An Integrated Resource Discovery Component for Virtual Learning Environments (VLEs)

Areej AlHogail[1] and Samir El-Masri[2]
[1]Department of Information Systems, College of Computer and Information Sciences, Imam Mohammed bin Saud University, Saudi Arabia
[2]Department of Information Systems, College of Computer and Information Sciences, King Saud University, Saudi Arabia

Abstract: *Virtual Learning Environments (VLEs) are becoming widely used in universities around the world to support the traditional learning. Many valuable learning resources are uploaded to the VLEs systems every day by tutors in forms of lecture notes, tutorials, assignments, and tests. Making these resources available to reusing and sharing through the VLE would increase the added value of these systems. In addition, it could save tutors' time and enhances course content development. This paper proposes a component that will be added as a plug-in into a VLE in order to facilitate resources discovery and extraction through the use of metadata to aid in learning objects reusing and sharing. Furthermore, it leads to create an open access repository for learning objects that aid in developing course content. The paper will also present a background review of VLEs, learning objects, metadata, and resource discovery.*

Keywords: *Resource Discovery, Virtual Learning Environment VLE, E-learning, Learning Objects, Metadata.*

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1. Introduction

Information and Communication Technology (ICT) has offered new opportunities to higher education institutions around the world to facilitate and enhance the learning and training experience. It helps to provide practical solutions for flexible learning and teaching in higher education. Therefore, the use of Web-based learning technologies is becoming an everyday practice for most campus-based university students [6]. Furthermore, e-learning have become an essential component in the higher education. Recently, one of the most used e-learning technologies in universities around the world to support traditional learning is the Virtual learning Environments (VLEs) such as Blackboard and Moodle. In addition, Web 2.0 tools such as wikis, blogs and whiteboard have been integrated with many VLEs to add more strengths and advantages.

In VLEs, information resources are organised where knowledge could be distributed and information could be shared and reused easily and effectively. However, locating and reusing these resources is a complex process which needs an application that is able to meet up with the rapidly developing technologies and the rapid expansion of learning resources that are added everyday; and at the same time provide simple means for content authors and users [16, 17]. The VLE aims to support the creation, management and sharing of information on the web [1]. Yet resource discovery tools are not integrated with every VLE.

Searching resources is a complicated process and a time consuming activity and many of the most valuable resources remain undiscovered and underused [23]. Facilitating information discovery is a key success for the VLE especially that one of its main goals is sharing and reusability. Researchers have been investigating the available VLE's features to explore to what extent higher education's institutions are making use of the powerful VLE tools to create a learning environment that facilitates and enhances knowledge acquisition for 21st century student. Despite the fact that the existing VLE have included a variety of great tools and technologies, still more work and research is needed to be done in order to enhance the existing VLEs systems. This paper proposes a resource discovery component for Virtual Learning Environments (VLEs). The component should be installed into the VLE in order to discover and extract learning objects that have been stored in the resources databases, such as lecture notes, presentations, assignments, links to external resources and other learning objects. This operation should be done in an effective way using the metadata that have been used to classify the learning objects; in order to facilitate resources discovery and extraction to be reused by tutors. Furthermore, it helps creating an open access repository for learning objects that assist in developing course content. The structure of the paper will start with a review of the VLE technology, this is followed by a background review of the learning objects, metadata and resource discovery. Then, a

detailed explanation of the proposed component will be presented. Finally, the paper will be concluded by a discussion of future work and a conclusion.

2. Background

Following sections will present background information about the VLE, learning objects, metadata, and resources discovery.

2.1. Virtual Learning Environments (VLEs)

VLEs have emerged towards the end of the 1990s and have transformed the traditional and distance learning. Liber and Britain in [13] described VLE as a learning management system that blends the functionality of computer-mediated communications software (e-mail, bulletin boards, newsgroups ... etc) and online methods of delivering course materials.

A VLE is a web content management system that is designed to support teaching and learning in an educational setting, which enables the customization of course materials and management. It provides the ability for users to access course content from remote locations by using a web based application to deliver content over the network. It also integrates the student information systems and authentication protocols to control who access what via a user name and password. On the course page, course materials are called learning objects [7].

