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Print to Pixels: the implications for the development of learning resources

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Abstract

In this paper we reflect on the implications for pedagogy and infrastructure of the move from paper based resources to digital learning resources. A model of production of paper based educational resources is proposed, and the way in which the move to electronic educational resources has interfered with this process is outlined. Some of the negative implications of these changes for pedagogy are explored. Some approaches available to resolve the interferences are identified. IMS-LD is identified as a key technology, and drawing on the work of the UNFOLD project the concepts underlying the exchange of chunks of pedagogy, and institutional policy regarding copyright are discussed. Conclusions are offered summarising the most promising approaches and the issues to be addressed.

Introduction

Littlejohn (Littlejohn 2003) describes how *numerous national and international initiatives have been funded to investigate ways in which digital learning resources might be developed, shared and reused by teachers and learners around the world (so as to benefit from economies of scale)*. The idea of sharing and reusing learning resources, however, is at least as old as the book, however, and as Downes has pointed out (Downes 2001) "today's classroom is already an example of extensive resource sharing". So it seems that we are confronted with a major initiative to implement an established practice (sharing learning resources) in a new context (digital technology).

This has been successful in many respects. There are many commercially produced digital learning resources, and many web pages produced by learners and teachers. Digital resources have many advantages, e.g. interactivity, no printing costs, improved access, and learning situated within learners' technical environment. Nevertheless it seems to me that in the move from paper to pixels something of great value has been lost. This paper proposes a simple model which helps to clarify this, and identifies current technologies and approaches which can help in recovering the processes which have been lost in the move to the digital domain.

Twenty years ago I was studying a Postgraduate Certificate in Education, and in great need of help in planning for my teaching practice in schools. I was fortunate to have access to an Educational Resources Centre, a large room whose walls were covered by shelves containing box files full of classified lesson plans and resources contributed by teachers and some of the more successful students. Any teacher or student in the area could take advantage of this huge pool of documented practice in a wide range of subjects. Often the learning resources would be duplicated using cyclostyle machines, ready for use. There were many more resources are found than can possibly be used, and as students we would sometimes browse categories of resources

until something useful appeared, but often we would rely on word of mouth recommendations, and the most successful lesson plans and resources became refined and widely used. Similarly in departments in schools teachers would ask their peers for suggestions for ways to approach tricky subject matter or teaching problems. In this way useful teaching strategies could be shared among practitioners and the most effective became more widely used. When excellent teachers became teacher trainers or authors of course books, these strategies were made available in a high quality format to the wider school community. The effectiveness of some of these resources can be evaluated in full scale trials (although research, and particularly action research, is also appropriate at all levels). Thus, for paper resources, there is a continuum between individual resource creation, and professional publication, mediated by appropriate technologies and social structures, and ensuring that shared and published resources are rooted in practice. We can look in vain for equivalent structures in the digital domain.

The resources pyramid

Summarising the scenario described above, there is a wide base of practice which can be produced by any teacher. The results can be shared by practitioners and gradually be filtered to inform a much smaller set of resources which are professionally published. The creation and refinement of resources is (inevitably) informed by explicit or implicit theories of learning, but the resources progress up through the layers of the pyramid is determined by pragmatic factors (i.e. are they useful in the classroom with a particular group or groups of learners). We can represent the process as a pyramid:

