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Learning Objects: Teaching with Technology

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ABSTRACT
Learning objects provide easily accessible and individualized learning facilitated through flexible deployment of networks of small, reusable components from multiple sources. A good learning object helps students understand a worthwhile concept accurately, concretely, and well-presented. They also take students through a structured experience that draws on creative pedagogy. Despite their time-honored use and discussion in the area of information technology, learning objects are still the Cinderella sister of the other materials and objects used in education. The aim of this article is, therefore, to investigate the role of learning objects in enabling and enhancing learning. Firstly, learning objects are defined and the evolution of the learning object movement is explored. Then the need for learning objects is considered and the attributes or characteristics of learning objects are examined. The structure of learning content and the issue of granularity is also investigated. Finally, the benefits and risks associated with adopting a learning object approach are considered and learning object repositories are investigated.

Introduction

Recent developments in e-learning have resulted in the emergence of the concept of reusable learning objects. In the old paradigm, learning was organized into lessons and courses that met specific pre-defined objectives. In the new paradigm, content for learning is broken down into smaller, self-contained pieces of informational content that can be used alone or can be dynamically assembled into learning objects to meet the "just in time" requirements of a learner (e-Learning Consortium)[1]. Currier and Barton [2] believe that the widespread use of learning objects will create a learning object economy that will enable the sharing and reuse of digital learning materials for teaching and learning.

Learning object definitions

There is, however, no universally accepted definition of a "learning object" as the term means different things to different parties, partly because learning objects come in a variety of shapes and formats. Educational resources range in diversity from a book chapter to a transparency slide and can be applied to a range of purposes (Australian Flexible Learning Framework)[3].There are a number of different terms used to describe learning objects, including educational objects, reusable learning objects, instructional objects and sharable content objects (Hamel and Ryan-Jones[4] and Horton and Horton[5]. The IEEE Learning Technology Standards committee (LTSC), in promulgating the Learning Object Metadata (LOM) standard, defines a learning object as "any entity, digital or non-digital, that may be used for learning, education or training"[6]. Wiley[7] challenges the usefulness of this definition, citing it could "technically include anything and everything". Wiley, therefore, narrows the definition of a learning object to "any digital resource that can be used to support learning". McGreal and Roberts[8], however, describe a learning object as "any entity, digital or non-digital, that can be used or referenced in technology-supported learning". Wagner[9] states that the general consensus among authors is that learning objects are "the smallest element of stand-alone information required for an individual to achieve an enabling objective or outcome". This is supported by the e-Learning Consortium[1], who classifies a learning object as a "self-standing, discrete piece of instructional content that meets a learning objective".

According to Wagner[9], learning objects ensure that complex content can be broken down into smaller, more meaningful "chunks" that can be assembled and reassembled to meet individual learner requirements. Hamel and Ryan-Jones[4] state that these small, pedagogically complete segments of learning content can be assembled as needed to create larger instructional units such as courses. Heng (2003) concurs that learning objects are a form of instructional learning technology that is composed of small learning chunks which can later be re-assembled or combined to form course materials. Thomas and Horne[10] refer to learning objects as "bite-sized" pieces of digital content that can be difficult to learn from in isolation, but enable learning when placed in sequence with other learning objects. The sequencing of the learning objects as well as the mode of delivery are important concerns. Anido, Fernandez, Caeiro, Santos, Rodriguez and Llamas [11] describe an educational resource as an entity that can be used or referred to during a learning process. Multimedia content, books, manuals, programmers, tests, software applications, tools, people and organizations are examples of educational resources. Shepherd [12] provides several examples of types of learning objects, including video demonstrations, tutorials, procedures, stories, assessments, simulations and case studies.

Evolution of Learning Objects

Learning objects are an application of object-orientated thinking to the world of learning[12]. According to Jacobsen (2001) and Friesen (2003), the term "learning object" was first popularized by Wayne Hodgins when he named the Computer Education Management Association (CedMA) working group "Learning Architectures, Application Programming Interfaces (APIs) and Learning Objects". Hodgins is credited with "coining" the term while watching his children play with

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Lego™ building blocks, and realizing that learning development efforts may benefit from plug-and-play interoperable content that could be assembled as needed. This led to CedMA becoming involved in the development of learning objects.