VLEs can be used to support traditional learning because they offer the student a wide range of learning tools and functions that aids in delivering, communicating and managing the course. Main functions it offered as stated in the literature [7, 12,14, 20] are: communication facilities such as e-mail and discussion board that could offer synchronous or asynchronous communication; course content publishing tools, such as course notes and interactive course material content; announcements or a notice board facility to publish information that the tutors or administrators wishes to pass on to the students; testing facilities, self evaluation tools and grading tools, allowing students to take course tests from a remote location; automatic feedback to the student's learning behavior; scheduling/ calendar, to provide scheduling information; resources facility to link other web resources; course management facilities to control access and submission of work by students; assignment submitting; group projects facility which supports students' collaboration; web 2.0 technologies such as wikis, blogs, whiteboard, authoring tools, and polls.
In addition, VLE's can also facilitate the delivery of course content in a variety of formats, catering for the varied range of learning styles and learning preferences found in any class group [7].

There are several available VLE software systems in both forms, commercial and open source software for instance:

- **Moodle** (Modular Object-Oriented Dynamic Learning Environment): is an open source learning content management system that has been adopted by many institutions around the world. It has been designed from a social constructive perspective. Moodle has been developed under the general public license GNU. It can be used on almost all servers that can use PHP without any modification. Users can download and use it on any computer and can easily upgrade it from one version to the next [12].
- **Sakai** is open source software which is distributed under the educational license. It is a Java based service-oriented application. Sakai is a community of academic institution, commercial organization and individuals, all work together to develop a common collaboration and learning environment [5, 18].
- **Blackboard** learning system is a commercial web-based server platform. It can be installed on local servers or it can be hosted by Blackboard ASP solutions. It is mainly used to add online elements to courses which are traditionally delivered in face-to-face, blended or in completely online courses [18].
- **ATutor** is an open source web-based learning content management system that is used to develop and deliver online courses in social networking environment which is designed using accessibility and adaptability in mind. Open source technology makes it an effective tool for presenting instructional materials on web or independent online courses [18].

Other systems are available where some of them are open source and some of them are commercial. For instance, Gridcole, GIMOLOUS, ISIlab, DARE, NPTEL, COLEG, and Claroline.

2.2. Learning Objects and Metadata

Content of VLE's materials are developed in smaller manageable chunks known as learning objects [7, 8]. Learning Objects are defined as any entity that may be used for learning or training. It can be a document, file, image, or even an entire module that can be taken as stand-alone units of instruction. Learning object can be programmed, tagged, and stored. They have increased sharing and reusability [8]. Moreover, learning objects can be created within the VLE, or imported from external sources.

The development and application of learning objects have become an area of interest to many researchers and e-learning organizations that are looking to benefit from the potential costs and time savings and advantages associated with sharing and reusing of learning resources [15].

Metadata is "data about data". It is a record that consists of structured information used to describe learning objects. Metadata enables the identification,

storage, retrieval, and management of learning objects. It allows the learning objects to be searched based on keywords or tags that are describing each learning object when uploading them with an aim to facilitate its retrieval from a collection of resources [17]. Furthermore, Haase in [9] has defined the metadata as "any data which conveys knowledge about an item without requiring examination of the item itself." The key benefit is to describe resources in order to facilitate resource discovery [7]. Description of resources normally would give better results for search than resources that are not described in standard models. Therefore, metadata helps to search, organize, and retrieve resources efficiently and precisely [17].

There are different available standards aiming at standardizing the educational metadata. For instance, Learning Object Metadata (LOM) from the IEEE, and the Dublin Core (DC) [2, 11, 22]. In metadata standards, each resource is described using multiple statements. For instance, the element set of a simple Dublin Core consists of 15 statements known as elements like Title, Description, Creator, Subject, Date, Language etc. To clarify, when a presentation is uploaded to a course on "programming with Java" taught to undergraduate students of computer science program, then the metadata of that presentation will be classified under "computer science", "programming with Java", target audience set to "higher education". Content sharing, weblogs and social sites introduce tagging, annotation, rating, commenting, and discussion mechanisms, that can also be applied to educational resources. Recent metadata standardization approaches used for such content are: metrics of user participation in communities in the User Labor Mark-up Language "ULML; http://userlabor.org/" and the Attention Profile Mark-up Language "APML; http://www.apml.org/" [11].

