype and the calculated concept rubric can be used for an essay grading system or to evaluate assessments manually. The essay grading system can use an OWL file containing the rubric.

Post-assessment Because extracted content criteria of rubrics are connected to a subject's matter or a set of electronic documents out of that subject it is possible to show the missing parts and the lecturer can give accurate recommendations for improvement.

3.4 Rubric examples and systems

In the following chapter some systems are shown that are using rubrics to get an insight in that field of research. One weak point all of those tools have in common is their inability of deriving rubrics automatically.

3.4.1 e-Examiner

This tool was developed by Christian Gütl (Guetl, 2007) and his colleagues. It automatically creates test items, assesses students answers and provides feedback. This system is not working with rubrics but it evaluates exams automatically and therefore it is interesting for our research especially because of the tools that are introduced to that system.

This system consists of a Tomcat server to which a MySQL database is connected as well as an answer assessment module called GATE (Sheffield, 2009). The customer connects over a web client via HTTP to the Tomcat server. For automatic assessment a hybrid approach was applied that is built on a natural language preprocessing chain and on ROUGE characteristics that are used for automatic evaluation of text summaries.

3.4.2 I-Rubric

I-Rubric is a web-suite that provides tools for working with rubrics. (Reazon Systems, Inc., 2009) This tool can be used for creating, assessing and sharing rubrics. It is free and easy to use and there are a lot of predefined ontologies available.

3.4.3 Ontario rubric

The Ontario rubric system is used to mark students in the province of Ontario. (Wikipedia, 2009b) It is a chart with five columns where in the first column the categories are filled in and the other four columns show the levels 1 - 4.

The rows consist of the following categories:

- Knowledge/Understanding
- Thinking/Inquiry
- Application
- Communication

A disadvantage of that rubric is the wide range of the scale. For example when a score of 80% - 100% would have been reached a score of 1 will be given. Thus, a finer scale would be better for an meaningful mark.

3.4.4 Rubistar

Rubistar is another rubric creation system where rubrics can be created by hand. (Rubistar, 2009) Several templates are available to create them out of the box. The website can be used collaboratively. But as in all available rubric creation systems it is not possible to extract or create rubrics automatically. Nevertheless the websites can be used almost intuitively and a huge set of already available rubrics for different purposes and grades are available.

3.5 Semantics on rubrics

Next, the semantics on rubrics, which are widely accepted for teaching purposes, will be discussed. Rubrics consist of a set of criteria, a definition of each criterion and a scoring scale, which is divided into levels.

The Ontario Rubric System, for example, consists of a chart with five columns. The first column holds the category and the other columns contain the grading-levels 1 to 4.

The Webquest Web Research evaluation for students (Webquest, 2009) instead offers rubrics or tasks that are posted from different schools. Each task consists of a learning task and its evaluation. The task itself consists of the following points. Introduction, Task, Process, Evaluation, Conclusion, Credits. The evaluation part contains the rubric. The category is presented in the 1st column and the other columns contain the level or the requirements of each level or criterion.

3.6 Content and concept retrieval

We have started our research by looking for approaches to retrieve content or concepts out of an electronic set of documents. To get a better understanding of the basics of information retrieval we have gained knowledge out of a book named "Modern Information Retrieval"(Baeza-Yates & Ribeiro-Neto, 1999) as well as out of a course about information search and retrieval held by Christian Gütl at Graz, University of Technology that provides a good background into that topic. Therein algorithms for content or information extraction such as the TFIDF (term frequency inverse document frequency) weight or algorithm, models to store data for faster retrieval and matching purposes, and the information search and retrieval workflow are described.

But there are also additional techniques available that are not mentioned in the book as formal concept analysis (FCA) (Priss, 2006).

Also we have decided to use a toolkit named Text2Onto(Cimiano & Voelker, 2005) that was written at University of Karlsruhe in Germany. This toolkit uses GATE (A General Architecture for Text Extraction) (Sheffield, 2009) to retrieve content out of electronic documents. But as a main feature they have implemented many algorithms for concept, subclass of, and instance of extraction.

Thus, the retrieval of concepts out of electronic documents can be divided into two parts. At first the content has to be retrieved and stored in a computer readable format and consecutively the retrieval of concepts has to take place. Content retrieval with the help of natural language processing tools, for example, can be achieved with the GATE or the Lucene (Apache, 2010) framework. To retrieve concepts there are many algorithms available and some of them are implemented in the Text2Onto toolkit.

An additional advantage of the Text2Onto toolkit is the use of a probabilistic ontology model (POM). Such a model works with relevance values calculated for each concept, subclass-of, or instance-of entity.

Since this toolkit contains some approaches that are useful for our prototype we chose to embed Text2Onto into our system. Another advantage is the language the toolkit was programmed in, which is Java, and that the toolkit was published as an open source software. Beside that there is a NeOn toolkit (NeOn, 2009)plug-in available as well, which is beneficial for us because we also decided to implement our prototype as a plug-in for the NeOn toolkit and therefore we knew that this toolkit was already used with this system. But in contrast to the plug-in that is already available our approach provides an ontology about the taught topic (depicted by an electronic set of documents), a visualization of that ontology and the user does not have to search for the best algorithm because a set of algorithms is chosen automatically to retrieve the most meaningful concepts. Additionally, there is also an expert perspective available where the algorithms can be individually chosen by the user. Also a rubric creation feature will be implemented and there will be a possibility to alter ontologies after concept extraction.

3.7 Ontology creation

For our prototype we have decided to work with ontologies. Thus, a proper ontology representation had to be chosen. There are several representations available as for example OWL and F-Logic. Also we came up with the following requirements regarding our ontology representation. It has to be user-friendly, easily exchangeable, extendable, and stored in a well known, standardized format. Furthermore, the representation has to be integrable into the Text2Onto toolkit as well. It is necessary to make the ontology user-friendly because in our case the ontology creation is intended to be done with human support. Also the ontologies have to be easily exchangeable with other software and extendable to be able to add, for example, relevance values.

As a result we chose the OWL language (W3C, 2009a). This is because OWL is quite popular and therefore it can be used for exchange with other programs. Another advantage is the use of XML where ontologies can then be parsed by other programs that are working with the standard OWL format and/or XML.

As described in the OWL definition there are three OWL sublanguages available and because only concept-subconcept relations and instance-of relations are needed for the first prototype it is feasible to use the OWL DL sublanguage with some special adaptions because of the use of relevance values. After the adaption regarding the relevance values this ontology is also known as a probabilistic ontology model (POM) (Cimiano & Voelker, 2005).
Another restriction to the representation is the need of only having one parent per child. This is because of the used visualization technique and the transformation into concept rubrics afterwards.

3.7.1 Ontologies possessing multiple parents

A question that came up in the research process is the arrangement of concepts in an indented list visualization. An ontology provides the option that a concept may have more than one parent. That accrues a conflict in regards to an indented list because in such a list this is not easily realizable.

Thus, we decided, if a concept is linked to more than one parent, to take the most relevant one and delete the other subclass-of relations.

3.7.2 Artificial concepts

Because GATE retrieves content by using word stems it may happen that artificial concepts like su- or ten- are extracted out of a document. Those concepts are of course no real concepts and therefore they should be removed. But such terms can also be helpful because users may be inspired to create new concepts out of them by working with those abbreviations. But this is only useful if the ontologies are reviewed by hand after the automatic extraction process, which is intended for our prototype.

3.8 The extraction of rubrics out of an ontology

In this section our research in implementing a rubric creation software is stated.

After the retrieval of an ontology out of a specific topic or subject a content rubric criterion has to be extracted. This process uses the result of the concept retrieval process stored in a probabilistic ontology model (POM).

The criterion to be extracted should consist of an arbitrary number of levels that can be provided by the lecturer. The previously retrieved concepts now have to be broken up into the specific number of levels. The levels are mapped to the grades the students can achieve. Therefore, those who are achieving higher levels have to mention more concepts than students who are achieving lower levels. But also the relevance of a concept is important. A student, for example, has to know the most important concepts at least to pass an exam. Therefore, weights or relevance values are added to the retrieved concepts.

Hence, the most important concepts will be demanded for the lowest level to pass and the lecturer can adjust the number of concepts therefore. The rest of the concepts will be split up evenly onto the remaining levels.

In a next step it may be interesting to also let the lecturer adjust the remaining levels as well. Thus, the lecturer is able to better adjust the rest of the grades.

3.9 User interface

Today a user interface is very important for almost every kind of software. This applies to our system as well and therefore it was important for us to create a good user experience. Visualization tools for ontologies as well as modification options for documents and ontologies, and the human support in the creation of a rubric's content criterion will be stated in this section.

3.9.1 Ontology visualization techniques

Visualization tools are important for providing a good overview of the subject. There are several visualization techniques available.

They can be divided into the following categories (Katifori et al., 2007):

- Indented list
- Node link and tree
- Zoomable
- Space filling
- Focus and context distortion

- 3D landscapes

All of the categories mentioned above are dividable into 2D and 3D visualization models except of 3D landscapes.

3.9.1.1 Visualization categories

In this section the visualization techniques are analyzed to be able to pick the best techniques for our prototype.

Indented lists give a good overview over subclass-of relations but it is harder to display, for example, attributes that are connected to other concepts. Thus, it is also complicated to display subclasses that are belonging to more than one parent. To resolve that problem either the parent concept has to be displayed multiple times or the ontology has to be restricted to one parent per concept.

A node link and tree visualization is similar to an indented list but from a graphical point of view. Here the relations between classes and their subclasses are drawn as lines. Thus, it is possible to have multiple parents but then the visualization can get confusing.

A zoomable visualization consists of a graph that is providing a zoom effect for a better viewing. It is possible to display only a part of interest by zooming into the graph. The advantage is that there is an overview provided in which it is possible to zoom into for having a more detailed view.

Space-filling visualizations are, for example, a radial space-filling tree. Such trees consist of a circle as a root concept and around that circle the subclasses are shown as circular discs. Those subclasses again may have other subclasses that are connected to the parent classes.

Focus and context distortion visualizations are 2D or 3D hyperbolic trees. The nodes or classes in the middle of the visualization are bigger than the nodes around those classes and when the graph is moved the node that is currently displayed in the middle of the graph will grow bigger and therefore that one is easier to read.

3D Landscapes are 3D representations of ontologies visualized as a landscape. This landscape consists of buildings that can be seen as concepts and the height of those buildings describe the relevance of those concepts.

3.9.1.2 Decision making

While trying to find the most suitable visualization technique to be utilized in our prototype the following questions came up in the research process:

- What is the best visualization for a standard user who just wants to get the concepts out of a specific topic?
- What parts of a retrieved ontology should be visualized?
- What kind of information the user wants to change on the retrieved ontology?

Because in the first place there is no need to work with attributes it is sufficient to only display subclass-of relations. Also we decided to use a 2D representation because a 3D representation looks nice but is often confusing.

The most important part of an ontology that has to be visualized for our purposes is an overview of the classes or concepts and their subclass-of relation. Therefore an indented list can be used, which provides a good view of subclass-of relations and additionally an arbitrary number of concepts can be shown. This is necessary because the concept retrieval algorithms of the text2onto toolkit are retrieving a lot of concepts.

As a second visualization we chose a radial space-filling tree visualization. This tree is good to read and relevance values can be indicated by different node colors. A disadvantage is that a huge number of concepts or classes can not be shown in a radial space-filling tree. The nodes are arranged as circular discs and therefore about 7 to 10 concepts can be shown per level. But the retrieved concepts should not contain more than 10 concepts anyway to get a good overview about the topic and if someone wants to see more of the retrieved concepts the intended list can be used.

3.9.2 User interface for concept manipulating

The user interface itself has to inherit the functions to add, delete, and modify concepts. Also the relevance values have to be adaptable by the user. The functionality to add, delete, and modify concepts can be done with almost every visualization technique that is capable to display the name of concepts. For changing the relevance values it makes sense that the concepts can by differentiated by such values. Thus, either the concepts have to be distinguishable by colors, for example, or the relevance value is shown in the visualization directly, which is possible with indented lists. The values can then be changed by either a slide-bar or by altering the value displayed in an indented list.

3.10 Available tools

A very important part of our research was the choice of tools and frameworks for our prototype. Therefore we researched toolkits that are working with and/or using ontologies. Because we decided to use Java as programming language it was also advantageous to find tools and frameworks also programmed in Java or consisting of a Java interface.

There are several toolkits using ontologies available. Examples therefore are Protege (Standford University, 2009) and NeOn (NeOn, 2009). Because the NeOn toolkit is written as an Eclipse RCP (Rich Client Platform) application (Eclipse Foundation, 2009b) and therefore extendable with plugins we decided to make a contribution to it and to develop a plugin called Rubrico. To extract concepts we decided to work with the Text2Onto (Cimiano & Voelker, 2005) toolkit developed at University of Karlsruhe, Germany.

NeOn and Text2Onto are both programmed in Java as an open source software. Because of this feature we decided to work with those two programs.

3.10.1 Tools or frameworks for implementing an user interface

There are several frameworks available to implement platform independent user interfaces as SWT (Standard Widget Toolkit) by the Eclipse Foundation, SWING developed by Sun (now Oracle), QT (a framework owned by Nokia) or higher level frameworks as Eclipse RCP and others. SWT and SWING are developed in Java and QT in C++. Thus, for our purposes SWT and SWING were better options because we wanted and have developed our prototype in Java. But because an Eclipse RCP application is based on SWT and provides mechanisms to create user interfaces with the power of Eclipse techniques as editors and navigators, for example, we have used this framework. Additionally, the NeOn toolkit is also developed as an Eclipse RCP application.

3.10.2 Tools for retrieving data

For retrieving data and extracting concepts out of that data there are several options as GATE (Sheffield, 2009) and Apache Lucene (Apache, 2010)available. Text2Onto (Cimiano & Voelker, 2005) on the other hand is a toolkit that uses GATE (Sheffield, 2009) for content extraction as well as word stemming and to retrieve concepts algorithms as, for example, TFIDF (term frequency inverse document frequency) and RTF (relative term frequency) are implemented. Thus, we have decided to use the Text2Onto toolkit because several algorithms for concept extraction are already implemented, this toolkit is programmed in Java, and available as open source.

3.10.3 Tools for creating ontologies

To be able to work with ontologies programatic libraries are necessary as for example OWLAPI (University of Manchester, 2010) and KAON2 (University of Oxford, 2010). The difference between OWLAPI and KAON2 lies in the used license models. KAON2 is only available as closed source and only free to use for non commercial purposes. On the other hand OWLAPI is open source and free to use. Also by working with KAON2 we found some bugs in functionalities crucial for our system. Thus, we have decided to use the OWLAPI library even though KAON2 is used in the Text2Onto toolkit. Additionally, it is possible to adapt this library, which is advantageous for our research work.

3.11 Conclusions

In this chapter literature research as well as research in techniques or algorithms for deriving rubrics were stated. Additionally, it was analyzed how a good design process can be achieved by using rubrics and ontologies. Regarding the literature research we were interested in the assessment design process, as mentioned above, in rubric creation systems already available in the market, semantics on rubrics, about content and concept retrieval in general, and available tools feasible to be used for our work.

With that base of knowledge and a rough plan on how to extract rubrics and how to be able to deploy them in the different assessment phases we were now ready to start working on our prototype, which is discussed in the next chapter.

Chapter 4

Outcome: The Rubrico prototype

This chapter discusses the development of our prototype. Therefore the system specification and the system design will be stated. The system specification starts with global considerations about planned features followed by requirements that evolved out of the design process. Afterwards the system design will be mentioned. That contains the chosen tools and frameworks, a mock-up and a UML-diagram of the prototype, the necessary adaptions of the used toolkits, the realization phases of the prototype and the design of the radial-space-filling tree visualization and of the Rubrico plug-in itself.

4.1 System specification

Firstly, general considerations about the implementation are stated, secondly the chosen tools and frameworks are explained, and finally, the system requirements are outlined.

4.1.1 Global considerations

A question emerged in the pre-planning phase was the decision to cooperate with another system. Thus, it would have made sense to work together with a system that is widely spread and used at Curtin University (Curtin University of Technology, 2010) where the prototype was built. Because Blackboard (Blackboard Inc., n.d.) is used at this university and widely spread all over the world it seemed to be advantageous to cooperate with. But because there are a lot of other systems on the market and to be flexible we decided to export our data in a standardized OWL format that, for example, can be used in another program. Also, we decided to develop this prototype in connection with the NeOn Toolkit. This toolkit is based on Eclipse, and therefore we decided to make a contribution to it with an Eclipse plugin. This plugin can then be used by any other system that uses Eclipse. Additionally, the derived ontologies and content criteria can also be used separately by any other system that is able to work with OWL ontologies.

As written above we also thought to implement it into an e-learning environment like Blackboard or others. This will be a further interesting task but at first we want to immerse ourselves into other features of the program. As well a clearly defined interface to our system will be built that provides a standardized output with the help of XML, RDF and OWL.

4.1.2 Requirements

4.1.2.1 Intention of the prototype

The prototype is intended to retrieve concepts out of PDF, HTML, and text files. Therefore, the content out of documents added to a document corpus has to be analyzed for calculating concepts (or classes), subclass-of relations and individuals. This information can then be expressed as an ontology. Also, links back to documents have to be stored to be able to assign the calculated concepts to specific passages in a document.

The calculated ontology will then be visualized by an indented list and a radial space-filling tree. The list as well as the radial tree will be modifiable by humans. After the ontology is adapted a rubric will be created out of it. Thus, the prototype development is split up into three main parts. The text retrieval and ontology creation part, the human interaction part and the rubric creation part.

To accomplish that task the NeOn Toolkit that uses Eclipse, ZEST, GATE, KAON, the OWLAPI and Text2Onto will be used.

4.1.2.2 Features to implement

The features we agreed to implement are as follows:

- Features for retrieving concepts
  - functionality to execute algorithms (user interface button and procedure that controls the process)
  - option to reset a pre-calculated ontology from a previous execution
  - implement the possibility to select or deselect algorithms that subsequently are used to retrieve concepts
  - normalize the relevance values so that the sum of all concepts equals 1
- User interface requirements
  - Features implemented in views (a view in Eclipse is a window that displays information)
    - NavigatorView features (indented list)
      - alter concept names
      - alter concept relevance values
      - create cloned ontologies

      - the list has to be sortable by relevance value and name
      - add custom concepts
      - remove concepts
    - CorpusView feature
      - ability to add and remove HTML, text, PDF files
    - Radial-space-filling-tree-view features
      - highlight relevance values of nodes
      - highlight selected nodes
      - display nodes as circular discs
      - add label-text drawn in a curve as well as radially depending on the size of the circular disc
    - WorkFlowView features
      - provide a standardized set of algorithms
      - provide a view to select and deselect algorithms to customize the workflow
  - Status-bar for displaying the current state of the concept retrieval process
  - ProjectWizard
    - implement a wizard to create a new project
  - Perspectives (In Eclipse a perspective consists of a specific set of views and editors)
    - an expert perspective for users who want to develop their own set of algorithms used in the retrieval process
    - a standard perspective for users who just want to extract concepts with a standardized set of algorithms

- Data storage requirements
  - develop a RubricoProjectProvider class that provides an interface for data storage functionalities

  - implement ontology versioning to be able to restore older versions
  - develop XML DTDs (document type definitions) for storing information
    * filelist.xml for handling files added to a corpus
    * ontos.xml for storing information about created ontologies
    * algorithms.xml defines the set of algorithms that should be used for the next concept extraction process of a specific project
  - all ontologies will be stored in an OWL format

- steps to further improve the prototype
  - create a view for individuals
  - implement drag and drop functionality in the navigator view as well as the radial-space-filling-tree-view

4.1.2.3 Text, content retrieval and ontology creation requirements

As mentioned above we have decided to work with the Text2Onto toolkit as well as the NeOn toolkit. Because some functionalities are not implemented the way we need them and the Text2Onto toolkit is available as open source we defined the following improvements.

- Preselection of Algorithms: Because most of the people just want to retrieve concepts or ontologies out of their documents and do not want to worry about the executed algorithms in the background pre-selected sets of algorithms have to be provided. Thus, an expert and a standard user perspective will be implemented.
- Because the reimport of POMs created by extracting concepts is not possible with this toolkit that feature has to be implemented as well.

- Weights have to be added to documents in the document corpus: In most of the cases the user is able to decide which documents are more important than others. Therefore, a field will be added to the corpus view for giving the document a predefined weight.
- Try to avoid flat ontologies: Ontologies derived by Text2Onto are too flat, which means that there are too little subconcepts extracted.
- Implement additional algorithms for better retrieval of concepts and subconcepts. That can maybe achieved by implementing FCA (Priss, 2006)or a predefined global ontology used to better parse documents.

4.1.2.4 Human-computer interaction requirements

Our prototype is intended to work with human support. Therefore, as in almost every other software it inherits a user interface. For this interface the following human-computer interaction requirements came up in the specification phase.

Very important for our purposes are visualizations that reflect ontologies in a way users can work with intuitively and where the user easily understands the meaning and purpose of it. Such visualizations also have to be easily adaptable to be able to alter the information therein.

Therefore a main task in building this prototype is to implement an easily adaptable visualization of an ontology, which has to be modifiable and where concepts have to be highlighted in accordance to the calculated relevance value. Also, a drag an drop functionality will be implemented to be able to move concepts for adding them to a different concept tree.

All individuals that belong to the currently selected concept will be shown in a list at one side of the visualization.

Concepts can be added, deleted or edited in an indented list visualization.

Every change that will take place in one of the visualizations should be shown in real time in all other representations.

4.1.2.5 Rubric creation requirements

After a rubric is created it is necessary to store that rubric somewhere to be able to work with it later and make it possible for other software products to import it. Thus, we decided to store those rubrics in an OWL format. Such an OWL ontology consists of four layers also called subclasses. The first layer describes the subject name, the second the rubric criteria, the third depicts the achievable levels and the 4th layer consists of the concepts together with their individuals that have to be mentioned in an exam to gain a specific level.

Therefore, the following points have to be implemented into Rubrico.

- A button to start the rubric creation process
- An algorithm for deriving such a rubric ontology
- An Eclipse view for displaying that rubric as a table and subsequently a visualization technique for that rubric.
- The rubric visualization then has to be adapted to be modifiable by a human being.

4.1.2.6 Interface requirements

This section describes the requirements that came up for the different interfaces namely the programmatic and the graphical user interface.

Programmatic interface There will be no programmatic interface in the beginning for third party software products but interfaces in form of XML files will be provided.

The ontology itself will be stored in an OWL syntax, which is based on XML. The remaining information will also be stored in an XML syntax as file-lists were the produced ontology is based on, lists consisting of the used algorithms of the last retrieval process and lists containing the cloned ontologies of a project.

Graphical user interface Because our prototype will be developed as an Eclipse plugin it will consist of perspectives and views. For our purposes we want to implement a standard and an expert perspective.

The features the user interface will inherit are as follows:

In the standard perspective the following views will be implemented:

- Concept-ontology corpus View
- Non concept-ontology corpus View
- An indented list to display concept-ontologies
- An indented list for non-concept-ontologies
- A concept-ontology visualization view
- A non concept-ontology visualization view

Additionally to the views in the standard perspective in the expert perspective a workflow-view to let the user choose the algorithms that should be used for concept extraction will be implemented.

4.2 System design

This section starts with the chosen tools for our prototype, then a mock-up depicting the graphical user interface and UML class diagrams describing the architecture are shown. Those class diagrams are supported by activity diagrams. Afterwards the necessary adaptions to the ZEST, the Text2Onto and the GATE toolkit are stated. Finally the realization process is outlined.

4.2.1 Chosen tools and frameworks

We agreed to use Java as programming language in connection with Eclipse as programming environment. Furthermore we decided to work with the Text2Onto toolkit, which is available in Java and open source. The prototype will be developed as a plug-in to the NeOn Toolkit. To visualize ontologies we have decided to implement a radial space-filled tree. This visualization will be integrated into the ZEST (Eclipse Foundation, 2010) toolkit, which is a visualization toolkit that uses Java SWT and Eclipse.

