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INTEGRATION OF INFORMATION TECHNOLOGY FOR INTERACTIVE LEARNING: OOP USING C++ COURSE CASE STUDY

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ABSTRACT: E-learning grows rapidly and it draws the attention to an important shift in the educational paradigm. This research tries to propose and design an intelligent e-Learning environment for students in which classification techniques and user profiles play the role of an automatic interactive classification system. This system will simplify the task of finding the learning materials and related topics. Our research discusses how specific concepts of the theories of indexing, classifying, retrieving and consultation of a collection of learning materials based on student profiles might support various instructional functions of e-Learning. In this research, we conduct an experiment that carried out on educational materials for C++ Language. Such an experiment has very special features, which make it different from other approaches by using thesaurus as a tool for classification. It is important to evaluate the effectiveness and efficiency of our approach. The experimental results illustrate an overall performance of classification techniques, having 88% of correctly classified.

Keywords: e-Learning, classification, thesaurus, interactivity

1. INTRODUCTION

Information and Communication Technology is changing our life, the way we communicate, the way we create, transmit, access, and use of information and knowledge. The rapid changing of Information and Communication Technology is highly influencing the higher education especially significant for our research and academic institutions, colleges and universities. Information and Communication Technology has extended students´ possibilities to enhance learning and has given them unprecedented and immediate access to up-to-date information from all over the world.

This study focuses on a case study involving classification of the learning materials based on thesaurus and the classification techniques. We describe the architecture of the system, function, mechanism and finally show some preliminary system evaluation. The students can easily locate learning materials by using our system. The system is a flexible self-learning environment for the student, and at the same time a collaborative communication environment, to support mutual deep and effective understanding between students. In this environment, a student should be able to choose the most appropriate learning materials. S/he can select and learn the contents (general or narrow topics) that s/he desires.

In the following, we first give an overview of previous work. In section 3 we discuss how we can use thesaurus in education, In Section 4 we give an overview of the System. In section 5, we present a case study for the course OOP in C++ with an experiment and evaluation. We tested the indexing and classification functions using a collection of learning materials developed for an online course for Avicenna project at Al-Quds Open University. Finally, Section 6 is the last section and presents the conclusions.

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1.1. Literature Survey

Many studies have been addressed and examined by several researchers in order to improve the implementation of interactivity and management of online learning materials through e-learning management systems. Each study focuses on a special technique as an application for e-learning management systems. In what follows, a brief discussion is presented for some related work achieved in this respect.

Research by Salam (2103) describes a web-based Intelligent Tutoring System (ITS) framework. The model consist of two parts user environment and pedagogical environment. The system uses ontologies as domain knowledge to improve the sharing and reusing of teaching materials. His paper attempts to emphasis the importance of intelligent tutoring system by confirming the effectiveness of tutorial programs based on artificial intelligence for developing web-based learning communities.

The intention of Abu Naser (2008) research was to develop an intelligent tutoring system called CPP-Tutor for helping students to learn how to program in C++ language. Results show that the students learned the concepts of programming more quickly and effectively compared to students learned the same concepts using traditional methods of teaching.

Aggeliki (Aggeliki,et al., 2012) describe a semantically enriched representation (ontology) of knowledge domain in the field of Informatics. The main aim of their work is to further exploit their ontology within intelligent e-learning applications. They integrated their ontology with an already constructed ontological schema related to learning outcomes. Their approach enhance the learning outcomes discovery of learning materials and retrieval of related learning items.

The paper by Chen (Chen et. al., 2011) present a design of an ontology for mobile phone domain that contains the components and the style of mobile phone. The ontology presents the main terminologies of the mobile phone. This ontology is used to generate quiz to evaluate the capability of mobile phone salespersons on their product knowledge.