For educational resources, it is usually described using LOM and DC, however, these standards may leave out some useful and related information. Therefore, some researchers suggested combining metadata standards for educational resources with the manual metadata.

Manual metadata is manually created metadata by experts, authors, or end-users. In contrast to automatic metadata, the generation can be of high quality, given an understandable metadata schema. Scientific and educational publishers organize their contents along standardized or proprietary metadata schemes in order to make their resources more retrievable and reusable. Generating metadata manually however may be slow, expensive, and not scalable. It may be inappropriate in dynamic domains and authors may produce inconsistent metadata [11, 22].

The main functions associated with metadata in content management systems are read, query and write. *Read* Enables third party to access metadata. *Query* use protocols to browse or search content. *Write* enables authoring applications to directly upload and publish a resource into repositories in order to make the resource available for search and reuse [11].

Metadata plays an important role in electronic learning repositories to achieve domain based knowledge retrieval; semantic interoperability; learner centric educational architecture; and reusability [17].

2.3. Resources Discovery

Among many of the issues present in the design and implementation of a VLE is resources discovery. Tutors use a range of tools to discover resources they require and may prefer simple search interfaces such as Google for resource discovery [21]. These resources may be located physically within library or digitally on the Web or other electronic databases. In case of digital resources, resources are available in a large number of formats and interfaces, which has often meant that users were directed to a number of different local or external systems to find the information they required [21]. The implication is that many academic resources failed to be discoverable and that may in turn affect the perceived value of them. The usefulness of the content and collections depends on how easily it can be discovered, located and gained access to them [17]. Making learning objects available is critical to the purpose of reusing learning resources in the VLEs. Resource discovery will add value to the VLE system as resource locating is time consuming.

The learning objects metadata should allow an application to recognize the structure of a resource by enabling field-based searches such as author or title, which would facilitate resource discovery capabilities [2]; that in turn will allow the reusability of learning objects. Metadata provides sufficient information that describes a resource to enable intelligent resource discovery agents to differentiate between what is relevant, irrelevant, or redundant to a specific search query [17, 9].

Metadata has improved the resource discovery process as it ensures encoding of semantic distinctions of various elements. For example, a search for work written by "Shakespeare"; the search will yield results where the element name "author" carries value "Shakespeare". Thus in a collection of resources it becomes simpler to identify works by "Shakespeare" instead of retrieving just everything about or by "Shakespeare" in reply to particular query [17].

There are several projects and research proposals that aim to discover resources and link it to VLEs. One of the well-known projects for resource discovery in VLE is the DiVLE Program that aims at linking Digital Libraries with the VLE which was funded by the Joint Information Systems Committee (JISC). PORTOLE was part of that project that aims to produce a range of tools for tutors, which could be used to enable them to discover information resources from the library such as

journal papers, and then embed these into their course modules from within a University VLE [19].

In addition, a framework proposed by Brusilovsky and Nijhavan in [3] that allows course materials reusing by allowing a course author to search for the relevant learning objects in repositories of educational material and include them in their courses as described in Figure 1. Their approach aims at reducing course development time and improving the quality of courses by making high-quality educational material available for the learning community. However, their system aims to replace the VLE, whereas in our paper, the aim is to integrate the reusing of learning objects with the VLE.

