Learning Object System for the Delivery of Quality Education

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ABSTRACT
A learning object is "any digital resource that can be reused to support learning." Learning objects are based on the notion that multiple educational institutions could share the use, and cost of the creation and management of the learning objects. The theoretical result of sharing learning objects leads to a much lower cost per educational institution. Learning objects are based on the generative and constructive learning theories that assert that learning is an active process of constructing rather than acquiring knowledge; instruction is a process of supporting that construction rather than communicating knowledge. Learning objects are also based on sound design principles of the object-oriented paradigm in computer science. These combined theories provide a framework for learning objects as: accessible, reusable, interoperable, adaptable, granular, versionable, cohesive, and loosely coupled. The purpose of this literature-based research is to explain the theory of learning objects and their benefits to organizations. This paper explains how learning objects can improve the delivery of quality education.

Keywords
Learning object theory; computer-based instruction; instructional technology; e-learning; education.

1. INTRODUCTION

1.1 History of Learning Objects
The theme of this paper is to discuss a new development of technology-enhanced known as learning objects. Learning objects are elements of a new approach to technology-enhanced education grounded in the principles of the object-oriented paradigm in computer science and instructional technology in education [26]. It's very difficult to determine who coined the term learning object and when this occurred, but established credit is given to Wayne Hodgins, a learning and information futurist [11]. The story says Hodgins was watching his children build things out of Legos while thinking about learning strategies. Wayne experienced an epiphany realizing that the world needed building blocks for interoperable pieces of learning – namely learning objects.

However, the Lego analogy, as explained by David Wiley, is an incomplete analogy in describing the inherent structure and nature of a learning object. The problem with the metaphor is the innate properties of Legos: (1) any Lego block is combinable with any other Lego block, (2) Lego blocks can be assembled in any manner one chooses, and (3) Lego are so simple and fun that even children can assemble them [26]. The presumptuous nature of this metaphor might lead one to believe that learning objects also have these properties.

Wiley argues that a system of learning objects with these properties is no more instructionally useful than Lego itself. Instead, he presents a more holistic and complete analogy – an atom. An atom is a small component that can be combined and recombined with other atoms to form a larger whole. However, atoms differ themselves from Lego in that: (1) not every atom can be combined with another, (2) atoms can only be assembled into certain prescribed structures, and (3) some understanding is a requisite to assembling atoms [26]. Although the differences among these characteristics of the analogies seem trivial, the implications of the differences are significant in understanding learning objects.

1.2 A Definition for Learning Objects
The term learning object surfaced nearly twelve years ago in a paper written by Hodgins, and since then has evolved into many different forms depending on the source. Unfortunately, understanding a learning object isn't as difficult as defining it. Since the concept of a learning object is still a relatively new idea, a definition of a learning objects is first provided to better describe their purpose.

A learning object, as defined by the Institute of Electrical and Electronics Engineer's Learning Technology Standards Committee, "is any entity, digital or non-digital that can be used, re-used or referenced during technology supported learning [12]." This definition is intended to include any form of instructional material that can be used during "technology supported learning." The IEEE definition is purposefully broad to include references to non-digital books, audio, periodicals etc. For example, this definition would include non-digital educational transparencies placed on an overhead projector during instruction, and digital audio clips explaining

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an educational concept because both could be referenced during "technology supported learning."

The problem with this working definition is not what it includes, but what is fails to exclude. It fails to exclude any noun that has ever existed in the history of mankind since it could be referenced during "technology supported learning" [26]. For instance, the definition would fail to exclude World War II since it could be referenced during "technology supported learning." To narrow down the range of possibilities, the definition, as defined by David Wiley, chosen for this paper is "any digital resource that can be reused to support learning." The range of possibility is now limited to include only digital entities, such as digital images, video feeds, animations, or perhaps web applications being used to "support" learning. Using this definition, it is easier to trace the use of learning objects to incorporate an e-learning strategy because the learning objects themselves are digital in nature and accessible over the Internet.

1.3 Example Learning Object

Figure 1 is a storyboard of screen shots from one of the Wisconsin Online Resource Center's learning objects. This particular learning object's purpose is to explain the operation of the six fundamental logic gates and the inverter are described by using truth tables, Boolean Algebra equations, switch analogies, and written statements [27]. The storyboard prescribes the definition, truth table, illustration, Boolean equation, and an interactive application of the logical AND gate. This learning object is interactive in nature allowing the user to learn only the material the learner chooses. This particular learning object is implemented using Macromedia technology and delivered using a standard Internet browser. All of the learning objects found in the Wisconsin Online Resource Center are meta-tagged to insure flexible content management and retrieval.