A specialized search engine for scientific documents has been adapted look for e-Learning material available using thesaurus (Schlenker, et. al., 2004). In their research they explained the method used for searching e-learning materials and they present their main finding and results of applying a thesaurus in the search process in the domain of e-Learning. They managed to identify a significant part of e-Learning material available and openly reachable with this approach with quite a high error rate.

The work of Pinheir (Pinheir et. al., 2008), propose an approach for program debugging that benefit from object oriented abstractions approach and the use of hierarchical model. The the main parts of the abstract components of the student's program are programming elementary patterns, functions and procedures. The abstractions can be used as an interactive dialogs with the student to improve his learning process and problem solving methods, in the different level of abstraction.

The work of Šimún (Šimún et. al., 2007) describes an adaptive web-based application which consists of three main parts: domain model, user model and adaptation model that they designed for the course of programming learning. In their system, they employ Semantic Web technologies in order to be able reuse existing educational materials and add a semantic layer responsible for personalization.

Gouveia (Gouveia, 2003) create a context to allow an interaction between the user and the context. The proposed approach of creation of context based on combination of thesaurus and referencing materials. The combined context will be very important and provide useful environments to support education, learning and training activities. Such a contexts will allow us

to prepare, access and use existing content in different ways, for different objectives and goals and associate with various activities.

1.2. Thesaurus in Education

In open and distance education, Learning Management Systems (LMS) used to deliver learning materials to students. These systems lack the structure and the semantic technologies that could benefit both learners and instructors by providing them with intelligent and interactive LMS.

In the educational field, we use thesauri for representing student profiles, teaching strategies, knowledge domains, as well as for competence and learning goal's modeling. Thesauri support education systems with reflective and smart, standardize the vocabulary of a knowledge domain, deliver explicit knowledge, and make communication easier and knowledge reusable. Thesaurus in education provides a semantic road map to individual fields and the relationships among fields. Thesauri map out a concept space, relate concepts to terms, and provide definitions, thus providing orientation and serving as a reference tool (Devedžiæ, 2006, Soergel, 1977, Abuzir, 2010, Abuzir, 2014).

1.3. An Overview of the System

In this section, we review the major aspects of our system that is based on thesaurus, indexing, classification and information retrieval system. (Abuzir, 2004, Abuzir, 2013). The architecture of the system consists of six models, which are the Domain model, the Student model, the interface model, the Information Retrieval model, Indexing and Classification models, Thesaurus Maintenance models, and the persistent Databases models (Figure 1).
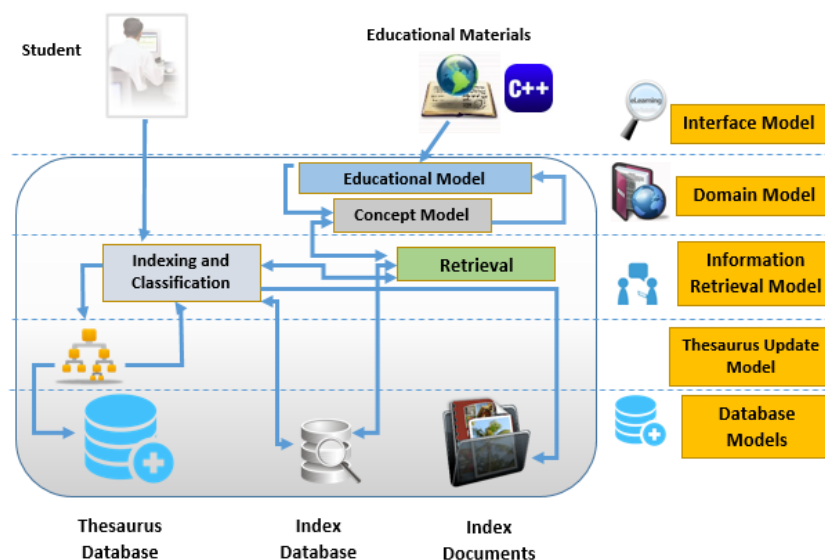

Figure 1. The Main Components of the System

In our system, we used the indexing and retrieval techniques that are based on the hierarchical structure of the thesaurus to create association relations between educational items and the concepts in the thesaurus.