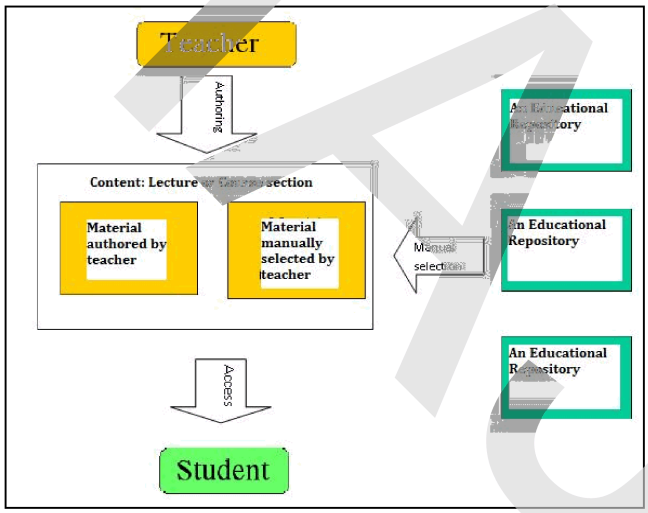

Figure 1. the re-use approach to course design and delivery, in [3], the authoring tools allow the teachers to discover and include resources into their course material. The student accesses static course material.

Singh and Singh in [18] discussed a resource allocation for collaborative learning environments, such as VLEs, to handle resource management issues related to discovery, scheduling, protection and administration. In their paper they proposed a grid-based resource management model consisting of Linux, Apache, MySQL and PHP. The interaction takes place through SOAP over HTTP.

There are several difficulties associated with resource discovery process; for instance, resources could be located in a large amount of dissimilarly structured repositories using different metadata standards and in different languages [2]. Solving disparate sets of learning objects is described as *Interoperability,* which propose a framework or language-like structure in which the meanings of dissimilar metadata descriptions could be conveyed between two or more systems [15, 2, 22]. In addition, resources may be in different search interface that may require the awareness of different search query languages [19].

Furthermore, Brusilovsky and Nijhavan in [3] mentioned that many resource discovery applications that address reusability, implicitly assume that a learning object is a moveable entity, usually a file that is stored in a repository and can be reused by copying into the course. However, advanced learning objects in modern Web-based education are not only text files, but may be interactive learning objects like images or even applets that cannot be simply packaged, stored, and copies as text files, and they have to be located in on a dedicated server [3].

The next section will give a detailed explanation of the proposed resource discovery component that will be integrated within a VLE to facilitate the discovery of learning objects to be reused by course administrators to save time and improve course development.

3. The Resource Discovery Component

In VLEs, courses that have been delivered contains many valuable learning objects such as lecture notes, PowerPoint presentations, assignments, examples, links to external resources and other learning objects. All these objects could be reused by other academics staff while maintaining the copyright and intellectual property issues, creating an open access learning objects repository. The component aims to achieve the reusability of learning objects. Reusability assumes that learning objects are described in a systematic way that facilitates the identification and integration of various learning objects [2] through the use of metadata.

In this model, resource discovery will be based on metadata that will be used to classify the content. All learning objects that are uploaded into the system must be classified with metadata that describe the resources. A search is performed on stored learning objects using metadata in order to locate the appropriate resources. In addition, the component will offer the option to modify the metadata for uploaded learning objects by the author of them giving users more flexibility when sharing resources. Search results will be returned to the user, who would then be able to review and select the suitable resources from those listed results. Then it can be downloaded directly to the course page of the VLE. Furthermore, valuable leaning objects could be found in other universities' resources databases. The component could be used to link these databases, assuming they are using the same platform, in order to maximize the sharing and reusability.

In order to illustrate the goal and purpose of proposed tool, a prototypical scenario is presented. User requirements are identified based on usage case scenario. It will show the different tasks that need to be addressed when trying to locate and use learning resources using summarized use cases. Then, user requirements will be derived. Finally, the component's description is presented.

3.1. Usage Scenario

Professor A is a university professor at university X in the domain of Information Systems. She is teaching the module "System Analysis and Design" for undergraduate students. The university is using a VLE to support the traditional face-to-face learning experience of the students. Therefore, professor A is using VLE to support her teaching. She is preparing the course content for her module such as presentations, tutorial sheets and some online quizzes to cover different topics in her module. She needs some ready resources that she might point to in order save time and make use of the share-ability of a VLE. She will use some extra resources in her course page that other tutors have produced and uploaded to the system, while keeping their copyrights. In the following, different tasks that professor A might do in order to search, extract and reuse learning materials that reside in the VLE resources databases.