4.2.1.1 Text2Onto

The Text2Onto (Cimiano & Voelker, 2005) toolkit is intended to be used for deriving concepts out of PDF's, HTML, and text files. Additionally, this toolkit works with POMs (Probabilistic Ontology Models) and provides a robust environment, which means that input data will only be processed once until it is not explicitly requested that the data should be reprocessed. With that feature a subsequent extraction process can be shortened.

4.2.1.2 Ontology visualization tool

An important feature of our prototype is the representation and visualization of classes and subclasses. There are a lot of techniques available today as, for example, crop circles or radial space-filling trees. But to be able to use existing toolkits the possibility to manipulate those ontologies or visualizations has to be available. This is because our interface has to interact with human beings to extract concepts and therefore most of the existing tools have to be adapted to meet our needs. As a result the source code would be helpful and the tool has to be written in Java. First we decided to work with a visualization toolkit called Prefuse (Berkely institute of design, 2010) and a radial space filling tree implementation developed with that toolkit by Christopher Collins (Collins, n.d.). But unfortunately that was not possible because our interface is programmed with SWT (Standard Widget Toolkit) and Prefuse uses SWING. Therefore we decided to use ZEST because that toolkit initially was written for SWT as well as SWING and is therefore applicable for our purposes.

4.2.2 Mock-up

To get an idea how the graphical user interface should look like, we have worked on a mock-up depicting that interface. This mock-up was made with the help of GIMP (The GNU Image Manipulation Program) by copying already available example widgets from SWT into our mock-up to get a look that is as close to the implementation as possible.

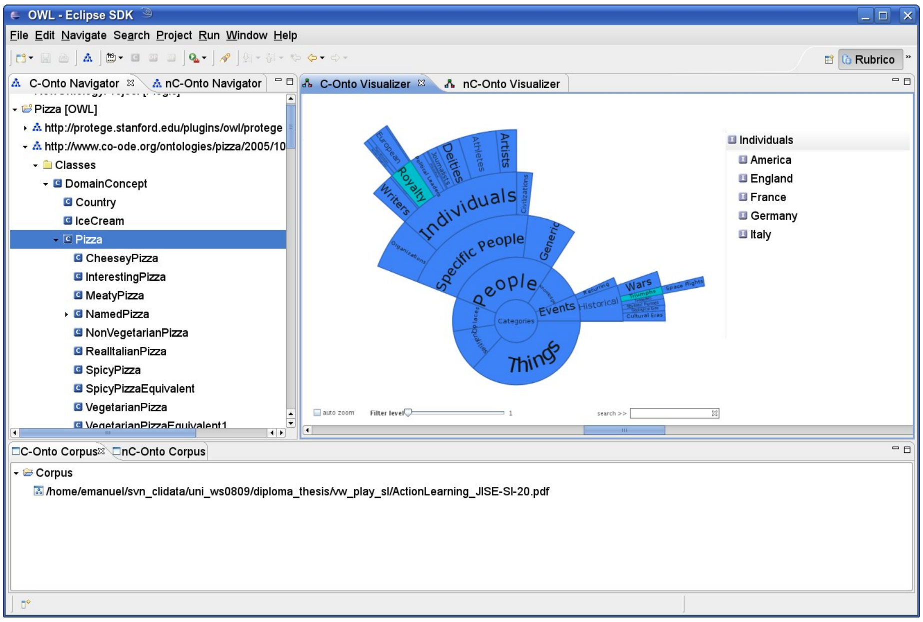

Figure 4.1: Rubrico prototype mock-up

The figure above shows the standard perspective of Rubrico as we have implemented it. It consists of concept and non-concept ontology navigator views, concept and non-concept visualization views for displaying the radial space-filling tree, and concept and non-concept corpus views for displaying the files that were added to that specific corpus. In addition to the views depicted above in the expert perspective a view for altering the workflow is implemented as well.

4.2.3 UML diagrams

To get an overview about the prototype three UML class diagrams are depicted below. The first one shows the prototype packages, the second diagram the graphical user interface and the third the adaptions made to the ZEST toolkit, which are derived classes from the ZEST toolkit for extending the functionality thereof.

Figure 4.2: Rubrico packages

In the UML diagram depicted above the Rubrico packages are shown. The most important are the gui, the zest, and the core package. The test and the research packages only were used for testing purposes. The gui package inherits all classes needed for the graphical user interface, the zest package contains the adaptions necessary for implementing the radial space-filling tree and the core package consists of classes that are used for both the gui and the zest package.

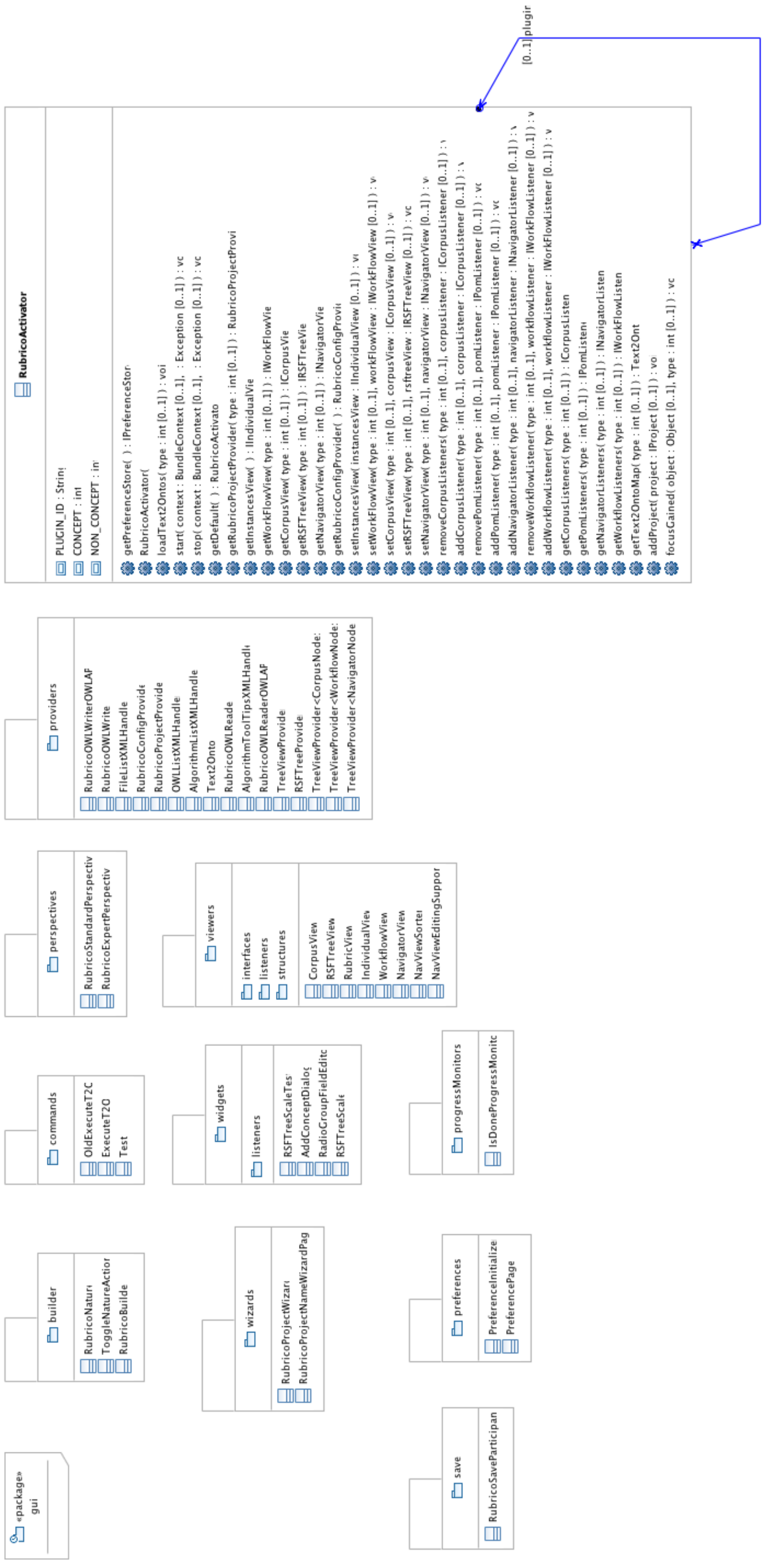

Figure 4.3: Rubrico graphical user interface

This diagram shows the packages and classes located below the gui package. The only class of that package is called RubricoActivator and is the most important class for the plug-in because it contains the plug-in activator method start and stop. It also handles the listeners and views. The package named providers contains classes for parsing XML files as well as the Text2Onto class, which inherits methods for working with the Text2Onto toolkit. Additionally, classes containing methods to provide data for the radial space filling trees are implemented. The package perspectives consists of classes providing the functionality for the standard and the expert perspective and the viewers package contains the views programmed for the plug-in. The commands package consists of a class for executing the algorithms, the wizards package a wizard for creating new Rubrico projects.

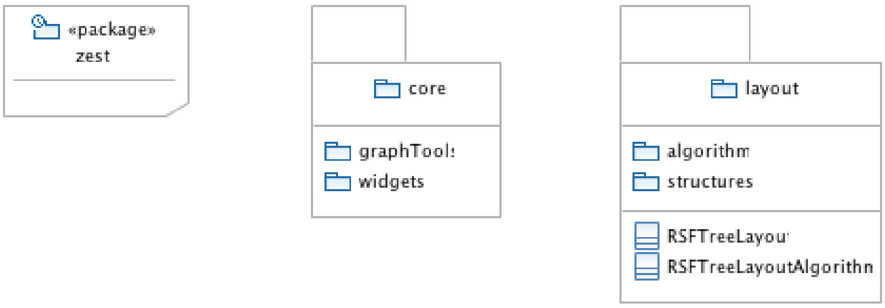

Figure 4.4: Rubrico ZEST toolkit adaption

The picture above depicts the adaption to the ZEST toolkit. The core package contains a graphTools package, which in turn contains a helper class for painting the labels shown as circular segments. The widget package inside the core package contains classes for radial space-filling tree labels and and radial space-filling tree connections. The layout package on the other hand contains the layout algorithm and necessary structures for calculating the radial space-filling layouts.

4.2.4 Adaption of the ZEST toolkit

Because the ZEST toolkit is not designed for displaying radial space-filled tree visualizations it has to be adapted. Therefore the node classes have to be extended and a new layout algorithm has to be added as well.

4.2.5 Adaption of the Text2Onto toolkit

The Text2Onto toolkit on the other hand needs to be adapted for being able to work with other operating systems as Linux and Mac OS X. Thus, the extraction algorithm for extracting data out of PDFs has to be adapted and a Linux and Max OS X compatible version of the third party product "pdftotext" has to be added to Text2Onto. Also, extracted POMs have to be saved and able to be restored afterwards. This has to be also implemented as well as a preselected set of algorithms to be able to extract concepts without the necessity to have knowledge about the used algorithm.

4.2.6 Adaption of the GATE toolkit

Text2Onto uses the GATE toolkit and therefore it is also necessary, as with the Text2Onto toolkit, to adapt the toolkit for being able to work with Linux and Mac OS X.

4.2.7 Realization of the prototype Rubrico

4.2.7.1 Realization phases

The realization of the prototype consists of 3 phases.

Phase 1 At first the Text2Onto framework will be adapted to our needs. That includes necessary changes for the use with Linux and Mac OS X, the preselection of a set of concept-extraction-algorithms, a possibility to save and restore POMs, and a mechanism to work with weighted documents. The visual representation of ontologies with an indented list is also planned in that phase.

Phase 2 In the second phase the ontology visualization with the help of a radial space-filling tree will be implemented. Therefore the ZEST toolkit has to be extended for working with circular disc nodes and a layout algorithm for arranging nodes has to be programmed as well.

Phase 3 In the third phase the rubric creator will be implemented. This will only be done if there is enough time left. There will be a button added for rubric creation, an algorithm to retrieve those rubrics out of an ontology, and a tabular and a space-filling visualization to display derived rubrics.

4.2.8 Design of the radial space-filling tree ontology visualization

4.2.8.1 Radial space-filling tree class architecture

To implement a radial space-filling tree visualization the Zest toolkit for eclipse will be used.

Therefore a package named au.edu.curtin.rubrico.zest will be created, which contains the following classes:

RSFTreeLayout This is the main class in regards to the layout. It extracts a structure of nodes and builds a layout for a radial space-filling tree built on radial space-filling tree graph nodes (RSFTreeGraphNodes) and radial space-filling tree connections (RSFTreeConnections). This class also inherits methods for adding and removing nodes and connections.

RSFTreeGraphNode This class will be derived from ZEST's GraphNode class and represents a node in the radial space-filling tree. It overrides the constructor, and the createFigureOfModel, setSize and refreshLocation methods.

- createFigureOfModel: creates an ArcLabel instance and updates the figure.
- refreshLocation: refreshes the location of a component and sets the bounds of the arc.
- The setSize(double width, double height, int angleOffset, int angleLength) method will be used for setting the angleOffset and angleLength because the original method did not make use of angle-offset and angle-length parameters.

ArcLabel The ArcLabel class represents a label depicted as a sector of a circular ring. It consists of such a circular sector and a label that fits into it. The text will be placed between a start-radius and an end-radius and may be arranged in a curve or radially depending on the length and the available space. Such information will be provided in the LevelInfo class, which calculates the optimal value of the difference of the end-radius and the start-radius for a whole level of circular-ring-sectors.

RSFTreeLayoutAlgorithm The layout algorithm class calculates the layout of the tree. This tree is read out level by level and the node information is than added to the LevelInfo instance of the specific level. The LevelInfo instance calculates the correct radius, angle, the font-size and the text-position. After the tree is read out the paint method of all LevelInfo instances from the last level to the first will be executed.

The RSFTreeLayoutAlgorithm class also contains a variable for the maximum number of levels to be visualized.

RSFTreeConnection A standard connection of the ZEST toolkit is displayed as a line between two concepts but in our case those connections must not be displayed because they can be distinguished only through the position of the node.

LevelInfo A LevelInfo instance for each level will be stored in the RSFTreeLayoutAlgorithm class. It consists of level information such as the level number, the start and the end-radius of the circular disc segments, the nodes that are stored in a specific level, how the text should be placed inside a node, and the font to be used.

RSFTreeGraphMouseListener This listener handles the drag-and-drop and the clicking functionalities. Therefore this class will be derived from the ZEST's GraphMouseListener class.

The nodes can then be selected by clicking on them, multiple nodes by holding the control key while selecting. But the nodes must be connected somehow because it only makes sense to move a concept together with its subconcepts and not multiple unrelated concepts.

Once a RSFTreeLayoutNode has been deleted all selections have to be removed for not destroying the tree structure.

Later on also a short-cut functionality may be added for showing sub-nodes of the currently selected node if they are not shown at that moment.

4.2.8.2 Further design considerations

Due to the necessity of an external mouse-listener, which will be implemented inside a package of our prototype, some methods or classes inside the ZEST toolkit will not be available and therefore a lot of Graph and GraphNode methods of the toolkit have to be declared public. To prevent the need of changing the ZEST specification our extension for the ZEST toolkit could either be implemented into ZEST or a wrapper for ZEST's graph class has to be added to the ZEST toolkit.

4.2.9 Design of the Rubrico Eclipse plugin

The following eclipse-views and eclipse-perspectives will be implemented into our prototype. Also all other eclipse specific features as a project-nature, actions and a wizard will be mentioned.

Project nature A project nature named Rubrico will be implemented that stores settings and data such as extracted rubrics and POMs, a list containing the added document files, and the original documents.

Wizard A 'New Project Wizard' for adding new Projects.

Perspectives

- Expert Perspective: Shows an algorithm view in addition to the views displayed in the standard perspective.
- Standard Perspective: A mock-up that shows the views in the standard perspective is mentioned in chapter 4.2.2.
  - Consists of preselected algorithms. Thus, an algorithm view will not be shown in that perspective.

Views

- Rubric creation view
  - Is intended for further improvement of our prototype

  - A horizontal tree-layout already available in the ZEST framework will be used.
    * This layout consists of nodes and horizontal connections: The root node contains the subject. The second level consists of a node named "Content" because further there will be the option to add more criteria such as spell checking or formatting criteria. The third level contains the possible grades and the fourth level the concepts that are required to reach a specific grade.
    * The individuals will be shown in an individual table beside the tree.

- Ontology visualization view
  - Displays the RSFTreeLayout from above that displays a radial space-filling tree.
  - An individual list view will be displayed on the right hand side of the ontology visualization where it should be possible to add and remove individuals.
  - The visualization has to be zoomable

- C-onto, nC-onto Navigator
  - Displays a concept and a non-concept ontology as an indented list
  - Includes a drag and drop feature
  - Implements a functionality to add and a remove concepts
  - Displays concepts or classes and their subclasses
  - Also displays the available projects and the stored cloned ontologies of that projects

- C-Corpus View, nC-Corpus View
  - Shows a tree that consists the added documents of a specific project

  - One view displays the concept corpus files and the other one the non-concept corpus files
  - A relevance-value field is added to each document.
- IndividualView
  - Will be implemented during further improvement of the prototype
  - Displays the individuals matching to a selected concept.
- Workflow View
  - Consists of a list containing available algorithms that can be activated or deactivated.

Actions

- Add a save and restore functionality to be able to work with ontologies produced at a previous run of the program
  - The ontology and rubric information will be saved in OWL files and the applied algorithms and used documents in XML files
- The following actions for working with ontologies will be implemented
  - addNode(node, parentNode)
  - deleteNode(node)
  - modifyNode(node)
  - dragNode(node,newParent,depth)
- Action buttons to be implemented
  - Button for calculating rubrics: By clicking this button the rubric will be calculated out of an ontology and displayed afterwards.
  - Button for executing the selected or pre-selected ontology extraction algorithms: Those algorithms will be applied, the ontology updated and displayed.

4.3 Functionality and workflow

This section describes the functionality of our prototype and the supposed workflow. Below the workflow is depicted and afterwards some screenshots are shown to demonstrate the functionality of Rubrico.

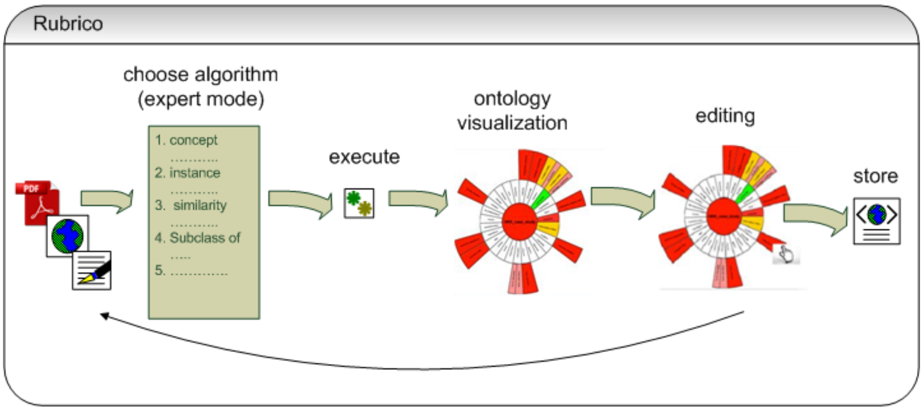

Figure 4.5: Rubrico Workflow

As mentioned above this picture depicts the workflow of Rubrico. The prototype gets a set of documents stored in a pdf, html, or text format. After that and when the Rubrico expert perspective was chosen the user is able to specify the set of algorithms that will be used for the extraction process. When the user clicks on the button named execute the algorithms will be processed and an ontology visualization of the retrieved concepts will be shown. This ontology can then be edited by the user and afterwards stored in an OWL format. To get a better result by choosing different algorithms or by adding documents to the corpus it is then possible to repeat that process.

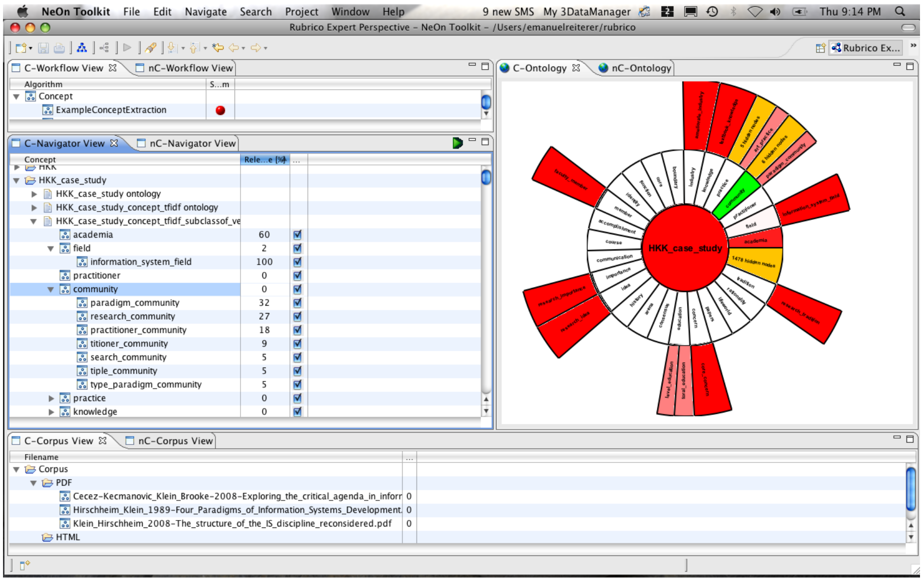

Figure 4.6: Rubrico Screenshot

Above a screenshot of our prototype is shown. Rubrico was developed as a plug-in contributing to the NeOn toolkit. Because the NeOn toolkit was developed as an Eclipse RCP (Rich Client Plattform) application plug-ins added to this toolkit are also Eclipse plug-ins. Our Eclipse plug-in consists of several views. A concept and non-concept workflow view as shown in the upper left corner of the screenshot, a concept and non-concept navigator view, which can be seen on the left hand side, a concept and non-concept corpus view, which is shown at the bottom and on the right hand side there is a radial-space-filling tree visualization.

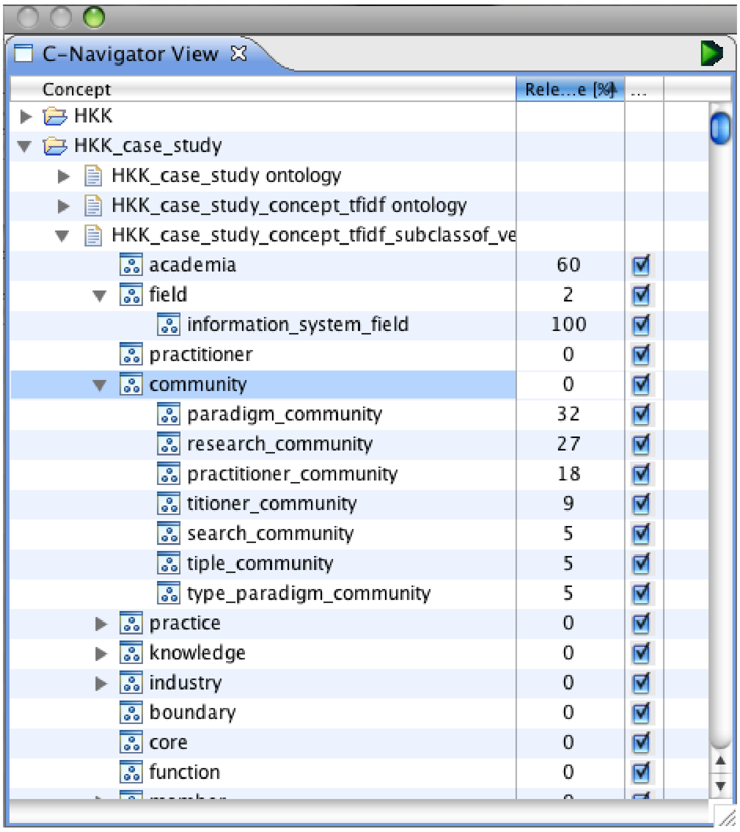

Figure 4.7: Rubrico Navigator View

There are two Rubrico navigator views added to the prototype, which are called concept and non-concept navigator view. Both views contain an indented list that shows the Rubrico projects created with that tool. Below the project lines such as HKK_case_study above ontologies are shown that are extracted out of the set of documents assigned to that specific project. Also it is possible to create cloned ontologies, which are copies of the original extracted ontology. Only cloned ontologies are editable by human beings. The ontology itself then contains the extracted concepts and subconcepts as well as the relevance value assigned to that concept. The checkboxes on the right hand side are used to exclude concepts temporary. All concept-names and concept-relevance-values of a cloned ontology can be altered in that visualization.

