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EXPERIENCES ON SHARING eLEARNING RESOURCES USING SERVICE TECHNOLOGIES

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ABSTRACT
Sharing e-learning resources efficiently and effectively is a challenge. One barrier is that currently available resources have not been described accurately and do not readily interoperate. In this paper, we present an evaluation of our novel e-learning services approach which aims to overcome these problems. Results from the evaluation suggest that it is quicker and easier to discover and choose reusable e-learning materials via our service approach, and that the approach offers both practical and educational benefits for its users.

KEY WORDS
Share Resources, Educational Services, Service Oriented Architecture, E-learning Resources

1. Introduction

Nowadays, the number of software tools to support e-learning is growing. These tools and the data they rely upon are valuable resources in supporting different aspects of the complex learning and teaching processes, including designing learning content, delivering learning activities, and evaluating students' learning performance. A crucial problem that the field currently faces however is that people/users cannot fully benefit from these resources as they have not been shared effectively and efficiently – there are many resources, and these have not been described accurately and in general they do not interoperate [1]. Furthermore, it is not uncommon for the tools to rely on different technologies, which further exacerbates the problem.

Service technologies, which have become popular among academia and industry largely due to their ability to facilitate interoperability, offer a potential solution for sharing and reusing e-learning resources. Instead of the traditional methods for system design and coding, service software can be developed by wrapping and reconnecting existing applications [2].

In our previous research, we have proposed a novel educational services architecture as a solution to this problem. Our approach not only wraps existing educational software as services, but also inserts a layer between users and e-learning resource providers – the Educational Services Bus (ESB) – so that these tools can be linked together and users will be able to access them efficiently. Additionally, information about each software tool is described and presented in the ESB, so that users are able to discover and compare the tools effectively [3]. Figures 1 and 2 show the differences before and after our services approach is introduced.

In this paper, we evaluate how well our ESB-based service approach supports the sharing of e-learning resources. Furthermore, although we argue that our service approach is able to support the sharing of many types of resources, such as assessment materials and students' learning information and so on, in this case study we focus in particular on e-learning materials currently stored in repositories. This is because it is the most well developed and commonly used resource in our community.

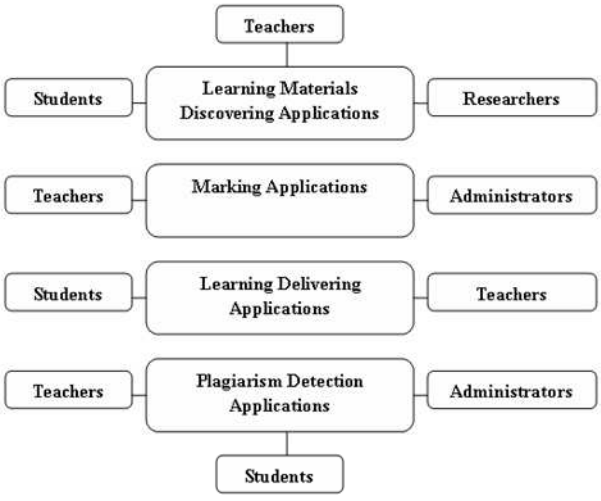

Figure 1.Educational resources without services

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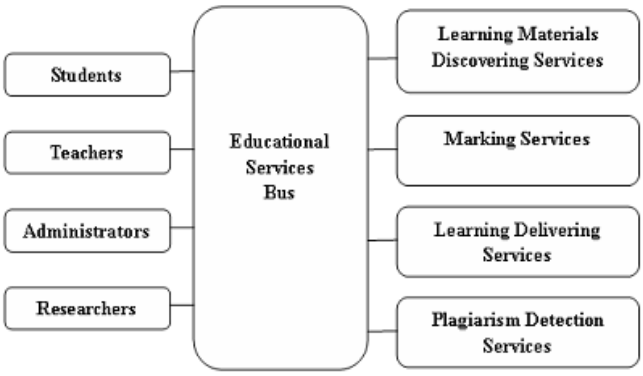

Figure 2. Educational resources with services

Today thousands and thousands of free e-learning objects are developed and available online across the world, more and more people have become interested in using and reusing them. Repositories to store these objects are gradually increasing in maturity.