1.4 Awareness and Impact on Organizations

Since the inception of the term learning objects, many different groups have started working in this area. The IEEE formed the Learning Technology Standards Committee to be on the forefront of development standards [12]. The IMS Global Learning Consortium, a non-profit organization, was formed to develop and promote the adoption of open technical specifications for interoperable learning technology [13]. Even Oracle did some early work that later developed into the Oracle Learning Application. Although the Oracle Learning Application never came to fruition, it did contribute to the culmination of future standards and technical innovations.

The US Federal Government is the world's largest training organization: it plays a critical role in the use of learning objects both in terms of being the largest "customer" and the direction of learning objects [14]. A satellite broadcast had top officials from the White House, the Department of Defense and the Department of Labor to name a few, who are working in this area. Hodgins, as a panelist, took advantage of the opportunity after the broadcast to discuss with the federal people the need for some common understanding and directions relative to their mutual interests in learning objects [14]. Hodgins subsequently met with them to organize a meeting for top level US Federal Government officials to drive a common understanding of the work being done in this area and how they can all work best to move forward.

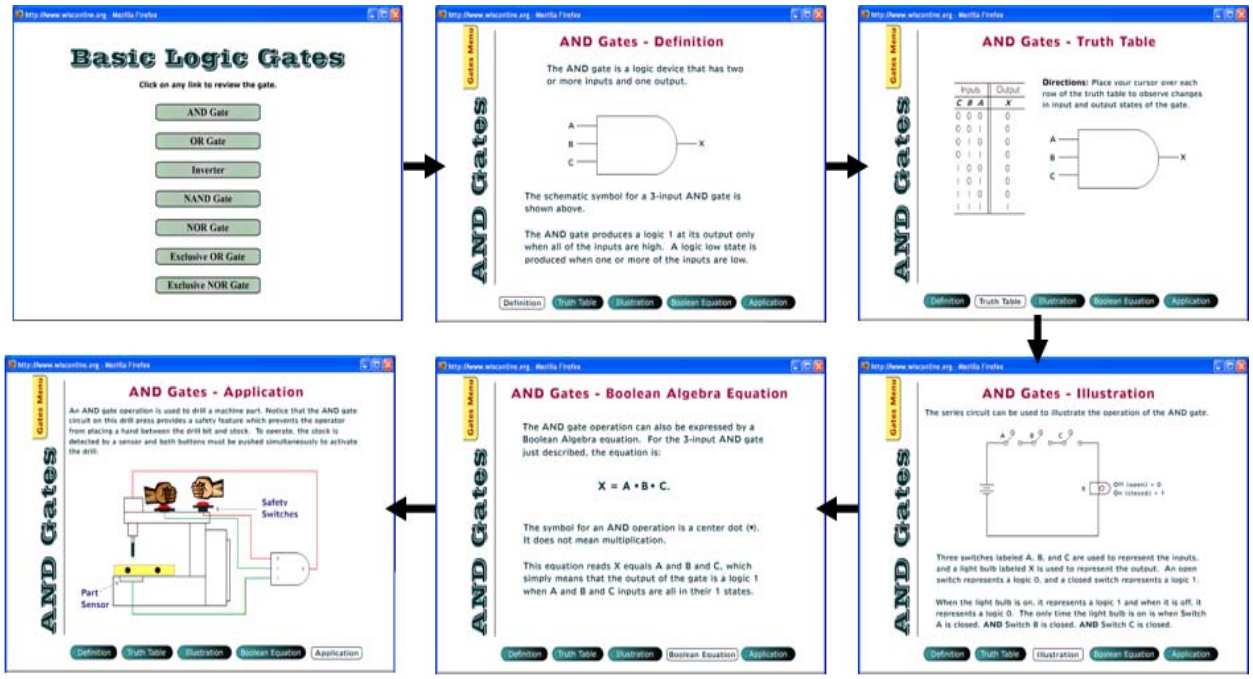

Figure 1 – Learning Object Example: Logical Gates, [27]

Steven Downes, a professor specializing in online design and research argues that the major benefit provided by learning objects to organizations can be reduced down to simple economics [7]. His conviction is based on the following assumptions:

Assumption: There are thousands of universities and colleges that teach introductory statistics, and part of this course generally requires a discussion on conditional probability.

Assumption: Although the instructor and textbook of this course may differ from institution to institution, the properties and equations of conditional probability stay the same. Therefore, there are thousands of similar descriptions of conditional probability.

Conviction: The education systems do not need thousands of similar descriptions of conditional probability. Instead, education systems need perhaps a dozen descriptions to suit the needs of individuals with different learning styles.

