Re-Use? Is this Re-Use?

Revisiting an Objective of the Intergeo Project

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An initiative such as the Intergeo project has the clear mission to allow many teachers to gain easy access to resources that can support their teaching practice when using them. Re-use then appears when the sole usage is insufficient and needs adaptations to the specific context. This paper investigates the common practices of re-use in computer-science literature, describes how it was implemented in the i2geo platform, and how the actual usage of the platform shows that the definition we first envisioned and that is widespread is short sighted. Following the observations of the practices, generalizations of the notion of re-use are proposed.

Keywords: Re-use; reuse; adaptations; usage; teacher resources; computer supported learning; Intergeo; dynamic geometry.

Introduction

Using computers to support mathematics teaching has been researched since several decades; quite often the computers have been considered to be tools to perform computations and explore their boundaries. Since the advent of the Web, computers have become means of publications and communications and the notion of *teachers' resource* has appeared: Gueudet and Trouche (2009) speak of *resources* in a very general sense as the set of materials that are produced for and by the teaching activity: a school-book, a software, an interactive exercise, or a file for a software are examples of such.

Many of the teachers' resources are made of computer-based files which can be exchanged through the Internet. The ones in the focus of the Intergeo project concern the usage of dynamic geometry systems. This includes the following and probably many other sorts of resources:

- files for the dynamic geometry systems (e.g. a Cabri file)

- teacher advices for the usage of the files and tools (often called *teacher sheets*)

- guidance for pupils in their usage of the files and tools (often called *handouts*)

- reports about the usages (e.g. a critique).

A good example of teachers' resource can be found on i2geo.net, the platform of the Intergeo project: It is depicted in figure 1 on the right, it is a resource made of an archive with a dynamic geometry file, teacher, and student sheets; it contains annotations and a review.

The **usage** of a resource of the i2geo platform by a teacher involves reading the information about the resource, downloading its files, using them (*reading them*, *playing them*, *executing them*, …), gathering material for classroom usage and making it available to his/her students. One speaks of **re-use** when the usage intent or usage context is different than that what was originally designed. This definition, applied to learning objects, matches that of (Wiley 2001).

Figure 1: an example of teacher resource presented in i2geo. The list of *files* involved is below the description while a previous shows the resource in action. The annotations and reviews are available in another tab.

Teachers' resources as defined in (Gueudet-Trouche 2009) as well as learning objects as defined in (Wiley 2001) are of a very general nature. The i2geo platform did not try to change this generality and proposes that a **resource** is made by its content (a file, a lesson-plan, a wiki-page, a web-address, …), its web-address (so that one can speak about it), and its annotations.

Our focus is on material to support mathematics learning. Although it is likely that the considerations of this paper extend beyond mathematics and beyond learning, we claim that it is appropriate to focus on mathematics, because of its intensive usage of tools and textbooks, is particularly adequate for such a study, and that resources for learning have particular workflows.

Of importance for a resource to be accessed, and thus used or re-used, is that it is annotated with the appropriate information. This enables search queries to find it. The **annotations**, or *the metadata* as such a set of information is generally accepted to be called, are an integral part of a resource and form the essential knowledge that enables the i2geo platform to offer services to access the resource and teachers to read about it. They can, thus, discover:

- the topics and competencies intended to be trained

- the educational level (including the region and curricular system)

- a short description

- the instructional component type, i.e., the function in the teaching activity

- the license and rights enabling the use and re-use

- evaluations about the resource's usage

This information structure, explained in (Hendriks *et al.* 2008), has been created as main input for the i2geo platform to allow teachers to share their resources with others. The sharing activity is mediated by the web-platform which even enables teachers of one language to find resources about a topic that another teacher has input in a different language. See (Libbrecht *et al.* 2009).

The Intergeo project has been focused on making this objective of sharing interactive geometry easier to reach with efforts in multiple directions summarized by Kortenkamp *et al.* (2009): the design and implementation of the multilingual platform and its search facilities, the agreement on a common file-format to share across the boundaries of dynamic geometry systems, and the creation of quality evaluations procedures and best-practice. In this paper we describe how this sharing becomes re-use.

Related work

This research is the result of the experience gathered during the Intergeo project and is based on the many investigations on how computer-based resources are put to use by teachers.

