Reusable LEARNING

National Science Digital Library
Reusability and Interoperability Workshop

A REUSABILITY FRAMEWORK

Robby Robson

Reusable LEARNING

The Stage for Reusability

- What?
  - Digital Learning Resources
- How?
  - Adoption
  - Adaptation (may require *modification*)
- Who?
  - Educators
  - Students
  - Authors
  - Collections

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Some Overarching Issues

- Diversity of potential audiences and uses
  - Math: It's is not just for breakfast
- Rights, access, attribution
  - R-E-S-P-E-C-T
- Modifiability
  - May the source be with you!
- Educators, authors and students often want *small pieces* of courses or modules
  - Sage on the Stage
  - Guide on the Side
  - Teachers in the Bleachers?
- Collections just point to resources
  - Intermediaries, not distributors
- Interoperability Meter
  - Standards: The ~~yard~~stick by which we measure success
- Quality versus reusability
  - Context is the friend of learning and the enemy of reuse

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Reusable Design

- Goal: *Create digital learning resources that*
  - *Do not limit the potential audience*
  - *Lower or remove the barriers to reuse*
  - *Do not reduce learning effectiveness*

- Belief: *Reusable design is good design*

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Reuse Scenarios: Classical

- *A college professor selects a book for a class*
  - May use all of it, parts of it or just the exercises
  - Cannot copy portions and re-publish without permission
- *A keynote speaker prepares to give the third version of the same talk*.
  - Uses almost all of an existing PowerPoint presentation
  - Alters some presentation elements (such as the opening slide, the footer and the date)
  - Updates a few slides

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Reuse Scenarios: Modern

- *A student uses a JPEG from a library of astronomical images*.
  - Pastes it into a report as is.
- *A teacher looks for information on native American forestry practices. She finds a university Web site that includes a section on this topic. She assigns it as reading for a report.*
  - Only part of the site will be used
  - Students may cut & paste from the site in their reports
  - May be included in a Web site the class is developing

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Reuse Scenario: Leading Edge

- *An applet allows students to alter parameters in a differential equation and view the resulting level curves.*
  - May be shown in a class or used in a lab
  - May be provided as supplementary material
  - May be incorporated into an online quiz
  - May be appropriate for courses other than mathematics
  - May require a particular version of a Java™ virtual machine or a viewer for a particular computer algebra system.
  - May be included in a course delivered by a Course Management System