Therefore, multiple institutions could share the use and cost of the creation and management of the learning objects. It does not make financial sense to spend millions of dollars producing multiple versions of similar learning objects when single versions of the same objects could be shared at a much lower cost per institution [7]. Downes argues there must be sharing, because no institution producing its own materials on its own could compete with institutions sharing learning materials. The costs are then based on the instructional content that is developed and shared.

The need for learning objects makes more than just economic sense. From a state-wide university standpoint, learning objects could help with: the inconsistencies and perceived duplication among courses and programs with the same titles, and in some cases, the same numbering; the difficulty in getting courses into the online arena, both from a development standpoint and from the perspective of how to manage and deliver such courses; the variability of technology from campus to campus, and as a result, variability of access for both students and faculty; and the competition among varying educational institutions and funding [5].

1.5 The Need for Learning Objects

The need for learning objects is in the information age is based on online instructional content can being shared to effectively reduce the costs of education. However, an important consideration is how learning objects improve the delivery of quality education. The primary purpose of this paper is to address this topic. However, as the discussion will reveal, learning objects alone are not sufficient to realize this improvement.

Learning objects should be thought of as cogs in a much larger machine that when thoughtfully constructed, sequenced, and managed potentially result in the improved delivery of quality education. Therefore, learning objects themselves do not result in any improvements to education. The learning objects system is what generates these improvements. A learning object system is a framework used to create and deliver learning experiences that support the educational needs of stakeholders [1]. Therefore, the approach to addressing the research problem is to describe learning object systems that can be tailored to suit the needs of a variety of organizations.

2. EVIDENCE

2.1 A Theoretical Framework

This section provides a theoretical framework for learning objects and learning object systems so that the theoretical principles can be later mapped to learning object systems. It is understood that learning object systems that are designed with sound instructional principles lead to robust learning environments. Learning object systems are also rooted in the object-oriented paradigm in computer science. A brief discussion of these technical design principles is also provided.

2.1.1 Constructivist Theory

Ritland et al. argue that there are alternative theoretical foundations other than a traditional instructional systems design perspective that can be applied to learning object systems based on constructivist and generativist philosophy of learning [20]. Constructivism is an educational philosophy or perspective that encompasses a wide variety of views, and theories. Duffy and Cunningham believe that the constructivist philosophies and theories converge on two primary principles: (1) that learning is an active process of constructing rather than acquiring knowledge; and (2) instruction is a process of supporting that construction rather than communicating knowledge [8].

Constructivists believe that a learner individually interprets their experience by building a unique internal representation of knowledge. Generally, constructivism holds that learning outcomes are largely based on the learners, and that learners are required to actively participate in the learning process to construct meaningful knowledge rather than acquire a predetermined set of skills in a pre-specified manner [20]. Ritland et. al argues that to incorporate constructivist principles, a learning objects system must generally be:

- Accessible – Since learning objects can be understood as digital entities they can be shared and distributed over the Internet. However, the digital definition is not enough to make learning object prevalent and accessible. The ability to search, identify, access, and retrieve learning objects is also necessary [9].
- Reusable – Learning objects must exhibit flexibility to reuse learning objects for multiple purposes, in different applications, in different products, and in different learning contexts using varying devices for numerous markets [9]. If learning objects are designed to be used in multiple contexts, then they can be reused easily rather than having to recreate material that has to be rewritten for each new context.
- Interoperable – A major tenet of learning object theory is the ability to use content developed by one organization on a given platform with one set of tools at a completely different organization on a different platform with another set of tools [9]. The

interoperable notion is imperative for learning objects to be useful, accessible, and reusable by other organizations.

- Adaptable – Learning objects should be able to be sequenced in a way that they can adapt to a learners needs – namely prescriptive learning. Because not all learners are the same, learning objects must be adaptable to suit the needs of learners with varying educational needs.

Ritland's et. al state that the computer environment should not be providing the knowledge and intelligence to guide learning. It should be providing the facilitating structure and tools that enable students to make maximum use of their own intelligence and knowledge – a constructivist strategy.

