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ADAPTATIONS TO A LEARNING RESOURCE

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Abstract: Learning resources have been created to represent digital units of exchangeable materials that teachers and learners can pull from in order to support the learning processes. They resource themselves. Leveraging the web, one can often find these resources. But what characteristics do they need in order to be easily exchangeable? Although several investigations have explored the ways in which resources are transforming the practice and ways to publish, few have considered realistic use cases, where the technical competency of the teacher is accounted for. Based on a concrete context-crossing exchange, this paper highlights facets of learning resources that enable an exchange of learning resources and, thus, the exchange of practices. Doing this allows us to highlight important facets that learning resources should show in order for them to be found, to be adopted, and to be adapted.

Key words: Learning resource, sharing, adaptations,

MSC classification: 97U70

1. Introduction: Learning Resources and their Environment

The introduction of computers has introduced multiple new possibilities of communication in our planet. Among them, a particular type of media is only to be found among the educators' community: learning resources.

Learning resources are similar to the learning objects described by D. Wiley [15]: they are digital artifacts that can be re-used in teaching and learning opportunities. The concept of learning resource can often be perceived as being quite general, going from a ruler to an exercise sheet, from generic software to didactical scenario. Among them, the Open Educational Resources (OERs) form a category of resources that are particularly easy to exchange because they are the objects of a permission: a license which allows free (re)distribution.

Learning resources have been studied in multiple research (such as the survey on mathematics resources' usage in [3] or the early vision [16]). In the mathematics education community, one can see several strands that converge around learning resources:

- Many advertise the important potential of learning resources to *enrich* the teachers' practice, for example to support him or her in deploying new technologies or pedagogies. In their investigations of the documentational approach [2] Gueudet and Trouche analyze the mutual enrichment of the professional development of the teacher and the learning resources they use and develop.
- Multiple research, e.g. recently [7], or less recently [13], shows that the *interpretation*, hence the *benefit* and the *sustained use*, of learning resources can vary drastically from one teacher to another. Kieran and others [9] show how a sample of learning resources become interpreted in very different ways by different teachers.

One would expect that the proliferation of learning resources, stimulated by a possibility to freely exchange them, would open the door to a wider use of digital technology in classrooms. It could become so widespread that resources would be available for all teaching practice types. However, this has not yet happened.

For this, learning resources need to find appropriate places of exchange, where different flavours can be easily identified, searched for, and proposed. That is the role of learning resources repositories.

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These are genereally web-based environements where users search for learning resources, exchange about them, collect them and rate them.

Several basic initiatives can be seen as learning resources repositories. Simple folders when one collects things are elementary examples; in these cases, the file names, folder names, and maybe the file-types constitute all of the information that allows a classification so as to assess or identify the resource; this is how the SFODEM initiative started in the mathematics education community in France [4]. Similarly, multiple online forums can be seen as collecting learning resources, or learning resources' URLs, embedding them within descriptions (of their use, of their qualities, or of their potential); this is the web-forum used by [7] in order to stimulate exchange about adaptations after training.

The contemporary learning resources repositories revolve around the idea of open educational resources, and offer through their web-access an ability for anyone of the public to easily visit, view, and consume, as well as, possibly, take part to the exchanges about the learning resources. Multiple example of such repositories exist. International examples include the i2geo.net platform, meant to exchange learning resources around dynamic geometry, the PhET repository of animations and scenarios for physics education (phet.colorado.edu), generic communities such as lemill.net, portal.opendiscoveryspace.eu, or curriki.org, aiming at covering any level of school in any domain. Many others can be found here and there at the local, national, or international levels. Each has its own set of members, its own methods to annotate and search learning resources, and its own methods of analyzing and reporting the quality.

Clearly, the communication that is possible through such platforms, as well as the abilities to offer a presentation of a learning resource on a web page, are strongly conditioned by the user interfaces of the platform, in particular the knowledge organization. For example, curriki.org and lemill.net have a fairly shallow model to denote the typical class level a learning resource is aimed at, e.g. 5th grade or 1st grade, whereas i2geo.net attempts to qualify it as fine as each educational region of Europe (e.g. *siebte Gymnasium Baden-Württemberg*). These differences impact the way learning resources are searched for and are contributed: too coarse annotations prevent fine grained searches necessary to obtain overseeable search results, too fine annotations may be difficult to enter (at query or contribution time) and may be missed in searches having searched for a neighbour term but not the desired one.