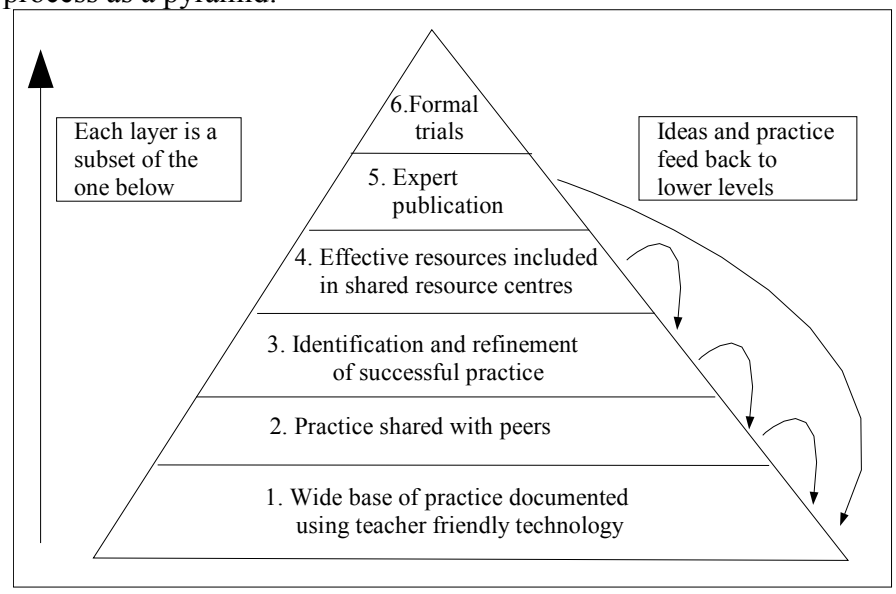

Fig 1: The resource pyramid: a model of publication based on shared practice

Please note that a) it is not claimed that all paper based educational resources are produced in this way, only that the process is available and enabled by the technology, and b) materials at the top do not necessarily produce better learning for a particular group of learners than those at the bottom, but they will be useful to and reusable by many teachers.

What happens to the pyramid with digital resources?

When working with digital materials resources barriers appear in the four lower sections of this pyramid, all of which concern the creation and sharing of resources. Taking each layer in turn:

1 *Raising the bar of technological competence*. Many teachers do not have the technical skills to create a simple web page, have insufficient or obsolete computers in the classroom, or do not have the skills to manage a class in working with online resources. In these circumstances it is very difficult to achieve wide base of teaching practice using digital resources. Moreover the effort involved in creating even a simple web page (when compared with a photocopy) means that creative flashes and quick solutions are less likely to be documented in digital materials.
2 *Infrastructure for sharing resources*. Processes which are easily managed on paper require a technical implementation and interoperability specifications if digital resources are used. On the other hand, if these conditions are achieved, the scope for sharing is greatly increased.
3 *Lack of reuse*. The refinement of learning resources depends on reuse. This is well established for paper based resources and lesson plans, and (while bearing in mind the restrictions of point 1) is become more frequent for digital learning content, but it is not common for lesson plans or other representations of practice.
4 *The copyright regime*in an online environment has an impact in two ways:
a) sensitivity to copyright infringement is much greater in an online environment, even when a "fair use" interpretation is applicable, because of the threat of legal action from copyright holders. A photocopied diagram or a recording used in a classroom attracted no attention, but the same diagram placed on the web will create problems, as described by (Lessig 2004)
b) some educational institutions would agree that "The ultimate goal of content providers and producers is to increase the value of their content to maximise return on investment" (Degen 2001), and may consequently restrict teachers from sharing their own products.

The drift to programmed learning

The breakdown of the pyramid in the move to digital technology, as described above, logically results in a drift towards programmed learning[1], for three reasons.

1. Interoperability specifications are needed to support the sharing of resources. SCORM is the most widely adopted specification, and its functionality corresponds closely to the definition of programmed learning as an "educational technique characterized by self-paced, self-administered instruction presented in logical sequence" (Encyclopedia Britannica). There is nothing intrinsically wrong with SCORM compliant materials, and teachers can (and do) use the resources in many other ways, but as there is no standard way to describe that use it is hard to share this practice online.

2. Creating digital resources is technically challenging for the majority of teachers, and so they use the materials they can find. Current metadata and search engines lead them mostly to simple documents or SCORM objects, as there is no widely adopted machine readable description educational activities and pedagogies.

3. If an education provider sets up a resources repository they are confronted by a complex task in checking all the contents for copyright infringement. They will have less legal issues to resolve if they distribute materials which they have bought from a publisher, who takes responsibility for checking on copyright infringement. These materials are, at present, largely SCORM based.

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1 an "educational technique characterized by self-paced, self-administered instruction presented in logical sequence" (Encyclopedia Britannica Programmed learning. **2005**.

How can the base of the pyramid be restored?