2.1.2 Generative Theory

The generative learning theory model, analogous to the constructivist theory, is that the learner is not a passive recipient of information but an active participant in the instructional experience, constructing knowledge through relating information in the instructional environment to his or her previous experiences and prior knowledge [10]. Ritland et. al argues the generative learning process requires the learner to manipulate, interpret, organize or in some active manner make sense of his or her environment [20]. The learner then creates meaning through generative associations between and among elements in the instructional environment and his or her knowledge base. The primary element is presenting the opportunity to construct new meaning from the learners' interaction with the instructional environment and understanding of specific content. Ritland et. al argues that to incorporate generativist principles, a learning objects system must generally allow:

- Versioning – The learning object system should allow for designed and created artifacts that permit multiple versions of objects to be incorporated into the system. This would require the incorporation of an archival process to clear the repository of unwanted and outdated contributions. Brooks provides a model for meta-model for the versioning of learning objects in a repository. (Brooks, 2003)
- Granularity – The learning object system should allow for learner-produced artifacts to be generated on different prescribed levels or according to levels in the taxonomy of learning object types [26] and tagged according to standards to allow further discovery, retrieval, and manipulation.

Ritland et. al argues that learning object systems should be able to be configured as generative learning environments in addition to instructional delivery systems [20]. The flexible, and dynamic nature of this type of learning object system aligns well with a generative, constructivist pedagogical approach to learning.

2.1.3 Learning Object in the Object-Oriented Paradigm

Software engineering is concerned with the design, development, and maintenance of large complex software systems [4]. If a learning object system is understood as a large complex software system, than the principles of software engineering can be traced to the design, development, and maintenance of a learning object system. Thought leaders of learning objects have rooted learning objects in the object-oriented paradigm, which is often associated with software engineering. The object-oriented paradigm is a software development concept that focuses on the behavioral and structural characteristics of entities. The principles of software engineering and the particularly the object-oriented paradigm can then be applied to learning objects.

The principle of cohesion suggests that each unit should be one thing and only one thing [4]. Boyle argues that a direct link can be made to the notion of learning objectives in pedagogical terms. This mapping implies that each learning object should be traced to a clear learning objective or goal. The notion of cohesion beckons another important characteristic – minimized coupling. This principle states that the unit should have minimal bindings to other units [4]. With respect to learning objects, this means that the content of one learning object should not refer to and use material in another learning object in such a way to create unnecessary dependencies. Boyle argues that this principle is detrimental for reusability. Thus from a software engineering perspective, the challenge of designing a learning object is creating a highly cohesive, loosely coupled, and richly pedagogical unit.

2.1.4 Learning Objects: A Paradigm Shift

The notion of learning objects is problematic for traditional education systems. Contemporary learning is moving away from the notion of learning settings being comprised of pages of text and classrooms, to more deliberately planned learning designs, learning tasks and processes structured in deliberate ways [17]. Oliver states that in previous settings instructional design had focused on developing pathways for learners through learning content, whereas in contemporary settings the designs are now focusing on providing learning activities that bring about planned learning outcomes.

Downes discusses how courses are the primary unit of delivery of education in today's education systems. However, Downes believes that courses themselves are not suitable candidates for sharing educational content. Therefore, it should come as no surprise that there is very little sharing of educational resources, even online resources, despite the tremendous cost savings [7]. The main theoretical benefit, again, of sharing educational content is economic. The introduction of learning objects in education requires a paradigm shift from no sharing learning environments to learning environments where information can be shared.

2.2 Learning Object Systems: From Theory to Reality

Thought leaders in the instructional technology community have begun to wrestle with mapping sound instructional principles to the technical attributes of learning object systems for education and training purposes. Much work is being done in the development of learning object systems. This section will describe the three primary components of learning object system, but will first discuss the stakeholders in a learning

object system and the open standard models being adopted for the implementation of learning object systems.

2.2.1 Learning Object Stakeholders

A learning object system has three primary stakeholders: learners, authors and instructional designers, and developers (administrators). This section will describe the roles each of the stakeholders plays in the learning object process. It is important to note that depending on the context, there may be more stakeholders in a learning object system.

- Learners – The learners are the primary users of the learning object systems. Learners issue requests to the learning object systems to gather information about specific content. Generally, the learning objects are designed to suit the needs of many different learning styles. Learning styles represent tendencies and general preferences, and different contexts often invoke different preferences. Nonetheless, learning objects can offer learners ideas, concepts, and information in a variety of forms that will likely benefit more learners than relying on a single presentational form.
- Authors and Instructional Designers – Learning object authors are those that create learning objects for specific learning objectives. Learning authors are generally faculty in varying educational domains with the expertise to develop learning objects that can be traced to specific learning objectives. Instructional designers, which in some cases are also authors, combine and sequence learning objects to create either larger learning objects or to create high-level instructional components, such as courses, lessons, websites, or books. The instructional designer could also be a teacher utilizing learning objects in a classroom. Instructional designers deliver learning objects through instruction.
- Learning Object Developers – The developers of learning objects are those that satisfy the technical requirements of a learning object system by designing, developing, and maintaining useful software applications for learning object systems. Because the developers are also given the task of maintaining the learning object systems, they also represent the technical administrators of the learning object systems. The developers are given the task of gathering the requirements of a learning object system and conforming to specifications provided by standards organizations such as IEEE.