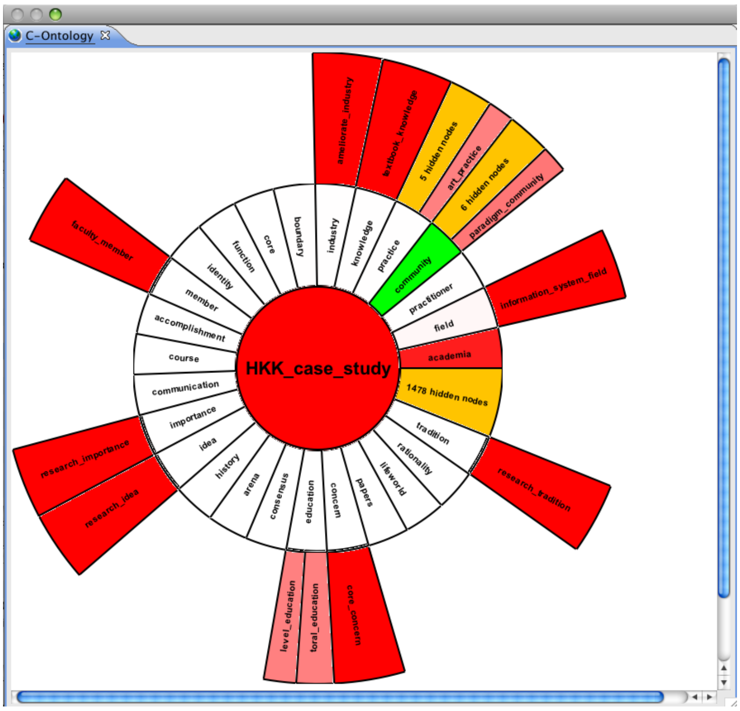

Figure 4.8: Rubrico radial space-filling tree visualization

The radial space-filling tree visualization shown above was added to the ZEST toolkit, which is a graph toolkit for the Eclipse platform. At first we wanted to use a visualization that was already programmed but unfortunately not for the Eclipse platform. Therefore we had to extend the functionality of the ZEST toolkit. This visualization consists of a circle in the middle which displays the name of the ontology. Next to this circle the nodes that are belonging to this ontology are shown. If there are too many concepts available the concepts that can not be displayed are shown as hidden nodes. Subconcepts that belong to a specific parent concept are displayed next to the parent concepts. The tree can be extended with subconcepts radially. All of the nodes are dragable and colored in regards to their relevance values.

4.4 Conclusions

In this chapter the system specification and the system design were stated. First it was necessary to specify the system and therefore we took global consideration into account and developed requirements out of it. After the requirements were clearly defined the design process commenced. Therefore we had to decide, which tools and frameworks will be used to be able to fulfill the requirements and after that a mock-up was developed to depict the graphical user interface. Then rudimentary UML diagrams where produced to develop the architecture of our prototype. But to be able to work with the used toolkits we had to adapt the ZEST, Text2Onto and the GATE toolkit. Finally, the realization process was split up into three phases and a more specific architecture in regards to the necessary classes and functionalities was developed for the radial-space-filling tree visualization and the Rubrico plug-in.

Chapter 5

Case study

In this chapter firstly an overview of this case study will be given. Secondly, the procedure of the case study is elucidated. Thereafter the survey that was carried out for evaluating the candidate's outcome, and finally the results are described.

5.1 Overview

This case-study was carried out for being able to analyze the accuracy of concepts that were retrieved with Rubrico (Reiterer, Dreher, & Guetl, 2010). Thus, the main goals of this study were to invite test candidates who were asked to retrieve concepts manually and sort those concepts by their relevance. Another assignment consisted of the assessment of automatically retrieved concepts regarding their meaningfulness and subjectivity. Additionally the candidates were asked to evaluate the possibility of deducing the subject matter of a document only with the help of automatically retrieved concepts.

Based on the results of this case study we would like to improve "Rubrico" further for getting more accurate results.

Because this is a case study, which should only assess the direction for further development we invited a number of 20 people where finally 10 participated in the whole study.

5.2 Automatic concept retrieval process

For our case study we have decided to take two papers out of a JUCS (Graz, University of Technology, 2010)journal. Those two papers were processed by our software prototype "Rubrico" using the following algorithms:

- Term Frequency Inverse Document Frequency (TFIDF) algorithm
- Example concept extraction algorithm
- Entropy concept extraction algorithm
- Relative Term Frequency (RTF) concept extraction algorithms.

Those retrieved concepts were further be used for being assessed by the test candidates and mapped to the manual retrieved ones in the post-processing phase of this study. More information about the used algorithms can be found in the thesis named "Deriving ontologies and assessment rubrics out of electronic documents with human support for automatic assessment purposes" (Reiterer, n.d.)

5.3 Case study procedure

The case study procedure is divided into the following steps:

1. Fill out the pre-survey.
2. Read the provided recommendation showing how to extract concepts.
3. Read the provided papers and carry out the concept extraction process.

4. Fill out the post survey.

As mentioned above the survey is split up into a pre- and a post-survey. The pre-survey was intended to gather overall data, which included a self assessment in terms of concept retrieval knowledge, how the test candidates are interpreting the term concept and questions about their education, age and area of expertise.

The post-survey's goals were to gather results of the candidates concept retrieval work and we also asked to evaluate concepts retrieved by our prototype "Rubrico".

5.4 Survey structure

The survey was realized with the Limesurvey software (Schmitz, 2010), which is a free and open source software for creating and offering surveys. Two surveys, a pre- and a post-survey were realized for our study.

The next subsection explains the pre-survey and in the subsequent subsection the post-survey is described. In both sections the question groups as well as the questions itself are described.

Both surveys are starting with the acceptance of our privacy policy. In this policy we declare that the university as executing organization is using the results anonymously and the data will not be handed over to other organizations.

The original text is as follows: "According to our privacy policy all collected data will be made anonymous and only used for research purposes. Personal information is never transferred, disclosed or otherwise shared with third parties. Anonymous data may be reused or shared for further studies."

5.4.1 Pre-survey

This survey consists of 7 overall questions. As already described those questions were chosen to retrieve general information about the candidates. Another advantage for splitting up the survey was to see how many of the invited persons would like to participate because most of the candidates who filled out the pre-survey were willed to participate in the whole case study.

Statements to the chosen questions except the privacy policy are mentioned in the following section.

5.4.1.1 Gender, age, and highest level of education

The first three questions were selected to classify our test-candidates. But we have also used them to analyze the influence of different groups in preferring specific concepts and in ranking concepts differently.

Gender The gender question was realized with the help of a check-box. After evaluating the results we found out that it could be helpful not only to provide 2 options, respectively man and women, but to add another check-box that offers the option “other”. This is coming more and more popular regarding the possibility of gender changing and the tolerance of the society in the present days. Therefore we will pay tribute to that in the next survey.

Age The age scale was provided in steps by 10 from 18 to 70 years. It was not necessary to get a more detailed scale under 18 and over 70 years because all of our candidates are aged in this range.

Highest level of education This question offered 6 levels of distinction. The choices were: Compulsory School, High School, University (Bachelor/Master), University (Phd or higher), and other.

The answers in combination with the answers of the post-survey should give an idea if people having a different level of education understand the term concept differently and also if the concepts differ much in terms of detailedness and the kind of vocabulary that was chosen.

5.4.1.2 Area of expertise

For this question a full text had to be provided that should give a glimpse of the know how the candidates brought into this study.

5.4.1.3 Concept definition and concept extraction procedure

The interrogative clause in the survey is as follows: "Please try to explain the term concept in your own words. Illustrate that by an example." and "How would you extract concepts? Please try to describe the procedure."

Here we were interested in assessing the knowledge in terms of concept definition by asking for an example. Also it was interesting to see the differences in their interpretations and extraction procedures especially when it is not someones core competency.

5.4.1.4 Self assessment in the field of concept extraction

The wording printed in the survey is as follows: "Please assess yourself in the field of concept extraction."

The question answer set is as follows: unexperienced, some experience, advanced and expert. The purpose hereby was to analyze the variations of the subjective assessment to the self assessment of the test candidates.

5.4.2 Post-survey

The post-survey was intended to fetch the candidate's results of the case study but we also wanted to test the accuracy of the automatically retrieved results and therefore let the candidates try to deduce from a set of concepts to a paper abstract.

Because this survey was a bit more extensive than the pre-survey it was divided into several question groups named as follows:

1. Privacy Policy
2. Questions regarding the first paper
3. Questions regarding the second paper
4. Questions regarding the two papers treated as one.
5. Questions regarding a third paper
6. Evaluation of automatically extracted concepts.
7. General questions.

The second, third, and fourth question groups were intended to fetch the results of our test candidates.

The fifth question group deals with the mapping of automatically retrieved concepts to a document's abstract.

In the sixth group the accuracy of concepts was asked to evaluate. Those concepts were automatically retrieved out of a document already read by the candidates during the case study.

Next, the questions out of each question group will be explained.

Because the privacy policy had been stated in the introduction of this chapter this group is not mentioned here.

5.4.3 Questions regarding concept extraction of the papers to be read

The groups "Questions regarding the first paper" and "Questions regarding the second paper" have the same structure and both are handled in this section.

This group addresses the retrieval of results in regards to the paper named "Creative Adaptive e-Learning Board Games for School Settings Using the ELG Environment" (Retalis, 2008) by Symeon Retails and "A Standards-based Modeling

Approach for Dynamic Generation of Adaptive Learning Scenarios" (Boticario & Santos, 2008) by Jesus G. Boticario and Olga C. Santos. These papers were asked to be read for carrying out this case study. Both papers are issued in the Journal of Universal Computer Science (JUCS) (Graz, University of Technology, 2010).

The first questions are intended to query overall aspects, the last one to provide the 10 top-ranked concepts. The latter embodies the results of the main task that had to be executed by the candidates.

5.4.3.1 Duration for reading the text and extracting keywords

The wordings of those questions are:

- How long did it take you to read the document and to extract keywords? Please enter the value in minutes.
- How long did it take you to extract concepts out of the retrieved keywords? Please provide the value in minutes.

Those questions are meant to be retrieved to see if it's feasible to retrieve concepts automatically with human support. Also we wanted to know how much time the test candidates invested in this survey and if the results are expressive enough.

5.4.3.2 General paper related questions

The aim of the next 3 questions is to gather information regarding the difficulty of the papers and the retrieved keywords as well as to get a short summary of the papers by the candidates.

The wordings of those questions used in the survey are as follows:

- The paper was difficult to understand.

- Try to summarize the paper in two sentences.
- Please fill in the retrieved keywords separated by comma.

The paper was difficult to understand This question was realized with the help of radio buttons named as follows: “Strongly disagree”, “Disagree”, “Agree”, and “Strongly agree”. The aim of this question is to analyze the reliablility of the collected concepts.

Try to summarize the paper in two sentences With this query it should be analyzed if the test candidates have read and understood the papers.

Please fill in the retrieved keywords separated by comma Here the retrieved keywords should be mentioned. The intention was to examine the difference between a concept and a keyword.

In your opinion how many top ranked concepts are sufficient to describe the paper? With this query we wanted to analyze the necessary number of concepts that should be extracted automatically to satisfy the user.

5.4.3.3 Gathering results

The last and most important point of this survey was to gather the retrieved concept of our test candidates.

The wording used in the survey is as follows: “Please enter 10 retrieved concepts starting with the most significant in descent order.”

The concepts have to be filled into text fields where one text field is provided for each retrieved concept.

5.4.4 Questions regarding two papers treated as one

In the case study the candidates also had to extract concepts where the two papers to be read were treated as one document. Therefore the goal was to retrieve concepts that can be assigned to both papers. The candidates got the possibility to either extract new concepts out of the papers or to use the already retrieved concepts in combining them.

This group consists of two questions:

- In your opinion how many top ranked concepts are sufficient to describe the papers?
- Please enter 10 retrieved concepts starting with the most significant in descent order.

Because the same questions were already asked in the previous group please refer to that explanation.

5.4.5 Questions regarding a third paper

In this group, which consists out of one question, three titles and abstracts were provided as well as a set of ten automatically retrieved concepts. The candidates had to choose the paper that belongs to that specific set of concepts. This part of the survey was intended to see if the automatically extracted concepts are expressive enough to deduce the correct paper.

The papers used in this query are:

Paper 1: “A Spiral Model for Adding Automatic, Adaptive Authoring to Adaptive Hypermedia” (Hendrix & Cristea, 2008)

Paper 2: “Machine Learning-Based Keywords Extraction for Scientific Literature” (Wu, Marchese, Jiang, Ivanyukovich, & Liang, 2007)

Paper 3: "Formal Representations of Learning Scenarios: A Methodology to Configure E-Learning Systems" (Helic, 2007)

Provided concepts: Beneath the concepts provided in this question are stated:

- collection
- learning goal
- subtype
- application
- learning scenario framework
- training
- student idea
- session
- scenario structure
- generalization

5.4.6 Evaluation of automatically extracted concepts

This group also consists out of one question where 10 automatically retrieved concepts from the first paper (Retalis, 2008) to be read have to be evaluated. Therefore a Likert Scale was used consisting of 4 options: "very insignificant", "insignificant", "significant", and "very significant". 4 options were used to eliminate mean scores.

The interrogative clause was mentioned in the survey as follows: "Please evaluate the significance of the following concepts on a scale from 1 to 4, where 1 depicts a very low significance value and 4 the highest possible value."

The concepts that had to be evaluated were:

student, environment, dice, paper, board, knowledge, customise, user, museum, adaptivity

5.4.7 General questions

The last question group addresses general question about the case study. It consists of 3 questions named as follows:

- What are your overall comments concerning this case study?
- What kind of difficulties have you experienced?
- Did you stick to the proposed procedure? If not please tell us your reasons and the chosen procedure.

All of those questions are realized with the help of full text answer-fields. The intention of this group is to get comments regarding the case study in terms of the amount of time spent on this study, difficulties that came up and if the proposed procedure was used by the candidates. Additionally, the test candidate is asked to describe the used steps if he or she has used a special procedure.

5.5 Results

In this section the results derived from the case study are stated. We asked 20 candidates to participate in the case study. Finally 10 candidates were willed to support us. This is not much but because we intended to make this case study to improve the software prototype "Rubrico" we are happy with that number of test candidates as well. Those candidates received a kick-off email and a short introduction regarding the term concept as well as a concept retrieval proposal. They were asked to fill out a pre-survey before they should start reading the text and extracting keywords and concepts. After the test candidates finished the process of reading the documents, extracting keywords and deriving concepts they were asked to fill out a post-survey where the test candidates had to provide results from the previous step. Also, the candidates were asked to give some statements about automatically retrieved concepts, the possibility of deducing a paper only by a set of concepts and some general questions about their experiences in the field of concept extraction.

Next, the results are explained and in the subsequent section the conclusions for further development of the prototype are stated.

5.5.1 Analyzing the results of the pre-survey

5.5.1.1 Gender, age, highest level of education, and area of expertise

From the 10 persons who participated in the case study 4 of them were female and 6 male. Thus, slightly more men took part in the case study, which is acceptable for our purposes.

6 of our candidates were between 18 and 29 years old and in the groups 30-39, 40-49, 50-59 and 60-69 always 1 person added him/herself to one of those groups. 8 of the test candidates are possessing a Bachelor's or Master's degree, one a PhD degree, and one is an engineer. Because of those qualifications we came to the assumption that the candidates were able to solve the tasks that are requested for this case study.

Most of the candidate's area of expertise lay in the field of information systems and software development. The other candidates are either experts in education, chemistry, or agriculture and alternative energy.

5.5.1.2 The candidate's definition of the term concept

There are several definitions for the term concept as mentioned in the paper Automatic Concept Retrieval with Rubrico (Reiterer et al., 2010). But with this question we only wanted to assess a common sense of that term.

Therefore it was sufficient if the interviewees are describing the term as, for example, "A concept is represented by a set of words related by a meaning". We decided that the concept definitions as well as the examples were in most cases well described and in all cases sufficient for using the results in this study.

Most of the candidates are describing the term concept as the main aspect of a document. But some of them are describing a concept as a whole process as for example the concept for developing a motor cycle. This is not completely correct but the understanding at least in the process of deriving concepts is good enough and a correct definition was provided after the pre-survey anyway.

5.5.1.3 Concept extraction proposal

The candidates were asked to describe a concept retrieval process as they would use for the case study. Most of them described the process as follows:

1. read the text
2. extract keywords
3. group them
4. assign a concept name for that group

Because this is similar to our proposed concept retrieval process we noticed that for most of our candidates this procedure seemed to be common usage. One candidate would like to apply a knowledge representation method, which is not necessarily wrong, but implies that the person only wants to retrieve concepts automatically, which is in our interest but not entirely possible as described in the thesis "Deriving ontologies and assessment rubrics out of electronic documents with human support for automatic assessment purposes" (Reiterer, n.d.).

5.5.1.4 Self assessment

With this question we found out that in the end unexperienced users had much more difficulties in defining the term concept correctly. Also their extraction process was not exact enough and in one case the question about the extraction proposal was not understood at all.

5.5.1.5 Pre-survey conclusions

We were glad to see that 9 of 10 participants who took part in the whole study had proofed an acceptable knowledge and understanding in the field of concept extraction. The contestant with the token “jap8sxzqnzwp7rc” in contrast did not seem to be interested in the case study at all.

5.5.2 Analyzing the results of the post-survey

First the analysis of the papers named “Creative Adaptive e-Learning Board Games for School Settings Using the ELG Environment” (Retalis, 2008) and “A Standards-based Modeling Approach for Dynamic Generation of Adaptive Learning Scenarios” (Boticario & Santos, 2008) as well as those two papers treated as one are stated. Second, the candidates understanding in the mapping of concepts to a specific paper and the significance of automatically retrieved concepts are mentioned. Finally, the answers to overall questions regarding the case study are explained.

5.5.2.1 Analysis of the first paper

Extraction time The time the candidates required for reading the text and extracting keywords amounted between 25 and 95 minutes with an average of 49 minutes. For those who required the most amount of time, except one, agreed with the question that the paper was difficult to read. An exception was the candidate with the token “jap8sxzqnzwp7rc7” who already showed some lack of interest in the pre-survey. He or she required 95 minutes for reading the text, 15 minutes for extracting keywords, and disagrees strongly that the text was incomprehensible though this person seemed to be at least motivated in the post-survey because of the time the user required.

The rest of the contestants who are not agreeing with the incomprehensibility of the text required between 20 and 45 minutes for reading the text.

For extracting concepts out of the retrieved keywords the candidates necessitated between 5 and 45 minutes but most of them lay between 5 and 15 minutes. The average amounted to 15.5 minutes. Therefore the candidate with the token "rzm2rtp9a59hce8" may have retrieved well-thought-out concepts because he or she required 45 minutes for concept extraction. Also the contestant's concepts with the token "2xz82d4cjcw75kp" could be interesting because it took him or her 30 minutes. But this is just a preliminary assessment and the latter candidate also said that the text was almost incomprehensible for him and this could decrease the accuracy of the retrieved concepts.

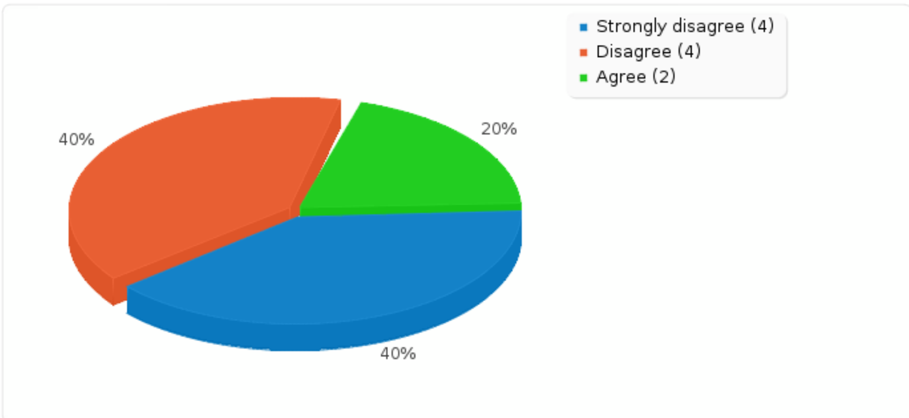

Figure 5.1: Chart regarding the question: The first paper was difficult to understand

Document's summary All of the candidates provided a good summary of the paper in two sentences. Everyone mentioned the introduction of an e-learning board game that uses an adaptive authoring tool for adapting to the user's needs. Some of them also mentioned the use of a non randomized dice. But we also found out that it could be sufficient to just read the abstract to be able to write a summary as the candidates provided. This problem should be minimized with the next question where the candidates are asked to provide the retrieved keywords where it is possible to see if the keywords are only taken from the abstract and the introduction or not.

Keyword extraction The contestants retrieved between 19 and 44 keywords for this document. By analyzing those results it seems that there is no relation between the number of retrieved concepts and their self assessment in the field of concept extraction. But there seems to be a relation, again only if you exclude the contestant with the token "jap8sxzqnzwp7rc", between the incomprehensibility of the document and the number of keywords. Candidates who did not understand the text well enough have retrieved much more keywords then the rest, namely 36 and 41. The contestant we excluded in this analysis retrieved the greatest number of keywords but said that he or she understood the text quite well. But to confirm this suggestion a more extensive case study has to be made.

Additionally we found out after analyzing the keywords that the candidate with the token "2xz82d4cjcw75kp" probably mixed up the two documents because he or she mentioned some terms that are only mentioned in the second document.

Finally, we can say after analyzing the keywords that all of the candidates read at least more than the abstract and introduction because everyone included several keywords that were taken out of different sections of the document than the first two. An exception may be the participant with the token "a7p3mys54f3rzxm" because most of the extracted keywords are mentioned in the introduction and the conclusion. But that proof is not sufficient for the moment.

Concept extraction The average number of concepts that are necessary to be extracted in the candidate's opinion are 5.8. Thus, most of the participants do not necessarily need a lot of concepts to be able to describe the content of a document. But this is only for the first document and because the second paper is a bit larger we came to the conclusion that this could influence the necessary number of concepts to describe the document sufficiently. The maximum number of necessary concepts, which the participants consider to be sufficient, is 8 and the minimum is 3.

Most of the contestants unveiled as top ranked concept either learning games, learning systems, or board games but one candidate took the term education. With this question it is evident that, even if the most people took a similar term, some of them are different and therefore this confirms the subjectivity of the retrieved concepts. But nevertheless there are also a lot of similarities as well. Especially when the first three concepts are considered because more or less the same terms are mentioned there and only the ranking is different. In the analysis we also have seen that the lower ranked concepts are indeed more specific than the toped ranked ones. Of course this was intended on the one hand but on the other hand it also shows that, if people are interested to get just a rough overview, the first 6 concept should be sufficient enough. But if someone wants to go more into detail it can be helpful to get some lower ranked concepts as well.

5.5.2.2 Analysis of the second paper

Extraction time The time required for reading the text and the keyword-extraction-time ranged between 30 and 120 minutes with an average of 72 minutes. This is reasoned by the length of the text which is about six pages longer than the first paper and more complicated to be read. Here it is also evident that the participants who had problems in understanding required much more time to read the text. But this result is not convincing enough because most of the candidates said that this text was pretty hard to understand and one candidate who disagreed also required 90 minutes. Nevertheless, in combination with the first paper this fact should be proven until we make a more expressive study with a greater number of candidates.

For retrieving concepts it took the candidates between 3 and 90 minutes with an average of 24.1. Because one candidate only required 3 minutes we can not be sure that the retrieved concepts are accurate enough and that he or she invested enough time for this task. This is also because it took much longer for most of the candidates in extracting concepts out of the second paper than out of the first one.

