Learning Object Creation, Management and Reuse by Non-experienced Content Developers

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Abstract

According to standardization initiatives and vendors of both authoring tools and Learning Content Management Systems (LCMSs), the application of 'learning objects' promises an effective and efficient way of creating, managing and reusing learning materials. However, actual reuse is nowadays seldom applied optimally, mostly mainly at an 'instructional clipart' level, in a non-automatic way. Also, the creation of learning objects appears to be as complex, time-consuming and expensive as with traditional multimedia learning material. The pilot study described in this paper is aimed at gaining insight in the creation and management process of learning objects, to determine optimal support for content developers.

Authors biography

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INTRODUCTION

In applying E-learning, the availability of interactive, multimedia learning content is one of the most important factors. Although there is much attention to E-learning systems like Learning Management Systems (LMSs) and Learning Content Management Systems (LCMSs), these systems have to be provided with the appropriate learning content, otherwise they cannot contribute to effective learning processes.
Learning content can be acquired by purchasing it Commercial Off The Shelf (COTS) (Rosenberg, 2000). In most cases the first option will not be sufficient, due to the very specific training needs of organizations like for instance the Military. In the second option, one can choose to develop learning content in-house, or outsource it. But in both cases, domain knowledge provided by domain experts like Subject Matter Experts (SMEs) or instructors is required. So their involvement in the specification and development phase is crucial and often very substantial. To reduce costs, many organizations choose to create learning content in-house, by involving these domain experts in the actual learning content development. Since they are non-experienced programmers or content developers, authoring tools that promise easy and fast development of learning content, are used to support these domain experts. Currently, many LCMSs are equipped with such authoring facilities (Chapman & Hall, 2001).

According to learning technology standardization initiatives and vendors of authoring tools and LCMSs, the application of 'learning objects' promises an effective and efficient way of creating, managing and reusing learning content (E-learning consortium, 2002). For instance the Advanced Distributed Learning (ADL) initiative has based its SCORM model entirely upon learning objects[1]. Learning objects are small, independent chunks of learning content, that can be easily (re)combined into different kinds of learning arrangements. In theory, such modularization of learning content offers amongst others new perspective on development, as reuse of learning objects can make such processes much more efficient: create once, use many times. In particular, for the non-experienced developers, as they can reuse learning content / -objects created by colleagues or professional developers. However, the actual benefits of reuse of learning content are not proven in practice yet, and many consequences are not yet well understood.

This empirical study investigates how non-experienced developers like domain experts, developing learning content by means of learning objects, can be supported by means of authoring tools.

[1] ADL is a typical example of a learning technology standardization initiative. The purpose of this US DOD / White House initiative is 'to ensure access to high-quality education and training materials that can be tailored to individual learner needs and made available whenever and wherever they are required. This initiative is designed to accelerate large-scale development of dynamic and cost-effective learning software and to stimulate an efficient market for these products in order to meet the education and training needs of the military and the nation's workforce in the 21st century. It will do this through the development of a common technical framework (the Sharable Content Object Reference Model (SCORM)) for computer and net-based learning that will foster the creation of reusable learning content as instructional objects'. For more information see www.adlnet.org. For other examples of standardization initiatives, see the comprehensive overview provided by IEEE LTSA document (www.edutool.com/ltsa).

BACKGROUND

The Royal Netherlands Army (RNLA) has over 10 years of experience in content development by domain experts. A field study we conducted in 1999 and 2000 revealed a number of problems (Boot & Van Rooij, 1999, 2000). Most development projects exceeded time and budget constraints significantly. Apparently, content development is much harder than assumed. Despite the application of authoring tools, content development still requires considerable amount of programming- and technical knowledge. Also, these non-experienced developers find it hard to translate their knowledge of traditional, classroom-based didactics into interactive, multimedia learning content. Besides this problem, many domain experts focus too much on technical issues and neglect many important didactical issues. These problems occur despite the application of authoring tools that claim to support domain experts in developing learning content.

This situation is applicable to many organizations. As a reaction to this situation, vendors of authoring tools are starting to provide 'zero-programming' tools. These tools offer standard solutions for standard problems, by embedding these solutions into templates (Limbach, 2001). These templates can be filled easily with the desired domain knowledge by means of wizards. Once filled, the templates constitute a piece of learning content. Examples of build-in solutions are default interfaces, standard navigation structures, glossaries and learning activities like drag-and-drop questions etc. However most tools focus mainly on the above-mentioned technical issues, some pretend to be 'didactic templates'. They embed didactical models, like for example Gagné Nine Events, into the templates.