Searching for a resource

Assuming that professor A wants to create a lecture on "The software development lifecycle". She wants to locate resources stored in the database regarding this topic. She will use the search interface provided. She will fill the fields required to easily identify her request. The fields will be used to search the metadata of the available resources. The query will be

Return every 'Lecture' which 'hasTitle' 'software development lifecycle'

She can also specify the author or include some keywords or other search criteria.

- **Finding relevant materials**. The search will return several results. Resources returned could be HTML pages, power-point files, text file, images, PDF files or even links. It should be displayed in a list with checkbox next to each resource. Professor A browses each resource description and check relevant materials. Then she selects most relevant learning objects using the provided checkboxes.
- **Adding the resource to the course web page**. After checking the relevant resources that professor A wants to upload to her course page, she selects the upload button. A dialogue box will ask her to select and confirm the desired location of the materials. Content should be organized in hierarchal structure. For instance, under the course page, course content that will also be divided as folders for each topic, hence added resources will be located in a place that is easily accessible by students. Furthermore, each learning object will still keep the name of the original author in order to maintain their copyrights.
- **Upload learning objects to the VLE**. Every time professor A wants to make a resource (e.g. a PowerPoint presentation) available to her students, she will need to upload it to the course page. This is a normal procedure in the VLE; it should be available then in the VLE learning objects resources database in order to create an open access learning objects repository which the university (or other universities) communities could make use of. Each learning object will be classified automatically using the metadata using information like author, time stamping information, course identification, degree, title and so on. However, if professor A wants to make her resource more discoverable and accurate she can modify the object's metadata by selecting the modify button provided by the tool in order to be able to add extra custom information and keywords.
- **Modify learning object's metadata.** The modifying option allows professor A to add extra clarification fields to her lecture presentation metadata that she will upload to the VLE. She will add keywords like "Software life cycle models", "Waterfall Software Development Model", "Prototyping Life Cycle", "Iterative Life Cycle Model" and "Object oriented Life Cycle Model". These extra key words could be valuable for another tutor looking specifically for any subsection in that lecture. She can also edit the title from "Lecture 1" as it has been saved, into "Software life cycle models".

3.2. User Requirements

Several requirements can be derived to form the basis of the resource discovery component. They are summarized in the following list.

- Search and query to discover learning objects that match a specific search criterion in the local resources repository; and the resources of joint institutions' VLE repositories.
- Return a list of the learning objects that meets the search criteria.
- Browse learning objects.
- Ability to select related learning objects.
- Uploading selected learning object to the course page.
- Modifying the metadata of uploaded learning objects that are created by the course administrator.
- A user-friendly interface that allows the easy access to search, select and then upload the learning objects in order to improve the interaction between of the user and the content.

To sum up, the user requirements above required a tool that can discover learning objects based on metadata tags that are associated with each learning object describing the semantics and parameters related to this object.

3.3. Role of Actors

The role of each person who would interact directly with the resource discovery component is identified, as follows:

3.3.1. VLE Administrator.

The VLE Administrator has the ability to add or remove the plug-in from the VLE installation to enable or disable the resource discovery component for a particular course. Moreover, she will be in charge of assigning the course administration power to the users. In addition, the VLE Administrator will be responsible for the creation and classification of the automatically generated metadata for each learning object uploaded to each course in the VLE. The course administrator (tutor) will then be given the chance later to manually modify it.

Figure 2 shows the processes associated with VLE Administrator when using this component in addition to general VLE processes.

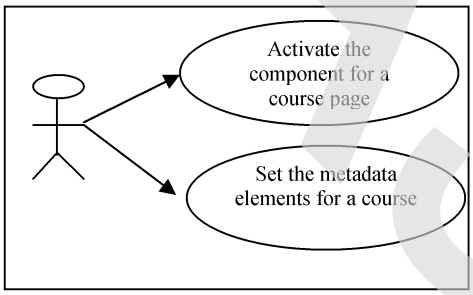

Figure 2. Processes associated with VLE Administrator.