Several research strands have been proposing models of digital resources. For this, we refer to the report on best practice of sharing of the Intergeo project (Mercat *et al*. 2009). The diversity of these models shows that a theory-neutral sharing platform should be flexible in its model of resources and thus consider resource annotations and re-use in a broad way.

Petrides *et al*. (2008) surveyed how re-use happened in the Connexions repository during its first five years. In this paper, resources are *modules*, which are entities of authoring of this repository, and re-use can be both the creation of a new version of the same module or branching into a new resource. The survey indicates a growing trend to re-use.

A book soon to appear (Gueudet *et al.* 2011) draws a very broad panorama of the life of digital resources used in mathematics teaching as observed in multiple educational systems. Several papers in this book describe the life of a resource until it reaches an actual usage in the classroom and continues thereafter.

Several recent published works also underline the diversity of the role of resources in the support of teaching. In Ruthven *et al.* (2007), the concept of *interpretative flexibility* is introduced based on several case studies of mathematics teachers in britain. Remillard (2005) proposes, after a broad review of didactical literature in the USA a differentiation between *intended* and *enacted curricula*, that the use by teachers of *curricula* is a participatory relationship which has its roots and constraints in the teaching practices. These papers show that teacher resources are likely to be used and, if possible, modified, in multiple ways.

While these studies concentrate on the usage of resources in the classroom, we attempt, in this paper, to elucidate the usage by a teacher of digital resources contributed by another: the re-use. It involves sharing (contributing, annotating), discovering, and adapting, all ultimately aimed at using in the classroom.

Outline

The paper first describes the classical forms of re-use under their technical aspects, indicating their advantage and drawbacks in the spirit of sharing quality resources. It follows with a description of the workflow of resources contributions and discovery on the i2geo platform showing how re-use can become wild. This opens the doors towards broader conceptualizations of re-use. Open perspectives conclude the paper.

1 Classical Re-use Practices

In this section, we review the classical re-use practices in wide use on the web. It involves a re-using author and a sharing author. This review will allow us to compare the value of each practice.

Copy-and-paste is probably the most widespread means to re-use. Within the edition of a file, copy-and-paste is used to transport a fragment of content from one *place* to another. Copy-and-paste is quite wild: generally, no trace is left of the transfer, and further adaptations are almost always possible. This is probably why it is most used.

Copy-and-paste is well suited for the purpose of introducing citations. Considering copy-and-paste as one of the best-practice means to re-use on a sharing platform would be wrong: copy-and-paste leads to the proliferation of duplicates, some of which are mildly adapted, some not, with almost no possibility of control or awareness of it. A search engine would return all *mild duplicates* as different results leaving users to identify which is best.

Copy-and-branch is the other widespread practice, and the one implemented in the i2geo platform. It involves starting with a file, bringing it in one's workspace (*to copy*), and further editing it (*to branch* as in versioning systems).

Copy-and-branch is widely used in desktop systems where « copying a file to serve as a basis for *the next file* » is one of the most widespread practices to start the work of such an activity as preparing slides for a presentation.

Hyperlink and **Transclusion** are two web-based methods to bring the reader of a file to read a file from somewhere else. Hyperlink implies that the user follows the link and reads the other file in its original context while transclusion, a term coined by Nelson (1999), involves embedding the content of the other file into the file in question.

Both methods are perfect in terms of respecting the origin and avoiding the duplication, but they are much less used because of their inherent fragility and their impossibility to change the content for the purposes of the readers of the file being edited.

This adaptability requirement seems to be essential for mathematics teaching as Lokar *et al*. (1998) noted. Even though it has been neglected for a long time by traditional publishing companies. Remillard also reports that involving teachers in the modification of the *curriculum* may be a way to engage them in their usage of it.

All these methods share the same objective in math education: enriching the documents of the classroom activity being prepared by the available contribution of someone else, be it a fragment or a modification of it.

2 Re-use on the i2geo Platform

The i2geo platform is a web-server that collects teachers' resources using dynamic geometry. It allows contributors to submit resources as sketched in the introduction in the form of arbitrary files and annotate them with information for its display. It allows readers to view the contributions, play them right away if a dynamic geometry file, and view the information about it. A function allows the information to be searched, some through multiple languages and curriculum regions. For more information on the platform we refer to (Libbrecht *et al.* 2009).