These are the primary stakeholders in a learning object system; however, there are potentially more stakeholders in a learning object system. For instance, if an organization, such as Cisco, implements a learning object system for training purposes within its organization, then the learners become the employees being trained with the system, the authors and instructional designers become the training department within the organization, and the developers are an in-house Information Technology (IT) department, an external IT service provider, or both. However, in this context, the managers would also play a critical role in the system's development. Managers would look specifically at the costs and benefits of such a system and aid in its direction.

2.2.2 XML and Open Standards

The instructional characteristics of learning object system provide a set of requirements for the design of learning object systems. The standards should be reusable, accessible, interoperable, and adaptable. Accessibility and interoperability of learning objects is technically achieved using the Extensible Markup Language (XML) over the Hypertext transfer protocol (HTTP). This has become the established transportation protocol to share learning objects in a distributed environment [21]. These standards conform to the generative and constructive learning theories.

Many different open standards have been established for the structure of learning objects; such as, Learning Object Metadata (LOM) standard produced by the IEEE 1484.12.1 [12]. The IEEE standard approved December 10, 2002 defines a meta-model to categorize and describe learning objects. By conforming to these standards using XML, learning resources from different providers are available in a consistent format for sharing, searching, and indexing on the web. The LOM standard includes some sixty plus fields to describe a learning object. Many of these fields directly relate to Wiley's learning object taxonomy.

Other widely accepted open standard models are available. Another popular open standard is the Sharable Content Object Reference Model (SCORM), an Advanced Distributed Learning initiative [3]. The SCORM standard is commonly used for the implementation of interoperable learning management systems. A definition and description of a learning management system is provided in the following section. The SCORM model follows a similar standard to the LOM model with respect to the required fields. Bohl et al. believe that the SCORM standard stands the chance to become the standard dominating the market. However, this early in the game, no reliable and valid measurements can be provided to support this belief.

2.2.3 Learning Object Authoring Tool

The utilization of a robust authoring tool is the first step in developing a learning object system. Universities have pioneered the creation of authoring tools for next generation learning environments demonstrating diverse pedagogical approaches [24]. The IT industry has also equipped computers with robust authoring tools in record-breaking numbers. Macromedia's Authorware and Director are especially popular in e-learning environments. There are numerous other proprietary authoring tools available. These tools enable authors to create dynamic interactive instructional content for learners.

Authors of course content develop learning objects using these authoring tools. These tools generally follow a standard, such as SCORM or LOM. An authoring tool is similar to a computer assisted software environment. The authors are actually creating two data sets when creating learning objects: the learning object content, and the learning object metadata. After the learning objects are created, they are inserted into a learning object repository.

2.2.4 Learning Object Repository

The core of a learning object system is a central repository (database) containing hundreds to thousands of individual learning objects. The information stored in these repositories would be accessed by an array of applications and end users, including learners and the instructional designers. Attached to each learning object in the database is metadata. The metadata includes subject-specific information by conforming to the open standards.

Two core models for learning object repositories exist. The most common form is a centralized form in which the learning object metadata is located on a single server [7]. This type of architecture is evident in Figure 1 where the metadata is stored on one server and the content is stored on many others. An alternative model is the distributed learning object model, in which the learning object metadata is contained in a number of connected servers. Distributed learning object repositories typically employ a peer-to-peer architecture to allow any number of servers to communicate with each other [7].

Learning object systems around the world could access this metadata to form its own complete set of learning resources. The learning repository will retrieve only that metadata relevant to the search request; therefore, it is filtered metadata that will be accessed by the learning systems. Some of the more common learning object repositories include: the University of Wisconsin Online Resource Center, Multimedia Educational Resource for Learning and Online Teaching (MERLOT), and the Apple Learning Exchange.

2.2.5 Learning Object Management System

As evident by the discussion till now, learning objects are typically small. However, most educational institutions deliver larger chunks of instruction – courses [7]. Using a Learning Management System (LMS), an instructional designer defines major features of the course: its topic area, or perhaps its grade level. The author then instructs the LMS to search through the learning object repository for relevant resources. From the search results, the author may review a learning object or select it for inclusion in the course. The LMS retrieves the object metadata from the repository and inserts it into the course package. The LMS automatically adds institution-specific formatting and prepares the package for delivery [7].

While an instructional designer could locate and assemble learning objects by hand, it would be tedious and unproductive. The basic LMS performs two major functions: it provides instructional designers with a means of locating learning objects, and it assembles them into standard compliant learning units [7].