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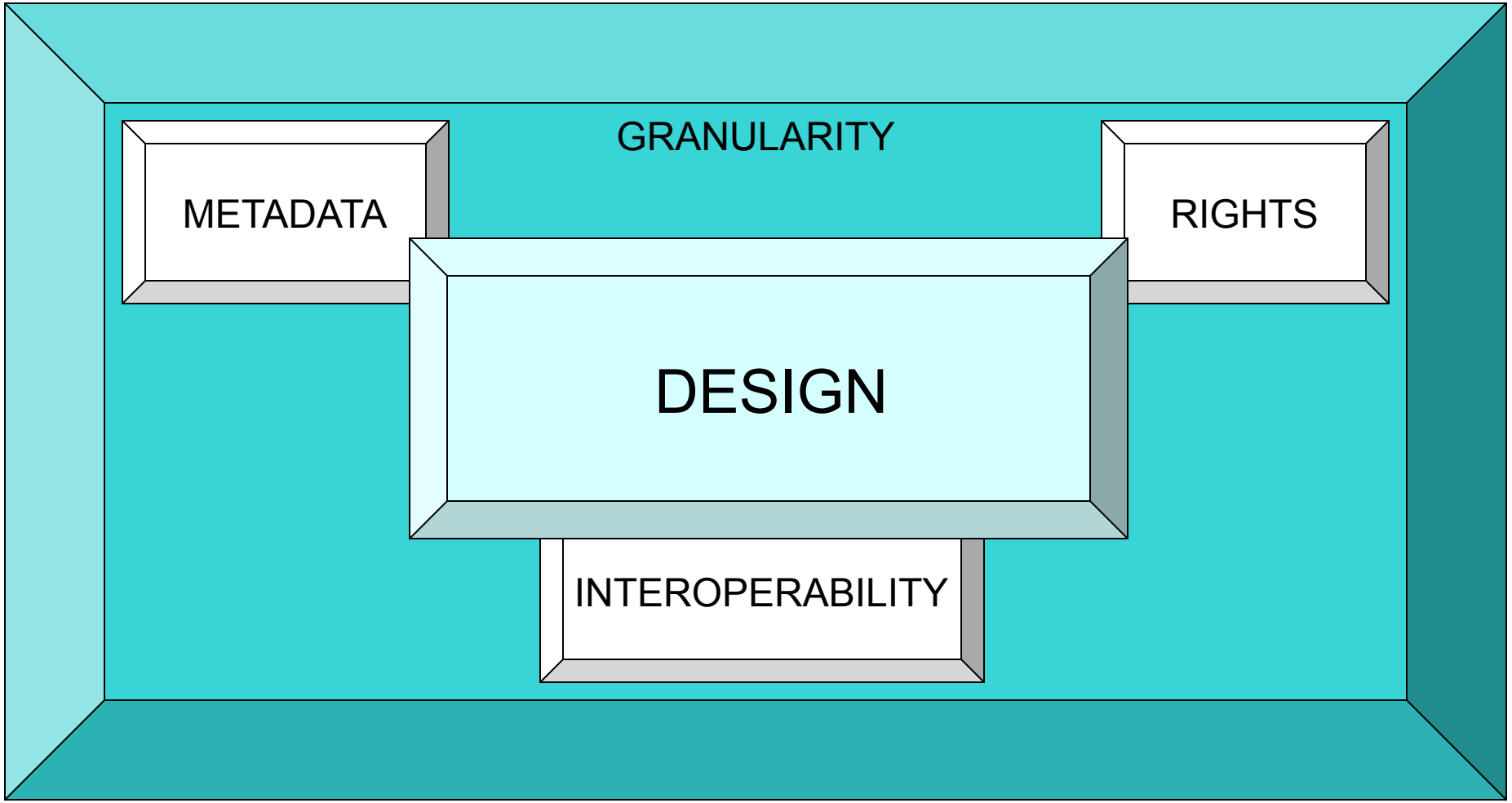
Reusability Framework



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Reusability Factors

- GRANULARITY
  - Determines meaning of "reuse"
  - Defined by "content model"
- INTEROPERABILITY
  - Technical
  - Involves Standards
- RIGHTS
  - Copyrights
  - Terms of Use
  - Ability to Modify
  - Attribution
- METADATA
  - Descriptive
  - Context (Educational)
  - Technical
  - Usage Instructions
- DESIGN
  - Content
  - Presentation
  - Structure
  - Pedagogy
  - Context