Due to the growing attention towards standardization of learning technology, many authoring tools also focus on creating standardized learning objects. These learning objects are standardized in structure, the way they connect to other learning objects, the way they are labeled with information indicating what kind of learning object it is (metadata), and the way the can be delivered by learning systems. By using learning objects, developers can create new learning arrangements (courses, modules, lessons, practice items etc.) by searching for existing, relevant learning objects to reuse. Using the appropriate metadata to label the learning objects can enhance these searching activities. The ADL-SCORM model prescribes a set of metadata fields that can be used for this. If a learning object is found that matches the need completely, the developer is finished. If learning objects are found that matches only partially, the developer can adapt one or more learning objects to create the learning object he needs. For this adaptation process, the developer can sometimes search for assets (the ADL-SCORM term for lower order learning objects like graphics, video-files etc.) within Sharable Content Objects (the ADL-SCORM term for higher order learning objects like lessons, learning activities etc.), in order to reuse these assets in the new learning object. If there are no matching learning objects found, the developer starts creating a new learning object from scratch.

In all of these cases, the new learning object can be (re)used for training or development purposes by other instructors or developers. This process of creating, storing, searching, reusing and adapting is supported by modern LCMSs (Chapman et.al. 2001). LMCSs consist of databases with content management features, and often additionally provide (template-based) authoring tools for the creation or adapting of learning content.

In practice however, it appears that actual reuse of learning objects is seldom applied optimally, mostly mainly at an 'instructional clipart' level (Wiley, 2001). Efficient reuse is more difficult that on first sight, because of the following reasons.

1. *Technical reasons*. Reuse requires standardization; otherwise learning objects are not compatible with each other. But standardization is still in its infancy. Many standardization initiatives like ADL-SCORM are still evolving, which makes it sometimes hard to standardize current learning objects to be future proof. Also, information about standardization is complex and difficult to understand, especially for non-experienced developers. Hence the need for template-based authoring tools that offer support in these issues. Unfortunately these tools suffer the same problems with the still maturing standards. Furthermore, the labeling process (adding metadata to learning objects to find them back later) is not clear to many developers (Stout, Slosser, & Hays, 2001). For example, it is not clear which labels and information should be used for labeling learning objects.

2. *Didactical reasons.* An important problem is that it is unclear which size a learning object exactly should be for optimal reuse. This may not seem an important issue, but for a developer searching for a learning object about how to operate a radio, it is crucial to know this size for the purpose of reusing it in a series of other learning objects about radio's. Another problem is that in a learning arrangement comprised of a series of learning objects, it is logical to use the same tone, expressions and abbreviations. If one learning object of that series is reused in another setting, this can be very confusing and unclear for the learner. So the developer is required to adapt the learning object, which lowers the efficiency of reuse. Finally, learning objects from different countries or organizations, or even departments, do have (sometimes only implicitly) very different didactical, semantically and cultural assumptions embedded, which may cause problems for reuse.

3. *Psychological reasons.* Non-experienced developers can be afraid to share their products with others, as this exposes their expertise and personal ideas about didactics to other people. Also, in many organizations the 'not invented here' syndrome can prevent to use learning objects from other sources than their own (development-) departments.

4. *Security and juridical reasons*. Especially in Military organizations, much information is sensitive and classified. This is obviously a serious threshold for reuse by others. Another bottleneck is the Intellectual Property Right (IPR) issue. The developer of a learning object (or his organization) normally holds the IPR of that object. For other developers or organizations that want to reuse this particular learning object, it is unclear how to deal with this issue. Should the original developer be consulted or paid? But how much should be paid? Should he be paid also if the original learning object is adapted and therefore changed? And is it allowed to adapt the learning object?

Although the application of learning objects seems to be promising, much work has to be done to overcome these bottlenecks that can seriously hamper reuse and neutralize the potential efficiency benefits. Therefore, our research group conducted a number of studies to investigate how non-experienced developers deal with these new issues and how they can be supported in their development processes. In the first exploratory study, described in this paper, we focus predominantly on support that can overcome the mentioned technical, didactical and psychological bottlenecks that may hamper reuse. This development support is based upon on an template-based authoring tool and a LCMS that is ADL-SCORM compliant.

The following three research questions are formulated. Firstly, are domain experts as non-experienced developers able to develop qualitative good learning content efficiently by means of creating, reusing and adapting learning objects? Secondly, what are the requirements for template-based authoring tools and LCMSs to support non-experienced developers optimally in these efforts? Thirdly, how should metadata for learning objects be used to support non-experienced developers optimally in these efforts?