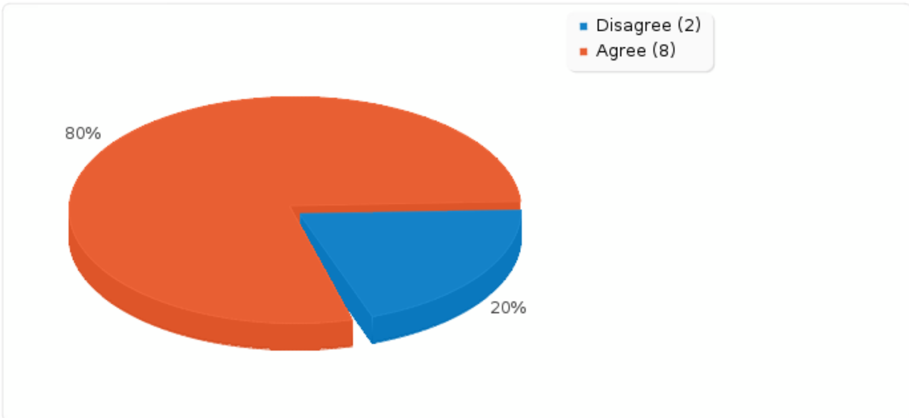

Figure 5.2: Chart regarding the question: The second paper was difficult to understand

Document's summary All of the summaries provided by the case-study-participants are explained correctly and therefore the data retrieved should be useful for our purposes. They mentioned a framework to create an adaptive coursework. Most of the candidates also referred to ADAPTAPLAN, which is analyzed thoroughly in this document, and one candidate mentioned alFanet as well, which is the predecessor of ADAPTAPLAN.

Keyword extraction The participants extracted between 27 and 140 keywords. That are quite a lot in comparison to the first paper also because the second paper is just a few pages longer than the first one. After analyzing the keywords we assume that most of the candidates read most of the paper. This must not be necessarily true with the extraction process of the candidate referring to the token “n785m3u8b59jx7j”. It seems that all keywords are taken out of the introduction and the abstract. But for the conclusion it will be interesting to see if the extracted concepts out of the abstract and the introduction are the same as other users extracted who read the whole document.

Concept extraction Between 5 and 20 concepts are necessary to retrieve out of the second document for making it possible to deduce to the content of the paper in the candidate's opinion. The average is 9.1, which is almost twice the number of concepts necessary for the first document. Because this document is not twice as long we have interpreted that not only the length of a document is crucial but also the complexity of the paper. We came to this deduction because of the fact that the majority of the contestants estimated this paper as difficult to be read.

The concepts itself confirm the similarity to the retrieved concepts of the first paper. Most of the candidates used ADAPTAPLAN as the top ranked concept or learning system with the hint to adaptivity. The second concept is often named “e-learning”, or “adaptive” if it was not used for the first concept already. Also alFanet, standards and pedagogical aspects are mentioned as second concept. It is also interesting to see that the user who retrieved only keywords out of the introduction and abstract came to similar concepts. That conclusion can be used for the improvement of our prototype because it got evident that the abstract, introduction and conclusion are containing almost the whole information for deriving concepts out of it. Of course, more detailed concepts are not easily retrievable only by using those sections but the most important concepts should.

5.5.2.3 Analysis of both papers treated as one

The survey's participants chose between 4 and 10 concepts as necessary number of concepts to be retrieved for both papers combined. The average amounts to 6.9, which is slightly more than the average number of concepts that were mentioned for the first paper. But because both papers are not identical normally less concepts than in the first paper should be retrieved in our opinion. But sometimes a new concept could be derived in combining two different concepts of both papers and maybe that is the reason that the average is 6.9. Nevertheless 5 participants came to that result and mentioned a little less concepts as necessary or at least an equal number of concepts as posted for the first paper.

One thing we found out is that 5 participants mentioned concepts that are only feasible for the second paper as ADAPTAPLAN or only for the first paper as ELG. This could have happened because of the interrogative clause we used for that question. Those participants may have understood to do not combine the papers but to just make one large paper out of it. This we have to correct for the next survey.

5.5.2.4 Analysis for mapping concepts to a specific paper

As already mentioned in the survey-structure-section above we provided a question where the user could choose between 3 papers where the abstract and the title was given. Also we offered a set of 10 concepts that were automatically retrieved out of the paper C named "Formal Representations of Learning Scenarios: A Methodology to Configure E-Learning Systems" (Helic, 2007). 80% of the participants have chosen the correct paper and 20% have chosen paper B named "Machine Learning-Based Keywords Extraction for Scientific Literature" (Wu et al., 2007). Because most of our candidates chose the correct paper our automatically retrieved concepts are already quite good for deducing to a specific paper without reading it. Of course this study has to be repeated with a greater number of candidates but for now this is quite a good result and assures

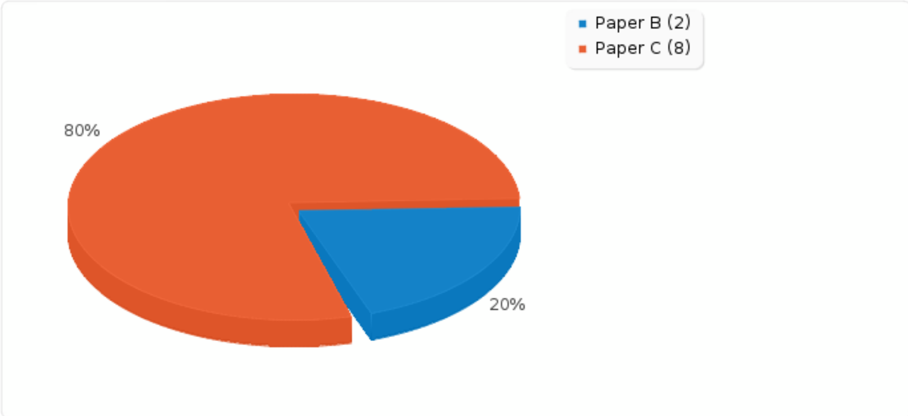

Figure 5.3: The chosen papers by mapping automatically retrieved concepts

us to do further work on our prototype “Rubrico”.

5.5.2.5 Analyzing the significance of automatically retrieved concepts

We asked our participants to rate 10 automatically retrieved concepts out of the first paper to be read (Retalis, 2008). For the retrieval process our prototype “Rubrico” was used. The concepts “student”, “board”, “customise”, “user”, and “adaptivity” were rated from most participants as significant concepts. However the retrieved concepts “paper”, and “museum” were rated as insignificant throughout all participants. With the concepts “dice”, “knowledge”, and “user” the contestants were undecided.

This question also shows that the interpretation in regards to the significance can be very subjective. Also it depicts the necessary improvement of our prototype because 2 concepts were rated as insignificant. Such concepts must not be retrieved automatically but as the case arises we implemented “Rubrico” in a way the user can interact with and thus he or she is able to delete unnecessary concepts. On the other hand we would like to do as much automatically as possible and therefore we will work on better retrieval algorithms to eliminate such insignificant concepts. Altogether we are happy that 5 concepts out of

10 were rated as significant and 3 concepts were accepted by the half of our participants.

5.5.2.6 Analyzing the overall questions of this case study

Experiences and difficulties Some of the participants were not happy with the post-survey because of too many questions and the length of the papers to be read. One person had problems with the acronyms used in the papers. Some candidates also had issues with the paper because the content was not related to their field of expertise and therefore hard to understand. But in general the feedback was quite positive, which encourages us to work on the suggestions mentioned and come up with a more extensive study after we have implemented the results we retrieved out of this survey.

Was the proposed procedure used by the candidates Everyone used the proposed procedure as mentioned in the slides that were handed out after filling out the pre-survey. Therefore no new proposals for retrieving concepts were mentioned.

5.6 Conclusions

Because only ten candidates participated to this case study the outcome is not as representative as it would be with more candidates. Nevertheless this number is sufficient to be able to get hints for further improvement of the prototype.

Improvements that have to be made are the retrieval of a sufficient number of concepts as well as the increase of the significance of the retrieved concepts. The results were not that bad but not good enough to retrieve concepts completely automatically. This will be a task for further development of the prototype.

That may be achieved by implementing better concept retrieval algorithms but also improvements have to be made in natural language processing. The number of concepts necessary for depicting a valuable picture of a specific document corpus depends on the number of documents and the desired level of detail. But nevertheless it is obvious that the number of concepts currently retrieved out of a corpus is much to high.

The points made in this case study have to be approved by carrying out a new case study with more participants after the finalization of the next prototype.

Chapter 6

Lessons learned

In this chapter we want to review the development process of the software prototype Rubrico from our current viewpoint and analyze the individual steps taken and the lessons learned while doing so.

At the beginning of our project we researched available literature and evaluated existing programs in the field of concept extraction, rubric creation and automated essay grading. The outcome of our research showed that there are a lot of systems in the area of rubric creation, but none of them supports the automatic extraction of rubrics. Rubrics still have to be created manually because the currently used algorithms are simply not perfect enough to allow the extraction of concepts and ontologies that do not need manual correction.

During the creation of our prototype we improved the used set of algorithms but the extracted ontologies still have to be adapted by human beings. During the development phase we also found out that the existing toolkits have to be adapted to be suitable for our purposes. But most of all we enhanced our knowledge in the field of concept extraction. The important question was to determine the number of concepts that are sufficient to describe a certain topic. There must not be too many concepts, because else the user may get irritated and is probably faster in reading the whole text rather than just the concepts. Thus, steps have to be taken to keep only the most important ones and additionally artificial concepts such as "-tion" have to be eliminated. Another important question in that context, which we tried to determine in our case study, is the question of the minimum number of concepts sufficient to describe a certain topic. Overall we learned that the process of concept extraction is very important and that the implementation of formal concept analysis could improve our prototype in the future.

Another valuable lesson we learned is the importance of usability and visualization techniques. Because we have to deal with different user groups possessing different skill levels the prototype has to be designed in a way that supports both groups. Therefore we created a standard view for inexperienced users, that uses a set of predefined algorithms and a complex view for experienced users that allows manual adaption of the workflow.

Chapter 7

Summary and future work

First of all we came to the conclusion that the concepts that were retrieved automatically by our concept extraction prototype Rubrico were categorized as significant ones by our test candidates. Thus, we have decided to proceed with our work on our concept / ontology retrieval tool and are trying to enhance the points that were mentioned by our candidates. This section is divided into several tasks we want to work on for further development on our software. These tasks are derived from the results of the case study and are split up into the number of keywords and concepts that are necessary for retrieving a good representation of the underlying document, the significance of the retrieved concepts, and the importance to correlate concepts to a specific section.

7.1 Number of keywords and concepts

One of the most important questions for us was to determine the number of concepts necessary to describe a specific topic sufficiently. The test candidates were asked to retrieve 10 concepts. Additionally, we asked them to name the number of concepts that are sufficient to describe the paper or topic in their opinion. Firstly, we noticed that all test candidates except two filled in all 10 concepts, which means that it is possible to derive that number of concepts. But the answers regarding the number of concepts necessary for describing the topic sufficiently are ranging between an average of 5.8 for the first paper and 9.1 concepts for the second one. As a results we found out that the number of concepts are increasing with the length of the accumulated documents used for concept extraction. We also asked for their opinion in the number of sufficient concepts for the two papers combined. There the contestants mentioned an average of about 7 concepts, which infers the idea that for more than one document the extracted number of concepts are in the range between the least extracted and the most extracted number of concepts.

Naturally this is only possible if the documents are related to each other. But because we want to extract concepts related to a specific topic this should be the case most of the time except each document covers a very specific part of the topic.

This information can now be used to extract some information about the added documents. Thus, it is possible to determine the similarity of added documents and also a categorization of those documents may be possible.

7.2 Significance of concepts

A feature demanded in using the concept / ontology extraction toolkit Rubrico is the significance of the retrieved concepts. Because the algorithms used nowadays are not effective enough this point is hard to achieve and therefore our tool is intended to be used with human support. But as software developers we are keen to improve our toolkit to be able to retrieve the most significant concepts possible even when the program is meant to be supported by the user.

Two questions of the post-survey were intended to deal with that topic. In one questions we have provided 10 automatically retrieved concepts and three titles plus abstracts referring to three documents. The contestants had to choose the title and abstract that matches to the provided concepts. Almost 80% chose the correct paper. This result supports our work but is still improveable. Also we just let the candidates choose out of a small set of papers. One way to overcome this problem will be to rate the extracted concepts regarding their occurrence in the specific document and on the other hand to provide a kind of a concept storyline to help people to detect the main concepts more easily.

In the second question the candidates had to evaluate the significance of some concepts. Hereby we have noticed that not all of the concepts that were retrieved out of the document were significant enough for them. But with some concepts it got evident that those were considered subjectively because the candidates rated them differently. This showed us the necessity to improve the concept extraction process. It also reflected the significance of the concepts detailedness as can be seen by the concepts paper and museum. Both terms are evident parts of the provided document but paper is far too superficial and museum on the other hand only represents a small part of the document and is not described explicitly enough.

7.3 Concepts mapped to specific sections of a document

When we have started to work on Rubrico we decided to use ontologies as concept-representation. Because ontologies are providing a structured view about a topic it got evident to also structure or categorize the extracted concepts. This aspect is also supported by the case study as already mentioned in the section above. We found out that it could be useful to map the concepts against specific section of the document. Concepts that are extracted out of the abstract, for example, are more significant than when they are extracted in other sections. This technique can than be used to extract more significant concepts.

Furthermore such a representation can also be used for visualization purposes, which may help the user to set the detailedness of the topic represented by the extracted concepts. Also the user can then limit the shown concepts on specific part of the document.

7.4 Final statement

As a final statement we want to briefly mention the points that are planned to be worked on by further improving our prototype.

These are, the extraction of not more than a number of concepts sufficient to describe a document / topic, ways to improve the significance of automatically extracted concepts and the importance of mapping concepts to a specific section in a document.

Chapter 8

Appendix A

List of Figures

List of Tables

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Chapter 9

Appendix B

9.1 Survey results

Next the original survey results of the test candidates who participated in the whole case study process are stated.

Token	PPA *1	Gender	Age	Education	Area of expertise
kp3n7mnghdt224q	Yes	Male	18 - 29	University (Bachelor, Master)	Modern Inforation Systems
wap6c7ih4vg5e3b	Yes	Male	18 - 29	University (Bachelor, Master)	Information Systems
rzm2rtp9a59hce8	Yes	Male	40 - 49	University (Bachelor, Master)	Computer Science, Information Technology
2xz82d4cjcw75kp	Yes	Female	18 - 29	University (Bachelor, Master)	Education
g5zj3c93qk7qbbn	Yes	Male	18 - 29	University (Bachelor, Master)	software development
n785m3u8b59jx7j	Yes	Male	18 - 29	University (Bachelor, Master)	Telematics / Informatics
jap8sxzqnzwp7rc	Yes	Female	18 - 29	University (Bachelor, Master)	computer science
k8rv7u4c2kxrzc4	Yes	Female	50 - 59	University (Phd or higher)	chemistry
4rnsevfic3ahq4p	Yes	Female	30 - 39	University (Bachelor, Master)	Software development
a7p3mys54f3rzxm	Yes	Male	60 - 69	Engineer	agriculture and alternative energy, biochar production

*1: Privacy policy agreement

Table 9.1: Results pre-survey part 1

Token	Concept definition	Finding steps	Self Assessment
kp3n7mnghdt224q	A concept is a key phrase that expressess or represents a main content of a text.Example: Objectives in Software Development	First of all i would read through the text and highlight important content and phrases. 2. Then i would read throught the highlighted content again and would search for main phrases or build main topics	advanced
wap6c7ih4vg5e3b	a term concept is a single word or phrase that describes the main content and the main topic of text at its best	read the text carfully and try to understand it. find the main topics in the text and try to create superior expressions related to the main topics of the text	expert
rzm2rtp9a59hce8	Keyword, It is an idea or a general term for a set of related ideas or domain of knowledge. It is a generated keyword that can facilitate dealing with that set of ideas or knowledge. For example, the concept: concept extraction refers to identification and extraction of the concepts from a natural language electronic document and its associated work, techniques and domain knowledge	Apply a knowledge representation method.	unexperienced
2xz82d4cjcw75kp	An abstract idea.The teacher tried to explain the concept of data backup to the new computer users.	reading a section of text in context and highlighting the abstract ideas/notions	advanced
g5zj3c93qk7qbbn	A concept describes an idea and everything which is related to it. E.g. "tree"" is the concept for some types of plants with several similar properties. In this example the concept is a classification. But a concept does not necessarily need a physical real world representation. It can be merely an abstract idea as often found in mathematics."	Read the text and summarize it. Try to determine what a unit (sentence, paragraph) is referring too and try to summarize it in one word if possible. Then determine which of those are related and try to group them into concepts and find a name for each concept.	some experience

Table 9.2: Results pre-survey part 2

Token	Concept Definition	Finding steps	Self Assessment
n785m3u8b59jx7j	A concept is either a first draft for a solution to a specific problem respectively a rough plan for a project or an abstraction of an idea that hasn't been proven yet.An example would be that before you develop a web site you create a concept which defines the main aspects of the site you are going to build.	I would try to summarize the solution/plan/idea/... in one or a few sentences which outline the main points.	unexperienced
jap8sxzqnzwp7rc	an idea of how to realise something.	Extract a concept out of what? Sorry, no clue	unexperienced
k8rv7u4c2kxrzc4	number of words forming a termExample: Environmental protection	Read an article and extract key words representing the contents, pick out the most important ones, grouping and rearranging them.	some experience
4rnsevfic3ahq4p	A concept is a term (consisting of one or more words) that expresses a certain meaning	I would read the text and create a list containing important words and phrases characterizing the text. Afterwards I would group the words - merge those that express the same meaning and afterwards rank them according to their importance.	some experience
a7p3mys54f3rzxm	a concept is defined by the the meaning associated with a word (or a group of words)concept: bioenergy system meaning: a system that produces energy using regrowable sources	1. read the document2. make an excerpt containing the most important words3. reevalute the words (unify them, eliminate doubles)4. order them (most important ones first)	some experience

Table 9.3: Results pre-survey part 3

Token	PPA *1	KET *2	CET *3	Incomprehensibly	Summary
kp3n7mnghdt224q	Yes	25	5	Disagree	The paper introduces the ELG, an autohoring tool, for creating e-learning board games. It deals with the adaptivity, different learning activities and the authoring process.
wap6c7ih4vg5e3b	Yes	30	5	Disagree	This paper describes the usage of games for educational purposes. The main part of the paper is the introduction of the ELG which is an authering tool for developing e-learning board games.
rzm2rtp9a59hce8	Yes	45	45	Strongly disagree	The paper proposes and describes a method of utilizing electronic board games for providing adaptive learning. It uses snakes and ladders as an example
2xz82d4cjcw75kp	Yes	60	30	Agree	The paper is concerned with the development of adaptable educational systems and tools. Specific consideration is given to system architecture and it's degree of suitability for pedagogical application.
g5zj3c93qk7qbbn	Yes	25	5	Strongly disagree	Use digital games to foster student learning and participation. Design the games to adapt to the user and therefore foster the learning process further.

*1: Privacy Policy Agreement, *2: Keyword Extraction Time in minutes, *3: Concept Extraction Time in minutes

Table 9.4: Results post-survey part 1 (paper 1)

Token	**PPA *1**	**KET *2**	**CET *3**	**Incomprehensibly**	**Summary**
n785m3u8b59jx7j	Yes	20	5	Strongly disagree	They proposed a system to build board games to support e-learning. The innovation was the built-in adaptivity.
jap8sxzqnzwp7rc	Yes	95	15	Strongly disagree	The paper describes an interface to simply create an e-learning board game for educational purposes. It is adaptive in terms of creation (adaptation rules) and should also adapt to a learners knowledge level.
k8rv7u4c2kxrzc4	Yes	90	15	Agree	The educational value of board games is stressed and an ELG-environment for the creation and realisation of e-learning board games is presented. An adapttive tool facilitates the teacher to design a game according to the requirements of the students.
4rnsevfic3ahq4p	Yes	40	10	Disagree	The authors developed a system to create digital board games for educational puroses. They introduced the ELG game that offers an adaptive authoring tool and a fixed dice that allows the teacher to control the pupils learning process.
a7p3mys54f3rzxm	Yes	60	20	Disagree	The papers decribes the process of creating an adaptive elearning board game using the ELG environment.

*1: Privacy Policy Agreement, *2: Keyword Extraction Time in minutes, *3: Concept Extraction Time in minutes

Table 9.5: Results post-survey part 2 (paper 1)

Token	Keywords
kp3n7mnghdt224q	creatin adaptive e-learning games, board games, competitive environment, learning activities, learning goals, learning progress, eduactional process, adaptive authoring tool, ELG, designing games, authoring environment, question cards, creating and re-using learning activities, close-type self-assessment item, open-type assessment item, each activity can be rated, annotated according to a set of categories, feedback comments, name, type, goals per concept, category, difficulty levl, adding adaptivity, student´s knowledge level, student´s interests, activity data per student, dice, architectural design details, evaluation
wap6c7ih4vg5e3b	, educational process, cutomization of games, e-learning, board games, learning games, authering tool, ELG, lerning process, er-using lerning objects, question answering, feedback, automatic adjustment of difivulty level, re-using leraning activities, adaptivity, network sturcture, develop and deploy games, personalization
rzm2rtp9a59hce8	board games, interactive simulated learning, adaptive authoring, user friendly authoring, adaptive e-learning board, learning objects, meta-data, learning activity, learning process, self-assessment, adaptivity, adaptive learning rules, architectural decisions, instructional design, usability, interactivity, storytelling
2xz82d4cjcw75kp	learning systems, System architecture, system design, Modelling features, Dynamic modelling, Adaptive features, Authoring tools, authoring, IMS-LD, Pedagogical requirements, Educational specifications and standards, learning route, Learning styles, Learning experience, User features, Standards-compliant, runtime, course contents, ADAPTAPlan, Methodology, digital games, education, Value of use, Architectural elements, pedagogical elements, digital board game, learning experience, teaching philosophy (pedagogy), Creating, Customizing, ELG, Program Features/Environment, Program evaluation, adaptability, usability, reusability
g5zj3c93qk7qbbn	digital games, e-learning, authoring tool, learning activities, creativity , problem-solving skills, imagination,adaptive,game based learning,competitive environment,multiple players,interactive learning experience, learning objects,learning process,feedback,monitor,IMS QTI,evaluation,usability,learning objectives,instructional practices,personalization,

Table 9.6: Results post-survey part 3 (paper 1)

Token	Keywords
n785m3u8b59jx7j	e-learning, assessment, evaluation, games, board games, ELG, education,e-learning board games (ELG), adaptivity, game design, game development, IMS QTI compatible, web application, usable on PDA
jap8sxzqnzwp7rc	digital games, board games, duration of a game, quiz tool, player, learner, student, teacher, designer, educational process, competitive environment, challenge, learning goal, pc, dma, lan, wan, rules, level, learning goal, question items, dice, premarkable surface, university, primary school, interactive stimulation learning, having fun, interest of the student, adaptive authoring tool, learning activities, performance, reach the goals, customize, address learning problems, educational benefits, interests and motives of students, facilitate and motivate the learning rate, preschool, multiple players, moving pieces across, interactive learning experience, level of learning, designer of educational games, educational content
k8rv7u4c2kxrzc4	E-learning, board games, ELG-environment, educational process, interactive learning experience, adaptive authoring tool, multiple players, learning activities, learning goals, user friendly authoring environment, adaptive e-learning boardgame, reusing learning objects, ELG authoring environment, playing space, dice rules, metadata, grafical design, game objects, educational activities, questions, runtime environment, creating and reusing learning activities, adaptivity, student´s knowledge level, student´s interests, activity data per student, ELG architectural design,web server, SQL server, Visual basic, IIS mail server, Microsoft´s media server, Ajax technology grafical user interface, ELG templates of rules, educational level, educational objective, interface representations, interface actions, learning concepts, interface objects, challenge, feedback, reusability of learning objects
4rnsevfic3ahq4p	ELG game, elearning, board game, adaptive authoring, learning goal, learning activity, non randomized dice, customizing games, learning rate, learning process, authoring environment, assessment techniques, learning object, concept map, knowledge level, interest, activity data, score, webtechnology structures, interactivity, feedback, curiosity, control mechanisms
a7p3mys54f3rzxm	education, ELG game, learning activities, adaptive authoring tool, student, teacher, learning goal, dice not randomized, facilitate and monitot learning rate, board game, learning object, knowledge level, interests, activity data, score, game metadata, architectural design, web technology structures, classroom

Table 9.7: Results post-survey part 4 (paper 1)

Token	NNC *1	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
kp3n7mnghdt224q	6	learning games	adaptive authoring tool	e-learning	ELG	authoring process
wap6c7ih4vg5e3b	7	e-learning	learning board games	authering tool	e-assessment	formative assessement
rzm2rtp9a59hce8	7	board games	interactive simulated learning	adaptive e-learning board	adaptive learning rule	adaptive authoring
2xz82d4cjcw75kp	8	learning systems	adaptability	architectural elements	morelling features	pedagogical elements
g5zj3c93qk7qbbn	7	adaptive learning	game based learning	learning objectives	personalization	authoring tool
n785m3u8b59jx7j	3	e-learning board games (ELG)	innovation: adaptivity	dice is not randomized but controller by teacher	support for game design and thus easy game development	mobile friendly web application
jap8sxzqnzwp7rc	5	Education	E-learning	Game	Adaptation	Motivation
k8rv7u4c2kxrzc4	5	ELG-environment	authoring tool	e-learning	board games	educational process
4rnsevfic3ahq4p	5	ELG game	elearning	adaptive authoring environment	learning object	web based technology
a7p3mys54f3rzxm	5	ELG game	E-learning	adaptive authoring	monitoring of learning process	web technology

*1: Number of necessary concepts in the candidate's opinion

Table 9.8: Results post-survey part 5 (paper 1)

Token	Concept 6	Concept 7	Concept 8	Concept 9	Concept 10
kp3n7mnghdt224q	learning activities	adaptivity	e-assessment	educational values	formative assessment
wap6c7ih4vg5e3b	ELG	personalized learning	adaptive environement	reusability of lerning objects	development of games
rzm2rtp9a59hce8	usability	instructional design	interactive simulated learning	learning objects	architectural decision
2xz82d4cjcw75kp	learning experience	usability	educational value	educational specifications	educational standards
g5zj3c93qk7qbbn	learning process	learning objects	competetive environment	monitoring	instructional practices
n785m3u8b59jx7j	use of games in education is well documented	supports assess-ment/evaluation	having fun while learning stimulates learning	standards based	IMS QTI compatible
jap8sxzqnzwp7rc	Application Area	End-User	Adaption Items	Game Authors	Game Objects
k8rv7u4c2kxrzc4	adaptivity	ELG architectural design	xxx	xxx	xxx
4rnsevfic3ahq4p	fixed dice	students needs	learning style	monitoring of learning process	educational services
a7p3mys54f3rzxm	student	teacher	xxx	xxx	xxx

Table 9.9: Results post-survey part 6 (paper 1)

Token	KET *1	CET *2	Incomprehensibly	Summary
kp3n7mnghdt224q	40	8	Agree	The paper shows the development and modelling process of adaptive courses in learning mnagement systems. Therefore the aLFanet approach, which uses standard modelling approaches, and the ADAPTAPlan approach, that uses user modelling, planning and machine learning techniques, are introduced.
wap6c7ih4vg5e3b	70	15	Agree	This paper focuses on an approach of dynamic generation of adaptive learning scenarios with the help of various standards. Therby the ADAPTAPlan is introduced which is a framework for developing and modelling standard-based adaptive lerning scenarios.
rzm2rtp9a59hce8	90	90	Agree	The paper describes the process and several related concepts relevant to creating and adaptive learning tool and scenario.
2xz82d4cjcw75kp	60	30	Agree	Developing standards-based (systems and educational) learning management systems.
g5zj3c93qk7qbbn	45	10	Agree	Adaptive e-learning courses based on standards. Support the authoring task through several design decisions.