However, it is a challenge for most users to find quality and useful materials efficiently and effectively from these repositories. As beginners, users do not know where materials are so they have to spend a significant amount of time to learn and use these repositories. Indeed, users may not even be aware of the existence of the repositories. The materials present in repositories are often poorly described and indexed, and cannot easily be accessed since their user interfaces differ substantially. As a result, people tend to lose interest and fail to find the materials they want by using current approaches, even when they are experienced users.

We therefore argue that there is a significant need to improve current methods to search e-learning objects, so more people will be able to quickly and easily discover useful materials for their needs. The core aim of this case study is to determine if our service approach is able to better support this and how.

In the rest of the paper, we will first discuss the related research on sharing e-learning materials. Then we describe how we have conducted an experiment to evaluate our approach, together with the design prototype software tools, following which we present and discuss the results of our evaluation.

2. Related Work

Many people from both industry as well as research communities have attempted to develop reusable e-learning materials and repositories in which to store them and make them accessible. These repositories have collected quality learning materials from different subject areas, and contain material written in different languages [4].

One key challenge that arises however is discovering appropriate materials from these repositories, since each repository has a different user interface and the search facilities operate differently. Researchers have tried to improve this, for instance Curlango-Rosas *et al.* [5] have proposed a tool to provide extra information (metadata) to describe each item of material, in order to support the searching of web based e-learning materials though a number of popular repositories, such as Merlot [6] and Ariadne [7]. Nevertheless, their work has limitations as the searches apply to individual repositories and thus users cannot perform searches on all repositories simultaneously.

Work has been done to apply service principles in e-learning as well. Although there are proposals for systems, there is little discussion on implementation and evaluation of those systems. For example, Ren *et al.* [8] have developed a high-level platform to share educational resources in general by following the Web service standards, however their approach has not yet demonstrated how to share resources in practice, (in particular the sharing of e-learning materials,) nor has it been evaluated as of yet.

On the other hand, some researchers have explored e-learning services in depth, but, their works lacked wider applicability. For example, Chang *et al.* [9] have developed and implemented a learning contents providing service which is able to rank the search results for different users. The shortcoming of their work in our context is that it has not covered the sharing of other searching services, and it lacks feedback from potential users.

The novelty of our solution lies in (a) the comprehensive application of a service approach to all stages of the e-learning process facilitated by an Educational Services Bus, and (b) the fact that we do not restrict ourselves to Web services [3]. Our approach uses service technologies, and addresses not only the problem of providing descriptions of learning resources, but also linking those resources together.

3. Experiment Design

In order to evaluate whether our service approach can improve searching and sharing of a set of educational resources and repositories, we conducted an experiment in which we compared the effectiveness of our approach

with that of the use of current technologies. We constructed two (functionally equivalent) software tools which allow the user to search for materials from a number of repositories. The "Current Tool" (CT hereafter) was essentially a shell for the search software provided individually by the repositories; the "Service Tool" (or ST) was a prototype implementation of our service architecture. The idea of ST is to integrate several existing repositories for searching for e-learning materials, similar to how people search a single interface for scientific publications from several databases.

In ST, each repository (e.g. Merlot [6], Ariadne [7] or Jorum [10]) is wrapped as a service – for example, the Merlot service, the Ariadne service and the Jorum service. Details about each service are stored and published within the ESB. Teachers and learners can compare many repositories at the same time, and choose appropriate repositories from multiple service providers based on their needs. Differences between the repositories have been described clearly, in terms of languages, subjects, and user reviews. Because these services are linked together via the ESB, searches can be performed in one go, and the search results are presented in a single list, as illustrated in Figures 3 and 4.

In CT, users begin by visiting the 'Collection of E-learning materials repositories' screen (shown in Figure 5). They then use the links provided on the page to access different repositories separately. In this approach, people will access one repository in each search. Descriptions of the individual repositories do not include comparisons between them, and the search results are presented differently in each repository. Users may encounter materials which are repeated in different repositories.

In order to find out which approach is better to find useful materials and how, and if they can actually solve the sharing problems identified, we performed the following three activities to collect data during our experiment.