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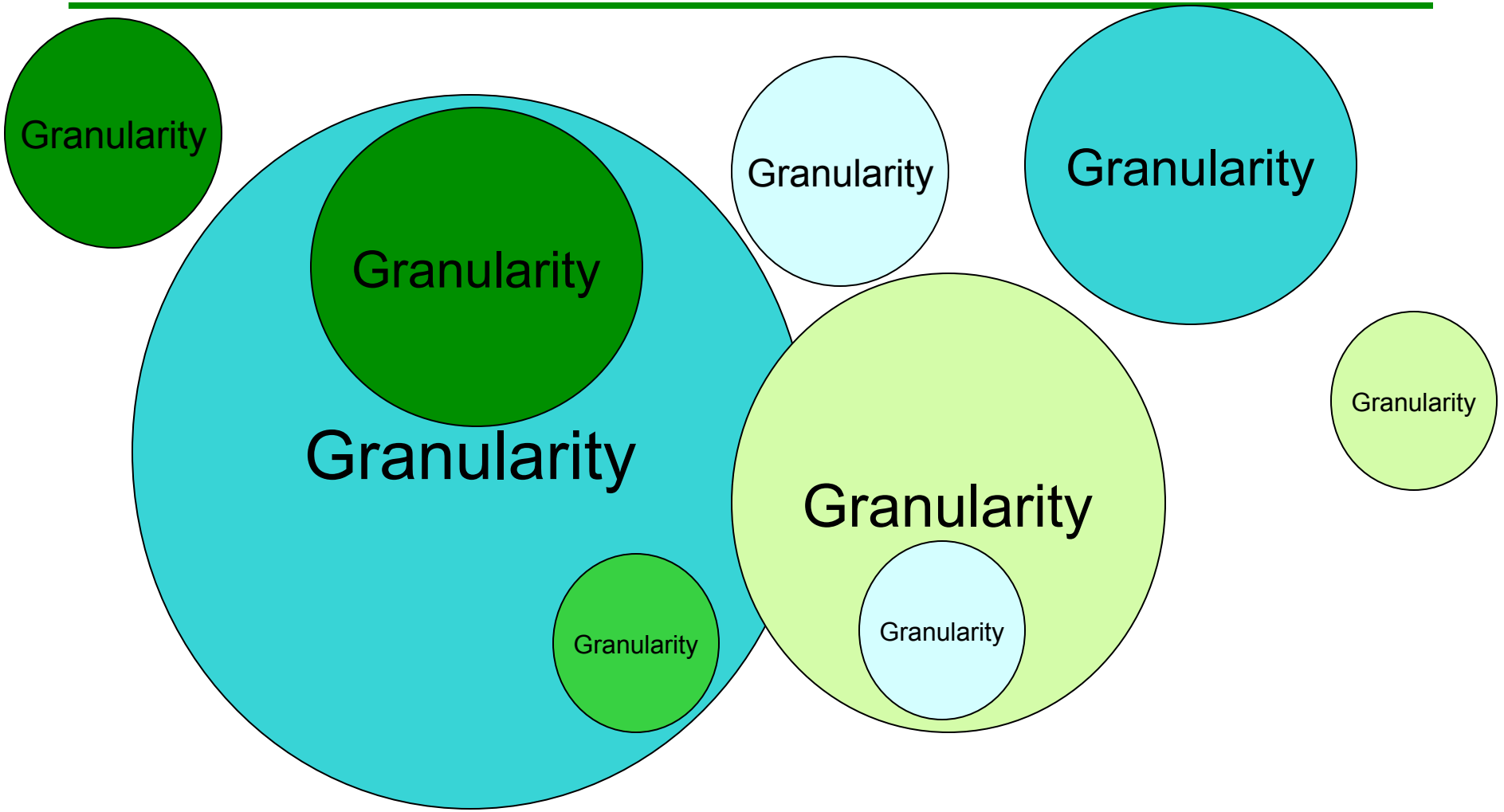

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Background

- Aggregation models combine *technological* aspects with *pedagogical* aspects.
- Intended for modification by communities of practice
- Model used is
  - Based on *Learnativity* (www.learnativity.org)
  - Adopted by the NLII Learning Object Virtual Community of Practice (Yes, that's LOVCOP)