*1: Keyword Extraction Time in minutes, *2: Concept Extraction Time in minutes

Table 9.10: Results post-survey part 7 (paper 2)

Token	KET *1	CET *2	Incomprehensibly	Summary
n785m3u8b59jx7j	30	3	Disagree	They built a framework to dynamically generate learning design templates to create adaptive e-learning scenarios.
jap8sxzqnzwp7rc	115	20	Agree	Authors describe issues identified during research projects that assist the creation of adaptive coursework. And give details to user modelling and data extraction as well as other important aspects in designing LMSs.
k8rv7u4c2kxrzc4	120	30	Agree	A new modelling approach for designing e-learning courses - ADAPTAPLAN - is described and its advantages in comparison with its predecessor, alFanet, are highlighted. The new approach allows the author of a course to concentrate more on the contents and the goals, because a great deal of the design work is done by a planning engine and it also allows a better adaptation to the needs and abilities of the students.
4rnsevfic3ahq4p	60	15	Agree	The paper tries to find a standards based approach for dynamic generation of adaptive elearning scenarios. They developed the ADAPTAPlan project and described their experiences in the creation process.
a7p3mys54f3rzxm	90	20	Disagree	The paper describes the ADAPTAPlan project which focuses on dynamically gerenating adaptive learning scenarios.

*1: Keyword Extraction Time in minutes, *2: Concept Extraction Time in minutes

Table 9.11: Results post-survey part 8 (paper 2)

Token	Keywords
kp3n7mnghdt224q	modelling approach for dynamic generation of adaptive learning scenarios, developing standard based adaptive corses, eLearning cycle, design tenplates, user modelling - planning and machine learning techniques, learning material, pedagogical models, learning styles, user model, IMS, unexpected situations appear at runtime, aLFanet approach, adaptive course delivery, use of standards, user modelling techniques, standards from the IMS Global Learning Consortium, design of learning experience, administration, usage, auditing, dynamic pedagogical situations, experienced the design phase as a very complicated task, wide variety of elements, QTI authoring tools, usage of metadata, set of learning objects, instructional design, constrcution process, ADAPTAPlan, LMS, specification of learning activities, temporal restrictions, use of educational standards, learning routes, teaching and learning process, metadata, personalization, specification of the workflow, educational services, combining user modeling - planning and machine learning techniques, course structure, restrictions, modelling obejectives, questionnaires, contents, services, activities, user modelling features, learning styles, processing, knowledge level, collaboration level, identifying course services, metadata tagging, user profile modelling, links between each learning dimension and style, dynamic-based modelling, recommender systems, recommendation techniques, collaborative filtering, content-based techniques, adaption process, collaboration competency level, resources and learning styles,
wap6c7ih4vg5e3b	standard-based approach, adaptive e-leraning system, design phase, dynamic modelling at runtime, adaptive learning scenarios, user modelling, IMS lerning design, personlized lerning, authering task, manage all possible situations, LMS, educational specifications and standards, adaptive course delivery, dynmaic assistance, alFanet, use of standards, multi-agent architecture, ADAPTAPlan, design of adaptive scenarios, reusability, IMS standards, lerning design, step-wised approach, leraning activities, lerning objects, educational services, modelling alternative learning itineraries, dynamic feedback, run-time tracking, collaborative learning, personalized, user model, course model, IMS-LD course design, unit of lerning, user modelling, lerning styles, knowledge level,collaboration level, course materials, course services, metedata creation, lerning resource type, difficulty, interactivity, user profile, full life cycle of learning, recomender systems, reusability and flexibility
rzm2rtp9a59hce8	dynamic modeling, personalized learning, authoring task, adaptive learning system, intelligent testing, collaborative tutor, rule-based adaptation, adaptive hyper book, learning styles, adaptive information filtering and retrieval, adaptive course delivery, user modeling, content packaging, adaptation, machine learning, collaborative learning, distance learning, course execution, planning engine, personalized learning scenario, Composite Capability / Preference Profiles, metadata tagging, density of semantics, interactivity level, collaborative competency level, recommender system, planning engine, multi-agent architecture, intelligent agent, reusability

Table 9.12: Results post-survey part 9 (paper 2)

Token	Keywords
2xz82d4cjcw75kp	ADAPTAPlan, Adaptive features, Adaptations,adapted response,Adaptive course deliver,Adaptive course deliver,Adaptive course work flow,Adaptive information,Adaptive learning systems,Adaptive scenario,Corrective adaptations,Rule-based adaptation,Administration,aLFanet,Alternative,Alternative learning routs,Applicability of the approach,Architecture,Architecture and authoring tools,Auditing,authoring,Author information ,Authoring approach,Authoring problems,Authoring task,Authoring tools,,Authors experienced,cognitive modality,Collaboration competency level,collaboration level,competency,Contents,context,Contextual support at runtime,current context,Controlling their interactions to successfully,characterized course contents,Course design,Course material,Course model,current specification,system design,runtime,,Design adaptive scenarios,Design and runtime adaptations,design phase,Design process,Design time,Designing,Developing,Developing and modelling standards-based adaptive scenarios for current LMSs,Device capabilities,Difficulties,Difficulty,Dimensions,Diversity of learning,Modelling features,Dynamic modelling,Dynamic assistance approach,Dynamic assistance developing and modelling learning design tasks,Dynamically acquired,Dynamically generated course design,Dynamic-based modelling,Educational specifications and standards,Educational standards,Evaluation tasks,Experimentation phase,Format,Identifying,IM-MD features,Implementing,Improve the adaptability and generalisability of learning routes,IMS-AccLIP,IMS-LD,IMS-LD skeleton,IMS-LIP,IMS-RDCEO,Inherent,Instructional design,Instructional objective,Intelligent solutions,Intelligent testing,Interactivity level,knowledge level,learner access device,Learner driven tasks,Learner needs,Learners' interactions,Learning activities,Learning design,Learning design and runtime adaptations,Learning dimension,Learning experience,Learning flows,Learning objects,Learning objects repository,Learning resource type,Learning route,Learning styles,Life cycle of learning,Resources and learning styles,Machine learning techniques,Metadata tagging,Methodology,Multi-agent architecture,Ongoing experimentation,,Oriented programming course,Particularized learning route,Pedagogical approach,pedagogical criteria,Pedagogical requirements,Personalised IMS-LD,,Personalised learning paradigm,Planning engine,Planning engine task,Problems,Process,Profile,Recommendation portlet,Recommendation strategy,Recommendation types,Recommender system,References,,Runtime adaptation bases its reasoning,Runtime adaptations,Services,Specification,Standards-based adaptive scenarios,Standards-based modelling,Standards-compliant,Structure sequence of learning objects approach,System architecture,Temporal restrictions,User features,User model,user modelling features,User modelling techniques in a multi-agent architecture,User profile,User profile modelling,Values,

Table 9.13: Results post-survey part 10 (paper 2)

Token	Keywords
g5zj3c93qk7qbbn	learning activities,learning objects,adaptive learning,e-learning,standard base,design templates,authoring task/process,IMS,design time,adaptation process,standards,course generation,user profile,management,auditing,pedagogical models,open source,dynamic assistance,scenario,machine learning,modelling,pedagogy,IMS-QTI,learning process,design time,run-time,learning style,knowledge level,collaboration (level),metadata,resources,user interaction,planing engine,life cycle,recommendation,agents
n785m3u8b59jx7j	e-learning, adaptive, e-learning, design templates, dynamic generation, user modelling, machine learning, high complexity, many possible situations, situations not always predictable,complex design phase, multi-agent architecture, IMS Global Learning Consortium compatible, assessment, evaluation, questionnaires, supports for different learning styles
jap8sxzqnzwp7rc	adaptive courses, design phase, dynamic modelling, performed at runtime, adaptation oriented learning scenarios, eLearning cycle, design, aLFanet project, ADAPTAPlan project,dynamically generated learning design templates, user modelling, planning, machine learning techniques, IMS learning design, set of data, personalised learning paradigm, authoring task, ITS, educational standards, adaptive learning systems, adaptive course delivery, students individual need, existing educational standards, intelligent solution, intelligent testing, capturing, analyzing student action, collaborative tutors, rule-based adaptation, distributed server, adaptive hyperbooks, re-using, AI, web based eduction, Learning Management Systems, learning material, padagogical models, learning styles, learning needs, adaptive scenarios, runtime adaptation, design time, management problems, padagogical requirements, developing and modelling learning design task, author, user feature, standard based modelling, device capabilities, applicability, experiments, multi-agent architecture, IMS Metadata, IMS Learning Design, IMS Content Packaging, IMS Question and Test Interoperability, IMS Learner Information Package, life cycle of learning, design, administration, usage, auditing, learner driven tasks, alternative learning tasks, logic, information, online courses, users interaction, students, lack of knowledge, hight interest level, system architecture, open source, GNU, interactive, evaluated, adaptive course work flow, metadata, pilote sites, evaluation, non-expert authors, design templates, instructional design, adaptive scenario, opern source architecture, research development, questionnnaire, web-services, collaborative work, research project, alternative learning routes, types of learners, group work, collaborative learning, learning objects, learner profiles, design issue, dynamic feedback, run-time tracking, machine learning techniques, planning engine, LD, IMS-LD skeleton, user model, course model, author information, course content, expected results, questions, Unit of Learning, platform interface, device, interactivity level

Table 9.14: Results post-survey part 11 (paper 2)

Token	Keywords
k8rv7u4c2kxrzc4	e-learning cycle, alFanet project, ADAPTAPLAN project, planning engine, web based education, dynamic course generation, learning materials, pedagogical models, user features, device capabilities, life cycle of learning, learning environment, learning experience, data administration, services configuration, runtime adaptation, adaptive course work flow, authoring tools, questionnaires, metadata, LD authoring tool, learning design, design templates, individual learner needs, user modelling and planning, machine learning techniques, evaluations, IMS_LD specification, collaborative learning, learning process, educational services, general LD, personalised learning route, bank of questions, unit of learning (UoL), learning styles, Felder´s model, Bloom´s taxonomy, collaboration level, density of semantics, collaboration tools, recommender system, knowledge level, collaboration competency level, resources
4rnsevfic3ahq4p	adaption oriented learning scenarios, elearning, alFanet, ADAPTAPlan project, design templates, user modelling, planning, machine learning techniques, adaptive learning systems, individual needs, learning management systems, runtime changes, multi agent architecture, IMS, design, administration, usage, alternative learning paths, learning object , metadata, instructional design guided by learning objectives, educational standards, roles, activiteis, educational services, workflow specification, learning activities, planning engine, logic framework approach, learning styles, knowledge level, collaboration level, metadata tagging, IMS- Acclip, IMS-RDCEO, recommender systemsmonitoring process of learner interactions
a7p3mys54f3rzxm	adaptive learning scenario, e-learning, alFanet, ADAPTAPlan, machine learning techniques, IMS, adaptive learning systems, students individual needs, multi agent architecture, IMS Global learning consortium, alternative learning paths, learning object, design phase very complicated, adaptive scenario, openACS, dotLRN, educational standards, educational services, workflow specifications, planning engine, learning styles, metadata tagging, recommender system, monitoring process, EM algorithm, agent tasks, personalized learning scenario

Table 9.15: Results post-survey part 12 (paper 2)

Token	NNC *1	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
kp3n7mnghdt224q	5	learning management system	e-learning	creating adaptive course material	ADAPTAPlan	aLFanet
wap6c7ih4vg5e3b	10	ADAPTAPlan	educational specifications and standards	LMS	adaptive learning scenarios	personalized learning
rzm2rtp9a59hce8	7	personalized learning	adaptive learning system	learning styles	rule based adaptation	user modeling
2xz82d4cjcw75kp	20	learning systems	System architecture	authoring	Educational specifications and standards	Learning experience
g5zj3c93qk7qbbn	10	adaptive learning	standards	learning process	authoring task	planing engine
n785m3u8b59jx7j	5	e-learning	adaptive	dynamically generate learning design templates	main issue: manage all the possible situations that may arise during the course execution	not every situation can be predicted, complex design phase
jap8sxzqnzwp7rc	10	Adaptation	Padagogical Aspects	Education	IMS	LMS
k8rv7u4c2kxrzc4	8	ADATAPLAN project	alFanet project	e-learning	dynamic course generation	pedagogical models
4rnsevfic3ahq4p	8	ADAPTAPlan	elearning	learning object	metadata	educational services
a7p3mys54f3rzxm	8	ADAPTAPlan	eLearning	learning scenario	IMS educational standards	adaptive learning

*1: Number of necessary concepts in the candidate's opinion

Table 9.16: Results post-survey part 13 (paper 2)

Token	Concept 6	Concept 7	Concept 8	Concept 9	Concept 10
kp3n7mnghdt224q	learning design	learning acivities	dynamic assistance	IMS standards	user modelling
wap6c7ih4vg5e3b	formative learning	dynamic assistence	alFanet	learning design	e-learning
rzm2rtp9a59hce8	adaptive information filtering and retreival	dyanmic modeling	collaborative learning	recommender system	multi-agent archotecture
2xz82d4cjcw75kp	User features	runtime environment	course contents	system design	adaptive features
g5zj3c93qk7qbbn	recommendation	modelling	dynamic assistance	knowledge level	planing engine
n785m3u8b59jx7j	user modelling	machine learning techniques	support for different learning styles	multi-agent architecture	IMS Global Learning Consortium compatible
jap8sxzqnzwp7rc	User Modelling	Design Elements	Data Modelling	Realisation Problems	Data Sources
k8rv7u4c2kxrzc4	educational specifications and standards	standard learning managing systems (LMS)	planning engine	LD	Felder´s model
4rnsevfic3ahq4p	IMS standards	user modelling	monitoring of learning process	runtime adaptivity	multi agent architecture
a7p3mys54f3rzxm	learning object	metadata	process monitoring	student	personalization

Table 9.17: Results post-survey part 14 (paper 2)

Token	NNC *1	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
kp3n7mnghdt224q	6	e-learning	adaptive course material	learning activities	learning design	adaptive authoring tools
wap6c7ih4vg5e3b	6	learning management systems	formattive assessement	e-learning	personalized learning	adaptive learning
rzm2rtp9a59hce8	7	Adaptation	user modeling	learning styles	rule based adaptation	dynamic modeling
2xz82d4cjcw75kp	10	Learning systems	adaptibility	Architectural elements	Modelling features	Pedagogical elements
g5zj3c93qk7qbbn	8	adaptive learning	authoring	learning objectives	learning objects	monitoring
n785m3u8b59jx7j	4	e-learning	adpative	design is complex, needs support	different approaches for adaptivity: user modelling, machine learning, human intervention	standards based
jap8sxzqnzwp7rc	5	Adaptation	e-Learning	User Modelling	Education	Web Technology
k8rv7u4c2kxrzc4	8	e-learning	ELG-environment	ADAPTAPLAN project	dynamic course generation	authoring tool
4rnsevfic3ahq4p	5	elearning	learning object	educational services	students needs	runtime adaptivity
a7p3mys54f3rzxm	10	E-learning	learning object	learning scenario	ADAPTAPlan	ELG game

*1: Number of necessary concepts in the candidate's opinion

Table 9.18: Results post-survey part 15 (paper 1 & 2 combined)

Token	Concept 6	Concept 7	Concept 8	Concept 9	Concept 10
kp3n7mnghdt224q	learning management systems	user modelling	ELG	ADAPTPlan	aLFanet
wap6c7ih4vg5e3b	reusabillity of learning objects	learning games	standardsation	ELG	ADAPTAPlan
rzm2rtp9a59hce8	metadata	instructional design	personalized learning	collaborative learning	multiagent system
2xz82d4cjcw75kp	Learning experience	Usability	Educational value	Educational specifications	Educational standards
g5zj3c93qk7qbbn	learning activities	learning process	user	personalization	IMS
n785m3u8b59jx7j	having fun while learning stimulates learning	support for different learning styles	games can be used to support the learning process, well documented	use wizards, templates to ease development of courses	frameworks for creation of e-learning courses
jap8sxzqnzwp7rc	Motivation	System Components	Research	Pedagogical Aspects	Realisation Problems
k8rv7u4c2kxrzc4	planning engine	standard learning managing systems	educational process	educational specifications and standards	adaptivity
4rnsevfic3ahq4p	monitoring of learning process	xxx	xxx	xxx	xxx
a7p3mys54f3rzxm	adaptive authoring	monitoring of learning process	metadata	personalization	student

Table 9.19: Results post-survey part 16 (paper 1 & 2 combined)

Token	Selected Paper
kp3n7mnghdt224q	Paper C
wap6c7ih4vg5e3b	Paper B
rzm2rtp9a59hce8	Paper C
2xz82d4cjcw75kp	Paper C
g5zj3c93qk7qbbn	Paper C
n785m3u8b59jx7j	Paper C
jap8sxzqnzwp7rc	Paper B
k8rv7u4c2kxrzc4	Paper C
4rnsevfic3ahq4p	Paper C
a7p3mys54f3rzxm	Paper C

Table 9.20: Results post-survey part 17 (Q18: map concepts to paper)

Token	student	environment	dice	paper
kp3n7mnghdt224q	significant	significant	insignificant	very insignificant
wap6c7ih4vg5e3b	significant	significant	significant	very insignificant
rzm2rtp9a59hce8	significant	significant	insignificant	insignificant
2xz82d4cjcw75kp	significant	very significant	insignificant	very insignificant
g5zj3c93qk7qbbn	significant	insignificant	insignificant	insignificant
n785m3u8b59jx7j	significant	very insignificant	very significant	very insignificant
jap8sxzqnzwp7rc	significant	very insignificant	significant	very insignificant
k8rv7u4c2kxrzc4	very significant	very significant	insignificant	very insignificant
4rnsevfic3ahq4p	very significant	insignificant	very significant	insignificant
a7p3mys54f3rzxm	very significant	significant	very significant	insignificant

Table 9.21: Results post-survey part 18 (Q19: significance of automatically retrieved concept out of paper 1)

Token	board	knowledge	customise
kp3n7mnghdt224q	significant	insignificant	insignificant
wap6c7ih4vg5e3b	very significant	insignificant	significant
rzm2rtp9a59hce8	significant	insignificant	insignificant
2xz82d4cjcw75kp	significant	significant	very significant
g5zj3c93qk7qbbn	insignificant	very significant	significant
n785m3u8b59jx7j	significant	significant	very significant
jap8sxzqnzwp7rc	significant	significant	very significant
k8rv7u4c2kxrzc4	very significant	significant	very significant
4rnsevfic3ahq4p	very significant	very significant	very significant
a7p3mys54f3rzxm	very significant	very significant	very significant

Table 9.22: Results post-survey part 19 (Q19: significance of automatically retrieved concept out of paper 1)

Token	user	museum	adaptivity
kp3n7mnghdt224q	significant	very insignificant	very significant
wap6c7ih4vg5e3b	very insignificant	very insignificant	very significant
rzm2rtp9a59hce8	insignificant	insignificant	very significant
2xz82d4cjcw75kp	very significant	very insignificant	very significant
g5zj3c93qk7qbbn	significant	very insignificant	very significant
n785m3u8b59jx7j	insignificant	very insignificant	very significant
jap8sxzqnzwp7rc	significant	insignificant	very significant
k8rv7u4c2kxrzc4	very significant	very insignificant	very significant
4rnsevfic3ahq4p	significant	very insignificant	significant
a7p3mys54f3rzxm	significant	very insignificant	very significant

Table 9.23: Results post-survey part 20 (Q19: significance of automatically retrieved concept out of paper 1)

Token	What have you experienced in working on this case study?
kp3n7mnghdt224q	There were too many questions.
wap6c7ih4vg5e3b	The study was time expensive.
rzm2rtp9a59hce8	Manual Extraction of concepts depends on prior knowledge and the context of the paper. It can also depend on the learning requirement. I think, elaboration, giving weights to each concept and relativity may be checked.
2xz82d4cjcw75kp	It will be interesting to know the level of consistency amongst the participant's extracted concepts.
g5zj3c93qk7qbbn	Took a bit too long.
n785m3u8b59jx7j	If it's not needed by the automatic extraction process shorter papers would have been nice :-)
jap8sxzqnzwp7rc	...
k8rv7u4c2kxrzc4	Very interesting, but also a little bit weird for persons who don´t have the adequate formation.
4rnsevfic3ahq4p	The papers were very long and partly difficult to read - the keyword already noted were a little distracting. The idea to evaluate the significance of extracted concepts is very good - it shows that during concept extraction possibly concepts which seem to be self-evident may be overlooked like for instance student or teacher.
a7p3mys54f3rzxm	The papers are long and difficult to understand for laity. This leads to difficulties in concept extraction.