Although many types of LMSs are available, the enhanced LMS will contain four essential features: an authoring application similar to the computer assisted software environment (CASE), a collection of learning objects described above, a means of sending the completed course to a delivery system (called a delivery interface), and administration tools [7]. The LMS systems have been enhanced to include additional features, such as intelligent tutoring or adaptive learning components for learners. Therefore, some LMS provide services directly to a learner. The enhanced LMS, sometimes referred to as a Learning Content Management System, is a hybrid system that contains all the essential elements of a learning object system.

Figure 2 depicts an enhanced LMS with respect to a learning object repository, the delivery device, and the learner. This diagram shows that a learning management is attached to a learning object repository which is generally a database consisting of the metadata and content data. The learning management system uses the data in the learning object repository to "deliver" a type of instruction to a learner. Therefore, an enhanced LMS will provide direct services to the learner. The learner views this information using a device, which is generally a web browser, such as Internet Explorer or Netscape. An important note is that the learner can access the learning content using many different devices. Some of these devices require mobile technology, such as a Personal Digital Assistant, or a wireless telephone.

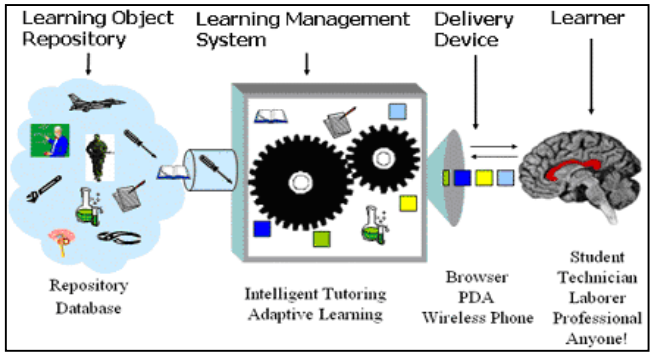

Figure 2– Enhanced Learning Management System, [22]

2.2.6 Learning Object Environment

The decision to utilize a learning object system is largely dependent on the type of learning environment. Three of the major different organizational contexts for the use of learning objects are the university, corporation, and military establishments. Collis et al. say that the use of learning objects will differ based on the environment in which the learning objects reside. A university setting is based on instructor-delivered courses with lectures. This approach remains the norm but web-based course-management systems, such as Blackboard, are routinely used to support the courses throughout their cycles [2].

A corporate environment typically uses two different delivery forms: a classroom with an instructor or an e-learning environment without an instructor [6]. A mixture of these two forms which is termed as "blended learning" is now appearing, but unlike the university setting, a course-management system is not typically used. Instead an LMS may be employed to deliver and track the e-learning component [6]. The classroom-portion of the blend generally does not make use of learning objects or electronic delivery systems unless instructional designers use learning objects for preparation (Rossett et al., 2003). A military setting uses a classroom

setting or computer-based training, but typically there is no combination of the two in a single course [6].

Collis et al. believes that the way in which learning objects are used and the strategy depends on the organizational context [6]. Collis et al. says specific questions need to be addressed to adopt a learning object system: "What is in it for the organization? Is there an organizational strategy? What is the reason for implementing a reuse strategy in the organization? [6]"

2.4 Potential Benefits of a Learning Objects System

Learning object systems provide many benefits to all the stakeholders. Wagner writes about a number of the benefits derived from a learning object system [25]:

- Increased value of content – The value of content is increased every time it is reused. This is reflected in cost savings by avoiding new design and production efforts. Selling learning objects or providing them to partners may offer additional revenue generation opportunities.
- Improved content flexibility – When content is captured in an object format, it can be reused much more easily than material that has to be rewritten for each new context or application.
- Improved updating, searching, and content management – Metadata tags describing various attributes of a learning object help organize, identify and locate relevant content. This improves searching, facilitates management and maintenance, and helps filter and select the relevant content for a given purpose.
- Content Customization – The learning object approach enables a just-in-time approach to customization by allowing designers to select, assemble, and rearrange content according to stakeholder needs.

South et al. identifies a more detailed inspection of the benefits of learning objects. South et al. identifies the "ilities" which are: durability, interoperability, accessibility, reusability, discoverability, extensibility, affordability, and manageability. It should not be surprising that most of the benefits, as discussed by South et al. and Wagner, derived from learning object systems directly relate to the learning theories presented earlier in the discussion. The notions of adaptability, granularity, reusability, interoperability, and accessibility are the pillars for learning object systems. These pillars lead to many potential benefits provided by a learning objects system.