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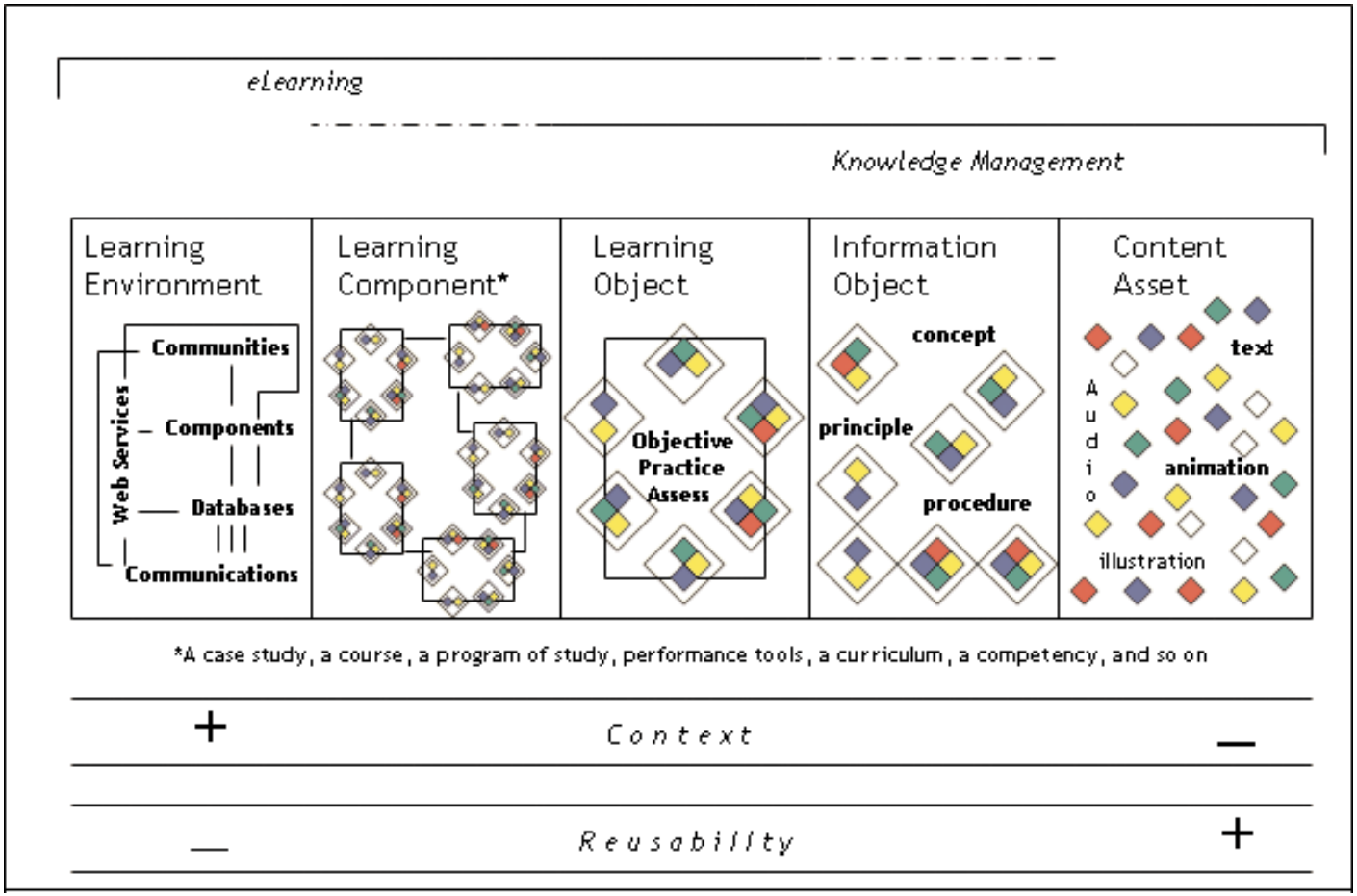
Learnativity Aggregation Model



Taken from: *Strategies and Techniques for Designers, Developers, and Managers of eLearning* by Ellen D. Wagner. E-learning Developers' Journal, Oct. 20, 2002.

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Learnativity Model - Explanation

Granularity	Explanation
Content Asset	• Images, text snippets, audio clips, applets, etc.
Information Object	• Text passages, Web pages, applets, etc. • Focuses on a single piece of information
Learning Object	• A collection of Information Objects that are assembled to teach a single learning objective
Learning Component	• Lessons, courses, etc. • Typically have multiple learning objectives and are composed of multiple learning objects
Learning Environment	• Combination of content and technology with which a learner interacts

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Instructional Design Background

- Robert Horn – structured writing (notion of "information object")
- Work of Mager, Gagne, Dick & Carey, Bloom
- Learning Objective
  - Single measurable (or verifiable) step on the way to a learning goal.
  - Says what a learner is expected to do or learn
  - Says how an acceptable level of achievement will be verified.