3.3.2. Course Administrator (Tutor)

Once the VLE administrator has enabled the resource discovery component, it will be visible on the tutor view of the course page interface as a button labeled 'Discover resources'. The course administrator then can search, select and retrieve different learning objects. In addition, course administrator will be given the possibility to manually modify the metadata of to the learning object while uploading it to the VLE.

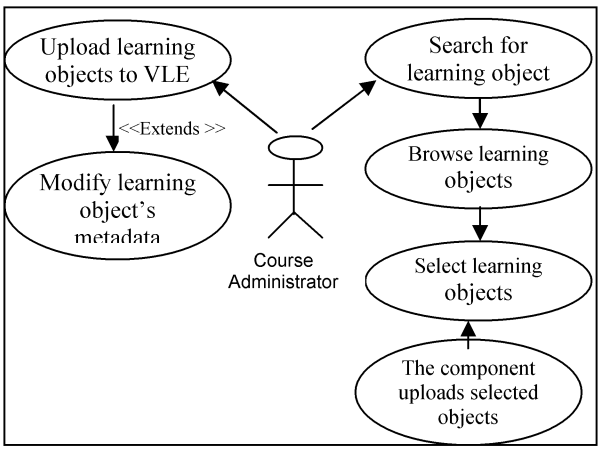

Figure 3. Processes associated with Course Administrator.

3.4. The Component Description

In this section a brief overviews will be given describing the component. The component will be developed as a plug-in to be installed into the VLE installation and activated by the VLE administrator. It consists of additional settings to both the course page and the learning object uploading pages. Figure 4 describes the proposed resource discovery component for the VLE.

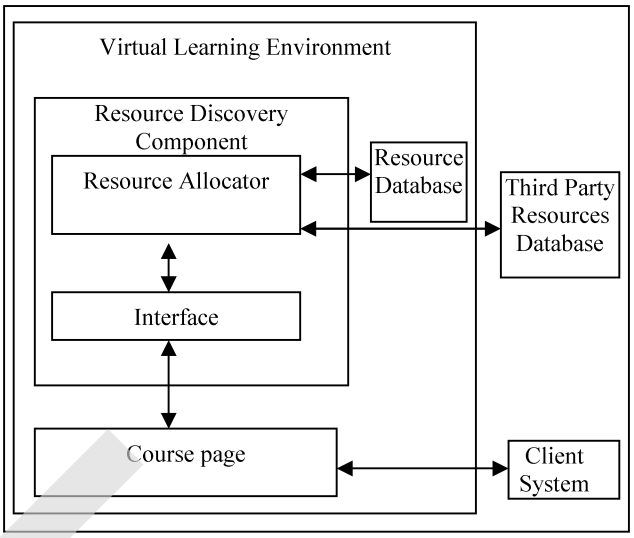

Figure 4. The proposed resource discovery component.

In the figure, the client system is a browser or a terminal of any kind that is capable of sending data over the internet. The client should log on to the VLE system first; the client request should go through the authentication and authorization system of the VLE to check client's authentication and authorization information. Once the client is authorized, she will be allow to access course pages of modules that she got the privilege to access. From each course page, the client (course administrator) will be able to call the resource discovery component. The request is sent to the component that will search in the resources databases of the VLE and any other institutions that join the system (third parties), after that it allocates the resources required and then retrieves them. Results are sent back to the client. Client will interact with the component through a user-friendly interface.

To interact with the component, two views are provided, course administrator view and VLE administrator view.

3.4.1. Course Administrator View.

Resource discovery component appears at the tutor's course page as a button labeled 'Discover resources' allowing a tutor to discover learning objects or the button 'Modify' to modify metadata when uploading learning objects. This component will be activated when user select 'discover resources' from the main

course page or 'modify metadata' button from the upload page.

The first section of the component is dedicated to searching through the learning objects repositories by the use of metadata. These metadata allow the learning objects to be searched based on different search field and keywords set when uploading each learning object. There are various headings which a tutor can search under for a specific learning object. In addition, a combination of various heading may lead to more precise resources.