We initially asked volunteer users to search for a set of learning materials, using the tools CT and ST, where the ST prototypes our service approach. 14 potential users took part in this experiment, and included students, lecturers and e-learning staff across different disciplines within our institution. These were selected not only because of the e-learning experience they have had during their studies and work, but also because they were interested and willing to try something new for e-learning.

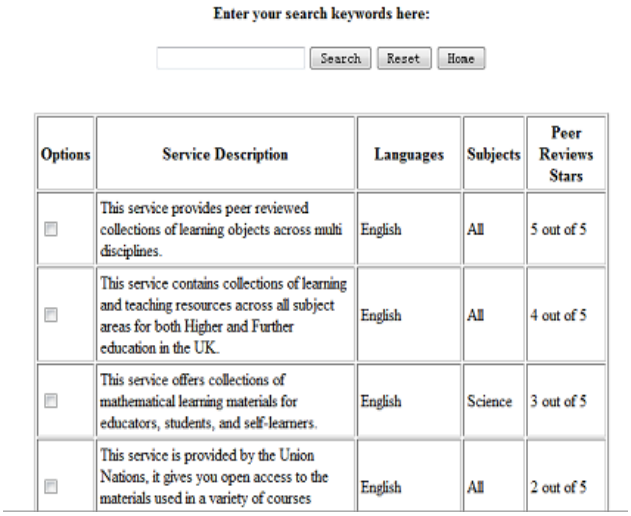

Figure 3. Repositories as presented in ST

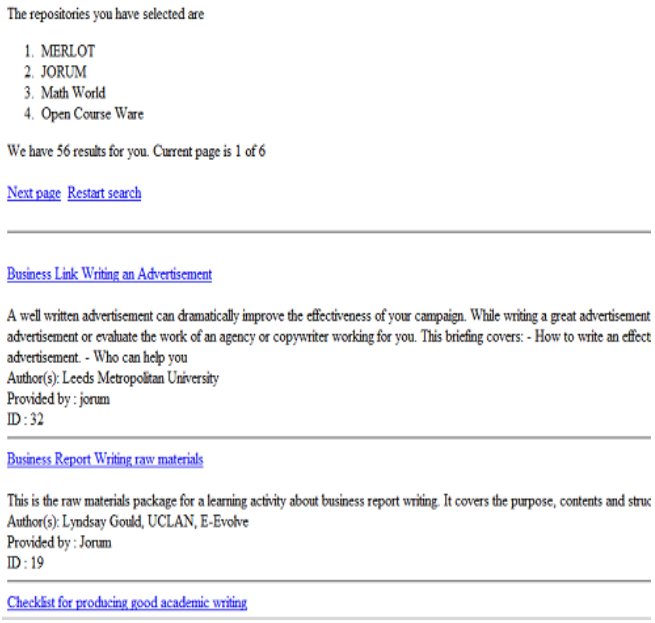

Figure 4. Search results as presented in ST

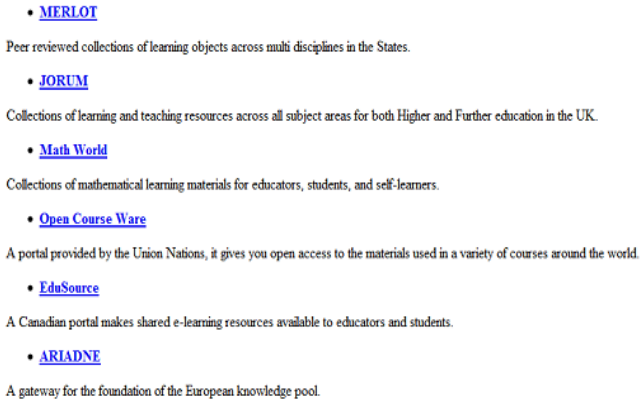

Figure 5. Repositories as presented in CT

We asked users to apply both current and service approaches to perform a common task – searching for e-learning materials from a number of popular repositories. After they tried each tool, we asked users to fill in a usability questionnaire (using five-point Likert scales) to measure their opinions on each approach. This first activity aimed to identify which approach they prefer and how significant the differences between the two tools are. We used the same questionnaire for each approach, and compared the results of the two questionnaires for each respondent, as illustrated in column 'Mean CT-ST' in Table 1 and 2.