2.5 Potential Drawbacks of a Learning Objects System

A learning object system is not the silver bullet to e-learning needs. Parish describes many of the problems with learning objects and learning object systems. Parish writes: (Parish, 2004)

- Lacking a clear definition – The learning object economy has difficulty defining a learning object. Without a clear picture of what a learning object is, it becomes extremely difficult to use them.
- Intellectual property rights – The question of ownership is also a problem. After an author creates a learning object and publishes it, the question of ownership arises.
- Language and geographical differences – A learning object might be useful in the United States, but that would not make it useful in India.
- Lack of knowledge and understanding – Many faculty members do not even know that the learning object systems exist.
- Difficult technical specification – The metadata data specifications, such as SCORM, require seventy plus fields for a single learning object.

These aforementioned topics are just some of the many difficulties relating to learning objects. There is no clear financial evidence to determine whether learning objects live up to their promise of financial savings or increases in productivity. All the material in the bodies of literature is still theoretical in nature. Other problems also exist. For instance, in the upcoming case study of the Wisconsin Online Resource Center, many challenges are presented that are difficult to overcome in the implementation of a learning object system. There is also the possibility that the learners might not learn from the available learning objects. Furthermore, there are steep costs associated with retooling, retraining, and recreating learning objects from other instructional content. Learning objects are not a perfect solution.

2.6 Learning Object Strategy

An e-Learning strategy is concerned with how information and communication technologies are utilized to facilitate learning – as over the Internet. The introduction of learning objects into the e-Learning community presents an unanswered question. Are learning object systems consistent with e-learning strategies? Vossen suggests that learning objects are the uniform foundation for e-Learning platforms [28]. A learning object system, as described by Vossen, is the stable technical and theoretical platform for e-learning. Two well-known learning object systems are frequently discussed in scholarly literature: Cisco's learning object system, and the Wisconsin Online Learning Resource Center. Each of these learning object systems are consistent with the organizations e-learning strategy. A brief case study of each of these systems is presented. These case studies attest to learning object systems being implemented on both a micro and macro scale, and also to a learning object system being consistent with an e-learning strategy.

2.6.1 Cisco's Learning Object System

Cisco's implementation of a learning object system is often discussed in scholarly journals as being consistent with an e-learning strategy. Cisco Systems transformed its instructor-led Career Certification courses into an e-learning format to better streamline lessons, allow thousands of employees to learn at their own pace, and arm its closest learning partners with reusable learning objects they could repurpose into customized

course offerings [15]. In early 2000, Cisco CEO John Chambers said that he wanted Cisco to be “the” e-learning company, and he was looking to its Internet Learning Solutions Group to deliver that vision. The Internet Learning Solutions Group decided to implement a reusable learning object strategy to answer his call [15].

Adopting a learning object strategy coupled with using an authoring tool known as OutStart’s Evolution, Cisco was able to redesign and rewrite all eight of its certification courses and create one content set [15]. This ensured that courses were consistent in instructional design and technical accuracy. Cisco’s learning solution partners embraced a blended approach now provides a package of offerings for each course: traditional classroom training, live virtual training, or self-paced e-learning. Partners also can take source content and create customized solutions for their customers by combining a variety of learning objects into new offerings [15]. Cisco reports that although many of its learning partners were reluctant to move to an e-learning format for delivery, they soon came to realize that their internal classroom instructors could benefit from a new approach [15].

Cisco’s vision depended heavily on partners. By developing a learning object system that combined OutStart’s Evolution, Cisco’s licensed learning management system, and internal custom applications, Cisco is achieving its goal: to enable all employees to use e-learning to access on-demand, personalized training, in the media of their choice, to improve job performance.

Cisco reports that the benefits to the learning object strategy are clear. Previously it could take nearly nine months to develop a course that now takes eight to twelve weeks to develop and execute. From a financial perspective, the capability to reuse content and a reduction in content development time, Cisco anticipates a five hundred percent return on investment [15]. For example, Cisco recently developed a course in half the time and budget by reusing learning objects, and over the past year, developed more than 130 courses, 2,500 lessons, and 20,000 reusable learning objects [15].

Cisco also attests to the use of learning objects in making prescriptive learning a reality stating there has been a collective attitude change among employees who now embrace e-learning as a critical career development tool [15]. Cisco now offers an assessment that prescribes the learning objects people need to achieve the desired performance. From a learning perspective, what Cisco cares about is performance, and performance measurement is a core strategy. This case study shows the use of learning objects as an e-learning strategy within a private organization.