METHOD

Design: We asked eight representative non-experienced developers of the RNLA to participate in an exploratory study of six days, in a laboratory setting. In this study, they received a number of meaningful and challenging development and content-management assignments, to be carried out by means of tools that support them in development and content management. Before, during and after the development assignments, questionnaires where used to gather information about their opinions. Also, during the assignments observers monitored the development process. Table 2 shows the design used for providing the assignments. Session 1 is shown. Session 2 did take up also 3 days, in which the same kind of assignments where repeated, but for different topics.

	Days	Teams 1, 2, 3 & 4	
		Assignment	**Topic**
Session 1	1 morning	Saving Assets	'Medical Instruments'
	1 afternoon	Searching Assets	Field orientation
	2 whole day	Developing SCOs	Field orientation
	3 morning	Saving SCOs	Field orientation
	3 afternoon	Search SCOs	'Medical Instruments'

Table 2. Assignments in Session 1.

Participants: In the experiment, we used four teams of each two experts working in the same domain. The two-person teams were used to represent their normal situation, as they normally work in couples. Also, this gives them the opportunity to articulate their reflections better to each other that will be beneficial to our process observations. The participants were all domain experts in a particular domain, namely Engineering, Medical, Artillery and Air Defense. The average content development experience was 4 years (s.d. 3), and their average experience with authoring tools was 2 years (s.d. 1). But they can be considered as novices, as they have participated in only a very limited number of productions, of relative low complexity. So each team consisted of two participants that share the same domain expertise but differed to some extent in content development experience. None the participants had experience with the specific tools that are used in this study to support them in development and content management.

Environment: The teams worked independently in small rooms, equipped with two computers, with the supporting tools installed and with broadband access to a central server. The tools used are the SCO generator and a repository. The SCO generator is an authoring tool based upon didactical templates that can simply be filled by means of wizards. Different kinds of multimedia files (in SCORM terms: assets) can be easily imported. The learning content made with the SCO generator consists of ADL-SCORM version 1.2 compliant learning objects packaged together into a course. According to the SCORM, these learning objects can be SCOs (lessons, parts of lessons, exercises etc.) that can be run separately, or Assets (graphics, documents, video files etc.) that are included in SCOs. The didactical model embedded in the templates corresponds completely with the didactical principles used within the RNLA. The repository resides on the central server, is custom build and simulates a typical LCMS, with functionality to store learning content / learning objects, add metadata to label the learning objects, and search engines to search for learning objects by means of metadata.

Tasks: There are five different assignments. 1) The developers must save a number of assets that where provided by us, by adding metadata and storing it in the repository. 2) The developers must search for assets, saved by another team, by means of metadata. 3) The developers must develop a piece of learning content consisting of SCOs, by means using the assets found in the previous assignment in the SCO developer and a didactical scenario provided by us. 4) The developers must save the developed SCOs, by adding metadata and storing it in the repository. 5) The developers must search for SCOs, saved by another team, by means of metadata. In both sessions, different topics for the assets and SCOs are used.

To use metadata, we provided the repository with a metadata-template, shown in Figure 1. We used the ADL-SCORM metadata set, but limited the fields to the 7 we felt where most important for reuse within the RNLA. These are listed in Table 2. Other ADL-SCORM fields are either not used or filled in automatically by the metadata-template. A search-template of the repository supported multiple ways to search assets and SCOs by means of metadata, namely searching by Keywords, Classification, Format, by Icon (thumbnail overview), or Open Search.

1.0 General
1.1 Title
1.5 Description
1.6 Keyword
4.0 Technical
4.1 Format
9.0 Classification
9.1 Purpose
9.2 Description
9.3 Keyword

Table 2. List of used ADL-SCORM metadata

Materials: The repository was filled before the study with enough both relevant and redundant assets. The redundant assets prevented search assignments from being too easy, and the relevant assets prevented developers from creating multimedia files themselves in stead of using existing once, as this wasn't the scope of the study.

Variables: In each assignment, a questionnaire was distributed. The questionnaire included questions about the way the assets or SCOs are saved, searched or developed. The questions where concerned with the opinions of the developers, the time needed and if they succeeded.

