Measuring Learning Object Reuse

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Abstract. This paper presents a quantitative analysis of the reuse of learning objects in real world settings. The data for this analysis was obtained from three sources: Connexions' modules, University courses and Presentation components. They represent the reuse of learning objects at different granularity levels. Data from other types of reusable components, such as software libraries, Wikipedia images and Web APIs, were used for comparison purposes. Finally, the paper discusses the implications of the findings in the field of Learning Object research.

Key words: Learning Object, reuse, granularity

1 Introduction

The reuse of learning resources is the *raison d'être* of Learning Object technologies. Reusing learning objects is believed to generate economical and pedagogical advantages over the construction of learning objects from scratch [1]. Creation of high quality learning objects is a time and resource consuming task [2]. Reusing them in many contexts helps to compensate for those creation costs. Also, learners could have access to learning materials of good quality even if those objects were produced for other contexts.

Due to the importance of reuse in the context of learning objects, it has been one of the most visited topics in Learning Object literature. Some papers concentrate on the theoretical issues that are thought to intervene in the reuse of learning material [3] [4]. Simple questions, such as what percentage of learning objects would be reused in a given collection, however, have no answers yet. Moreover, assertions, such as the inverse relation between granularity and probability of reuse [5] , are taken for granted, but have never been contrasted with real-world data. In recent times the landscape of learning object publishing has changed thanks to initiatives like Creative Commons (CC) [6]. This openness finally enables the study of reuse mechanisms. This paper uses this newly available information to perform a quantitative analysis of the reuse of learning objects of different granularities in different contexts. In order to provide a useful comparison framework, the same analysis is also applied to other forms of

component reuse, such as images in encyclopedia articles, libraries in software projects and web services in web mashups.

2 Data Sources

To perform a quantitative analysis of the reuse of learning objects, this paper uses empirical data collected from three different openly available sources. The sources were chosen to represent different reuse contexts and different object granularities.

Small Granularity: Slide Presentation Components. A group of 825 slide presentations obtained from the ARIADNE repository were decomposed and checked for reuse using the ALOCOM framework [8]. From the decomposition, 47,377 unique components were obtained.

Medium Granularity: Learning Modules. The 5,255 learning objects available at Connexions [7], when the data was collected. Some of these objects belong to collections, a grouping of a similar granularity as a course. 317 collections are available at Connexions.

Large Granularity: Courses. The 19 engineering curricula offered by ESPOL, a technical University at Ecuador, reuse basic and intermediate courses. When a new curriculum is created, existing courses, such as Calculus and Physics, are reused. 463 different courses were obtained.

In order to offer a reference for comparison, data from other reusable components was also obtained from openly available sites on the web. The sources were chosen to be as similar as possible in granularity to their learning object counterparts.

Small Granularity: Images in Encyclopedia Articles. A dump of the English version of the Wikipedia database was used to obtain the identifier of the images used in different articles. 1,237,105 unique images were obtained.

Medium Granularity: Software Libraries. The information posted at Freshmeat under the category "Software Libraries" was used to obtain a list of 2,643 software projects whose purpose is to be used in other programs. Each project in Freshmeat can declare which libraries it depends on. That information was used to measure the reuse of each one of the posted libraries.

Large Granularity: Web Services. Programmable Web compiles one of the most comprehensive lists of Mashups and Web Services available on the Web. Given that a the code of the Mashup is small compared with the code of the Web Services, the Web Service could be considered as coarse-grained in the context of the Mashup. 670 Web Services were listed in Programmable Web.

3 Quantitative Analysis

We measure the percentage of objects that has being reused within a collection. To measure this percentage, the number of objects that have been reused was obtained for each set. This number was then compared with the total number

of objects in the set. Table 1 presents the results of this measurement for each data set.

Table 1. Percentage of reuse in the different data sets.

Data Set	**Objects**	**Reused**	**% of Reuse**
Small Granularity			
Components in Slides (ALOCOM)	47,377	5,426	11.5%
Images (Wikipedia)	1,237,105	304,445	24.6%
Medium Granularity			
Modules in Courses (Connexions)	5,255	1,189	22.6%
Soft. Libraries (Freshmeat)	2,643	538	20.4%
Large Granularity			
Courses in Curricula (ESPOL)	463	92	19.9%
Web APIs (P.Web)	670	216	32.2%

The most interesting result from this analysis is that, in almost all the data sets, the percentage of reuse is close to 20%. This percentage is the same for learning object related sets and sets used for comparison. It is also maintained at different levels of granularity. However, two sets deviate from this value. The reuse of slide components has a percentage of reuse significantly lower (11.5%). On the other hand, the reuse of Web APIs is significantly higher (32.2%). A possible interpretation for this factor is presented in section 4.

The quantitative analysis seems to indicate that in common settings, the amount of learning objects reused is around 20%. While relatively low, this result is very encouraging for Learning Object supporters. It indicates that even without support or the proper facilities, users do reuse a significant amount of learning materials.

The quantitative analysis suggests that the percentage of learning object reuse in a given collection or repository is similar to the percentage of reuse of other types of reusable components, such as images, software libraries and Web APIs. This answer implies that learning objects are not intrinsically easier or harder to reuse than other types of components.

The theory of Learning Objects affirms that higher granularity leads to lower reusability. A naïve interpretation of the results contradicts this affirmation. The percentage of object reuse was similar regardless of the granularity of the object. Courses were even reused more often than slide components. Merging the theory with the empirical finding leads to a new interpretation of the role of granularity in the reuse of learning objects. This new interpretation involves also the granularity of the context of reuse as the determining factor. Objects that have a granularity immediately lower than the object being built are easier to reuse than objects with a much lower or higher granularity. For example,

when building a course, it is easier to reuse whole lessons than reusing complete courses or individual images. Also, when building a curriculum, it is easier to reuse complete courses than to reuse another complete curriculum or individual lessons. Empirical support for this new interpretation can be found in [9]. It was found that when building a slide presentation, the most reused component type was by far individual slides. The reuse of text fragments and individual images represent just 26% of the total reuse.

4 Conclusion

This paper offers a quantitative analysis of the reuse of learning objects in real-world scenarios. Long-held ideas and beliefs about learning object reuse are tested against empirical data. The results obtained in the analysis should force us to rethink some of those ideas. However, the analysis also shows that the theoretical and empirical developments made in other types of component reuse can be "reused" in our context to accelerate the understanding of the mechanisms behind learning object reuse.

Arguably, the most important conclusion of this work is that the reuse of learning objects is a process taking place in the real world, even without encouragement or the support of an adequate technological framework. However, it also can be concluded that the efforts made in Learning Object technologies to improve the reuse process through facilitating the different steps during the process can lead to increases in the amount of reuse.

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