While they were using the tools, as the second activity we counted the numbers of clicks each user made in order to discover a full list of learning materials in each approach, together with the time taken. The information allowed us to measure the comparative speeds for discovering materials in each approach.

For the final activity, we interviewed the users and asked them to reflect on both approaches. This was done to identify any further benefits or problems, together with possible future improvements to our services approach.

In order to reduce possible threats to internal validity, we ensured that all materials used for both approaches were the same, and that half of volunteers started from each approach.

4. Results

In the rest of this section, we present our results and the data analysis methods we used. To evaluate which approach is better at finding useful resources and how/why it is better from users' point of view, we analysed and presented our findings according to the following two hypotheses.

Hypothesis 1: Our services approach is able to discover learning materials from many repositories more efficiently than the current approach

We have conducted a number of quantitative analyses for this hypothesis. We have applied 8 2-sample t-tests to compare the differences in mean score obtained from both service and current approaches. Table 1 presents the test results. The first 6 tests are based on the answers from questionnaires. The last 2 are based on data collected from activity 2. The mean scores obtained from the service approach are higher, suggesting that this approach is faster.

Questions in H1	Mean CT - ST	P	Results
Which approach allows users to discover e-learning materials from different repositories more quickly?	2.86 – 4.5	0.0001	Service
Which approach allows different repositories to be searched at the same time?	1.79 – 4.86	0.0001	Service
Which approach allows search results to be displayed in a single list?	1.93 – 4.71	0.0001	Service
Which approach is able to connect the repositories together?	2.21 – 4.64	0.0001	Service
Which approach allows users to choose e-learning materials from different repositories more quickly?	3.07 – 4.21	0.0085	Service
Which approach allows users to discover repetition on search results more easily?	2.86 – 2.86	1	No SD
Which approach requires less time to discover the same amount of materials	340 – 54 seconds	0.0001	Service
Which approach requires less clicks to discover the same amount of materials	45 – 13 clicks	0.0001	Service

Table 1. Results for Hypothesis 1

The p values less than 0.05 indicate that the difference in mean score is statistically significant, which is the case for 7 out of 8 tests, and hence we conclude that Hypothesis 1 is supported [11].

During the interview, participants were given opportunity to express their views on searching speed. Several participants expressed clear support for the service approach, both at a general level – "service

approach is a big step forward" – and specifically – "I prefer it because I can search in one go", "I only have to access a single Front Page, rather than learning each repository's own structure one by one, and employing the same search mechanism multiple times." Another further identified how the service approach "... shows all the results in a single list, so I would be able to make decision more easily", and this was reinforced by a third participant who noted that, when using the current approach, he could not compare the results easily as he needed to consult different lists repeatedly. However, due to the time limit, the experiment failed to distinguish between the two approaches as to their ability to identify repeated search results.

Hypothesis 2: Our services approach is able to describe many different repositories more effectively than the current approach

We conducted both quantitative and qualitative analyses to test this hypothesis, and have qualitative evidence indicating that 13 out of 14 people prefer service approach because of this search function. Based on the answers from the questionnaire, six 2-sample t-tests are applied to identify which approach most people prefer in terms of describing the learning resources, and half of the tests support the hypothesis (Table 2). Evidence collected from interviews suggest the reasons for these results.

Most people agree that the service approach has provided more information to describe each repository, since it is easier for them to choose which repositories to use. Some respondents mentioned the ratings as being helpful since they "… could easily click the best one, and avoid the other ones." Another commented "The peer review is good to give a sense of other users' opinions, so when you make a decision about which is best, you want to know how other people think about them." Specific mention was made of the importance that materials be relevant: "For example, the MathWorld came out with lots of things which are irrelevant, if I know that, I will exclude it from search in the future." The problem of needing to visit all the repositories in turn when using the current approach was also mentioned as an issue.

Respondents agreed that in the service approach, e-learning resources are well organized and hierarchical, and provide users more options to choose. This allows for more personal flexibility: "People are used to use the repositories they are familiar with, or the ones they have been asked to use, the service approach gives them more choices, we like to have choices."