Procedure: All teams started with a one-day training session, in which the procedure and the purpose of the study where explained. Also, the functionality and operating of the SCO generator and the repository where demonstrated, in order to get acquainted with these support tools. The purpose of learning objects and learning technology standardization were not discussed, as dealing with these ideas was one of the depended variables. The usage of metadata fields for the labeling of learning objects was discussed, but not which values should be used to fill in the fields. During the training session, an example of a course created in the SCO generator was shown as a worked example. Then the first session started, consisting of three days, followed by the second session.

Data analysis: The data gathered from the questionnaires and interviews are analyzed with the statistical program SPSS.

RESULTS

Originally, four teams participated. Due to circumstances, one member of one team couldn't be present the second session. The data from this team is not included in the analyses concerning comparison of the teams, but only in other, individual analyses.

Reuse: Prior to the study, most developers where not convinced of the advantages of reuse. Four of the eight developers have reused assets from one course for another course, but other applications of reuse are rare. However, the developers indicated that they expected the presence of more reusable learning content within the RNLA. They also didn't object to reuse of their own learning content by others. But they identified a number of bottlenecks of reuse. The first bottleneck was that they didn't know from each other whom has which learning content available. Second, once they found out about a potential reuse possibility, problems with the accessibility of learning content and the interoperability between learning systems occurred. Third, incompatibility of the many different technical formats causes often customization, which is often as expensive as creation from scratch.

Support tools: Before the study, almost no developer had experience with a template-based authoring tool. The conclusion after the study about support by a template-based authoring tool was rather negative. But this is mainly caused by the fact that the tool used, the SCO generator, had some serious defects and bugs. However, the opinion about the usage of such a tool for reuse of learning objects increased from 3.6 (s.d. 0.78) in Session 1 to 5.3 (s.d.2.21) in Session 2, on a 10-point scale. This increase was significant ($p<.10$).

The opinion about the repository was also increasingly positive. In the first session, the usage of the repository for reuse was scored 4.7 (s.d. 1.8), but this increased in the second session to 6.1 (s.d. 0.69), also on a 10-point scale. This was also significant ($p<.10$). The developers where able to conduct search activities increasingly faster. In average, they needed in Session 1 for each SCO 2.6 minutes (s.d. 0.97). In Session 2 this was reduced to 1.1 minute (s.d. 0.37), which was a significant difference ($p<.05$). They preferred to search by Keyword or by Open Search, compared to the other search methods ($p<.05$). This was a stable effect during the experiment ($p<.10$).

Metadata: Before participating in the study, the developers did not use indexing or labeling methods for their learning content. After the study, the developers indicated that they see ADL-SCORM metadata as a means to provide insight in the available learning content within the RNLA. The relevance of the General fields Title, Description and Keyword was rated higher than the other four fields ($p<.05$). Also the usability of these three General fields Title, Description and Keyword was rated higher than the other fields ($p<.05$). The usability of the Technical field Format was also rated higher than the Classification fields Purpose, Description and Keyword ($p<.10$). The developers rated the relevance of the Classification field Purpose lower than all the other fields ($p<.05$). They had more trouble in filling the Classification fields Purpose and Description than the others five fields ($p<.10$).

CONCLUSION

The main conclusion of this study is that non-experienced developers like domain experts are able to develop and reuse SCORM-compliant learning objects, if supported properly. So, the promised benefits of learning objects seem to hold. But this does not mean that reuse occurs automatically and easily within organizations.

Reuse: The developers worked in an ideal laboratory situation. The bottlenecks they identified must be taken seriously when reuse is applied in the real world. To overcome these bottlenecks, it is recommended to implement a LCMS that has at least the positive rated possibilities of the repository used in this study, and to formulate concrete policy concerning content management.

Support Tools: Although not very positively about the usability of a template-based authoring tool, the developers think that once a good working tool is available, they would benefit from it. The application of the repository was successful. For the implementation of a LMCS, it is recommended to implement those search facilities that allow searching by keywords or do an open search.

Metadata: Although not familiar with metadata, the developers learned rapidly to use it. But the results also indicated that some fields are strongly preferred over others. More research is necessary about the usability of the other, not investigated ADL-SCORM fields. It would be interesting to see if the attitude of the developers changes, if they have to fill all the ADL-SCORM fields.

Our future research is focused on applying template-based authoring tools that embed more advanced didactical models like case-based learning or problem-based learning, in order to investigate if reuse of such, more complex learning content is also possible.

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ACKNOWLEDGEMENTS

The authors would like to thank the RNLA participants for their time and dedication and Allard Strijker (University of Twente), Robert Visscher (RNLA) and Martin van Schaik TNO-HF) for their valuable contributions to this study.