Table 9.24: Results post-survey part 21

Token	What kind of difficulties have you met?
kp3n7mnghdt224q	The text "A Standards-based Modelling Approach for Dynamic Generation of Dadptive Learning Scenarios"" was too long and hard to understand."
wap6c7ih4vg5e3b	It was difficult to build ten suitable groups out of the keywords and to find expressive concepts for this groups.
rzm2rtp9a59hce8	being unaware of mastering a concept, then it is difficult to identify its keyword.
2xz82d4cjcw75kp	I didn't understand many of the acronyms used in the papers which made it difficult to gain correct understanding and thus extract all keywords.Developing concepts was at times difficult when working with the keywords out of context.
g5zj3c93qk7qbbn	The writing style of the second paper made it much harder to analyze it properly.
n785m3u8b59jx7j	None
jap8sxzqnzwp7rc	very time consuming, concepts can be completely different only by choosing another level of abstraction
k8rv7u4c2kxrzc4	Because of lack of knowledge in this field, it was only possible to get the big picture, therefor it was difficult to identify the concepts.
4rnsevfic3ahq4p	Grouping the words and finally forming concepts was a difficult task.
a7p3mys54f3rzxm	See answer above.

Table 9.25: Results post-survey part 22

Token	Did you use the proposed procedure?
kp3n7mnghdt224q	Yes, at least partly.
wap6c7ih4vg5e3b	Yes I followed the proposed procedure
rzm2rtp9a59hce8	yes
2xz82d4cjcw75kp	Yes.
g5zj3c93qk7qbbn	I more or less followed the procedure but with less formality.
n785m3u8b59jx7j	Yes
jap8sxzqnzwp7rc	yes
k8rv7u4c2kxrzc4	Yes, I tried.
4rnsevfic3ahq4p	Yes
a7p3mys54f3rzxm	Yes I tried.

Table 9.26: Results post-survey part 23

9.2 Case Study Printouts

In this section several printouts are added in subsequent order as follows:

1. Paper no. 1 to be read
2. Paper no. 2 to be read
3. Pre-survey printout
4. Post-survey printout
5. Kick off concept extraction proposal

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Creating Adaptive e-Learning Board Games for School Settings Using the ELG Environment

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Abstract: The use of digital games in education is well documented in the literature. They have been used in preschool, K-12, the university. A specific type of digital games is board games. Adding board games to the educational process can lead to an interactive stimulating learning experience. With a board game, players often learn from one another while at the same time having fun in a competitive environment. In this paper we propose the "ELG" game, an e-learning board game that adopts the basic elements of a racing board game but fosters students' creativity, problem-solving skills, and imagination as students are trying to reach the end by improving their performance in a variety of learning activities. The innovative feature of the ELG is that it offers an adaptive authoring tool that enables teachers to customize their games according to the needs, interests and motives of students. The teacher enters hierarchically categorized learning activities according to the learning goals of a course, sets the rules and assesses the learning progress easily and simply. Students participate in a discovery or exploration trying to reach the goals. After attaining them their level of activities is upgraded and they are challenged to reach the next learning goal. The dice in ELG is not randomized but controlled by the teachers in order that they can customize adaptive learning rules. The educational benefits of exploiting ELG in the learning process is that the teacher can define the levels of difficulty according to the students' needs and interests, facilitate and monitor the learning rate of each student, combine a variety of evaluation techniques, and address potential learning problems in a timely manner.

Keywords: Adaptive environments, Authoring tools, E-Learning, Game based learning
Categories: L.2.0, L.2.1, L.2.2, L.3.0, L.3.4, L.5.1.

1 Board Games in the Educational Process

The use of games in education is well documented in the literature (Prensky, 2001; Prensky, 2006). They have been used in preschool, K-12 and universities (Tanner and Lindquist, 1998; Bailey, Hsu, and DiCarlo, 1999; Games-to-Teach Team, 2003; Kiili, 2004; Gee, 2005; Burgos et al., 2007). One particular category of games is "board games". A board game is played by multiple players who move pieces across a premarked surface using counters or dice. Adding board games to the educational process can lead to an interactive learning experience (Helliar et al., 2000). With a board game, players often learn from one another while at the same time having fun in a competitive environment. It is also believed that students have a unique and fun opportunity to evaluate their own level of learning by identifying concepts not yet mastered while playing (Massey, Brown and Johnston, 2005; Hoffjan 2005).

The added value of games has been very accurately stated by Marc Prensky (2006):

- Games are a form of fun. That gives us enjoyment and pleasure.
- Games are form of play. That gives us intense and passionate involvement.
- Games have rules. That gives us structure.
- Games have goals. That gives us motivation.
- Games are interactive. That gives us doing.
- Games are adaptive. That gives us flow.
- Games have win states. That gives us ego gratification.
- Games have conflict/competition/challenge/opposition. That gives us adrenaline.
- Games have problem solving. That sparks our creativity and learning.
- Games have interaction among peers. That gives us social groups.
- Games have representation and story. That gives us emotion.

The current challenge for designers of educational games is to find ways to fuse educational content with the gameplay, so that students can solve authentic problems, engage in meaningful scientific, mathematic, or engineering practices, think creatively within these domains, and communicate their ideas expressively (Salen and Zimmerman, 2003). Thus the scope of this paper is to present the ELG, an authoring environment for creating and instantiating e-learning board games. Thus ELG is both a design and a runtime environment for learning board games.

The innovative feature of the ELG is that it offers an adaptive authoring tool that enables teacher to customize the game according to the needs, interests and motives of students. The teacher enters hierarchically categorized learning activities according to the learning goals of a course, sets the rules and assesses the learning progress easily and simply. Students participate in a discovery or exploration trying to reach the goals. After attaining them their level of activities is upgraded and they are challenged to reach the next learning goal. The dice in ELG is not randomized but controlled by the teacher in order that they can customize adaptive learning rules. The educational benefits of exploiting ELG in the learning process is that teachers can define the levels of difficulty according to students' needs and interests, facilitate and monitor the learning progress of each student, combine a variety of assessment techniques, and timely address potential learning problems. The structure of the paper is the following: in the next section we will present the main features of the ELG authoring environment that enables teachers to design an e-learning board game. Then we will present the ELG's architectural design in order to better illustrate how students learn while playing in an adaptive environment. Finally, we will present the main findings from a brief evaluation study that we performed with teachers who tried to design e-learning board games using ELG. The paper will end with a brief discussion about the main future research and development plans.

2 Designing Games with ELG

Eric Zimmerman (2006) rightly pointed out that "Everyone – both developers and educators – forgets this one: making games is really hard." [http://www.ericzimmerman.com/texts/learningtoplay.htm]. It is even harder for teachers who have basic computer skills and prefer spending their valuable time on creating learning material rather than writing scripts in programming language for creating a board game.

Although there are plenty of ready-made educational board games, to our knowledge there is no authoring environment for creating them in an easy and user friendly way. The ELG comes to fill this gap. ELG offers a user friendly authoring environment which allows a teacher to easily and quickly create an adaptive e-learning board game re-using learning objects, such as images, questions, self-assessment or inquiry-based learning activities. ELG is also designed to offer a run time environment that allows multiple users (i.e. learners) to play an e-learning board game and collaborate while trying to solve a given learning problem. It also allows the teacher to monitor the learning process and give feedback or advice to learners when necessary. A screen shot of an e-learning board game which runs within the ELG run-time environment is shown in Figure 1. It is an adaptation of the well known board game “Snakes & Ladders”.

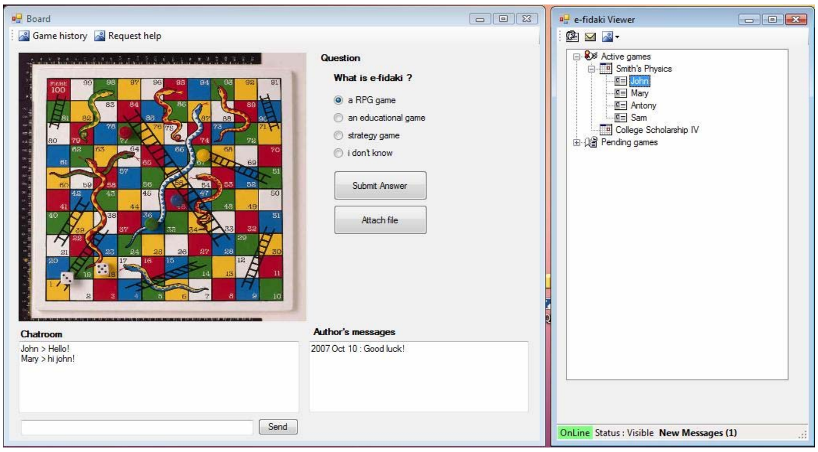

Figure 1: A screen shot of the ELG run-time environment

Today's board games should consist of colourful playing spaces rather than a classic grid of squares. Thus, it is important to allow a teacher-creator to customise the board according to his/her preferences, i.e. specifying the number of cells and adding any image that he/she likes on each cell or the background image that seems appropriate. ELG allows a teacher to do all these.

Moreover, an e-learning board game requires players to answer questions, some times arranged in a hierarchy ranging from most difficult questions to questions of intermediate difficulty, and then to questions of least difficulty. The players take turns by rolling the dice in their attempts to correctly answer the questions written on the question cards. The particular question card selected by each player as a result of his or her playing piece landing on a respective playing space corresponds to the question category for that question card set. It is the intent of each of the participants (i.e. the learners) in the game to be the first player to reach a specific end space located within the playing course and to correctly answer the question or questions on a question card selected from a predetermined question category.

With the ELG authoring environment, the teacher can specify the main elements of a board game, which are: i) the "board", i.e. the playing space; ii) the learning activities that will be presented to learners through the question cards, iii) the dice and iv) the rules that make a game adaptive. The ELG e-learning board game development process is shown in Figure 2.

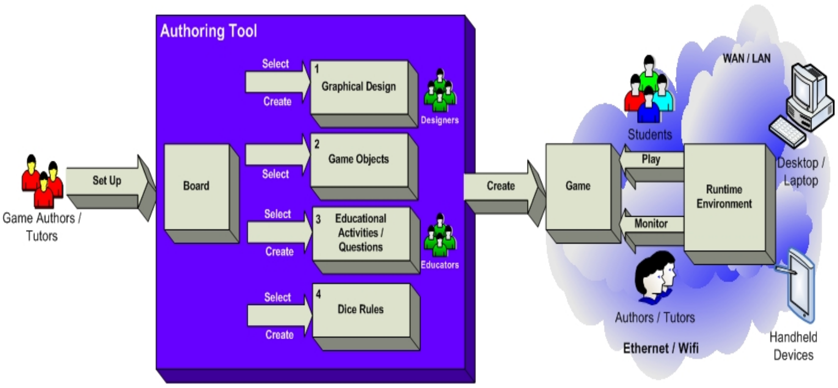

Figure 2: The ELG e-learning board game development process

Figure 3 shows a screen shot of the ELG authoring tool where the teacher adds meta-data for the game, i.e. title, course subject, educational level, etc.

Figure 3: Screen shot of the first step for creating an e-learning board game in ELG

3 Creating and Re-using Learning Activities

Students perform learning activities utilizing their knowledge and skills while a teacher is a facilitator of the learning process who intervenes when appropriate. A learning activity can be a close-type self-assessment item in the form of a multiple choice question, true-false, etc. It can also be an open-type assessment item where the student has to write a brief paragraph or create and submit a concept map, etc. The open assessment items are being assessed by the teacher while the close-type ones are automatically being assessed by the ELG runtime engine. The duration of a game can be more than a typical teaching session. Students can continue to play the game either at home or the next school days. A screen shot of the ELG authoring environment which allows a teacher to create new questions or search for existing ones is shown in Figure 4.

Each activity can be rated by the teacher as easy, intermediate or demanding according to its difficulty level. It can also be annotated according to a predefined set of categories, e.g. sports, literature and geography. The rating and annotation features allow the teacher to create a board game which could be adapted to the knowledge level and interests of the students. Moreover, the teacher can specify the feedback comments or the hints that will be shown to a student when he/she gives wrong answers to a given learning activity. For example, a teacher can allow the student to try again after having studied some online material.

The descriptive elements of the ELG activities are quite similar to the ones described in [Carro et al., 02]. Thus, an activity can be described by its *name*, its *type* ("multiple choice", "open question", "submission of a concept map", etc.), *learning goals per concept (*e.g. on the concept of "fractions", one learning goal is "Compare and order fractions"), *category* (sports, geography, etc), *difficulty level* (easy/intermediate/demanding).

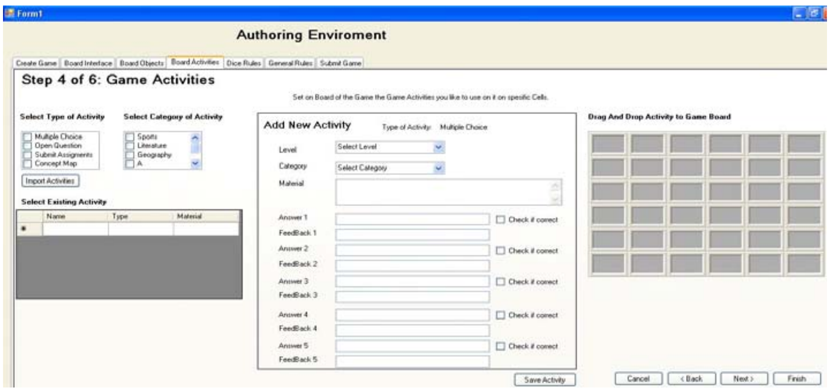

Figure 4: Creating Learning Activities via the ELG

Another innovation of the ELG is that the activities of a game are codified using the IMS QTI specification (IMS QTI, 2006) thus enabling ELG to interoperate with other IMS QTI compatible quiz tools. Thus a teacher could search at a repository with question items for adopting ready made questions to the game under development.

4 Adding Adaptivity

As already mentioned, the ELG allows teachers to add adaptivity into a game. In order to achieve adaptivity, the following elements are stored for each student:

a. *Student's Knowledge level*: Each student can be characterised as novice, intermediate or expert on a specific concept. The knowledge level is calculated at specific thresholds. For example if the score of a learner is greater than 85% at a specific activity or a set of activities then the student's knowledge level can be updated accordingly, e.g. change from novice to intermediate. As a result, the student will be asked to answer to questions of higher difficulty level.
b. *Student's interests:* information about the preferred categories of learning activities (sports, geography, literature, etc.). Having known the student's interests, the students will be called to answer questions that match his/her interests. For example, in the domain of maths, the math problem/activity that the student will be called to perform should be related to the student's favourite sport.
c. *Activity data per Student*: information like the questions that were tried, their difficulty, the hints used, etc.

Adaptivity can occur both when players are ahead (i.e. finding the game easy) and when they are behind (i.e. finding the game hard.) For example, when a player-student is behind the ELG could make navigation easier by decreasing the student's knowledge level and by giving the player more "power-ups," i.e. offering the player easier questions. When a player is doing well, and the game is becoming too easy, the ELG could automatically increase the student's knowledge level and offer the student more challenging learning activities.

The dice could also become a mechanism for adding customised adaptive learning rules. Apart from the usual randomised roll of the dice, the teacher could add the following rules (e.g. see Figure 5):

d. If a student has performed very well to a given activity (or set of activities), the dice could be "fixed" so that a player can roll high numbers. Thus, the teacher rewards the excellent performance.
e. On the contrary, if a student fails to solve a challenging activity or her learning scores are not very high, the dice could be "fixed" so that the student will roll low numbers.
f. Depending on a student's performance to one question or a set of questions, the dice could be "fixed" so that the player goes to special tiles on the board that could allow him to play once more or jump to other tiles.

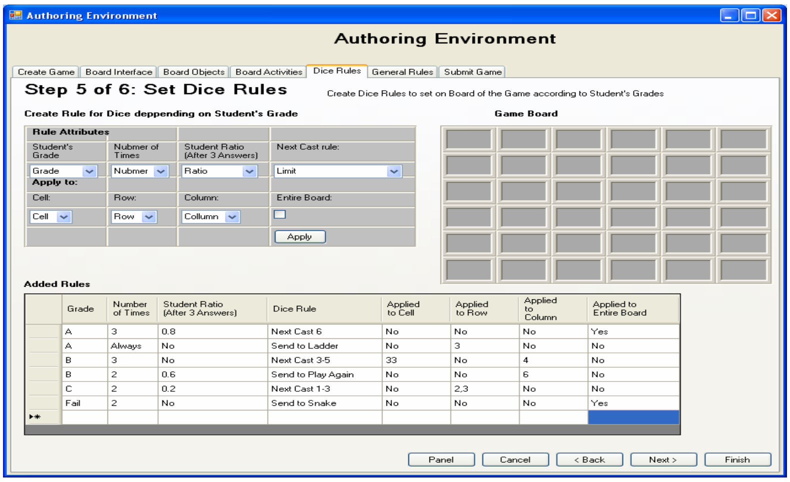

Figure 5: Adding Rules to an e-learning board game via the ELG

5 ELG architectural design details

The architectural decisions, which have been made when designing the ELG, allow students to play an e-learning board game almost anywhere and at any time. Learners and teachers may interact with each other through desktop-laptop PC's or PDA's and access the server side through Wifi or Ethernet protocols, while they are connected to LAN or WAN network. As shown in Figure 6, the main components of the ELG are: a Web server and an SQL server where data of the learning process (answers, scores, adaptive rules, students' profiles, etc.) are stored. During the execution of the game participants can exchange information -such as activity results or ideas about the problem solution- through a Mail and/or Media Server.

ELG relies on the latest web technology structures, offering a user friendly authoring environment combined with a powerful runtime engine implemented in Visual Basic .NET programming paradigm. It also takes advantage of the IIS mail server and Microsoft's media server in order to facilitate the communication between learners and teachers. For the graphical user interface Ajax technology has been exploited.

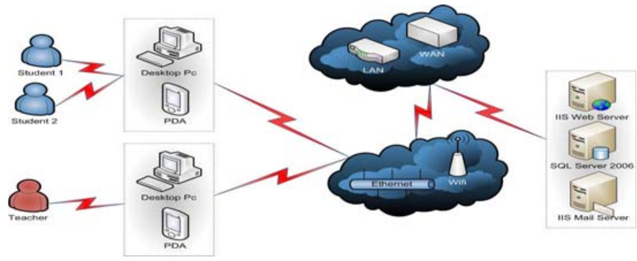

Figure 6: High level architectural deployment diagram of the ELG environment

6 Evaluation of the ELG

We performed a short term evaluation study with three school teachers. The main focus was on examining the ELG's added value from the teachers' point of view. At first, the ELG authoring capabilities and features were explained and exhibited to three (3) experienced in instructional design as well as motivated teachers (two from primary and one from secondary education) who have basic computer skills. The teachers had not any experience from using or designing educational games. All of them came from different schools and they wanted to try ELG at different subjects. Then we asked them to create independently a board game on a subject matter of their choice. Our main intention was to observe how usable teachers found the ELG authoring environment and how easy was to create add adaptation rules in their games.

It was extremely interesting and highly encouraging to find out that the three teachers developed challenging e-learning board games which had been comprised of various questions/learning activities of high quality. One teacher proposed a game for students of 7-9 years old. Her course concerned Mathematics in primary school and more specifically addition and subtraction with numbers from 1.000 to 10.000. Thus a game with learning activities about nutrients and calories in Mediterranean food was created. Another teacher tried to create an online version of the well known game about the European Union (original title: "L' Europe sur un plateau") scripted by Madeleine Deny.

The third teacher created a game that can be played at the new archaeological museum of Acropolis in Greece with the use of PDAs. As shown in Figure 7, she used the architectural blueprint of the museum as the background image of the playing space. She also designed learning activities which were related to each room of the museum. The students could give answers to either close-type questions or to open-type questions which required from the students to identify an object that holds specific characteristics (e.g. belongs to a specific period) and send its picture via an MMS.

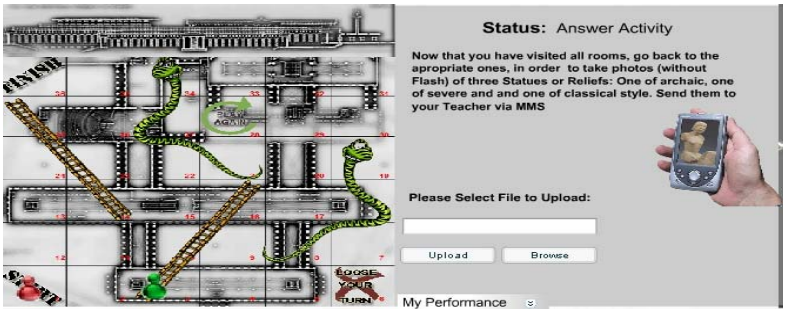

Figure 7: Example of a learning activity of a game which can be played outdoors, e.g. at the Acropolis archeological museum, with the use of PDAs

Moreover, we performed focus group interviews with the three teachers in order to gather their opinions about the usability of the ELG authoring environment. Each teacher explained to the other teachers the game and the rules that had been created. Teachers spent time on discussing about the types of the learning activities that had been designed for the needs of the games as well as the various rules that had been integrated into the games. There rules did not differ much. This is due to the fact that the teacher had been guided by the ELG authoring tool when creating them. When asked if they wanted more flexibility in creating other rules, the teachers answered that it was very helpful that they had been guided by the ELG's templates of rules for the needs of this step. On the contrary the types of learning activities, especially the open learning activities, that had been proposed differ a lot. This was inevitable since the educational level as well as the learning objectives of each game had been different.

After this first round of exchanging ideas about the games developed, teachers had been asked to comment on the usability of the ELG environment. Although there is no consensus on the heuristic criteria for evaluating the usability of educational game environments, Malone's (1992) heuristics seem to be the dominant ones. Thus we asked the teachers to express their opinion about

1. Content/Storytelling - The educational objective and content should be clearly stated in the game.
2. Interface Representations - A good game should map the learning activities to the interface actions and the learning concepts to interface objects.
3. Interactivity - A good game will always have gaming interactions that facilitate the mastery of the objective.
4. Challenge - A challenging game must have, as a goal, attainment which is uncertain and it should be personally meaningful and obvious or easily generated.
5. Feedback - Prompt feedback and rewards about the player's performance and progression should be provided.
6. Curiosity - A good game should have an optimal level of informational complexity. In other words, it should be novel and surprising but not completely incomprehensible.

7. Control - The game should offer a great deal of control to the player.
8. Mechanisms - Mechanisms for correcting errors and improving performance should be provided in the game.

This short evaluation revealed that the ELG authoring environment is usable because it grants teachers with freedom to apply their own creativity and teaching philosophy. Teachers could easily create games that could enable players to perform challenging learning activities which are associated with the objectives of the national curriculum. They believed that it was very easy to build a board game with an interesting and intuitive graphical user interface that allows players to proceed through the game smoothly. They also considered as very important the fact that they could customize and combine adaptive rules thus creating a challenging game. Although the idea of "fixing the dice" seemed very good, it was not clear to the teachers how to explain it to their students. Teachers mentioned that it is easy to predict how students would react when finding out that the game may be "fixed".

Teachers also appreciated that an ELG game can offer a great deal of control to the players who can also get prompt feedback from the teacher (or the game itself) when performing activities either alone or in collaboration with other fellow students. Finally, reusability of learning activities was considered a very important feature of the ELG authoring environment although they did not re-use any ready-made activity.

Of course, more exhaustive evaluation experiments in authentic classroom environments are needed to measure the quality of the board games that can be created via the ELG environment as well as to identify design and development weaknesses of the adaptation mechanisms.

7 Conclusions

Learning games, if used correctly, have the potential to add value to the traditional classroom-based instructional practices (Rotter, 2004; Van Eck, 2006). That is why it is so important that teachers have usable authoring tools to develop and deploy games. In this paper we presented the ELG which allows the teacher to easily create e-learning board games. Although there are very few board game authoring tools like the "Board Boss" by 5th Tradition Software, Inc., ELG is innovative because it allows teachers to easily create elearning board games. Since there is a genuine demand for personalization and scaffolding in e-learning systems (Cristea, 2007; Carro et al., 2004), adding adaptive features via usable mechanisms to board games similar to Trivial Pursuit, Monopoly, or Life can make the learning process highly stimulating.