The most explicit way to trigger a re-use in the platform is using the **copy function**: this function is activated by a link that is displayed for each logged-in user when a resource is displayed as can be seen in figure 2.

Figure 2: two occurrences of the *copy* link offered by the i2geo platform: in the single resource view or in the list of resources of a user.

The invocation of this function is followed by forms to input a revised metadata. Once filled, one obtains a resource that belongs to the current user and which he or she is invited to modify further. The resource starts a new life, in the hands of a new owner. The statistics show a disappointing amount of use of this function (less than 20 from Nov 2009 until April 2010).

Another form of re-use is enabled by the **collections**, a special form of resource on i2geo which is made of a list of other resources or folders. Collections can be used to group resources picked here and there but are particularly well suited to assemble sets of related materials for a given teaching event: teacher advice, dynamic geometry files, student sheets, assessments… This form of contribution is suggested as best-practice by Mercat *et al.* (2009). Collections allow re-use when a resource is in more than one collection. Various reasons, including the fragility of the platform, have made it such that this best-practice has not been very popular.

Several other types of usages of resources come close to be re-use but were not considered as such; we include them here to enlarge the somewhat narrow vision above.

The simple usage of someone else's content in one's own teaching is also a form of re-use since the usage is done for a pedagogical context that differs almost inevitably from its originator's intent. Many examples of this action are available:

- reading (hence downloading) the uploaded files (25'586 times between November 2009 and April 2010)

- receiving the files, maybe modified, from another place where it was published such as a virtual learning environment (uncountable)

Considering usage-by-others as a form of re-use may be a more important concern than actually expecting the re-use-by-copy or re-use-by-collection. The major witness of the usage-by-others has been offered by the work-package on quality of the Intergeo project; they are proposing in (Trgalová *et al.* 2011) and (Mercat *et al.* 2009) that reviews be written about the resource's usage. In the reviews any user registered to the platform can formulate a *judgement* on the *quality of the resource*. Reading the review questions (see Trgalová *et al.* 2011) clearly shows that the focus is not only on intrinsic qualities of the resource but also on the quality of its potential usages.

3 Common Workflow of i2geo Users

To better understand the numbers reported above, it is useful to dive in the workflow of users on the i2geo. One of the typical workflow is run by teacher users of the platforms and can be seen in the many log-books reported about by Bourgeat *et al.* (2010). They report an iterative process, which can break anytime, along the following lines:

- pedagogical objectives are set in advance (standards, class progress...)

- the search tool is used to identify relevant resources, per notions or otherwise

- each of the potentially relevant resources is evaluated against further criteria such as: *Can my students play it? Is it detailed enough?*; generally starting from the top of the results which are sorted by relevance

- a resource is chosen, its content is adapted, and prepared for use by the learners

- for this resource an *a priori* review is formulated

- if the resource is used in the classroom, an *a posteriori* review can be formulated

- only if the user deems it useful to have a new resource different from the original, he/she contributes it as a new resource.

One important aspect of this workflow is that no criterion is definitive; the usefulness of a resource is measured compared to the price of further actions of the teacher user: that person will be *using* this resource, as a tool to help him/her to teach or his/her learners to learn; a dimension of advantage (e.g. *rich interactivity*) may well be counterweighted with a dimension of disadvantage (e.g. *I can't adapt it to use the vocabulary I used, so some students will be confused*). This follows the model of (Gueudet-Trouche 2009) and (Trgalova et al. 2011): a resource is only as valuable as it can be useful or meaningful in the recipient's context.

Users that the author has met are generally users that know well several dynamic geometry systems so that, among others, transferring from one tool to another was one of the least expensive operation. Other costs are attached to other competencies of teachers. For example, planning a sequence that implements innovative pedagogical approaches is more expensive and, thus, more often sought by these teachers.

The lessons learned from such a workflow for the consideration of re-use on the i2geo platform is that, clearly, the notion of re-use using the copy function or using collections with shared resources, fails to cover the most frequent actions that can still be considered re-use (e.g. deployment for students, imitation).