2.6.2 Wisconsin Online Resource Center

The Wisconsin Online Resource Center is one of the largest and most successful implementations of a learning object system. The process of developing this system provides for an interesting case study. The Fund for the Improvement of Post-Secondary Education provided money through its brand new Learning Anywhere Anytime Partnership for a 3-year proposal to develop an online resource center of learning objects for nine courses called the General Education "core" in the Wisconsin Technical College System [5].

The e-learning strategy was to develop a learning object system based on new way of thinking in the field of curriculum development and course design. This new way of thinking would require that educators focus on learning and the learner by creating self-contained, reusable, high-quality learning chunks that could be combined and recombined in courses, learning activities and experiences, and assessments that meet a learner's immediate needs [5].

Chitwood et al. et al. describe the implementation of the system as a set of challenges. The fist challenge was taking the idea and mapping it to a written project proposal [5]. This challenge required the core team working on the project to gather support from sixteen other state districts. The next challenge required for all sixteen districts to meet (including technical staff, faculty teaching the nine courses, and administrators) and commit to the implementation of the project [5]. After a final commitment was made from all parties involved, the project went to the next level.

The next set challenges were human resource issues. The project required the commitment of faculty for the authoring of the learning objects, and a technical staff to implement the system. Furthermore, a concrete understanding of learning objects was required for the development team to understand what had to be done. The development team needed to train themselves in learning object theory. Other challenges relating the bureaucracy of a statewide education system and intellectual property rights were also encountered [5].

The resultant is a statewide system used by sixteen different institutions for creating, capturing, and delivering learning objects. Faculty authors from throughout the system create learning objects for each competency within the General Education [27]. Individual instructors then have the option to pick and choose from a vast assortment of the learning objects to customize their online courses and their on-campus courses for their students. The initial proposal was funded $1.6 million over a three-year duration. The project, now fully functional, only reports spending $800 thousand on the implementation of the Wisconsin Online Resource Center [27]. This case study shows the use of a learning object as an e-learning strategy within a public education system.

3. CONCLUSIONS

This research has documented the theory behind learning objects and the implementation and use of learning object systems. The premises of the constructivist and generativist learning theories are discussed to map the principles of these theories to the implementation of instructionally sound learning object systems. Constructivist and generativist learning theories suggests that learners is not a passive recipients of information but an active participants in the instructional experience, relating information in the instructional environment to his or her previous experiences and prior knowledge. These theories trace instructional principles that are evident in learning object systems: accessibility, reusability, adaptability, intolerability, and granularity. As

discussed in the evidence, these pillars are also the primary benefits that learning object systems provide.

This paper has documented the types of learning object systems that have been developed in the past ten years. Learning object systems continue to evolve; however, most system will include an authoring tool to create learning objects, a repository to store and deliver learning objects, and a learning management system to provide learners a complete learning experience. These components are the vehicles that deliver "quality education." Learning object systems provide an accessible digital forum where learners can easily access learning objects that map to specific learning objectives. The learning objects themselves are easy to access because they are digital and shareable over networks and because they are tagged in XML using a standard such as SCORM or LOM. Using the metadata, learners or instructional designers can do simple searches in a learning object repository to find the desired content.

The granularity of learning objects afford instructional designers and learning management systems the ability to supply students with a customized learning experience – namely prescriptive learning. Rather than a student relearning competencies they already understand in a course or textbook, a learning management system or instructional designer can combine and sequence learning objects that specifically meet a learners needs. The amount of time spent reading or listening to immaterial information can is therefore reduced.

Because the learning objects are compliant to a predefined standard, they can be used in varying software applications and platforms that accept the standard – confirming the interoperability of learning objects. This provides learners from varying location using heterogeneous machines access to learning content without the concern of compatibility. Furthermore, it easier to manage instructional content since the learning objects are stored in repositories and based on metadata. A learning object system streamlines instructional content. The true power behind a learning object is that different learners can reuse it many times. Learning objects are stored in database systems where they can be easily maintained and revised if necessary. So, if for instance a book becomes out of date, then a new version is released, costing learners more money. Using learning objects strategy authors can easily update a learning object in a database, and it does not require a new version (versioning) to be published because a learner can access the learning object on demand.

From a financial perspective, learning object systems promise great cost savings by streamlining educational content, which leads to an increase in productivity as evidenced by the Cisco case. Both educational institutions and learners, as discussed by Downes, can realize these cost savings. An educational institution could reduce the costs of creating and managing instructional content, and therefore the reduced costs would pass to the consumers of their services – the learners The many theoretical benefits provided by a learning object system make it a viable e-learning solution for many organizations. Learning object systems improve the delivery of quality education by providing many benefits to all the stakeholders in the system whether they are financial or operational in nature. However, many unresolved issues surrounding learning object systems need to be addressed.

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