The ELG is at a beta version which allowed us to evaluate its usability from teachers' perspective. We intend to further investigate what the students' experience will be, and how the interaction methods and metaphors of the games created with the use of the ELG authoring environment can best present content and motivate students to acquire knowledge and skills. We also plan to perform research and development on the interoperability between the ELG and the existing adaptive testing systems (Guzman, Conejo and Perez-de-la-Cruz, 07).

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A Standards-based Modelling Approach for Dynamic Generation of Adaptive Learning Scenarios

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Abstract: One of the key problems in developing standard based adaptive courses is the complexity involved in the design phase, especially when establishing the hooks for the dynamic modelling to be performed at runtime. This is particularly critical when the courses are based on adaptation-oriented learning scenarios, where the full eLearning cycle (design, publication, use and auditing) is considered. Based on the problems we experienced in developing such scenarios with a reusable, platform independent, objective-based approach in the aLFanet project we have established an alternative framework in the ADAPTAPlan project, which focuses on dynamically generating learning design templates with the support of user modelling, planning and machine learning techniques. In particular, in this paper we describe the problems we are tackling and how we are relaxing the design work by automatically building the IMS learning design of the course from a simplified set of data required from the course authors.

Keywords: Metadata and Learning, Learning Objects, Learning Activities, Learning Design, Semantic Web, Pedagogy guidelines, Educational standards, Design templates, Adaptive eLearning, User Modelling
Categories: H.3.5, H.4.2, H.5.4, J.7

1 Introduction

One of the more challenging tasks in developing the personalised learning paradigm is the authoring task. It has been the major bottleneck for decades, from the ad-hoc approach of traditional ITS to the current management of educational standards. However the development of adaptive learning systems has undergone considerable change over the last years. Initially there were research prototypes for developing adaptive learning environments but more recent efforts are focussed on providing general solutions focussed on extending existing educational standards to support adaptive course delivery addressing students' individual needs [Paramythis, 04]. In this respect, there have been two types of approaches. On one side there are those that provide intelligent solutions to cover different issues such as: intelligent testing [Guzman, 07], capturing and analyzing student actions to create collaborative tutors [Harrer, 06], rule-based adaptation with selection of stability [De Bra, 06], authoring of adaptive hyperbooks [Murray, 03], re-using educational activities through distributed servers [Brusilovsky, 04a], dynamic course generation through AI planning techniques [Brusilovsky, 03], etc. Furthermore, there have been several reviews that cover existing approaches [Brusilovsky, 03; Brusilovsky, 99; Cristea, 04; Brusilovsky, 04b]. On the other side, an alternative line of development is to incorporate, through the usage of educational specifications and standards (IMS, SCORM), adaptive processes into modern large-scale web based education, where current Learning Management Systems (LMS) are applied [Baldoni, 04; Boticario, 06].

All these developments are coping with a critical issue, which is to manage all the possible situations that may arise during the course execution, taking into account the diversity of learning materials, pedagogical models, learning styles and learning needs considered in the user model. Current educational specifications and standards (e.g., IMS family) assume that there is an ideal design scenario, where all required elements can be managed in the design time, or in highly-requested adaptive scenarios, some features can be integrated with runtime adaptations (e.g. dynamic grouping, adaptive information filtering and retrieval) as long as the adaptations are pre-defined at design time [Burgos, 06]. However, not everything can be specified in advance by the author because unexpected situations appear at runtime that cannot be predicted at design time [Zarraonandia, 06]. Furthermore, even knowing everything in advance does not suffice because of the management problems involved, i.e., describing all the existing possibilities and making the adaptation process sustainable over time. To tackle this open issue, our first approach was to set up a step-wise design process to support adaptive course delivery in an open LMS based on standards [Santos, 04a; Santos, 06]. Our experience shows that the design phase is experienced as a complex task, especially when the pedagogical requirements in the course flow can be affected by runtime adaptations [Boticario, 07a].

In the paper we briefly summarize the authoring approach implemented in aLFanet (widely disseminated in several fora) and present the on-going works in ADAPTAPlan, where we explore an alternative approach based on our previous experience in developing adaptive scenarios within current LMS. The ADAPTAPlan approach focuses on providing dynamic assistance to support the author in developing and modelling learning design tasks. The present proposal differs from other related course generation approaches based on planning [Brusilovsky, 03; Ulrich, 05] and asks the authors to focus on those elements that require their experience and expertise.

This paper extends [Boticario, 07b] -where the ADAPTAPlan approach was introduced- with further details and the results achieved up to now. First, we summarize the results obtained in the aLFanet project with respect to the authoring process as the basis upon which ADAPTAPlan derives. Second, we describe the standards-based modelling in terms of the user features and the device capabilities. Third, we present practical considerations regarding the applicability of the approach. Fourth, we describe how dynamic modelling can also benefit from this design to provide a contextual support at runtime. Finally, we present on-going experiments that focus on validating this approach.

2 aLFanet approach

The aLFanet project aimed at providing adaptive course delivery based on pervasive use of standards and several user modelling techniques in a multi-agent architecture

[Van Rosmalen, 05]. In particular, standards from the IMS Global Learning Consortium[1]: IMS Metadata (IMS-MD), IMS Learning Design (IMS-LD), IMS Content Packaging (IMS-CP), IMS Question and Test Interoperability (IMS-QTI) and IMS Learner Information Package (IMS-LIP).

Because adaptation is not an idea that can be plugged into a learning environment or into a particular component, but a process that influences the full life cycle of learning, aLFanet took into account a complex process of four interrelated steps: (1) design of the learning experience (based on objectives, learning activities, user profile and services), (2) administration (i.e., management of all data including users' roles, access rights and services configuration), (3) usage (i.e., actual use of designed activities on the learning environment within the class context), and (4) auditing (i.e., authors get reports on the actual use of course design, namely descriptions on how users have performed on learning activities, in order to adjust course design). In aLFanet the four steps can be formulated as learner driven tasks thanks to the combination of learning design and runtime adaptations [Boticario, 07b].

At design time, alternative learning paths (pedagogical models described in terms of IMS-LD) can be pre-coded for different types of users. The design created in IMS-LD contains the logic for the pre-designed adaptations and provides the hooks and the information upon which the runtime adaptation bases its reasoning. At runtime, the system adds two dynamic pedagogical situations to the former design adaptations that are recurrent in online courses and that can be detected from users' interactions: students with a lack of knowledge and students with high interest level. To this aLFanet builds on a system architecture described elsewhere [Santos, 05], which consists of a decoupled set of independent open source components available under the GNU GPL license: aLFanet LD and QTI Authoring Tools, Coppercore LD engine, aLFanet adaptive and interaction packages under the OpenACS/dotLRN community.

aLFanet has been evaluated at four different pilot sites and both strengths and weak points were detected [Boticario, 07a]. The most telling issue from the evaluation was that authors experienced the design phase as a very complicated task for two reasons: (i) the wide variety of elements to be described and the difficulties in controlling their interactions to successfully orchestrate an adaptive course work flow, and (ii) the state of development of the authoring tools themselves, which consisted of a QTI authoring tool to control adaptive features of questionnaires through the usage of metadata and a LD authoring tool for the specification of the learning design. Although several features were included in those tools, following the suggestions from the first evaluation in pilot sites (e.g., a dynamic tree generation for visualising a course tree), these features were not sufficient to deal with the complexity of the process for non-expert authors.

To lessen the workload of the authoring process we defined a four-step methodology that utilised design templates, which are widely accepted as a required support in the instructional design arena [Leshin, 92]. First, course materials were developed as a set of learning objects. Second, metadata were added to those learning objects in order to be properly used in the course. Third, instructional design (pedagogical support) guided by learning objectives was defined. Finally, the fourth

[1] IMS Global Learning Consortium: http://www.imsglobal.org/

step was to build an adaptive scenario for the course, which allows delivering the course, adapted to the individual learner needs, from the combination of design and runtime adaptations. The latter step is crucial to support the required adaptations provided at runtime. Its construction process consists of a sequence of steps with increasing levels of detail and possibilities for adaptation (differential, material and situated analysis), and it is described elsewhere [Santos, 06].

An important issue related to the aLFanet approach and the authoring problems detected is that this project represented an early adopter of educational standards (it started in the year 2002 when IMS-LD did not exist and its predecessor EML was our initial option), and therefore we had to develop our own architecture and authoring tools to support the full life cycle of learning and the adaptive features [Boticario, 07a]. Currently, some of those features are included in the open source OpenACS/dotLRN architecture, which we are using not only to manage the collaborative work of aDeNu research projects, but to support the research developments. The main advantages of using dotLRN LMS are 1) support for a wide range of educational standards (SCORM, IMS), 2) support for web services and 3) the accessibility of the provided services [Santos, 07a].

3 ADAPTAPlan approach

To tackle the aforementioned difficulties found in developing and modelling standards-based adaptive scenarios for current LMS we are exploring an alternative approach to provide dynamic assistance to authors, with the aim of helping them focus on those elements that require their experience and expertise. The ADAPTAPlan approach draws on utilising user modelling, planning and machine learning techniques to lessen the workload of the design phase in the previously described development of standards-based adaptive scenarios in current LMSs.

The general idea is to direct authors' attention to those elements they are used to manage and control in learning scenarios, like the specification of learning activities, temporal restrictions, evaluations, and not so much on a thorough description of alternative learning routes for different types of learners according to their features (i.e., learning styles, cognitive modalities, interest level, preferences…), which in any case are strongly dependent on learners' interactions and their evolution over time.

We differ from other course generation approaches in various ways. First, our approach relies heavily on a pervasive use of educational standards in current LMSs [Santos, 07a]. Therefore it is different to other ITS sequencing approaches that provide alternative descriptions for small-scale web-based education and research level systems [Brusilovsky, 03]. In particular we utilise IMS-LD as the top level driver of course workflows. This entails that authoring is supported by a high level specification to describe the teaching and learning process that is to be uploaded in standards-compliant LMS. Authors can describe roles, activities, basic information structure, communication among different roles and users; and all these using a pedagogical approach [Burgos, 06]. Furthermore, in IMS-LD the structure of the learning scenario is separated from the learning materials and services. Materials can then be reused within different scenarios. The scenarios can also be reused and new materials added. But first and foremost the driving force behind this approach is that through the IMS-LD specification authors have access to describing and implementing learning activities based on different pedagogies [Koper, 05], including group work and collaborative learning [Bote-Lorenzo, 04]. Therefore, as [Ulrich, 05] has pointed out, based on a structured sequence of learning objects and using different collections of tasks and methods that can be planned differently, this approach provides more enriched pedagogical descriptions than other course generation approaches, which are based on rules or provide access to learning materials via their metadata. Furthermore, it enables personalization (multiple roles can be involved and group or collaborative processes can be described) and more elaborate sequencing and interactions based on learner profiles (level B and C, which provide property manipulation), and therefore goes further than other related systems that consider providing the output as a sequence of learning objects in a similar structure to IMS-CP [Ulrich, 05].

Our proposal is also different from those that support IMS-LD authors in introducing corrective adaptations in the form of auxiliary specification files, which are constructed after an evaluation of the initial design on real users [Zarraonandia, 06]. Those approaches could cause additional problems in distance learning universities, where the monitoring process depends on tutors instead of the original authors. We are focussed on design issues and we argue that a critical problem is the specification of the workflow and corrections that could come up from the evaluation of the design on real users. At ADAPTAPlan, the author is requested to define the learning process in terms of objectives, learning activities, learning objects, educational services (i.e., forums, calendars, document storage spaces, etc.) and a set of conditions, initial requirements and restrictions in IMS-LD level B. Level B allows for modelling alternative learning itineraries, dynamic feedback, run-time tracking and collaborative learning [Bote-Lorenzo, 04].

ADAPTAPlan follows a step-wised approach combining user modelling, planning and machine learning techniques [Santos, 07b]. The process consists of 7 consecutive steps within a continuous loop intended to improve the adaptability and generalisability of learning routes (see figure 1):

1. The author provides the initial specification of course materials and modelling features (as described below)
2. From these requirements and the user model the planning engine generates a particularized learning route
3. The course learning route along with all the materials is loaded into the LMS
4. An extended version of the LD is provided with all the available resources so that if needed (step 5) replanning considers the course global picture
5. The planning engine provides a new plan when the original plan fails for that particular learner or the author has set up a stopping point (e.g., a general evaluation)
6. The planning engine guides the process with the new plan (step 5)
7. Every course execution is monitored and analysed in order to provide the required inputs for generating a general LD, which considers all the particular situations that took place. The new LD is expected to provide a better description of all the required particulars and can be further tested and extended with new course executions.

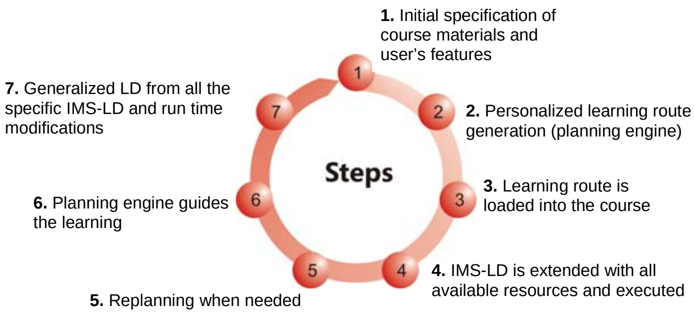

Figure 1: ADAPTAPlan step-wise process

Next, the specification requirements for courses are presented along with the work on a course from the ongoing education program at UNED (The National University for Distance Education in Spain).

3.1 Standards-based modelling of courses

Following the ADAPTAPlan approach, the author is requested to provide simple information about the course structure, pedagogy and restrictions that together with the user model can feed the planning engine to generate the personalized IMS-LD course suited to each learner. To deal with this approach, first we have identified the data to be filled in by the author for the planning engine. With these data an IMS-LD skeleton is built and stored as the course model. Next, the planning engine can use the user model (IMS-LIP and IMS Accessibility for LIP preferences) and the course model (IMS-LD skeleton) to generate the IMS-LD course design. These set of data is as follows:

- **Objectives**. The list of objectives to be worked on within the course is needed to link different design elements: contents, activities, resources, questionnaires.
- **Questionnaires**. To support the automatic creation of IMS-QTI questionnaires by the planning engine, a bank of questions has to be defined by the author. This task implies providing the following information for each question (item in IMS-QTI terminology): 1) text of the question, 2) possible answers, 3) correct answer, 4) score, 5) feedback for the right and wrong answers. Moreover, to dynamically create questionnaires from a large bank of items, each question has to be characterized by the following metadata: the objective, IMS-MD and Felder's features [Felder, 02] to identify for which type of users each item is more appropriate. Once the bank of items is defined, the name and questionnaire type (e.g. pre-knowledge, self-assessment, evaluation) have to be provided. Furthermore, the rules to dynamically build a questionnaire on the fly (according to the Selection and Ordering specification from QTI) have to be provided as well. This information comprises the number of questions to be included in a questionnaire and

how that number has to be selected from the bank of items. The later is provided in logical language (if-then clauses and logical operators).

- **Contents**. The course contents are external resources from the IMS-LD point of view. The course author has to provide the objectives where the contents are appropriate, and characterize them with Felder features and IMS-MD, as done with the questionnaire items above. Moreover, the location of the contents (local or external via URL) has also to be provided.
- **Services**. From the design point of view, services have to be independent of the LMS to be used at runtime. However, at design time the authors can provide the descriptions to allow their creation at publication time in any platform that supports that type of service. The idea is that different services are provided to perform different activities within the course. This information includes the title, the objectives (to be worked by the learners with that service) and the type of service, covering both traditional eLearning services such as forums and file folders, and collaborative ones such as the Logic Framework Approach [Santos, 04a, Santos, 04b].
- **Activities**. Here, the course author is only requested to provide the name, objective, wording, user roles involved and structural relations among activities (prerequisites, sequence and obligation). Specifying the structure for the activities and how they are related to course materials and services, the learner user model and even the interaction preferences is the most complicated task. However, if the course author has provided the previous information a planner can propose the structure for the activities part.

Finally, the initial course flow in IMS-LD is produced by the planning engine based on three data sources: (*i*) author information about the course structure, pedagogy and restrictions, (*ii*) characterized course contents and resources (i.e., teaching materials), and (*iii*) the expected results of the different questionnaires (tests on learning styles, cognitive modality and pre-knowledge test) and the evaluation of the modules performed by the learner in the previous modules' objectives (from the assessment questionnaires) (see figure 2). The generated IMS-LD formalizes the design of a learning process in a Unit of Learning (UoL) that is adapted to the individual learner's needs and can be executed in any standard-compliant LMS.

As can be seen in Figure 2, the specifications provided at design time are highlighted with thick arrows whereas those to be managed at run-time are shown in thin arrows. Moreover, since the novelty of this approach is based on the simplified specification of personalised learning scenarios we have not provided examples of how the different parts of an IMS-LD can be linked, which are illustrated elsewhere [Boticario, 07a].

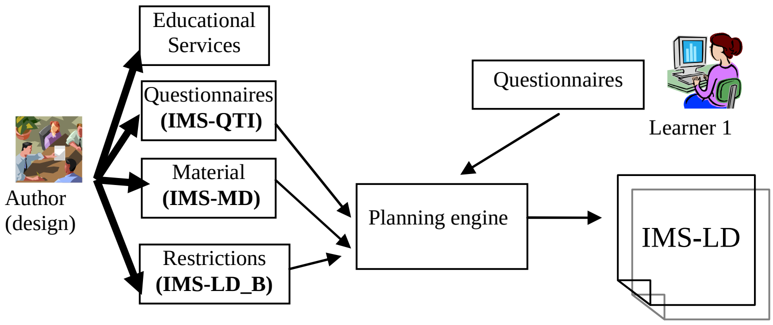

Figure 2: Initial course flow generation in ADAPTAPlan

3.2 User modelling features

From the initial experiences in different courses with the general approach previously described, in particular in an “Object Oriented Programming Course” (OOPC) and a course on “How to teach through the Internet” in the on-going education program at this university from year 2000 [Santos, 07c], we have come up with a more detailed specification of the user modelling features to be considered in the design phase. The current specification is intended to provide a wide-range of adaptation options to the planners, and consequently to the final IMS-LD.

The user modelling features that have been considered for designing the standards-based course are as follows [Baldiris, 08b]:

- **Learning Styles**. Keefe defines learning styles as the "composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment” [Keefe, 79]. From the practical viewpoint the Felder’s Model, which focuses on the ways people take in and process information [Felder, 96], has been chosen. Felder’s selected dimensions are “processing” (with a range of values from active to reflective; active/reflective), “perception” (sensory/intuitive), “input” (visual/verbal), and “understanding” (sequential/global). The learning styles are used to divide learners into different clusters, depending on Felder’s dimensions, and those clusters are managed as fuzzy sets. The details are described elsewhere [Santos, 07c]. Basically, the idea is to identify strong preferences for one category (e.g., 9 or 11 value for the “verbal” cluster within the input dimension) so that the learning process could improve its effectiveness with instruction and materials adapted to those preferences.
- **Knowledge Level**. It is assumed that students master knowledge as they progress in the learning process. To manage this evolution the six levels of knowledge defined by Bloom’s taxonomy [Bloom, 56] (Knowledge, Understanding, Application, Analysis, Synthesis and Evaluation), in

increasing order of competency have been modelled. The knowledge level of a learner with respect to those levels can take one of the possible values: novice, average or expert.

- **Collaboration Level**. Collaboration indicators can be obtained from learners' active interactions in the course services, such as forums, shared files, comments, ratings, etc. As in the knowledge level feature, six competency levels in increasing order have been considered. The proposed levels (non_collaborative, communicative, participative, with_initiative, insightful and useful) come from previous experiences in collaborative settings [Santos, 04b] and each level has three alternative values, i.e., low, medium and high. According to this, a student that "makes comments and contributions that are considered by other learners" is assigned the high value for the "useful_learner" level.

Moreover, the device capabilities have to be taken into account to produce an adapted response for the user in the current context. The W3C Composite Capabilities/Preference Profiles (CC/PP)[2] specification is used to manage the device capabilities. The user preferences regarding access device are also stored in the user model (in terms of accessibility preferences). In this way, ADAPTAPlan system is able to adapt the contents to the user's access context in a dynamic way. The access device profile can be queried through an external CC/PP User Agent Profile repository (from the Open Mobile Alliance[3]) to provide some adaptations: i) changes on the platform interface to be properly displayed on the device, and ii) selection of some learning objects according to the CC/PP profile associated with the learner access device from those previously selected according to pedgagogical crieteria [Baldiris, 08a].

3.3 ADAPTAPlan in practice

To actually implement the ADAPTAPlan approach course designers should take into account the following steps, which resemble the methodology defined in aLFanet:

1. Developing course materials: materials are to be defined as a set of learning objects: this includes creation of IMS-QTI assessments and learning objects for the course contents.
2. Identifying course services: services within environments which coincides with e-learning resources, i.e., forums, news, calendar, document area, bookmarks, FAQs, comments, surveys, etc. The management of services that can be attached to a learning activity includes users' roles, access rights and services configuration. The definition of this type of services within an environment to be used at runtime is illustrated elsewhere [Boticario, 07a].
3. Metadata tagging for course materials: contents, activities, resources and questionnaires (see above) should be linked to objectives. Resources can be characterized with the following features from IMS-MD:

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[2] W3C CC/PP specification: http://www.w3.org/Mobile/CCPP/

[3] OMA UaProf specification: http://www.openmobilealliance.org/tech/affiliates/wap/wap-248-uaprof-20011020-a.pdf

- Learning Resource Type: defining the didactic element allocated to the resource (exercise, simulation, table…)
- Format: setting the type of format to present the information (text, multimedia, graphic…)
- Density of Semantics: subjective measure of the descriptive character of the resource at hand. This points to the Felder's perception dimension so that the more descriptive is the resource the more appropriate for a sensitive learner; otherwise it better fits an intuitive one.
- Difficulty: identifying the expected knowledge level to deal with that specific resource.
- Interactivity level: describes the degree of interactivity associated with the resource.

Apart from the above IMS-MD features that are to be defined at design time, we have identified specific features from the users' interactions that can be used in runtime adaptations. In particular, comments, ratings and categories.

Moreover, the knowledge level is always associated with an objective within the course. It may be the global goal of the whole course, the partial goal of a chapter or section of the course, or at a lower level of granularity, the operational objective of an activity or task to be done during the course.

4. User profile modelling: defining the IMS-LD properties to model the different types of users provides the basic features that support adaptations, which are to be considered by the planning engine (see figure 2) to generate the personalized course workflow. The user profile is a combination of IMS-LIP and IMS-AccLIP that defines the profile of the user together with and IMS Reusable Definition of Competency or Educational Objective (IMS RDCEO). In more detail:
   - IMS-LIP: provides the general framework to define the general user characteristics, such as identification, goals, certification and licenses, acquired competencies, interests, etc. It can be linked to other specifications like IMS-RDCEO, which defines the user competencies. In particular, to drive adaptations we have considered Felder's Learning Styles, Knowledge Level based on Bloom's Taxonomy and the Collaborative Competency Level (see above).
   - IMS-AccLIP: an extension of IMS-LIP that considers the users preference regarding accessibility. IMS-AccLIP modifies the <*accessibility*> element in IMS-LIP, by removing the <*disability*> element and by addition of the <*AccessForAll*> element in this label. This new element considers information about how the materials are displayed, how the learner interacts with the system and the learner's preferences about the content.
   - IMS-RDCEO: a minimalist but extensible XML data model to define competencies or learning objectives. With this model it is possible to achieve a clear definition of competencies. It does not adjust to any particular curricular model and depending of the

author different characteristic elements of the competency can be considered. Each UoL in a LD refers to objectives that can be associated with an IMS-RDCEO competency definition. A learning object could be classified to contribute to a competency, referring from the *<classification>* element to a competency model, and relating IEEE LOM with IMS-RDCEO.

The learning style is something inherent to the learner, and the knowledge level is the knowledge acquired by a learner as regards a competency or instructional objective.

The collaborative competency level has to be promoted for each student in the context of a course. Actually, that level considers the participation inferred through the interaction data (obtained from forums, chat and other collaboration tools) and the access frequency of the user in a specific course [Baldiris, 08c].