4 Broadening Re-use and Its Utility

The definition of re-use formulated in the introduction applies to many resources, much broader than just computer files or anything that has a URL. In particular, it applies to the relationship of *being inspired by someone else's usage* or even to *apply a theory*. We argue, in this section, that such a generalization is probably necessary and that a relationship with a name beyond re-use should be investigated, input, and displayed. We contend that such a generalization needs a manual input in many cases.

We have seen above situations of re-use which are beyond those of the concrete data-file exchange: among others, for normal i2geo users, if the physical-file-

based copy is more *expensive* than the creation of a new resource, the latter will be preferred. For such an action as imitation, who can make the statement that a re-use has been done? At this point, certainly only the author himself, indicating, for example, by a citation, that he/she is inspired by someone else's resource. Similarly, for the copy-and-paste and copy-and-branch methods, there is no method, to date, to trace automatically the fragments' origin; attempts at capturing the life cycle information is at its infancy, see e.g. (Lehmann *et al.* 2008).

A generic relationship of re-use is weak in meaning, but it can have a greater utility than the relationship of physical copy of a file. For example:

- The author that imitates has an advantage of keeping such a link for him to come back to the same for a refined observation, or to observe evolution.

- External authors may be much interested by the links indicating that someone else has been re-using (a part of) a given resource (in any of the senses above): this gives credibility to the piece of content, raises its applicability spectrum, and also allows third-party authors to look at different *transformations* of the first resource, for the better or for the worse.

- When a source of inspiration is changed, this may interest the re-using author, and, conversely, when a re-used resource is further changed, this may interest the source author.

Having had such a definition of re-use at the start of the Intergeo EU project would have delivered a very different measure of re-use and certainly a changed vocabulary: had the users had early the possibility of inputting some form of re-use relationships, they could have initiated the contribution work smoothly: they would have started from an existing web link, which was most of the known content before the project; they would have continued with a simple trace of an external resource with shallow classification, they could have then continued with refined extracts from this trace, and later with other derivatives. Visitors from the wide web would be able to enter most of the nodes of this relationships' graph and go backwards and forwards to understand the evolution of the resource towards a refined documentary organization according to the best-practice.

This should be compared to the current state of the platform where duplicates do exist but are only mentioned in text, if at all.

Conclusion

Classifying the relationships between resources that generalize the relationship of being technically copied is the research problem opened by this paper. It should allow users who are creating resources in a totally different world to declare their inspiration or copy.

Such a relationship, at this point, should, in the majority of cases, be requested to be input manually by the authors. This is probably feasible and useful. Before the actual implementation of such a feature within a web-based service, the possible types of relationships remain to be investigated. Here are a few that are worth mentioning, between two resources A and B:

- *A is a copy of B*
    - o *A is a copy and modification of B*
- *A is used inside B* (transclusion or copy-and-paste)
- *A is inspired by B* (imitation)
- *A has a part that is a part of B* (copy-and-paste)
    - o *A had a part that was a part of B*
- *A is* (was) *a translation of B*

while other relationships such as *A quotes B* is probably not of relevance for the notions of re-use.

Such relationships appear to be quite applicable for the resources that have been catalogued within the Intergeo project but further experiments are needed to validate it.

The generality of the concept of resource, as sketched in the introduction, may be one of the main impediment to characterizing re-use which is a concept with roots in the software development practice. We believe that focussing on the editorial workflows of works of different publishing or didactical natures can reveal the concrete nature of these relationships as well as their common meaning. It is likely, that different documentary natures yield different methods of inputs of the re-use relationships.

The relationships of re-use have the potential of stimulating the fuzzy creation of Communities of Practices which appear as fundamental to allow the authoring process to go forward by the evolution of the shared meaning enabled by the

concretely authored resources (the *reifications*) as explained by Fischer and Ostwald (2003). For example, the blogosphere is host of such communities of practice where the actual resources and the comments intermix each other and allow refined resources: blog posts that treat the same subject in a better way.

Within a sharing platform similar to the i2geo platform, or even within the broad web, such links could be made visible and be exploited as witnesses of evolutions: for example, it could show the evolution of resources *around* a given resource and notify the interested parties of the change. A model of such a community and its technical implementations remain to be described, in particular one that allows an inexpensive enrolment within a community as well as intensive collaboration.