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Granularity, Decomposition & Reuse

Granularity	Decomposability	Reuse
Content Asset	Indecomposable	• Rarely, modification of presentation and style.
Information Object	Into content assets.	• Content assets sometimes extracted • Sometimes modification of presentation and style.
Learning Object	Into content assets and Information objects	• Meant as self-contained • Some modification of presentation and style • Some extraction
Learning Component	Into learning objects	• Suspect: Most reuse is of learning components is reuse of learning objects contained in them
Learning Environment	Into content, technology and processes that support learning	• Component reuse • Not reusable in sense being discussed

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Other Aggregation Models

- LOM
  1. The smallest level of aggregation, e.g. raw media data or fragments.
  2. A collection of level 1 learning objects, e.g. a lesson.
  3. A collection of level 2 learning objects, e.g. a course.
  4. The largest level of granularity, e.g. a set of courses that lead to a certificate
- SCORM
  - Assets
  - Sharable content objects (SCOs)
  - Content aggregations

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Granularity Summarized

LOM Level 4	LOM Level 3	LOM Level 2	LOM Level 1	LOM Level 1
Learning Environment	Learning Component	Learning Object	Information Object*	Content Asset
LMS / CMS "Total Experience"	Chapter Lesson Unit Course	Addresses Single Learning Objective	Fact Concept Principle Process Procedure	.doc .wav .swf .fla .jpeg .mpeg
SCORM, the Next Generation	SCORM Content Aggregation	Sharable Content Object (SCO)	Asset or SCO	Asset

*From work of Robert Horn

Applets / Flash Movies / Interactive Content

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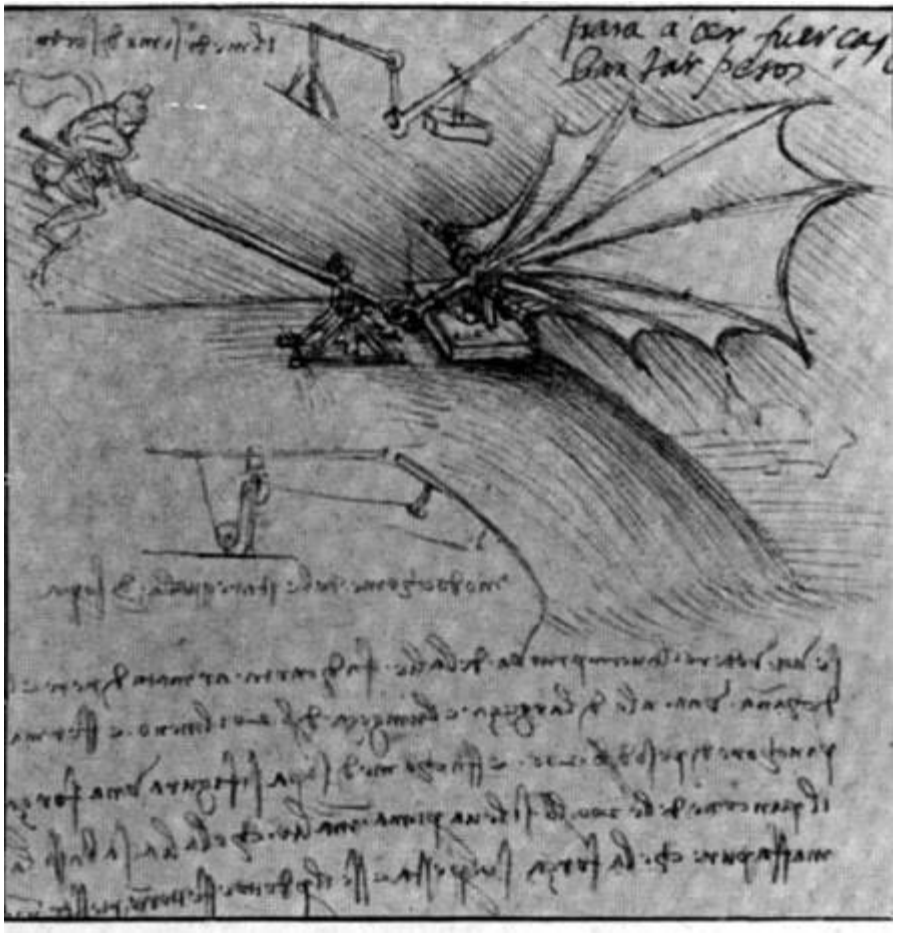
Design