It is not claimed that programmed learning is bad, or even that other approaches might be better, simply that there is a need to avoid leading teachers to adopt a particular approach for technical rather than educational reasons. The reconstitution of key sharing aspects of the pyramid in the digital context will enable the whole range of learning resources (not just content) to be rooted in the creativity of teachers' practice and developed in collaboration with peers. To achieve this is necessary to intervene at the conceptual, technical and policy levels. In a complex system such as this such interventions are systemic in their implications, and their resolution requires action at a number of different levels, not simply the introduction of a new application or workflow.

Infrastructure for sharing resources

The technology available to enable sharing of digital resources has greatly constrained sharing, and we devote a substantial part of our discussion to this issue. Paper resources are used by all learners and teachers, and they have certain advantages (all learners and teachers have the skills to make them and duplicate them, and they can be exchanged and stored without any special technical requirements) as well as disadvantages (they can only be shared with people who share the same geographic location unless they are physically transported, copying can be expensive, and adapting them is complicated when compared to creating the original document). For digital resources the situation is almost the exact reversed. In order to share digital resources effectively an infrastructure is required, with accepted specifications for interoperability. In this regard HTML has been a major step forward in providing universal means of exchanging documents. The SCORM application profile (consisting principally of IMS specifications) has been widely adopted, and adds some valuable functionality, enabling the resources to be sequenced, described with metadata, include assessments and monitor use. SCORM does not, however, represent how multiple learners and teachers work with the resources in different activities. IMS has produced the IMS Learning Design specification (IMS-LD) to meet this need, and this is a key technology in addressing the problems we have identified. IMS-LD defines Units of Learning (UOLs) by representing how *people* carry out *activities* in an *environment* composed of learning resources and services. IMS-LD is a large and complex specification, and interested readers can find detailed information in (Koper and Tattersall 2005). The functionality offered by IMS-LD is still unfamiliar to many educationalists, so we here identify four aspects developments around the specification which are relevant to this paper.

- *An Educational Modelling Language*. IMS-LD emerged from work done in the Open University of the Netherlands (OUNL) (Koper and Tattersall 2005) when it was decided to move all its courses online, while maintaining the wide range of pedagogic approaches used. All existing Virtual Learning Environments[2] (VLE's) created limitations, and so it was decided to create an in house system. An attempt was made to create models of the key pedagogic approaches, but it soon became evident that this would be a never ending task, as the variety to be handled approached that of the number of courses taught. The solution was an Educational Modelling Language (OUNL-EML) with an XML binding which could be used to define a very wide range of pedagogic models (Koper, Hermans et al. 2000). This language was then adapted and adopted by IMS as the base for their Learning Design specification (IMS Global Learning

[2] Also known as Learning Management Systems (LMS)

2003)

- *An eLearning methodology.* The OUNL started to use OUNL-EML in their online teaching, and indeed it is still in use today, and a methodology also had to be developed to support the creation and use of UOLs. The OUNL methodology was also adapted to the requirements of the new specification, and is included in the IMS Learning Design Best Practice Guide (IMS Global Learning Inc 2003)

- *A set of applications.* UOLs were developed for OUNL-EML using FrameMaker[3] and the EduBox player (see (Koper and Tattersall 2005)) was developed to run them. Since the publication of IMS-LD there has been an initiative underway to produce tooling for the new specification, which has been coordinated by the Valkenburg Group[4] and by UNFOLD[5], a coordination project funded by the European Commission. Many applications are now vailable, including Open Source initiatives such as the RELOAD[6] editor and the CopperCore[7] learning design engine. An updated list of applications is available from the UNFOLD website.

- *An interoperability specification.* The mission of IMS is to create interoperability specifications for eLearning, and so, by definition, that is what IMS-LD is. Its purpose is to enable applications to exchange UOLs, and to ensure that learners working on the same UOL using different applications on different platforms will be organised in the same way, and will participate in the same learning activities with the same resources. IMS-LD does not constrain how eLearning applications should work, it only specifies an import and export format which they must be able to work with if they want to be IMS-LD compliant. Thus, at the risk of oversimplifying, a UOL can be seen as an interoperable lesson plan. The use of IMS-LD therefore does not require the use of a particular methodology or infrastructure, as demonstrated by MOT+ (Paquette, de la Teja et al. 2005), and work in progress with the LAMS[8] and the Moodle[9] community.