Last but not least, the spread of a practice of establishing an explicit re-use link could help authors publish learning resources on the web with more confidence. Indeed, each time we have asked digital learning resources' authors to consider a license with the right to redistribute modified versions (the right to *derive*), we have met this same question: *But what are other people going to do with it?* This may start to bring the first answers.

Acknowledgements

Bibliography

Bourgeat F., Calpe A., Digeon M., Esfahani E., Leyraud I., Soury-Lavergne S., Thomas R., Touraille O., and Trgalová J. (2010). Working on ressources quality assessment on i2geo. *Proceedings of I2GEO Conference 2010*. See http://cermat.org/i2geo2010/.

Fischer G. and Ostwald J. (2003). Knowledge communication in design communities. In Bromme R., Hesse F., and Spada H. (editors), *Barriers and Biases in Computer-Mediated Knowledge Communication*. pages 1-32. Kluwer Academic Publishers., 2003. See http://l3d.cs.colorado.edu/~gerhard/papers.html.

Gueudet G. and Trouche L. (2009) Towards new documentary systems for mathematics teachers? *Educational Studies in Mathematics*, 71(3), 199-218, DOI 10.1007/s10649-008-9159-8.

Gueudet G., Pepin, B., Trouche L. (2011, *to appear*). *From Text to 'Lived' Resources: Mathematics Curriculum Materials and Teacher Development*. Springer Verlag.

Hendriks M., Libbrecht P., Creus-Mir A., and Dietrich M. Deliverable d2.4: Metadata specification. Deliverable 2.4, Intergeo Project, Available at http://www.inter2geo.eu/files/D2.4-Metadata-Spec.pdf, June 2008.

Kortenkamp U., Blessing A. et al. (2009), Interoperable Interactive Geometry For Europe – First Technological and Educational Results and Future Challenges of the Intergeo Project. In V. Durrand-Guerrier et al. (Eds.), *Proceedings of the Sixth CERME conference*, 2009. http://www.inrp.fr/publications/edition-electronique/cerme6/wg7-11-kortenkamp.pdf

Lehmann L., Rensing C., Steinmetz R. (2008): Capture of Lifecycle Information to Support Personal Information Management. In: Dillenbourg P., Specht M.: *Times of Convergence: Technologies Across Learning Contexts, Third European Conference on Technology Enhanced Learning, EC-TEL 2008*, p. 216-221, Springer. ISBN 978-3-540-876-04-5.

Libbrecht P., Kortenkamp U., and Mercat C. (2009). I2Geo: a Web-Library of Interactive Geometry. In *Proceedings of the Workshop on Digital Mathematics Libraries 2009*. See http:// i2geo.net/xwiki/bin/view/Main/Proceedings.

Lokar M. (1998), *DERIVE v slovenskih srednjih šolah. Analiza anket*, Zavod za šolstvo.

Mercat C., Hasek R., Leistenschneider M., Pech P., Recio T., Soury-Lavergne S., and Trgalová J. (2009) Report on best practises for DGS content. Deliverable D6.2, Intergeo Consortium, Nov 2009. See http://i2geo.net/xwiki/bin/view/Main/Publication.

Nelson T. (1999). Transpublishing: A simple concept. web-page, March 1999. See http:// xanadu.com.au/ted/TPUB/TPUBsum.html accessed Sep 18th 2010.

Petrides L., Nguyen L., Kargliani A., and Jimes C. (2008). Open educational resources: Inquiring into author reuse behaviors. In *Proceedings of ECTEL 2008, Maastricht*, Markus Specht and Pierre Dillenbourg (eds), volume 5192 of LNCS, pages 344-353. Springer Verlag.

Remillard, J. T. : Examining key concepts in research on teachers' use of mathematics curricula. *Review of Educational Research*, 75(2): 211-246, 2005

Ruthven, K., Hennessy, S., Deaney, R. (2008). Constructions of dynamic geometry: A study of the interpretative flexibility of educational software in classroom practice. *Computers and Education* 51(1), 297-317.

Trgalová J., Jahn A.-P., and Soury-Lavergne S. (2011). Quality assessment process for dynamic geometry resources in Intergeo project. In this volume.

Wiley D. A. (2001) Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy. In Wiley D. A. (editor), *The Instructional Use of Learning Objects*, pages 1-35. Association for Educational Communications and Technology, 2001. See http:// reusability.org/.