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Design Layers

Layer	Definition
Context	Language, cultural knowledge, subject knowledge, relations to other learning resources and other factors that are needed to properly interpret a digital learning resource
Pedagogy	How a digital learning resource is used as part of a learning strategy or instructional design
Structure	How a digital learning resource is structured into assets, information objects, learning objects, etc. and how these are navigated or sequenced
Content	The information that is contained in a resource and that is intended to affect a change in cognitive state
Presentation	How a resource is rendered and what visual and auditory elements will be used to render it

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Context & Reusability

- *Context is the friend of learning and the enemy of reuse*
- Contextual elements that can be isolated or eliminated
  - Culture dependencies
  - Cross-references
- Learning and information objects can be made self-contained: *design for disaggregation*
- Metadata
  - Encodes context
  - Is separate from the learning resource

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Pedagogy & Reusability

- *A learning resource is more valuable if it can be used for more types of learning*
  - In-class
  - Online
  - Mentored study
  - Self-study
- Pedagogy is often embedded in sequencing & navigation, style, and content.
  - Separation is better.

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Separating Pedagogy from Structure, Content & Presentation

Less Reusable

- Forcing a sequence through previous and next buttons
- Referring to a lab experiment throughout a resource
- Using Elementary School Styles

More Reusable

- External Sequencing & Navigation
- Isolating components that require specific educational settings
- Addressing as wide an audience as possible

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Structure & Reusability

- *Adoption requires structures that isolate components*
- *Adaptation may require re-structuring*
- Standards help
- Structures themselves are reusable!

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Separating Content From Presentation

- This is the point of mark-up languages
- Key words:
  - Styles
  - XML
  - Re-branding & Skins
  - (Learning) Content Management Systems

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Importance of Layers

Context	Context	Context	**Context**	Context
Pedagogy	Pedagogy	**Pedagogy**	Pedagogy	Pedagogy
Structure	Structure	Structure	**Structure**	Structure
Content	**Content**	Content	Content	Content
Presentation	Presentation	Presentation	Presentation	Presentation
Content Assets	Information Objects	Learning Objects	Learning Components	Learning Environments

Bold: More Important
Gray : Less Important

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Granularity and Design

Learning Environment	Learning Component	Learning Object	Information Object	Content Asset
• Don't tie learning components to a learning environment (standards help)	• Pedagogy and context affect reuse • Structural delineation of learning objects important	• Context matters • Avoid navigation that links structure to pedagogy and context • SCORM, IMS, AICC help separate structure	• Like content assets • Avoid cross-references that entangle content with pedagogy, structure & context	• Separate presentation from content • Avoid contextual dependence if possible • Standards are not specific to learning

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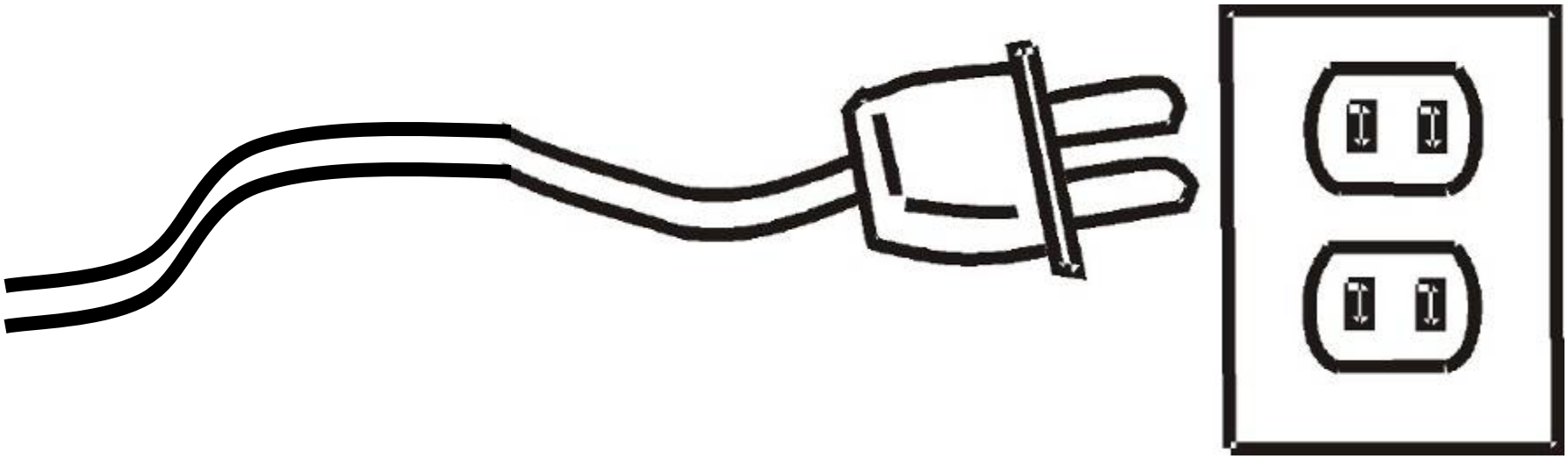
Interoperability