A particularly strong difference among the learning resources' repositories exist in their approach to *quality*: a visible assessment of the relevance of a learning resource made by users. While many repositories offer simple one-dimensional assessments (the so-called *ratings*), PhET does not offer ranking but only displays core objects (the animations) that are made by them and invites scenarios to be posted in any fashion; Curriki differentiates itself by making a basic check right after contribution but otherwise support free contributions of any resources' quality, and i2geo does similarly but requires evaluators to consider the resource under multiple (dynamic geometry-specific) aspects.

These differences stimulate the aim of this study: answer the research question: “How learning resources are searched for, are found, are evaluated for their potential and are adopted.” While multiple research about the impact and interpreation of learning resources are available, notably in the book of [3], very few describe the discovery process of learning resources and the move towards adoption. This paper aims at contributing in this direction by presenting a detailed adoption process and describing the qualities of a learning resources that lead to this adoption.

While interpretations and adaptations are recognized to be diverse, learning resources repositories, through their schema, standardize somewhat the dimensions of the space of possible adapations, at least their description which is encoded in the *metadata* that the repository manipulates and is the only information that is visible right away when meeting the resource. It is thus interesting to study the concrete adaptations dimensions together with the repositories dimenstions. This appears to follow the idea of a “learned adaptation” whereby teachers routinely perform adaptations to cope for their local context as explained in [1].

2. Case Study of a Resource Adoption and Adaptation

We shall focus our study on the use of the i2geo.net platform by teachers. This platform has the role of sharing of learning resources with dynamic geometry. While dynamic geometry files are among the supported types of the learning resources of this repository, it is not the only possibility and any media type, URL, collection, and archive is allowed. In particular, scenarios that articulate the usage of tools, including those of dynamic geometry, can also be found. Our case study example is such a resource.

The author has chosen to adopt and adapt a resource for his usage as a teacher in the 7th grade in Germany, at the local school. The chosen resource is focussed on the concept of linear mappings and leverages a real world description of a topic judged exciting for the target learners. It has been realized by Marina Digeon, a teacher in the region of Lyon in France. The resource is called "Utilisation de la notion d'échelle et le Pentagone", its i2geo view is depicted in the figure 1. It can be seen at the URL http://i2geo.net/Coll_Group_IREM-INRP-AcademiedeLyon/UtilisationdelanotiondechelleetlePentagone.