From 1992 to 1995, several disparate groupsstarted working with the early concept of learning objects. The Learning Object Metadata Group from the National Institute of Science and Technology and CedMA grappled with learning object issues such as modularity, database centricity and tagging objects with metadata[13]. Several other groups such as the IMS Consortium in North America and the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE) began to work in the learning object arena. Tom Kelly and Chuck Barritt began working on learning objects, first at Oracle and then Cisco Systems, which culminated with the release of Cisco's white paper on Reusable Learning Objects in 1998. That paper, in conjunction with the work of the industry standards and specifications bodies, did much to move learning objects to the forefront learning technology by 2001[13].

The Need for Learning Objects

According to Jacobsen (2001), the learning market is demanding a quicker and less-expensive way to build and maintain content. Duval and Hodgins[14] note that much research has been conducted into learning objects, on the premise that the reuse of content components can lead to important savings in time and money, and enhance the quality of digital learning experiences. This would result in faster, cheaper and better learning. Hamel and Ryan-Jones (2002) agree that learning objects can be shared with other users, recombined with other objects or redesigned by other instructional developers with reasonable cost savings. Friesen (2001) adds that learning objects promise easy and low-cost multimedia course creation. New learning objects can be created by educational professionals, instructional designers, or other professionals who have an educational goal in mind, but cannot find existing learning content to meet their needs. The created learning objects may then be reused in other situations (Smith, 2004: 2).

The promise of learning objects is that they can be leveraged, copied or linked by multiple authors, placed into multiple learning or training programs and then delivered in a range of delivery media [15].Learning objects promise to take learning to new levels of personalization and relevance. They promise to offer an environment for individualized learning that is easily accessible and enabled by the reusable components over networks (Shepherd, 2000). Learning objects allow information to be presented in several different ways[16]. The vision of the learning object economy is that learning objects will be placed in public repositories for free reuse or in commercial repositories for sale, and these objects can be used as needed by instructional developers for personalized learning. For this to occur, learning content needs to be developed as reusable, stand-alone learning objects that are tagged with metadata[4].

Learning Object Attributes/Characteristics

Friesen (2001) states that learning objects are supposed to be modular, interoperable and discoverable. Longmire[17] believes that in an environment in which context is scalable and adaptive, the ideal learning object content is non-sequential, able to satisfy a single learning objective and accessible to broad audiences. Barritt and Alderman[15] list the ideal features of learning objects:

- Objective-based – able to accomplish a single learning objective
- Context-free – able to stand-alone from the rest of the associated hierarchy
- Interactive – although not required, engaging learners is key to their achieving the objective
- Self-descriptive – have associated metadata
- Self-contained – capable of standing alone or in unison with other learning objects
- Format-free – created free of "look and feel" formatting

There are a number of additional attributes of learning objects that are further explored in this section.

Reusability

According to Kilby[18], learning content is modularized into small units of instruction suitable for assembly and reassembly into a variety of courses. Course developers do not have to develop all the content for a particular project, since objects can be reused on several projects[5]. Once created, a learning object should function in different contexts, that is, they should be relevant to audiences beyond the original target audience[19] .Smith[16] notes that learning objects can be reused or repurposed which promotes cost-effectiveness. Duval and Hodgins[14] distinguish between different kinds of reuse: multiple distribution formats and media, multiple purposes, multiple deliveries and multiple "disciplines". Barritt and Alderman[15] note that pure reuse is an ideal scenario. In practice, many authors adopt a repurposing approach where objects are changed to meet specific needs.

Interoperability

Interoperability refers to instructional units that interoperate with each other regardless of the platform, developer or Learning Management System (LMS)[18]. Polsani[19] concurs that the learning object should be independent of both the LMS and the delivery media. Longmire[17] states that learning objects should be portable between applications and environments. A difficult attribute to satisfy is the notion of durability. This refers to learning content that withstands evolving delivery and presentation technologies without becoming unusable[18].