Questions in H2	Mean CT – ST	P	Results
Which approach is able to show the differences between all the repositories more accurately?	2.93 – 3.86	0.037	Service
Which approach allows users to access all the search screens more easily?	3.36 – 4.29	0.031	Service
Which approach allows users to choose suitable e-learning materials more easily?	2.57 – 3.64	0.0073	Service
Which approach is able to more clearly describe each repository?	3.36 – 3.64	0.49	No SD
Which approach allows users to choose between repositories more easily?	3.79 – 3.79	1	No SD
Which approach allows user to find out if each item of material is accessible or not more easily?	2.86 – 3.5	0.13	No SD

Table 2. Results for Hypothesis 2

Another respondent commented on the clear focus that the service approach supports: "… it has stated the goal clearly to me, it helps me to go to the right place more easily."

However, the current version of ST is not perfect, as the results from the last 3 tests show, and suggestions were made for adding extra features or information in the future, including a sorting feature while people are comparing the repositories. More information on peer comments and ratings were requested, including "information on how popular each material is, how many people have used them before." and "what each one's strong bit is, not only what people think is good, but why it is good."

A further suggestion was to add information on which materials each user should use, by considering users' roles or level of IT skills. For example, "Maybe you could have different services for students or teachers" and "You could also classify them as beginner level, or advance level … That depends on how complex the user is, what level of skills they have. I guess that would be a good idea if you have a series of checks on what level of tools they are. We have many tools available, but not many staff have the capabilities to use them."

Although not directly relevant to the approach, the 'look and feel' of the tool was perceived as significant. There were suggestions for more images such as logos or symbols, and fewer texts to describe repositories. For instance, "I think it is too wordy … people don't like to read that much text … I think the description needs to be shorter." This may help to explain the responses to the questions which related to clarity.

Thus it is clear that some further improvements can be done. The overall evaluation shows that the service approach is effective for describing learning materials and their repositories. However, the insufficient clarity with which the resources and repositories are described offsets this generally positive evaluation.

5. Discussion

Results from this experiment have suggested that, our proposed service approach is able to better help with discovering useful e-learning materials, because ST allows the users to find pertinent, meaningful results more quickly and more easily. The short interview with each volunteer at the end of this experiment has also suggested that, using ST to share current e-learning materials can bring other potential benefits:

- Individuals do not have to develop new materials from scratch, they can reuse or modify discovered materials to suit their needs, and this could save their time, cost and other human effects. Half of volunteers have addressed this.

- 9 out of 14 people have believed that, from users point of view, ST can bring more choices to them, they can get access to more and better quality materials which interest them, as the results, they are more motivated to use and reuse more materials in the future.

Our experience has provided direct evidence to support sharing benefits that other experts has discussed. For example, in a JISC's institutions' development report, Rothery [12] predicted that sharing can bring the benefits on "saving time and cost by reuse", "making better quality resources available". He has also mentioned that current learning management systems or repositories are excellent to create and store reusable e-learning contents. However, they are not really designed for sharing. This case study suggests that our service solution offers much greater potential to support this.

Our service solution also has potential to cope with problems in sharing e-learning resources. Literatures have mentioned a number of technical and educational issues in sharing e-learning resources, such as the technological needs to enable resources discovery, improve users' interfaces, educational needs to ensure resources are findable and used appropriately [13] and so on. Our work has provided a successful approach to deal with them.

6. Conclusion

This paper has presented evaluation results on applying our proposed service approach to sharing and reusing e-learning materials. Most users who took part in our experimental evaluation preferred our approach to the ones available within e-learning today. The findings also suggest that our service approach allows users to more quickly and effectively discover e-learning materials, than can be done using current approaches.

As we have maintained earlier, our proposed service approach also has the potential to share other educational resources, such as learners' information, assessment materials and so on. Due to the limitations on time, cost and human resources, we cannot implement the share of all these resources in this case study. However, the success of sharing e-learning materials in this experiment suggests that, our service approach, in particular the Educational Services Bus we have proposed, has potential to minimize the expense to develop educational resources and maximize the benefits of using and reusing current educational resources.

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