- Learning Object Type: This option will only show content which is specific to the object's content type under the headings of All, Lecture, Lab, Tutorial or Assignment.
- Author: search for content created by a specific author. This will require the entry of a name to be searched by or all authors will be displayed if matching to other criteria.
- File Type: This option allows the user to specify what file type they are looking for in case the tutor knows the type of the file he/she is looking for such as text document or a presentation in a PowerPoint format. The options available are, All Files, Text Document, Spread Sheet, Presentation, Web Link, PDF file, Sound file, and Movie file.
- Degree: Allow for the search for learning objects designed for postgraduate or undergraduate.
- Course Name: this option allows the search for all content created for a specific course.
- Programme name: this option allows to limit the search for specific degree and audience.
- Key words: this option allows the search for content titles, all content metadata, and content keywords set by the author. All content with similar terms to the search criteria will be displayed.
- Time: search by time stamp which represent the date of creation of the object, in order to search for documents uploaded in specific period of time. For instance, last month, or last year, or between specific years.
- Language: this option allows limiting the search to specific language. It specifies the language of the content of the resource. This option has more value in universities in countries where English is not the native spoken language and resources may be available in more than one language.

Figure 5 shows a visual representation for the search interface of the course administrator view.

The second section of the component is dedicated for uploading the learning objects to the VLE. Each learning object uploaded should be classified automatically using metadata as classified by VLE administrator. However, the author can also manually modify the metadata to give it more clarification and make it more discoverable to increase the reusability. There are various headings in which a tutor can use to clarify a specific learning object

- Keywords: this option allows adding extra keywords to the object to make the discovery more accurate and concise.
- Title: author can change the title of the object to make it more representative, in case the automatically generated title is not adequate.
- Learning object type: this information should be assigned automatically based on the location it has been uploaded to. However, course administrator can modify the type from a drop down list of a given options which are: Lecture, Lab, Tutorial, Assignment, and Test.

Figure 5. The search for resources interface in the course administrator view.

Figure 6 shows a visual representation for the Modify interface of the course administrator view.

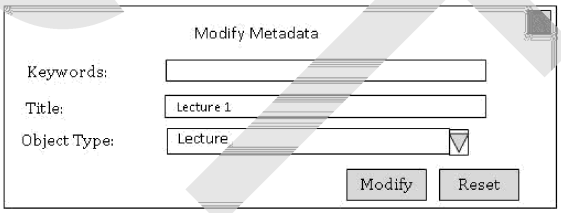

Figure 6. Modify metadata interface when uploading resources to the VLE in the course administrator view.

3.4.2. VLE Administrator View.

Once the component is installed, a new set of settings will appear for the VLE administrator in the course settings page. The new settings will allow the administrator to enable and disable the resource discovery component in each VLE course page.

As metadata will be used for resource discovery process, each learning object needs to be categorized, and associated with the relevant metadata elements. Metadata will be generated automatically for each new learning object as set by the VLE administrator for

each specific course and can be also modified by the author of the object as described earlier. The administrator will categorize the learning object added to each course page under various headings of metadata elements as described in the next section.

3.5. Metadata Elements

The following table presents a list of the metadata elements that will be used in this component and their description. They have been selected based on the Dublin Core elements, however, it has been modified and some elements have been removed or replaced by other elements in order to make it compatible with the requirements of this component.

Table 1. The metadata elements that have been used in the model.

Element	Description
Title	Title of the learning object, i.e., the name given to the resource.
Author	Author of the new uploaded learning object, this will be automatically assigned as the name of the course administrator or as given by the VLE administrator. However, this could be extended to include an organization or a service.
Date	Automatically given the date of the availability of the resource in the VLE. Recommended practice for encoding the value of the date is as defined in a profile of ISO 8601, and follows the YYYY-MM-DD format [10].
File type	Text file, Word Document, Spread Sheet, pdf, PowerPoint presentation, link, HTML page, image, video…etc. this is automatically assigned based on the file extension.
Learning object type	Lecture, tutorial, lab, test, assignment, or extra resources. This is should be assigned based on what area in the course page it has been uploaded to, nonetheless, it could be modified by the course administrator later.
Degree type	Undergraduate or postgraduate. Automatically assigned based on the degree registered for that course, in order to specify the target audience.
Programme Name	The name of the awarded degree. Automatically assigned based on the degree registered for that course.
Course Name	Automatically assigned based on the registered course name.
Keywords	Phrases and keywords entered manually by the course administrator to describe the topic of the resource.
Rights Management	Automatically assigned by the VLE administrator. A Rights management element will contain a rights management statement for the resource, or reference a service providing such information. Rights information often includes Copyright, Intellectual Property Rights, and various property rights [10].
Rights Holder	Automatically assigned by the VLE administrator. It includes a person or organization owning or managing rights over the resource [10].
Language	A language of the content of the resource. This is especially important in universities in countries where English is not the native spoken language.