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Definition of Interoperability

- Extent to which a digital learning resource will "plug and play" on different platforms.
- Extent to which a digital learning can be modified using different tools.
- Ease with which two software components (or systems) can exchange and correctly interpret each others' data.

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Two Approaches to Interoperability

- **"Standards"**
  - HTML
  - XML
  - Learning Object Metadata
  - SCORM
  - IMS Questions & Test Interoperability
  - MathML
  - And many others . . .
- **Standardized formats**
  - PDF™
  - Flash ™
  - Java ™
  - MS PowerPoint ™ / Word ™
  - TEX
  - And many others . . .

NOTE:

1. Standards may exist within a small community – e.g. the British systems of weights and measures or TEX
2. The meaning of interoperability and the appropriate standards depend on granularity

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Granularity and Interoperability

Learning Environment	Learning Component	Learning Object	Information Object	Content Asset
• All about the system • General IT infrastructure standards • IMS Enterprise, OKI, …	• Like Learning Objects • Avoid tying to specific learning environment	• All about the content • SCORM, AICC, IEEE, IMS … • Exchange via XML-based formats • Authoring tools can be specialized	• Like Content Assets • Special issues for software • Standards for Questions & Tests • Tools are not specific to learning	• All about the format • Use common formats • Use standards • Avoid dependence on proprietary software or plug-ins

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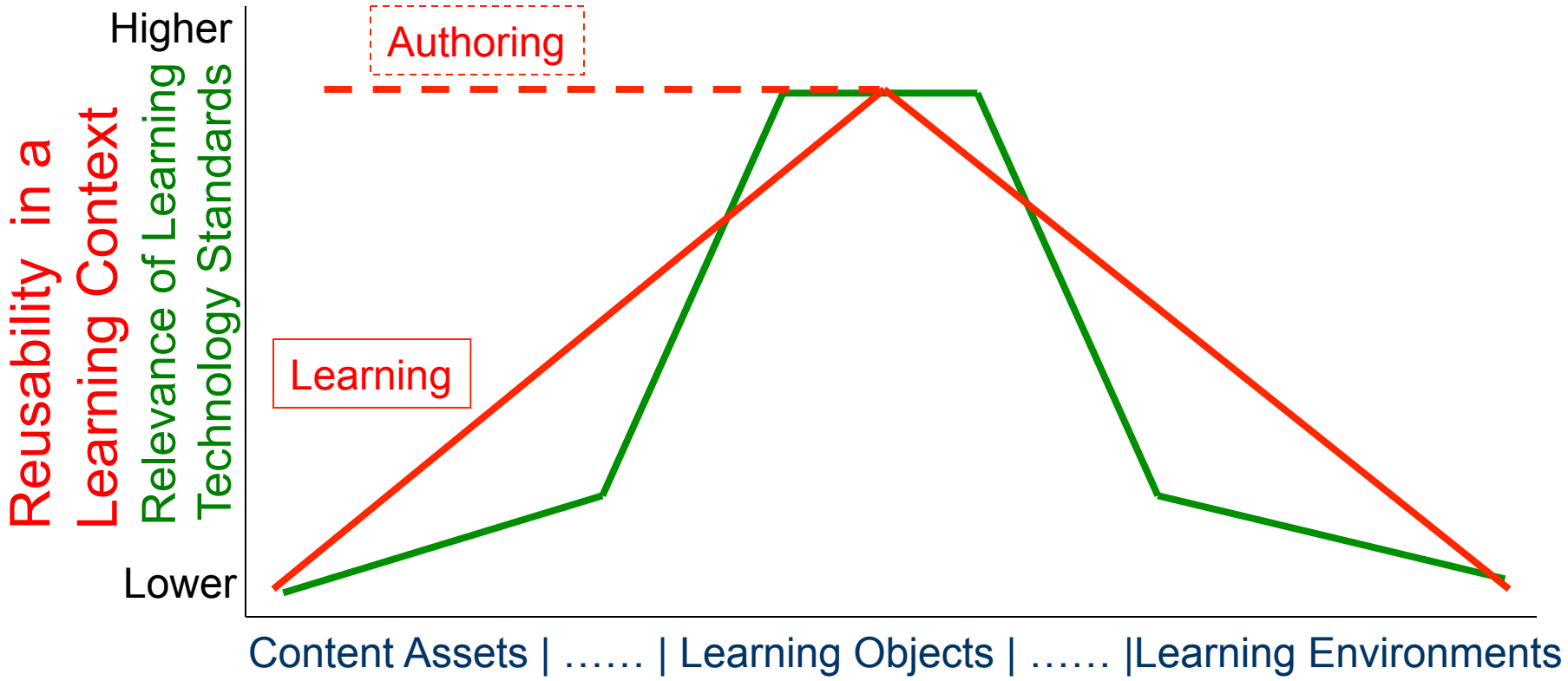
A Comment on Learning Objects