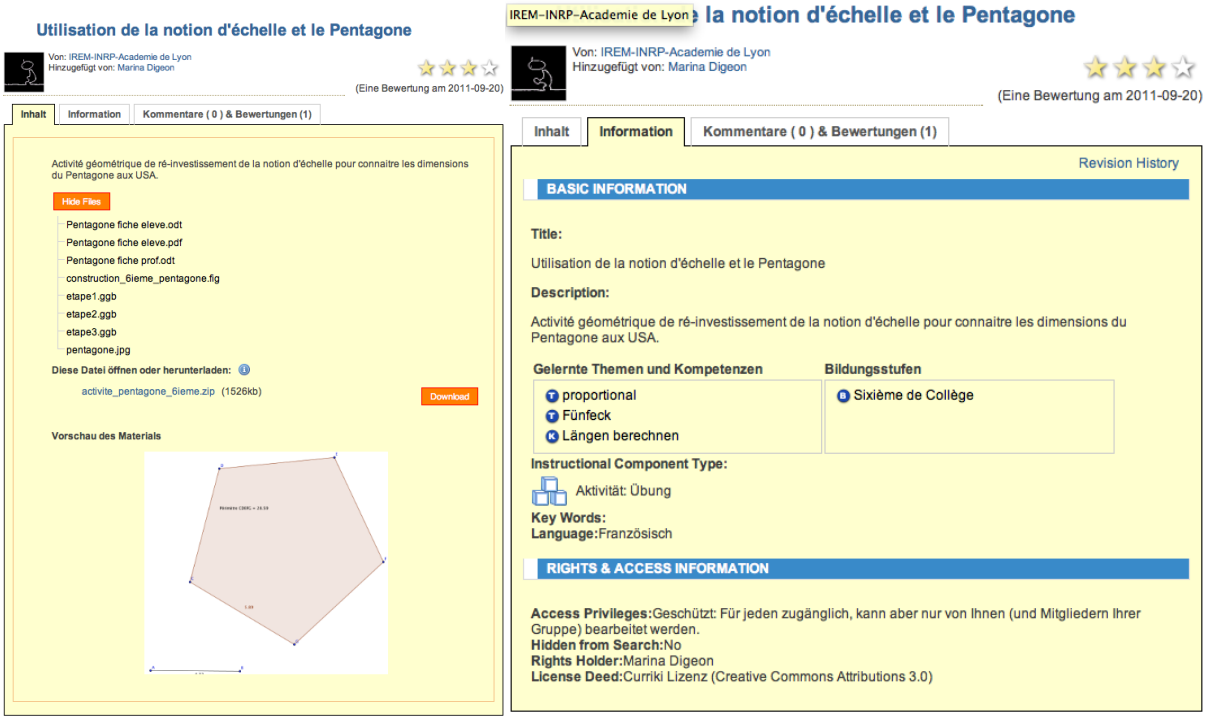

Figure 1: *The original "Pentagone" learning resource in its content and metadata view. Individual files are looked at by clicking on their names in the archives list.*

The displayed resource presents a title, a description, a list of files, the preview of a situation where it is used, the author name and a group where it was conceived; moreover, it is enriched with pedagogical annotations that describe how it has been designed to be used: in which school context (sixième de collège), for which topic (proportional, …), in which role (activity: exercise), and with which license it is shared. Aside, the summary of quality ratings is displayed.

The resource contains multiple documents that both help the teacher to apply it and to prepare for its use in classroom. With very similar settings (e.g. with the same curriculum objectives and the same software configurations), a re-use can be made without a change.

This resource has been adapted by the author of this paper (thereafter named the *adopting author*) so as to cope with a new context. The adapted resource has a similar title ("Travailler l'échelle sur le pentagone") and can be seen at the URL http://i2geo.net/Coll_polx/Travaillerlechellesurlepentagone .

It is depicted in figure 2. The resource displays similar information complemented with ongoing tasks and origin information.

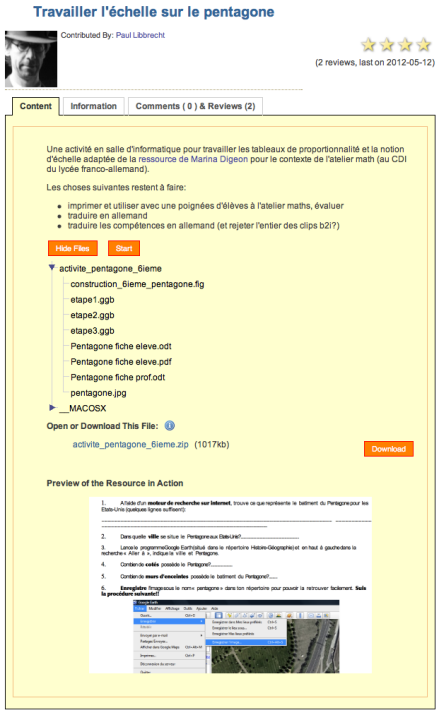

Figure 2: *The adaptated learning resource.*

This resource was found, adopted, and adapted for multiple reasons, which are all more or less connected to the repository display. The reasons are characteristics of the resources that correspond to situations of the recipients.

- It had an intersecting topic with the current target topics.
- It did not have an intersecting educational level (but the level understood to be similar).
- It was sufficiently complete to be felt as easily applicable.
- It was delivered with a source so that an adaptation was possible (and legally feasible).
- It was written in a language that the adopting author could understand (and, in this special case, re-use).
- The software actions described seemed generalizable to others known to work in the lab.