4. Implementation Suggestions

The implantation of the proposed component is suggested to be built using MySQL and PHP; as Singh and Singh in [18] mentioned that MySQL and PHP have the advantages of being open source, mature, compatible with many applications and well tested.

The proposed component is planned to be installed as a plug-in to the locally developed VLE or to open source software VLE like Moodle. One possibility is to develop it as a patch code to add the component capabilities to the installation of the VLE. However, Goslin et al. in [7] mentioned some complexities that are associated with code patching such as that it may lead to difficulties if any rollbacks need to be performed on the code in the future and also if an update occurs, difficulties may also arise because core code updates may overwrite the changes that have been made after applying the patches.

5. Future Work

In the future, the work could be extended to include the relevance ranking of results of the search. It will need a specific algorithm to classify the relevance to search criteria and should cluster similar results together. Moreover, the current discovery technique is based on only the metadata of the learning object. An extension could be applied to the tool to search through the body of the learning object especially that most objects are text based.

Furthermore, the resource discovery component could be enhanced to support the linkage to other platforms in order to cover more institutions and third parties.

6. Conclusion

Preparing course materials is a complicated process and a time consuming activity. Many of the valuable resources that have been created and uploaded to the VLE remain undiscovered and unused although they could improve the development of other course materials.

The content of VLE's materials is called learning objects which may include a document, image, lab/tutorial, PowerPoint presentation or a link to a web resource. Metadata is used to classify each learning object by giving a description and a categorization for each object.

This paper proposed a resource discovery component that should be integrated with the VLE in order to facilitate the discovery of required learning objects that reside in the VLE recourses' database, and then extract them for browsing, and upload the appropriate ones into the course page. The component will be activated by the VLE administrator and then will appear on the tutor course page allowing him to search using keywords or a specified metadata. It discovers all related resources based on the search criteria that will be used to match the metadata of available learning objects.

Metadata will be assigned automatically to any new learning object that will be uploaded to the VLE using tags created and assigned by the VLE administrator. However, any new learning object's author, can also modify the metadata using this component in order to make it more discoverable and reachable.

This component provides the academic staff a greater flexibility, time saving, and advantages when creating learning materials in order to produce course content more efficiently and effectively. In addition, it could assist in creating an open access learning objects repository.

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Areej Alhogail, is a lecturer in the department of Information Systems at Imam Mohammed Ibn Saud Islamic University. She received her BSc. degree in Computing and Multimedia systems in 2003 from Leeds Metropolitan University, UK; and MSc in Information Systems Management in 2008 from DeMontfort University, UK. Currently, she is pursuing a PhD degree in Information Systems at King Saud University, Saudi Arabia. Research interests of her include information security management, human factor in information security, security culture, e-learning and the management of information systems.

Samir El-Masri, is an associate professor at the department of information systems, college of computer and information sciences, King Saud University, Riyadh, Saudi Arabia from 2009 till present. Dr El-Masri received his Master degree (1994) and PhD (1997) from Grenoble National Polytechnic Institute, France. Dr El-Masri worked at Hokkaido University, Japan from 1998 till 2001 and he was assistant and then associate professor at University of Western Sydney and University of Sydney, Australia from 2001 till 2006. Dr El-Masri worked in the IT industry as a senior manager in large software development consulting companies in Sydney Australia from 2006 till 2009. Dr El-Masri has interests in e-learning, Internet web contents and Health Informatics researches, and has more than 70 published papers at International conferences, in books and journals.