With this understanding in place we can now consider how IMS-LD can help to reconstruct the Resources Pyramid, and two aspects can be distinguished, modelling and sharing practices, which require different tooling.

Modelling practice with IMS-LD

IMS-LD is the best established Educational Modelling Language and so it addresses the need in **layer 1** of the pyramid for a means whereby teaching **practice can be represented and documented in a machine readable format**. It should be noted, however, that this layer specifies *teacher friendly technology*, and at present IMS-LD is far from being as teacher friendly as HTML, let alone a photocopier. In part this is due to general problems with both the design of computer interfaces and teacher's levels of skills, but it is also clear that the interfaces of the applications available to work with IMS-LD editors are only appropriate for professionals or for enthusiasts who are willing to spend the time learning them. Progress is, however, being made

[3] http://www.adobe.com/products/framemaker/main.html
[4] http://www.valkenburggroup.org/valkenburggroup-org.htm
[5] http://www.unfold-project.net and http://moodle.learningnetworks.org/
[6] http://www.reload.ac.uk/
[7] http://www.coppercore.org/
[8] http://www.lamsinternational.com/
[9] See the discussions on http://moodle.org/

towards usability, and for a discussion of these issues see (Griffiths, Blat et al. 2005) and (Griffiths and Blat 2005).
Teachers cannot be expected to spend additional time in preparing resources for sharing, so strategies must be sought which make their work *easier*, and as a by product also produce interoperable and sharable resources. This is the case for two interesting programs which advise teachers on pedagogy, and provide them with suggested lesson plans, which are represented in IMS-LD: LearningMapR (Buzza, Richards et al. 2005) and the CEPIAH project (Trigano and Pacuar-Giacomini 2004) which has produced the NetUniversité system[10]. Similarly an opportunity is presented by the pressure on teachers in some countries (eg the UK) to do more in documenting their teaching in order to strengthen accountability standards of teaching. For example a well designed lesson plan editor which used IMS-LD as its file format would do much to generate a resource base of sharable practice. Finally IMS-LD interoperability has the potential to transform the situation, if for example LAMS and Moodle users can create UOLs easily.

Sharing practice with IMS-LD

Layer 2 of the pyramid refers to **sharing practice**, and IMS-LD is also valuable in this respect, providing a means of exchangning the practice documented in UOLs. Following the terminology used in an UNFOLD discussion paper (Griffiths 2005) an **Exemplar UOL** is an example of how to resolve a problem in Learning Design. The focus of the problem could be technical (e.g. how to include a QTI evaluation in a UOL) or illustrate a pedagogic approach (e.g. the Versailles Negotiation (IMS Global Learning Inc 2003). The exemplar is the UOL itself, complete and ready to run. A **Learning Design template**, like a template in any other aspect of computing, is a partly completed file to which the user can add data. A template can be made from any UOL, but it only makes sense to make a template from a useful and reusable UOL. Thus a template may be seen as a partly completed exemplar, with place holders where information is to be added.
UNFOLD has created a set of templates documented as follows:

- A narrative, (free text description of the learning activities)
- A lesson plan (with no LD specific aspects)
- A worksheet (one step nearer to LD)
- A walk-through (Screen shots from UoL)
- The example UoL itself (an exemplar)
- A part completed UoL to be filled in.

The interface provided for filling in the completed UoL is not part of the template and it could be a general purpose editor, or a specialised application.
Teachers do not only exchange complete lesson plans, they also exchange useful documents and activities (at various levels of detail). If such exchanges are to be mediated by computers then a rigorous machine readable description will be required at a lower level of granularity than the UOL. For items of learning content SCORM provides a viable solution, but defining and describing activities in an interoperable way is more challenging. Participants in the UNFOLD Teachers and Learning Providers Community of Practice have been sharing their approaches to sharing useful chunks of pedagogy, and the principal concepts used are outlined in a discussion paper From Primitives to Patterns (Griffiths 2005) which is the basis for the following discussion.