In order to facilitate the planning engine task of providing resources to students according to their learning styles a table of correspondences, based on previous related work [Peña, 04; Karagiannidis y Sampson, 04], has been proposed. That table establishes links between every learning dimension (e.g., processing) and style (e.g., active), and the different resource types (e.g., experiments), which are valued amongst three possible alternative values: “very good”, “good”, and “indifferent”. Thus, “Very good” represents a high value of a particular resource (e.g., simulation) for a given dimension (e.g., highly visual), whereas a middle value corresponds to “indifferent”. Therefore, that table provides a clear specification of the types of resources for each learning style. For instance, an active (processing), intuitive (perception), global (understanding), and visual (input) learner can be provided by simulations, diagrams, figures, graphs, slides, and experiments as resource types. The details related to that table are described elsewhere [Baldiris, 07; Baldiris, 08b]. Moreover, examples of definitions that illustrate how to model the above elements in their corresponding specifications can be found in [Baldiris, 08b].

3.4 Dynamic-based modelling in ADAPTAPlan

As in aLFanet, ADAPTAPlan covers the full life cycle of learning (design, publication, use and auditing), which means that the specification of courses previously described represents just the design time issues but there are other features to support the run time of learning scenarios. While interacting with the system the learner is supported by a recommender system and the planning engine when needed. The latter takes control for replanning when the execution of the automatically generated course work flow (IMS-LD) reaches a blockage for whatever reason (e.g., the learner cannot meet a course milestone or get stacked in a particular learning activity) (see figure 1).

A multi-agent architecture is in charge of providing a continuous monitoring process of learner’s interactions, learning some modelling features with machine learning techniques and providing recommendations to learners [Santos, 07c]. Actually, one of the lessons learned from the aLFanet project [Boticario, 07a] is that personalized learning flows do not suffice and learners tend to feel stress and lack of support when facing sequences of learning activities with their corresponding exercises and tests. To mitigate this problem and cope with unforeseen situations at design time we are applying a recommender system that is intended to provide the more appropriate recommendations amongst the available ones. The recommendation strategy decides internally the final recommendations from the pool of generated ones, taking into account the learning context provided by the IMS-LD and the user's interactions. To that end the recommender system follows a hybrid approach based on a multi-agent architecture which offers the flexibility for combining different recommendation techniques, collaborative filtering and content-based techniques [Santos, 08a]. Furthermore, several relevant factors have been detected to classify recommendation types (motivation, platform usage, collaboration, accessibility, learning styles and previous knowledge) so that they can be prioritized depending on the particular situation within the course (e.g., give priority to collaborative recommendations within a collaboration stage) [Santos, 08b]. The recommendations are provided through a new recommendation portlet that has been integrated in the dotLRN platform (see figure 3).

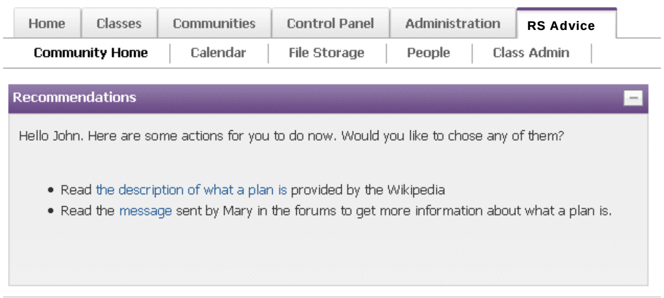

Figure 3: Recommendation portlet integrated in the dotLRN platform

The global system architecture to support dynamic features, called ADA+, consists of different intelligent agents that carry out diverse tasks. Some of these agents provide adaptation tasks using machine learning techniques in order to support 1) the user modelling (e.g. the Collaborative Competence Adapter) and 2) the adaptation process itself (e.g. the Learning Style Adapter). Other agents carry out integration tasks such as the Yellow Pages Agent and the Communicator agent. The Main Adapter is the principal adaptation process. It uses data provided by all the other agents and planning techniques to generate an IMS Learning Design adjusted to the user characteristics. The process for constructing learning routes and the details of the architecture are described elsewhere [Santos, 07c; Baldiris 08b; Baldiris 08c]. In this section we focus on describing how the adaptive features enrich the dynamically generated course design.

From the user model features described so far we have focussed on dynamically updating the following items:

- **Knowledge level**. The knowledge level is dynamically acquired through the analysis of learners' interactions with the learning objects and activities, and the evaluation results obtained from tests, questionnaires or other evaluation tasks.

- **Collaboration competency level**. The collaborative model is developed using database information about the learner's interaction in the collaborative tools. Data is pre-processed and the EM algorithm has been applied to generate users' clusters with similar collaboration behaviours [Baldiris, 08a]. Depending on the student's collaboration level the system can facilitate the generation of recommendations to encourage collaboration when needed.
- **Resources and learning styles**. The initial table of the types of resources more appropriate for each learning style (see above) can be adjusted according to the continuous monitoring process of learners' interactions and the machine learning tasks that have been defined. The process is described elsewhere [Baldiris, 08a] and consists in learning how each resource type addresses each learning style according to the given scale: very good, good or indifferent. To this, the system relies on the interaction traces that show the types of objects that have been chosen by a particular learning style cluster.

3.5 Ongoing experimentation activities

For the experimentation phase, we have created a course to be tested at UNED pilot site following the ADAPTAPlan approach, adapted from a course on "How to teach through the Internet" taught in the on-going education program at this university from year 2000. This course has already been designed following the aLFanet approach [Boticario, 07b]. Now, to comply with the ADAPTPlan proposal, we provided the above simplified information for the course. We took existing contents (point 1 from section 3.3), identified the required services, i.e. forums, FAQs, file storage area (point 2), tagged the resources and associated them with the corresponding learning objective (point 3), and selected the relevant user features to be considered (point 4).

Moreover, the ADAPTAPlan approach has also been applied to an "Object Oriented Programming Course" at Universidad de Gerona (another project pilot site) focussed on basic Object Oriented Programming topics such as object, class, inheritance, polymorphism, and encapsulation. The definitions of these concepts were done by experts in the subject. In the course, learning objects are organized by media type (e.g. sounds, graphics, text, and animations) in order to address the different learning styles of the student [Santos, 07c].

Actually, project partners focussed on planning issues have made progress in different areas to support the ADAPTAPlan approach, such as obtaining full HTN planning domain from learning objects repository [Castillo, 07a], developing a general planning formalism based on constraint programming and adapt it to an e-learning setting [Garrido, 07], including an expressive language for integrating existing protocols and a rich set of temporal constraints to deal with the specific domain of distance learning [Castillo, 07b], defining a new approach for case-based planning that is being applied to solve uncertainty factors when generating the plan [de la Rosa, 07].

4 Conclusions and future work

In this paper we have described design issues of a dynamic assistance approach for developing and modelling standards-based adaptive scenarios for current LMSs. In particular, we describe the problems we are tackling (from our past experience in the aLFanet project) and how we are relaxing the design work by automatically building the IMS-LD of the course from a simplified set of data required from the course authors (objectives, questionnaires, contents, services and activities). This approach is being carried out in the ADAPTAPlan project and has already been applied in an existing course from the on-going education program at UNED and in an “Object Oriented Programming Course” (OOPC) at Universidad de Gerona.

Our initial experiences have shown that course authors are much more predisposed to provide this set of information via a web-based interface rather than defining the whole IMS-LD design. In fact, with the existing contents from the course on ‘How to teach through Internet’ we have developed the corresponding IMS-LD applying both aLFanet and the ADATAPlan approaches. On the former, there were too many issues to focus on while doing the design (even applying the methodology provided) and it was very easy to get lost in the design process, increasing the time spent on it. However, the ADAPTAPlan approach helps to focus on the important elements. Even without applying the planning engine, it is easier for authors to come up with a more detailed design than following the aLFanet approach. What is more, it is technically possible to define a mapping between the IMS-LD structure and the planners’ language defined in terms of properties, predicates and conditions. Bearing in mind the UNED pilot site, the next steps are to compare the output provided by different planners with the original IMS-LD design that we have built from the authors’ set of data provided. Evaluations with more end-users are also planned for the third year of the ADAPTAPlan project.

It is important to note that the design of adaptive scenarios is still a complicated task. As shown in this paper, to support the automatic generation of a personalized IMS-LD a wide range of modelling features have to be provided. We expect that the development payoff comes from the reiterative application of the approach on courses with a significant number of students with varied profiles. This takes place in open courses (ongoing education program) at UNED, where the lifelong paradigm is actually implemented with students who are 30, 40 or 60 years of age or even older. This foresight has to be validated over the coming years since this is the first time the current open course “How to teach through the Internet” has been modelled according to the ADAPTAPlan approach.

Furthermore, the reusability and flexibility of the approach is based on the usage of standards-based educational scenarios and open LMSs to describe and manage all the required information, and on a multi-agent architecture that interoperates with the LMSs by means of web services. This architecture offers the flexibility for combining different recommendation techniques, including collaborative filtering and content-based techniques, as it is described elsewhere [Baldiris, 08c].

Finally, we claim that the combination of techniques that are being applied in ADAPTAPlan have a particular interest since they can be considered an instance of a general type of problem focussed on providing personal assistance to users in terms of combining planning and user modelling techniques, as it is shown in a system for planning tourist visits [Castillo, 08] .

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Pre-Survey referring the Concept Extraction Case Study

The aim of this survey is to gather data for validating an automatic concept retrieval process. Therefore manual concepts have to be retrieved from the provided papers taken from a JUCS Journal.

Thank you very much for your participation in this case study.
It shouldn't take too long.
Have a lot of fun.

There are 8 questions in this survey

Privacy Policy

According to our privacy policy all collected data will be made anonymous and only used for research purposes. Personal information is never transferred, disclosed or otherwise shared with third parties. Anonymous data may be reused or shared for further studies.

1 [PP_Agreement] Do you accept the privacy policy displayed above? *

Please choose **only one** of the following:

Yes

No

General Information

To be able to rate the results appropriately answers to the following questions are appreciated .

2 [GI_Gender] Gender *

Please choose **only one** of the following :

- Female
- Male

3 [GI_Age]Age: *

Please choose **only one** of the following :

- < 18
- 18 - 29
- 30 - 39
- 40 - 49
- 50 - 59
- 60 - 69
- >= 70

4 [GI_Edu]Highest level of education: *

Please choose **only one** of the following :

- Compulsary School
- High School
- University (Bachelor, Master)
- University (Phd or higher)
- Other

5 [GI_Area_of_expertise]What is your area of expertise? *

Please write your answer here:

6 [GI_Concept]Please try to explain the term concept in your own words. Illustrate that by an example. *

Please write your answer here:

7 [GI_Finding_steps]How would you extract concepts? Please try to describe the procedure. *

Please write your answer here:

8 [GI_SelfAssessment]Please assess yourself in the field of concept extraction. *

Please choose **only one** of the following:

- unexperienced
- some experience
- advanced
- expert

Thank you very much for your participation and we wish you a lot of fun in reading the papers and extracting concepts.

01.01.1970 – 01:00

Submit your survey.
Thank you for completing this survey.

Post-Survey referring to the Concept Extraction Case Study

At first we want to thank you for the hard work you have done. We appreciate this very much.

In this post-survey, the results of your work are prompted. Therefore please have all your results on hand to be able to finish this survey quickly.

There are 22 questions in this survey

Privacy Policy

According to our privacy policy all collected data will be made anonymous and only used for research purposes. Personal information is never transferred, disclosed or otherwise shared with third parties. Anonymous data may be reused or shared for further studies.

1 [PP_Agreement]Do you accept the privacy policy displayed above? *

Please choose **only one** of the following:

Yes

No

Questions regarding the first paper

In this group results are gathered for evaluating the document "Creative Adaptive e-Learning Board Games for School Settings Using the ELG Environment".

2 [P1_time1] How long did it take you to read the document and to extract keywords? Please enter the value in minutes. *

Please write your answer here:

3 [P1_time2]How long did it take you to extract concepts out of the retrieved keywords? Please provide the value in minutes. *

Please write your answer here:

4 [G1_Q1_Readability]The paper was difficult to understand. *

Please choose **only one** of the following:

- Strongly disagree
- Disagree
- Agree
- Strongly agree

5 [G1_Q2_Summary]Try to summarize the paper in two sentences. *

Please write your answer here:

6 [G1_Q3_Keywords]Please fill in the retrieved keywords separated by comma. *

Please write your answer here:

7 [G1_Q5_NumTop]In your opinion how many top ranked concepts are sufficient to describe the paper? *

Please write your answer here:

8 [G1_Q6_TopRanked]Please enter 10 retrieved concepts starting with the most significant in descent order. *

Please write your answer(s) here:

Concept 1	
Concept 2	
Concept 3	
Concept 4	
Concept 5	
Concept 6	
Concept 7	
Concept 8	
Concept 9	
Concept 10	

Questions regarding the second paper

In this group the questions regarding the paper "A Standards-based Modelling Approach for Dynamic Generation of Adaptive Learning Scenarios" are stated.

9 [P2_time1] How long did it take you to read the document and to extract the keywords? Please enter the value in minutes. *

Please write your answer here:

10 [P2_time2]How long did it take you to extract concepts out of the retrieved keywords? Please provide the value in minutes. *

Please write your answer here:

11 [G2_Q1_Readability]The paper was difficult to understand. *

Please choose **only one** of the following:

- Strongly disagree
- Disagree
- Agree
- Strongly agree

12 [G2_Q2_Summary]Try to summarize the paper in two sentences. *

Please write your answer here:

13 [G2_Q3_Keywords]Please name the retrieved keywords separated by comma. *

Please write your answer here:

14 [G2_Q5_NumTop]In your opinion how many top ranked concepts are sufficient to describe the paper? *

Please write your answer here:

15 [G2_Q6_TopRanked]Please enter 10 retrieved concepts starting with the most significant in descent order. *

Please write your answer(s) here:

Concept 1

Concept 2

Concept 3

Concept 4

Concept 5

Concept 6

Concept 7

Concept 8

Concept 9

Concept 10

Questions regarding the two papers treated as one.

16 [G3_Q2_NumTop]In your opinion how many top ranked concepts are sufficient to describe the papers? *

Please write your answer here:

17 [G3_Q3_Concepts]Please enter 10 retrieved concepts starting with the most significant in descent order. *

Please write your answer(s) here:

Concept 1	
Concept 2	
Concept 3	
Concept 4	
Concept 5	
Concept 6	
Concept 7	
Concept 8	
Concept 9	
Concept 10	

Questions regarding a third paper

18 [G4_Q1_Concepts2Paper]Please assign the retrieved concepts to the correct paper.

In this question you will be presented with the title and a short summary of three papers. After that a number of concepts will be shown and you will be asked to determine from which of the previously presented papers they have been extracted.

Paper A:

Title:
A Spiral Model for Adding Automatic, Adaptive Authoring to Adaptive Hypermedia

Abstract:
At present a large amount of research exists into the design and implementation of adaptive systems. However, not many target the complex task of authoring in such systems, or their evaluation. In order to tackle these problems, we have looked into the causes of the complexity. Manual annotation has proven to be a bottleneck for authoring of adaptive hypermedia. One such solution is the reuse of automatically generated metadata. In our previous work we have proposed the integration of the generic Adaptive Hypermedia authoring environment, MOT (My Online Teacher), and a semantic desktop environment, indexed by Beagle++. A prototype, Sesame2MOT Enricher v1, was built based upon this integration approach and evaluated. After the initial evaluations, a web-based prototype was built (web- based Sesame2MOT Enricher v2 application) and integrated in MOT v2, conforming with the findings of the first set of evaluations. This new prototype underwent another evaluation. This paper thus does a synthesis of the approach in general, the initial prototype, with its first evaluations, the improved prototype and the first results from the most recent evaluation round, following the next implementation cycle of the spiral model [Boehm, 88].

Paper B:

Title:
Machine Learning-Based Keywords Extraction for Scientific Literature

Abstract:
With the currently growing interest in the Semantic Web, keywords/metadata extraction is coming to play an increasingly important role. Keywords extraction from documents is a complex task in natural languages processing. Ideally this task concerns sophisticated semantic analysis. However, the complexity of the problem makes current semantic analysis techniques insufficient. Machine learning methods can support the initial phases of keywords extraction and can thus improve the input to further semantic analysis phases. In this paper we propose a machine learning-based keywords extraction for given documents domain, namely scientific literature. More specifically, the least square support vector machine is used as a machine learning method. The proposed method takes the advantages of machine learning techniques and moves the complexity of the task to the process of learning from appropriate samples obtained within a domain. Preliminary experiments show that the proposed method is capable to extract keywords from the domain of scientific literature with promising results.

Paper C:

Title:
Formal Representations of Learning Scenarios: A Methodology to Configure E-Learning Systems

Abstract:
Nowadays, advanced E-Learning systems are generally pedagogy-aware. Commonly, these systems include facilities for defining so-called learning scenarios that reflect sophisticated pedagogical approaches such as collaborative writing or project-oriented learning. To support different learning activities from such scenarios the technological infrastructure of these systems must be appropriately adjusted and configured. Usually, this configuration process is laced with a number of difficulties. Most of these difficulties are caused by the fact that scenario capturing is achieved through informal user-developer dialogues. Typically, the result of such informal dialogues contains inconsistent and incomplete information because of misunderstandings and the complexity of the interactions within a

scenario. Consequently, the configuration of the system is suboptimal and a number of iterations are required in order to achieve better results. In this paper an approach to improve this situation is presented. This approach is based on a general formal representation model for describing learning scenarios. A particular formal description of a concrete learning scenario is obtained through a user dialogue with a wizard tool. At the next step, this formal description might be automatically processed to facilitate configuration process. The paper is concluded with some experiences gained by applying this approach in two E-Learning projects.

Below you can find the set of automatically retrieved concepts concerning one of the 3 abstracts above:

collection
learning goal
subtype
application
learning scenario framework
training
student idea
session
scenario structure
generalization

Please choose the paper you are thinking is the correct one that matches the extracted concepts above? *

Please choose **only one** of the following :

- Paper A
- Paper B
- Paper C

Evaluation of automatically extracted concepts

What do you think about the extracted concepts named as follows. They have been automatically retrieved out of the paper "Creative Adaptive e-Learning Board Games for School Settings Using the ELG Environment". These concepts were post-processed by a person only by deleting unnecessary concepts. Please assess them regarding their significance.

19 [G5_Q1_SigProp]Please evaluate the significance of the following concepts on a scale from 1 to 4, where 1 depicts a very low significance value and 4 the highest possible value. *

Please choose the appropriate response for each item:

	very insignificant	insignificant	significant	very significant
student				
environment				
dice				
paper				
board				
knowledge				
customise				
user				
museum				
adaptivity				

General questions.

20 [G6_Q1_Experiences]What are your overall comments concerning this case study? *

Please write your answer here:

21 [G6_Q2_Difficulties] What kind of difficulties have you experienced? *

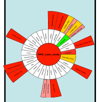
Please write your answer here:

22 [G6_Q3_Procedure]Did you stick to the proposed procedure? If not please tell us your reasons and the chosen procedure. *

Please write your answer here:

You have completed the survey. Thank you very much for your participation and if you are interested in our results we would like to recommend the following website.
01.01.1970 – 01:00

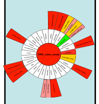
Submit your survey.
Thank you for completing this survey.



Appendix regarding the Case Study concerning Manual and Automatic Concept Retrieval

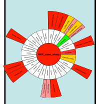
How would you characterize the term concept?

Emanuel Reiterer
Graz, Technical University, Austria
Christian Gütl
Graz, Technical University, Austria
Curtin University, Perth, Australia



Background Information

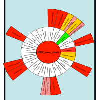
- Please read this information carefully
- Content
  - A short overview about our work
  - Concept definitions



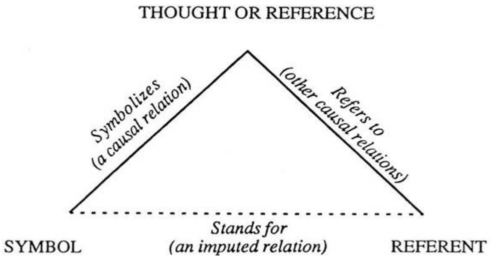
Automatic Concept Retrieval Tool Rubrico
Project Goals

- Retrieve Concepts out of electronic data
  - Supported formats are pdf, txt, html
  - Intended for use in automated essay grading
    - Concepts are extracted automatically with human support
    - These concepts are then transformed into assessment rubrics
    - The automatically built rubrics, among other information will then assess essays automatically
- To support our results with a case study
  - Helpful for the development of new requirements for further development
  - Achieved by
    - Retrieving concepts by using different combinations of concept retrieval algorithms
    - Analyzing these concepts by mapping them to manual retrieved ones

Concept Definition 1/2

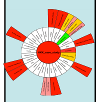


- Several definitions are available
  - Set of words related by a meaning
  - Concepts can also be described by Sense and Reference, Meaning, or Denotation
    (Frege 1892)
    - Sense and reference are two different aspects of the significance of an expression
    - Reference: Bearer of the name. Object in question.
    - Sense is associated with a complete sentence. It is the thought that expresses the object. This can also be seen as a concept.



Semiotic (Meaning) Triangle
(Sowa 2000)

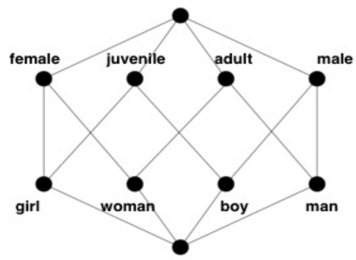
Concept Definition 2/2



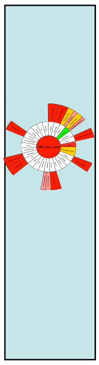
Concept Definition through Formal Concept Analysis (Rudolf Wille 1982)

- Galois Connection
  - Formal Object (girl, woman, boy, man)
  - Formal Attribute (female, juvenile, adult, male)
- Concept is described through
  - Extension: set of formal objects of a formal concept
  - Intension: set of formal attributes related to the Extension
- Visualized by Concept Lattices

	female	juvenile	adult	male
girl	x	x		
woman	x		x	
boy		x		x
man			x	x



Concept Latice Example (Priss 2007)



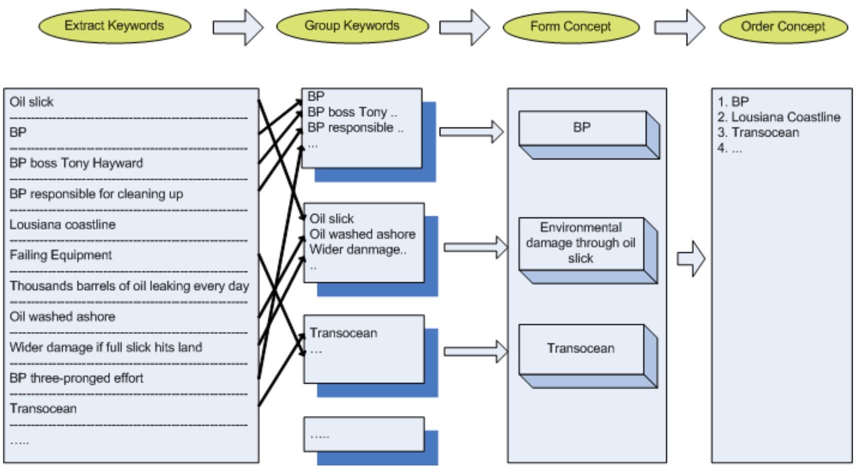
Manual Concept Retrieval Proposal

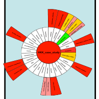
- The next slides describe a proposal for retrieving concepts manually
- Please keep in mind that this is just a proposal and if you prefer to use a different procedure feel free to do so

Manual Concept Retrieval

Manual concept retrieval proposal:

1. Read the text
2. Extract keywords
3. Group keywords
4. Form concepts
5. Order concepts

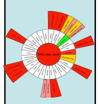




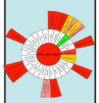
Manual Concept Retrieval for a combination of documents

2 proposals for retrieving concepts out of a combination of documents are depicted below:

- First approach
  1. Unify the set of concepts that were retrieved out of each document
     1. Take all retrieved concepts
     2. Remove duplicates
  2. Rank the retrieved set of concepts
- Second approach
  - Unify the extracted keywords and repeat the steps depicted in the last slide excluding the first 2.



Thank you for your attention and for participating in the case study



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