In Domain Model, educational materials space represents a set of learning items that compose all educational materials. The system locates and maps the learning items with their

concepts based on the Root Terms in C++ Thesaurus. Figure 2 demonstrates three top level of C++ Thesaurus hierarchy. Lower levels trivially expand the hierarchy of the C++ thesaurus. Naturally, the upper level central node is the C++ OO programming. The second level represents the abstract meta-concepts, which combine entities that are more concrete (Encapsulation, Inheritance and Polymorphism). The major difficulties were to compose and to construct these intermediate concepts.

Relation between root terms and learning items determines which learning item(s) is necessary for the student to know on that particular level of topics structure. An example of learning item space and concept is shown in the Figure 3.

Domain model represents semantics and structure of educational materials. We divided domain model into three connected parts:

- Educational Items Space- Content of online course "object-oriented programming in C++ language".

- Root Terms (concepts) Space- the second part of the domain model consists of Root Terms (the main concepts in the course) that represent characteristics and classification of educational material.

- Mapping educational items to concepts- educational items from educational materials space are associated with the relevant concepts in the root terms space by defined relations based on indexing and classification techniques in our system.
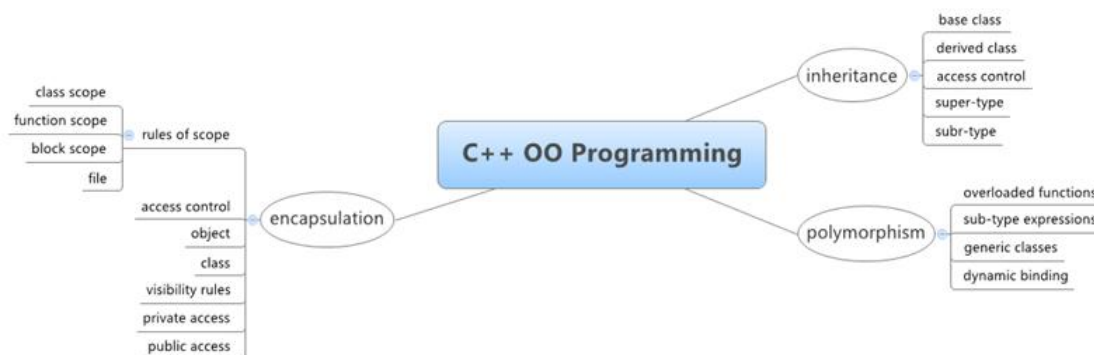

Figure 2. Root terms and top-level terms in C++ Thesaurus
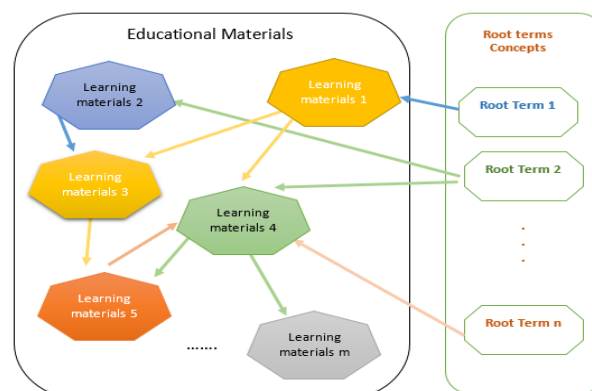

Figure 3. Domain Model: Educational Items, Root Terms in C++ Thesaurus and Mapping

The second component of our systems is a Student model (student profiles). The student model collects general user information, and maintains student interaction within the system. This model used in analyzing student needs. We can classified Learning items into different types of levels: Semantic level to map educational items to the concepts in the thesaurus and Conceptual level based on the hierarchy structure of the thesaurus. Each kind of knowledge requires different strategies, so nodes will be presented to learners in different manners. The next step is to make a decision about which learning item from which nodes should be represented, so that students can use the educational items until they are finished with that node. The last step is to repeat the process until each node is completely selected.