The adaptations that have been performed have been the following because the contexts were quite different:

- Change of software:
    - Cabri Géomètre to Euklid Dynageo (for its easy picture insertion),
    - Google Earth to OpenStreet Maps (for its openness and lack of installation),
    - use of the Windows-standard screenshot mechanisms (for the development of the learners' competencies).
- Change of informatics comptencies mentions (which are little present in the target school)
- Polishes for, mostly, the personal taste

These adaptations have been made possible because the resource was *authoring-complete*, that is the authoring sources were delivered along. Something that could be seen by inspecting the set of files as displayed in the figures.

3. Typical Requirements for Resource

While this learning resource has represented a project for both its original author and the adopting author, which started to communicate, it becomes a learning resource for others, only once posted to a repository. These aspects are the ones that interest us when speaking of requirements of a resource. Attempting to extend the best practice in [12] we present here, desirable attributes of a learning resource posted in a repository. We group them in reasons to find, reasons to adopt, methods to adapt.

3.1 Reasons to find:

Finding is employing search and navigation tools in order to isolate desirable resources.

- Classifications such as topics and target class-level are used as queries in the search and as expressive displays of the resources' characteristics. On i2geo and a few other platforms such as Open Discovery Space, one has the possibility of doing so in one's own language.
- Words of the title and description help to provide a quick glance of the resource before being chosen.
- The same holds for classification annotations such as the didactical role, and for the graphical preview of the resources.
- Such words might also have been used to search for the resource, but without cross-language effect that subjects and levels can reach.
- The attractiveness of the appearance is more often than not, an argument that stimulates the value of a found resource. This is among the results of [17].
- The usage of search engine is known to be interactive and indeed, [12]: “Of course, depending on what you will or will not find, some of these parameters can evolve”. Indeed, in the experience above, first few searches have probably been on related topics (e.g. linear mappings) without actually finding the exact topic. Search suggestions are, thus, an important ingredient. As well as navigation through search results and generalization.

3.2 Reasons to adopt:

Adopting is the selection action where a resource is chosen for future work (re-use with or without adaptation).

- Almost all aspects of the findabiliy count as reasons to adopt, the biggest being the relevance to the learning context and current learning objectives.
- If a resource is not modifiable in its license (e.g. CC-BY-NC) or in its software (e.g. in an output format such as a PDF or a video), all aspects, until the tiniest, of the resource count as a reason to not adopt. A single failure, which cannot be compensed for by the intervention of the teacher (e.g. shorten a video play, use an alternative software, or tell the students to ignore a part) leads to a rejection.
- If a resource is modifiable, in a format the adopting author can adapt, then reasons to adopt are to consider the current state of the resource as a good starting point for further work. The software used to edit is of importance; other facets include the facts that the files included in the learning resource are inspiring and easy to manipulate, or that the intended changes are easily envisioned by the adopting author.

3.3 Reasons to adapt

Adaptations are the process of modifying the received learning resources so as to reach readiness for the intended classroom usage. The differences between an original resource and its adaptations can be almost of any nature. The differences are generally similar to the following, which come close to the analysis of Hilton and Wiley [5]:

- Deleting parts in order to take less time or be combined with others.
- Combining the resource with others, which may come from completely different sources. This includes enriching some of the files with new ideas, new perspectives or new advice.
- Adaptating the language so as to cope with different terminology, different softwares, different pedagogical traditions or other differing dimensions of the educational context. Such changes range from simple software and screenshot replacements, until changes as radical as a rewriting to support a changed role distribution because the adapted resource is to be played in collaboration. Among the particularly important changes are the changes of software, something that has been seen by the author as quite common for personal flavours and as necessary to meet the reality of the classroom or the knowledge of the students.