[10] http://www.cepiah-hds.utc.fr:8080/CEPIAH/web/index.jsp

Sharing activities

One approach which is being explored is the exchange of IMS-LD *activity structures*. The word "activity" is open to some misinterpretation. As Koper has pointed out (Koper 2005) activities are sometimes taken to mean "an opportunity for someone to do something", such as a the sport of basketball. Similarly, in online education a chat environment or a conferencing system could be thought of as an activity which is available to users. In IMS-LD, however, an activity is understood in the psychological sense, as "that which is done by the person", while the context which provides the opportunity for this to happen is an environment. An IMS-LD activity has its own learning-objectives, prerequesites and metadata, and typically refers to learning objects and/or services to be used. There is also an activity-description, which provides information and instructions about what the user should do. Activities can be grouped into *activity structures*. Since IMS-LD Activities are separate from Roles and Resources so they are potentially reusable resources. The fact that "nuggets" (see below) exported as IMS-LD fragments can be imported in the RELOAD Learning Design Editor indicates this is a viable approach.

The concept of the learning activity *nugget* was introduced by the work of Southampton University in the Dialog+ project. According to (Conole 2005) the project arrived at this definition of a learning activity, in consultation with practitioners. A detailed taxonomy of learning activities was produced, building on previous work (for example, upon Laurillard, Vygotsky, Bloom etc). Similarly Sarah DeFreitas work on learning activities and Laurillard's work on tools is used. Using the toolkit a practitioner can define learning activities, and produce a plan for a lesson or part of a lesson. The sequence of activities defined in a nugget is congruent with an activity structure in Learning Design, and sdo it has been possible export out of Dialog+ to a Learning Design activity structure and import into RELOAD LD Editor. This is a very encouraging development for the exchange of practice mediated by IMS-LD.

Casey uses the term *primitive* to refer to a related concept (Griffiths and Blat 2005), drawing on computer science, where it is used to refer to datatypes provided by a programming language as basic building blocks.. Similarly in 3D design a primitive is a basic structure which can be combined with others and refined. Applying this concept to pedagogy Casey indicates an interactive event in a classroom, such as "discuss this text" or "research this topic on the web", indeed any basic element which may be useful in any context. The identification of a set of primitives depends on decisions on how to divide the continuum of educational practice into chunks, a debate which can most effectively be conducted by a community of teachers, and which is in itself a potent training approach. The result is a rougher, more tentative approach to pedagogy, which is not based on a particular theoretical perspective. This closeness to practice has the potential to provide a set of concepts which support effective discussions about practice. As with nuggets, it is proposed that these structures can be represented in IMS-LD.

Sharing patterns and good practice.

The concept of *pattern* is not always clear, and it has been the cause of considerable debate within UNFOLD. Many people use the term "pattern" to indicate an example of best/good practice[11], for example the Pedagogical Patterns Project states that "Patterns are designed to capture best practice in a specific domain. Pedagogical patterns try to capture expert knowledge of the practice of teaching and learning" (Pedagogical Patterns). The eLEN project takes a similar

[11] My thanks to Davinia Hernández Léo for pointing this out in UNFOLD online discussions

line: “Design patterns in e-learning are descriptions of good practice in e-learning” (E-LEN project 2005). This approach does not match the idea of a *pattern language* as originally formulated by Alexander: “A pattern language gives each person who uses it, the power to create an infinite variety of new and unique buildings, just as his ordinary language gives him the power to create an infinite variety of sentences” (Alexander 1979) p. 167. Each pattern addresses a problem and provides a solution, but Alexander’s formulation stresses that the point of patterns is not to lead to automatic reuse, but rather to support creativity. In the context of pedagogy this would imply supporting teachers engagement with pedagogic problem solving, rather than providing ready made solutions. McAndrew, Goodyear and Dalziel (McAndrew, Goodyear et al. 2004) propose that this model provides the basis for a pattern language for learning, with each pattern consisting of expository texts, such as the example below:

Pattern: COLLABORATIVE EVALUATION
Context: A group of learners need to understand the principles behind a particular technique so that they can progress to become able to select particular implementations for others and to be able to take part in producing further examples themselves. Such learners need to develop an appreciation of the different forms available, the structure they have and why particular forms are suitable for some tasks.
Body: The contradictory challenges in this are the need to understand the structures that have been used alongside the need to see new ways to do things. The breadth of what is available needs to be examined alongside understanding how the software might apply when used in depth. It is important to balance individual views with group views and established positions from literature and other sources.
Solution: Building a collaborative evaluation enables the sharing of the work load and brings in the views of others to enable testing of consensus and variation in the depth that each individual may look at a particular example.
It is associated with patterns for LEARNING THROUGH DISCUSSION, COLLABORATIVE LEARNING and NETWORKED LEARNING PROGRAMME. It builds on patterns for DISCUSSION GROUPS, DISCUSSION ROLE, FACILITATOR, DISCURSIVE TASK, SEARCH, and CONSENSUS FORMING.

From (McAndrew, Goodyear et al. 2004) Fig. 8 *Collaborative Evaluation as a Pattern*

This difference in interpretation of the terms may not seem very profound, but it can have a major impact. In a paper based environment a teacher can take a description of a pattern and apply it as she or he sees fit, but if they are working with a VLE this degree of flexibility will not be available, as the representation of the pattern and its functionality will be explicit and restricted in order to be machine readable and interoperable. Consequently, the definition of the terms used has to be more rigorous when working with online learning resources and activities. If we do not specify clearly if patterns are the same as, or different from exemplars of good practice, then there is a danger of duplicating the development of systems which have the same functionality, or providing inappropriate solutions for teachers and pedagogs, or both

Repositories which represent use

From the above discussion it is clear that IMS-LD to facilitate the sharing which is needed to restore the resource pyramid in a variety of ways, but repositories are also needed to manage the process, and IMS has contributed by creating the Digital Repositories Interoperability specification (IMS Global Learning 2003). This paper not discuss repositories in detail, but instead refers the reader to the EduSplash (Hatala and Richards 2002) and LionShare (OKI Case

Study 2005) projects. We do however note that in order to address the third level of the Resource Pyramid sharing alone is not sufficient. For the identification and refinement of successful practice it is also necessary for use to be represented. As far as possible this should be automatic, as it has been clear for some years that users are relunctant to add metadata to resources (Thomas and Griffin 1998). Automatic analysis can show teachers which resources are popular in their area / age group / curriculum. Lionshare uses the Shibboleth system developed by Internet2 to create flexible trusted communities and in such a context it may be possible to identify the individual teachers who have been using the resources, enabling teachers to emulate the practice of their peers. It is encouraging that LionShare is released under the GPL license and uses peer-to-peer technology. because it enables any group of practitioners to create a repository without needing to be authorised, helping to widen the base of available practice. It would also be desirable to ensure that reworkings of UOLs are associated with the UOLs on which they have been based, to permit browsing up and down the hierarchies of parents and children. In the short term this may be best achieved by observing good practice in naming and workflow, but it would also be interesting to explore the possibility of analysing IMS-LD code automatically to seek out similarities and hilite related UOLs, or UOLs where, for example, a similar activity structure is used. An annotation facility is important so that teachers can associate notes with UOLs commenting on their usefulness or otherwise, and making suggestions for adaptations. It should not be expected that all users would make use of this facility, any more than all users of paper resources provide feedback, but any information provided would be of great value.

Communications enabling infrastructure

In a paper based environment the exchange of resources involves physical presence. This is of course a limitation, but the easy identification of fellow users in physical communities such as teaching departments, professional associations, libraries, etc. who can provide comments and recommendations is a key feature of the resources pyramid for paper based materials. When moving to an online exchange of resources it is technically possible to exchange a much larger number of resources (although this may be limited by the other factors which we have mentioned), but it is much harder to identify fellow users. This makes it harder to share comments and recommendations, and so it is important that the initiatives which we have identified to restore the resources pyramid are accompanied by a policies and implementations to promote online communities of practice among users. The power of such online communities is clear from the success which they have had in other domains, but it has not always proved easy to transfer this to educational context. From the perspective of our model we would expect that the most effective approach would be to a) integrate the communications infrastructure with the repository as much as closely as possible, so as to re-establish the link between resources and a social context, and b) implement trusted communities which are related to professional groups, where users can receive information about other participants and exchange recommendations with them much as they would in a face to face conference.