The third one is User Interface or Navigation Model. In this model, the system support student with two different ways to select their learning materials by two different ways:.

1. Selecting a learning item – the most appropriate learning item(s) from the educational materials space are selected by the student.

2. Selecting a concept – educational items are ordered by relevance for the student based on the concepts (root terms) selection.

The other models in our system represent the automatic indexing and classification engine that based on thesaurus to index and classify e-learning materials of the course. .In the thesaurus model, the structure representation and the expressive power of the thesaurus allows us to encode different relations between concepts. In our thesaurus, concepts represent entities in the hierarchy of the C++ Thesaurus. Besides the link representing the hierarchical relationships (whole-part, is-a and has), the order of concepts in the levels represent the interconnection between them and preferred sequence of their study, though the last one is rather a recommendation than a directive.

One of the primary goals of visualization and creation of C++ thesaurus is student interface for an educational system. In our system, the hierarchical structure of the thesaurus reflects the natural way to create a navigable interface for course materials.

2. METHOD

The course Object Oriented Programming in C++ is an e-learning course developed as a support for students in learning OOP in C++ at Al-Quds Open University. By developing our system, we are trying to achieve the following objectives:

- increases students' understandability of OOP in C++ by looking at the structure of the course that is based on C++ thesaurus.

- encourages students to learn OOP in C++ in an interactive way

- helps students to evaluate their own performance in this subject.

- helps students gain extra needed resources through this course by using the knowledge representation in the thesaurus of the course domain.

Experiment setup consisted of 25 students studying an OOP in C++. We used an online course developed in Avicenna projects at Al-Quds Open University (Abuir, 2006, Abuzir, 2007). We indexed the contents of this course by our system based on thesaurus. This automatically created keywords, concepts, and association maps between the keywords, concepts and educational items.

In order to retrieve educational item, C++ Thesaurus is used. The collection of all e-Learning materials is treated as a separated documents. The thesaurus reflects the interests of a student who is browsing the e-learning course.

3. EVALUATION

In our experiment, the classification parameter in our experiment was the three concepts. To test our system, we automatically indexed three units using C++ Thesaurus. We evaluated the results manually. The test results showed that a good indexing quality has been achieved. Precision and recall are the basic measures used in information retrieval systems for evaluation of their performance and their search strategies. Recall is the ratio of the number of relevant educational items retrieved to the total number of the relevant educational items indexed. Precision is the ratio of the number of relevant educational items retrieved to the total number of educational items retrieved. We can define the following notation:

NR = number of relevant educational items.

NRNR = number of relevant educational items not retrieved.

IIR = number of irrelevant educational items retrieved

IRR = number of relevant educational items retrieved

We calculated Recall and Precision using the following equation (1) and (2). Based on equation (3) we can find the total accuracy, which is 88%.

Table 1 shows the result of the classification. In the table, the column "Actual relevant educational items" shows the real number of educational items in our collection related to student. The second column shows the number of the educational items retrieved relevant to that student by our system. The third one provides us with the number of actual educational items that are relevant to that student from the retrieved educational items. The last two columns show number of relevant educational items that are not retrieved and the number of irrelevant educational items retrieved.

$$\mathrm{Re}\,call = \frac{NR}{(NR + NRNR)} * 100\% \qquad (1)$$

$$\mathrm{Pr}\,ecision = \frac{NR}{(NR + IIR)} * 100\% \qquad (2)$$

$$TotalAccuracy = \frac{NR + IRR}{(NR + IRR + NRNR + IIR)} \qquad (3)$$

We used the previous equations and result in Table 1 to find the precision and the recall. Figure 4 shows the percentage of recall and precision for each root term. Thesauri can be used to classify relevant educational items and can be used to suppress classifying of non-relevant messages by using broader and narrow terms. Based on equation (3) we can find the total accuracy is 88%.