Accessibility

Learning content should be available anywhere, anytime and be able to be reused across networks[18]. The learning object should be tagged with metadata so that it can be stored and referenced in a repository[19]. Friesen (2001) adds that it is the metadata used to describe learning objects that make them accessible or discoverable.

Delivery

Thomas and Horne[10] state that learning objects alone are not sufficient for learning to occur; the delivery thereof affects learning. Barritt and Alderman[15] state that delivery options include e-learning, instructor-led learning, blended learning (a combination of both), as well as other options. Thomas and Horne[10] add that learning objects can also be delivered in paper-based environments. Shepherd (2000) suggests that learning objects can be selectively applied (alone or in combination) by computer software, learning facilitators or learners themselves, to meet individual needs for learning or performance support. Learning objects can be used by course developers to develop courses and assemble them to meet the needs of individual learners. Teachers may deliver learning objects for whole-class or differentiated teaching[10]. Alternatively, the choice of which learning objects to assemble into a collection can be a decision made as required by a learner. Independent learners can create their own courses by assembling learning objects relevant to their own needs, moving towards an individualized and focused approach to learning[8]. Thomas and

Horne[10] include delivery of learning objects by learners for individual or group work. In the future, as standards and Learning Content Management Systems (LCMS) evolve, a LCMS may adapt learning objects based on the learner's real-time performance[18]. Learning objects can be used in a variety of ways. For example, learners could collaborate under the guidance of an educator in a classroom situation or work at home completing an assignment or even use a simulation to perform virtual experiments. Thomas and Horne[10] note that learning objects can be delivered via Learning Management Systems (LMSs) or Virtual Learning Environments (VLEs). Learning objects may also be integrated into a course using a LMS to create and manage links between objects[16].

Learning Object Content Granularity

Learning objects exist and interoperate at different levels of granularity[8]. The e-Learning Consortium[1] provides a model, depicted in Figure 1, of a learning object content hierarchy (also represented in Wagner (2002) and Duval and Hodgins (2003)). While there may be any number of levels in this Content Object model, the four main levels are:

1. Data or "Raw" Media Elements: consist of the "raw media" stored at a pure data level, for example, a single illustration or audio clip.
2. Information Objects: a set of data elements combined to form a media independent chunk of information. Examples include procedures and summaries.
3. Application Specific Objects: Information objects are assembled into application objects, based on a single enabling objective. Learning objects are found at this level of the hierarchy.
4. Aggregate Assemblies and Collections: The fourth and fifth levels are defined around larger terminal objectives, such as lessons or chapters, which can be assembled into courses.

When this content object model is put into operation and applied to learning, the power of the inherent flexibility and reusability of the model becomes clear. Once developed, a great mass of digital assets can be stored within a database-managed repository. With the aid of metadata to detail and describe their attributes, each is ready to be reused through mass customization by assembly within multiple contexts and applications, and delivered within multiple delivery mediums, formats and devices[14].

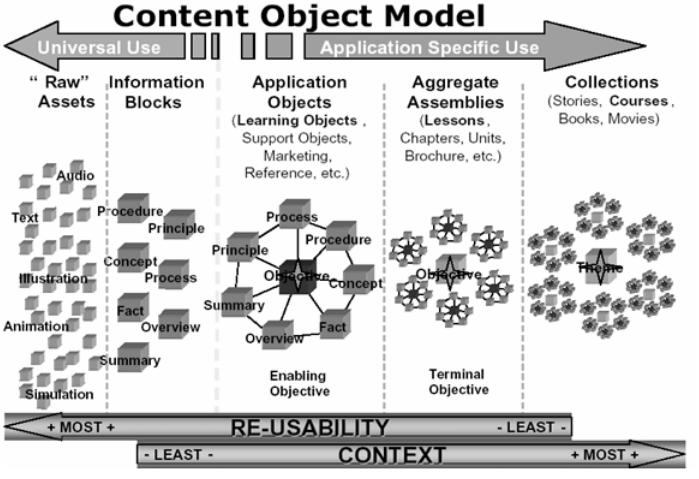

Figure 1: Modular Content Hierarchy(e-Learning Consortium, 2003,p.46)