4. Best Practice for Repositories and Resources

From the above reasons, one finds best practice recommendations for learning resources repositories and the way they are made available through them, which are not often mentioned:

- Searchability by fine grained aspects of the learning resources, in particular by fine grained topics, sounds to support the authors in finding appropriate resources. Other fine grained desirable dimensions could include the software names being used or the didactical principles followed. Moreover, the find process is supported if mechanisms to make the search process more interactive are offered. Approaches such as neighbour query suggestions [10], did you mean suggestions as described in [6, §4.3], or bringing recommender systems for learning [11] start to tackle this issue.
- Repositories should support the contributing authors in identifying the adaptability of their learning resources. Allowing an easy specialization of the search to the modifiable resources (as is done on flickr.com's search by license for example) appears to be useful. Moreover, supporting the identification of the availability of source files could help effectively avoid the *output only* type of publications as most often found in professional publishing houses or government based portals (e.g. only PDF).
- Support easy previewing of the learning resources appears to be an important way to stimulate adoption: listing the files of the resource, including graphical previews of the resource in action (as is done, for example in i2geo.net or in PhET and in almost every editorial part of the learning resources' portals) and including output formats as part of the resources so as to ensure a predictable view a click away from the resources' view in the repository, have helped the above process.
- Displaying visibly the *forking* relation between learning resources that are adapted may support another interactive search mechanism. Other such relations display have been used in several learning resources' repositories. For example the PhET repository's offer is centralized on about a hundred animations, to which thousands of learning scenarios of different flavours are linked. Similarly the repositories curriki.org and goorulearning.org organize learning resources into collections, and search results display this relationship. Both such approaches help searchers explore related resources and, from there, enrich their search queries.

While these best practice recommendations are almsot all implemented, no repository include all of them and evidence of their common applicability is not yet established. The arguments presented above all support them.

5. Conclusion

This paper has explored learning resources in their display within learning repositories. Such learning resources are often seen as supporting the teachers' practice in preparing their lessons. While the impact of the resources on the preparation and professional practice of the teachers has been studied, the search phase seems little studied yet. Based on the evidence that the search process is influenced by the inspection of individual resources, as far as the adoption inspection and the exploration of the adaptations, we have identified desireable aspects of the learning resources and their display that support a search, adoption, and adaptation process until the re-use in class.

The central example of this paper is a learning resource using dynamic geometry for the secondary school. We claim that such an example is typical of a learning resource exchange process. While this one has led to a resource that has been contributed back to the learning repository, most such processes are not and this is the reason the concept of dark re-use has been introduced [14].

Quite some questions arise following the paper. We list avenues which we think are promising below.

The "authoring-ready" nature is important to the use-case as above and is becoming more and more important as an essential characteristic of an adaptable resource. But can it be witnessed? Would it be suitable to ask registered users of a learning resources' repository the name of the softwares they commonly use so as to encourage the selection of "compatible" resources by putting those that employ usable software higher in the search results' list? Is the guessing needed, if one wants to identify if all sources are available for the adaptations to take place, satisfactory? For example, a data-graph may be included within word-processing documents but without the related data-set and spreadsheet document which produced it. This makes the data graph a throw-or-take-as-is object and can appear relatively late in the adaptation process; this can turn to a rejection, with bitter feeling of waste of time, or to considerable extra work.

The potential to enrich the teaching practice by sharing learning resources, while studied, is not yet studied to a large scale and in a way that can be generalized to cover, for example, the complete mathematics curriculum. While such approaches as [7] attempt at studying the long development processs of the learning resources' appropriation mechansim to a large scale anchored in the professional practice, they do so using a single community approach method. Could these efforts be turned into recommendations for learning resources repositories which can be used in many different participation conditions and timelines? The paper proposes suggestions based on a detailed analysis. But more substantial analyses are needed, so that widespread impact can be reached. Large scale initiatives such as the EU-wide Open Discovery Space platform or subsequent initiatives have the potential to measure impact differently.

Finally, another potential impact which has not yet been measured using learning resources but is emerging as a trend in the technology enhanced learning world is called "learning analytics" whereby traces of the learning processes are collected and summarized in a way that the learning can be witnessed. Learning resources repositories can benefit highly from such a feedback. An information display such "This resource has been successfully used in 70% of 27 classrooms by teachers in your network" may be quite effective in stimulating the adoption and in situating one's practice to that of the others. Few technical barriers remain to this end, but legal, ethical, and didactical unknowns brake currently the widespread deployment of such practices in learning resources. This has been demonstrated recently in sudden actions in the economy [8].

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