Table 1. A Summary Of the Result

Toot Terms	Actual relevant educational items	Number of retrieved educational items IRR	Relevant educational items retrieved NR	Relevant educational items not retrieved NRNR	Irrelevant educational items retrieved IIR
Encapsulation	63	57	58	6	10
Inheritance	22	24	20	1	3
Polymorphism	30	34	25	3	6
Total	115	115	103	10	19

Figure 4 shows that the average precision is 84 and average recall is 91 for all educational materials indexed and retrieved based on the root terms.
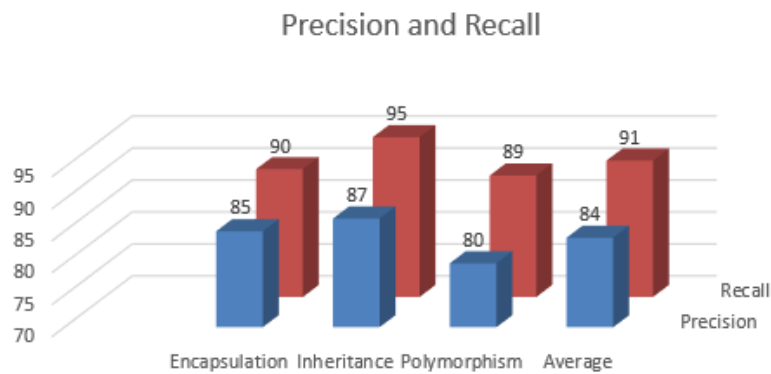

Figure 4. Graph Representation of Recall and Precision

The retrieval mechanism based on thesauri offers us advanced facilities to search educational materials, and enables us to treat the management of the educational items as an advanced documents management system. It offers facilities to locate and retrieve learning materials as well as to locate information contained in educational items. The student can easily find the topic in their online educational materials. The system can help the students to collect and group different educational items into related topics based on the roots of the C++ Thesaurus.

4. RESULTS AND DISCUSSION

Our research stresses the successful and professional role of knowledge structure for management of online learning materials. We introduced a number of enhancements to dynamic and interactive e-Learning systems in terms of learning materials management and evaluation.

This study provides student with a resource discovery tool for online learning items based on thesauri. This system provides learners or students with access to related educational resources, which takes places as a three-step process:

- the system accepts a query in interactive interface;

- it searches for educational items based on C++ thesaurus and optionally student profiles; and

- it delivers the required resources to the student.

Our system managed to identify and locate or retrieve a significant part of e-Learning material available with quite a low error rate. The abstractions level in the hierarchy structure of the thesaurus can be used as an interactive dialogs with the student to improve his learning process and problem solving methods, in the different level of knowledge. Such an approach will allow us to organize, process, manage and use existing learning items in different ways, for different objectives and goals and associate with various activities.

5. CONCLUSION AND RECOMMEDATIONS

This study presents a classification and retrieval techniques intended to aid in the management of learning resources. Particularly, these techniques are targeted to fulfil the needs of students. The retrieval mechanism, in our system integrated into an e-learning course and enabled students to work with the course as an interactive and intelligent LMS, where educational materials can be easily located and retrieved.

Our experiment demonstrates the validity of this approach, which based on the thesaurus and classification techniques. The Thesaurus represents an educational resource that should be considered as an integrated and complementary element in LMS that can respond to the growing demands of student and of learning systems in general.

This work evaluates the effectiveness of the classification and retrieval, in facilitating interactive learning and communications in open and distance education. The test results showed that a good classification quality has been achieved with 84 % Precision and 91% for recall.

The next version of the system may have a Smart Space for Learning which includes a number of Personal Learning Assistants. These assistants use learner profiles to search for, select and negotiate with suitable learning services.

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