A common issue of concern for learning object developers is the granularity at which objects are defined. It can be difficult to decide how much content to include in a single learning object. A learning object with too much content can be difficult to navigate, while too little content may result in learners finding that the outcome is not worth the time invested in using the learning object[16]. At the one end, learning objects are regarded at a micro level, as media assets. Although highly reusable at this level, helping developers in assembling content, it does little for the learner, who is not interested in how a learning component is made up, but only the functionality that it provides[12].In a Learning Object Repository (LOR), a smaller object must be provided with a proportionally higher amount of metadatato ensure that it is discoverable in the LOR, and that ma kes it necessary to store and manage many more objects[10].At t he other end, a learning object can be regarded as a fully self con tained piece of instruction, including information, mechanisms f or practice, and a means of assessment[12].

However, not all learning objectives can be met in full by a single, integrated chunk of material. There is a danger that learning objects will become too large and inflexible, hindering reusability, personalization and speedy, just-in-time access. Somewhere between these two extremes is a granularity level for learning objects that will place the needs of learners first, whilst recognizing the wide range of potential uses for, and benefits of learning objects. Figure 1 illustrates the trade-off between context and reusability at the different levels of granularity. Hodgins in Wagner [9]suggests that there is no set absolute size to a learning object, since the size of the object will be relative to the needs of the learners and requirements of given learning tasks. Shepherd[12] adds that what is really important is that the objects be short enough to be digestible and flexibly applied to a variety of situations. The time should probably take no more than 30 minutes to complete when used by a typical learner and many will last no more than a couple of minutes.

Benefits and Risks of the Learning Object Approach

There are many benefits for adopting a learning object approach to learning content development. As has been indicated, the benefits for learners are that personalized courses can be constructed to meet individual requirements, learning materials come in digestible chunks, and learning is available on a just-in-time basis[12]. Additional benefits are a consistent look and feel to learning content and the potential allowance of individual learning styles[15]. There are also benefits for instructors. Courses can be customized to suit the needs of different audiences, courses can be constructed from components emanating from a wide range of sources, and components can be used to meet a range of learning needs. Instructors can also find it easier to share information across departments[15]. The greatest benefit for developers is the reusability of content[17]. Barritt and Alderman[15] caution that in order for organizations to realize these benefits, they must follow a sound instructional design process. A benefit of learning objects is flexibility; where material that is designed to be used in multiple contexts can be used much more easily than material that needs to be rewritten for each new context[17]. Flexibility refers to the support for multiple modes of learning[16]. The next benefit is ease of updates, searches and content management. Metadata tags can facilitate rapid updating, searching and management by selecting only the relevant content for a given purpose. Customization can also be considered as one of the benefits of learning objects because modular learning objects maximize the potential for personalization by permitting the delivery and recombination of material at the level of granularity required[17]. Smith[16] adds that customization involves various combinations of learning objects combined to support particular learning styles. Another benefit is interoperability. Organizations can set specifications

regarding the development of learning objects based on organizational needs while retaining interoperability with other learning management systems.

Longmire[17] suggests other benefits are the facilitation of competency-based learning (with a focus on the intersection of knowledge, skills and attitude) and the matching of learning object metadata with individual competency gaps. Also, the value of content increases every time it is reused. Thomas and Horne[10]
summarize the benefits derived from learning objects as:

- Delivering industrial economies of scale. Learning objects enable efficiency through reducing duplication of the work of educators.
- Co-production of learning object creation. Sharing and improving teaching materials between educators could improve the quality of teaching.
- Scalability and networking. Learning objects can be accessible for all and be personalized for individual needs.