The chilling effects of copyright

As mentioned above, the intensification of the copyright regime and the restriction of “fair use” rights has had chilling effects on the exchange of digital materials, and particularly on level 4 of the Resources Pyramid, the inclusion of effective resources in shared resource centres. Lessig has described how current trends towards enormous penalties for copyright infringement have led institutions to reject any activity which could possibly be construed as illegal, even if the use is

clearly covered by "fair use" clauses. The result is that activities which were perfectly accepted in a paper based world are becoming outlawed in the online environment. As Lessig (himself a lawyer) has shown how *the astonishingly broad regulations that pass under the name "copyright" silence speech and creativity* (Lessig 2004) p.197. He argues that the solution must in part be legal, but he also identifies the Creative Commons (http://creativecommons.org/.) initiative as a key way to avoid the worst of the chilling effects: *Its aim is to build a layer of reasonable copyright on top of the extremes that now reign. It does this by making it easy for people to build upon other people's work, by making it simple for creators to express the freedom for others to take and build upon their work. Simple tags, tied to human-readable descriptions, tied to bulletproof licenses, make this possible*. ibid, p.282. For this to be effective institutions need to be convinced that the Creative Commons licenses are sufficiently flexible and watertight to meet their needs (not a difficult task) and that their interests are better served by having access to shared and adaptable resources rather than in attempting to gain competitive advantage by selling their content (rather harder). Once this policy has been established teachers and learners will need support in their use of Creative Commons licenses at all levels of the pyramid. This implies guidance and easy interfaces for applying licenses to all their productions, clear indications of what rights are given to users of resources covered by the Creative Commons, and inclusion of license information in the metadata held by repositories.

Conclusions

In this paper we have provided a simple model of the educational resource development process, and we have described why it is hard to instantiate this model in an environment where educational resources are electronic rather than paper based. We have identified and discussed aspects of ongoing research and development in the field of eLearning which may make this easier. We summarise our conclusions below, and stress that while they are related to the different levels of the pyramid, they are unlikely to be effective if taken in isolation.

Reestablishing the resources pyramid: summary of approaches and issues		
Layer of pyramid	**Available approaches**	**Outstanding issues**
Layer 4. Inclusion of effective resources in shared resource centres.	Peer-to-peer repositories which support different layers of trusted access encourage autonomous communities to set up resource centres. Awareness and use of Creative Commons at all levels of the educational resource production process is essential to avoid the chilling effects of copyright litigation.	The basic functionality of educational resources repositories is available in applications such as EduSplash and LionShare, but much remains to be done in integrating these with the functionalities identified in 3. below. Creative Commons has become widely used, but the argument in its favour has yet to be won at institutional level.
Layer 3. Identification and refinement of successful practice within an institution or Community of Practice	To help teachers identify successful practice the use of resources should be represented in repositories on the basis of machine generated data. Within trusted communities personal usage can be represented. Parent and child UOLs kept together. Annotation by users. Support for personal communication linked to resources.	The incorporation of these functionalities into educational repositories which can handle IMS-LD has hardly begun. This is unsurprising as IMS-LD is the only educational interoperability specification which can represent a wide range of pedagogic practice, and only now are large numbers of UOLs being produced which may create a need for these functionalities.
Layer 2. Successful practice	IMS-LD UOLs are interoperable and can be used to share practice. Range of sharable	Ability to combine chunks of practice other than full UOLs is starting to emerge, but more needs to

Reestablishing the resources pyramid: summary of approaches and issues		
shared with peers	pedagogy items proposed (exemplars, patterns, good practice, activities, nuggets, primitives...) Free peer to peer repositories	be done to clarify chunks used, and to provide easy to use tools. Free peer to peer repositories are starting to be established, and their use needs to be researched
Layer 1. Documentation of wide base of practice using teacher friendly technology	SCORM can document educational content. IMS-LD is an educational modelling language which can document practice in a standard way.	Many teachers are still uncomfortable basic computing skills, and IMS-LD editors are far too complex for them. Interfaces which are simpler by an order of magnitude are required. Applications are needed which help in teachers' practice, and generate sharable models as a by product.

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