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Interoperability for Collections

- All about the policy
- Metadata is key
- OAI, DOI, Fedora, …

- Multiple issues: see IMS Digital Repository Interoperability Spec
- Focus here on supporting *content* reuse

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Metadata

From the British Museum … Photos by RR

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Types of Metadata

- **Basic descriptive Information** (**bibliographic** metadata)
  - Enables a resource to be found.
  - Includes title, author, description, identifier and key words.
- **Contextual information**
  - Used to find resources for a specific context.
  - Includes grade level and intended audience.
- **Rights information**
  - Displays copyright & terms of use
- **Technical information**
  - Used to fine resources for a specific platform
  - Includes the format & software requirements
- **Usage information**
  - Enables resource to be used
  - Includes software documentation & instructor / student guides

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Granularity and Metadata

Learning Environment	Learning Component	Learning Object	Information Object	Content Asset
• Information rarely encoded as metadata • Exception is documentation	• Metadata applies to entire component • Contextual metadata important • Guides important	• Contextual metadata becomes important • Guides for instructors and students may be needed • May include reviews	• Like Content Asset • Educational metadata may be important • Documentation important for software	• Basic descriptive Information for catalog • Rights important • Technical metadata may be important

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Rights

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Types and Perspectives

- Rights important for reusability
  - Copyright & Terms of Use
  - Attribution
  - Modifiability
- Perspectives on rights
  - Author, Developer, Copyright Owner
  - Collection
  - Reuser

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Copyright & Terms of Use

- (Almost) all resources are copyrighted
- “We” are sloppy about granting and obtaining permissions
- “Fair use” is (almost) never applicable
- TEACH Act imposes requirements
- Issues with “deep linking,” “Framing” and “in-lining”
- *Recommendation: grant permission in advance*
- Creative Commons is one good solution

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Attribution

- Attribution is required
- “We” are sloppy about attribution

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Modifiability

- Includes *rights* and *ability* to modify
- Applies to adaptation more than adoption
- Source code, modifiable versions needed
- What does the copyright holder want to allow?

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Rights & Perspectives

	Copyright	Attribution	Modifiability
Author	• Should grant rights explicitly	• Include attribution • Require attribution	• Documentation • Modifiable versions • Require easily available tools • Permissions / licenses
Collection	• Must manage copyrights & licenses • Metadata is Collection IP	• Collections must manage attribution.	• Point to modifiable versions • Technical metadata
Reuser	• Wants permission and no hassles • Copyright and terms of use	• Properly cite and attribute work	• Tools needed • Permission needed

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Reusability Design Lab Next

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Questions? Comments?