There are also a number of risks associated with adopting a learning object approach. It requires a paradigm shift in the way education is viewed. Learners will require self-motivation to select learning objects. Instructors may view this approach as more work. They may have to organize or link learning objects into courses and the navigation of each object may be unique. Developers will build many small objects instead of a few larger courses, which could be perceived as counter-productive because of the additional work[1]. Smith[16] agrees that learning objects can increase author workload. Creating a high-quality learning object is a serious undertaking and requires time to plan, gather or create assets and develop, test and deliver the final product. The idea of constructing a personalized learning environment is still relatively new and is also a complex task. The developer must select and assemble learning objects to match learning interests, performance gaps, learning style and presentation preferences[9].

Smith[16], therefore, notes that the lack of technical expertise is a common barrier to creating learning objects. Initially, there is a steep learning curve to using authoring tools; however, new tools which can be easy to use are constantly being developed. Another potential drawback is intellectual property and copyright issues, a common World Wide Web issue not limited to educational technology. Who owns the object? Can it be freely distributed? Is the learning object a derivative work or a redistribution of the original? Does the learning object belong to the author or institution? These questions illustrate just some of the difficulties associated with ownership and copyright of digital learning content [16]. Friesen[20] raises several concerns in connection with learning objects and associated technologies, notably one of which is whether objects can be simultaneously both pedagogically neutral and pedagogically valuable. Learning objects are seen to be pedagogically neutral due to the flexibility of their delivery. Critics of the learning object approach claim that the pretence of pedagogic neutrality is aimed at disguising the influence of pedagogical models where learners are “empty vessels” and wherein a computer is the “pipe that pours in the knowledge”[10]. John Naughton, in Thomas and Horne[10], describes this as an “impoverished view of learning”, where information is confused with knowledge and information transfer confused with learning.

A challenge facing developers is how to incorporate effective pedagogy into the learning object. Learning does not always occur in an intended educational experience. The educational objective can be lost when attempting to “get to grips” with the technology. It is important to keep a clear educational goal in mind when developing the learning object[16].

Acommon myth is that learning objects can only support “te chnical-based” learning. However, they can also be used to develop “soft” skills such as sales or managerial skills. Another common myth is that learning objects can only be put together to form step-by-step learning architectures, following a page-turning metaphor. Ruth Clark[15] states that learning objects can be used for exploratory learning, guided discovery and receptive learning. However, learning objects do not solve every training problem. Although they can realize great benefits, little quantitative research has been published on the effectiveness of learning objects for a given performance problem[15]. Smith[16] suggests that before educators begin to create learnin g objects, they should investigate:

- What educational problems they are trying to solve?
- How do they envision the learning object being used?
- What rights issues are involved?
- What are the available resources for development?

The answers to these questions enable educators to focus development efforts more efficiently. Additionally, they will keep the educational goals in focus, allow for the choice of meaningful content that directly supports the educational goal, present content in appropriate ways, select appropriate activity structures, and consider assessment issues[16].

Learning Object Repositories

Longmire[17]states that there are two requisite components of a learning object: the object content and the metadata tag. Wagner[9] agrees that learning objects should be stored and accessed using metadata tags. Friesen[20] succinctly states that learning objects can be said to refer to digital educational resources and that metadata refers to their systematic description to facilitate searching and administration. Learning objects are authored in small pieces, assembled into a learning object repository and delivered to the learner through a variety of learning media[15]. Friesen[20] adds that learning object repositories represent online, searchable collections of learning objects. A learning object repository stores both learning objects and their metadata, either by storing them physically together or by presenting a combined repository to the outside world, while actually storing them separately[21]. An example of a LOR is the Multimedia Educational Resource for Teaching and Online Learning (MERLOT) repository. MERLOT is an international consortium that produces an online community where staff and learners from around the world share online learning materials[22]. MERLOT provides free, web-based resources for higher education.

Conclusion

This article analyzed the role of learning objects in learning, the need for learning objects and the characteristics of learning objects. Although there is no standard definition of a learning object, it is agreed that learning objects are small, reusable pieces of content that allow learners to achieve an educational objective. It is noted that the granularity of the learning object content is of key concern when developing learning objects. The benefits and risks of adopting a learning object approach and learning object repositories were examined. The literature reviewed has identified that learning objects add value to learning content development and the learning process, yet this approach does require a paradigm shift in how learning content is developed.

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