Pedagogically Sound Learning Objects: Towards a Useful Classification

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Abstract

In spite of the numerous discussions in literature, the learning object remains an ill-defined concept. In this paper, rather than attempting to clearly define what a learning object is, I discuss kinds of computer-based creations that might be recognized as a learning object by the community involved in design and use of technology-based educational resources. This discussion is supported by a small-scale inquiry into kinds of learning objects identified from a collection of resources developed by some teachers and instructional designers in Singapore. Six unique categories of potential learning objects were noted and defined through the inquiry: presentation object, practice object, information object, simulation object, conceptual model and contextual representation. These kinds of learning objects are discussed in this paper. The paper opens a possibility for the proposed categories to be challenged or for more categories of learning objects to emerge in further inquiries involving examination of larger repositories of learning objects.

Introduction

In the last few years, learning objects have received considerable attention in the education community. The original idea behind learning objects is that instead of traditional, direct instruction courseware packages, curriculum content can be broken down into small, reusable instructional components (Cisco Systems, 2001). The components can be tagged with metadata descriptors and deposited in digital libraries for reuse (IEEE, 2001; IMS Global Learning Consortium, 2002). So-called E-learning Standards have set essential technical requirements to ensure that learning objects are deployable across different Learning Management Systems (LMS) that automate packaging, reusability and tracking. However, this idea is rapidly becoming recognized as based on outdated learning theories (Jonassen & Churchill, 2004), because repackaging of such learning objects into lessons usually leads to structured and direct instruction. There is a general call within the academic community for reconsideration of what a learning object may be (see Anderson, 2003; Friesen, 2003; Wiley, 2002), as this concept appears to be poorly defined in respect to contemporary pedagogy, which emphasizes learner-centered practices and use of technology in this context. An alternative conception presents a learning object as any resource that can be used during technology-supported learning (see IEEE, 2001). This opens possibility for a learning object to be regarded as anything that can be used in any learning context. However, it might be reasonably argued that a definition as broad as this is of very limited use; thus, a clear and accurate definition ofa learning object remains open and indeed, might appear to be even more controversial than before.

In this paper, I report an outcome of a preliminary inquiry into learning objects. This inquiry involved examining a number of learning objects in order to explicate an understanding what kinds of computer-based creations developed by a community of teachers and instructional designers are considered to be learning objects. The inquiry was not an attempt to define a learning object in general terms. Rather, the inquiry aimed to facilitate the development of a classification that could be informative to individuals engaged in design of educational resources and integration of technology in teaching and learning. This preliminary inquiry intended to explicate an initial classification that could pave the way for further examination of large repositories of learning objects such as MERLOT (Multimedia Educational Resource for Learning and Online Teaching).

The Inquiry

The learning objects examined in this inquiry were collected from the following sources:

1. Learning Object Competition 2003 -- The Learning Object Competition was held in Singapore in November 2003. It was organized by E-learning Competency Center, a Singapore Government founded organization, the task of which was to monitor, promote and facilitate developments in the e-learning industry. The competition attracted 83 submissions from educational institutions, the corporate sector and interested individuals. The source of submissions is shown in Figure 1. It was clear that the majority of the submissions issued from educational institutions in Singapore. While all local educational institutions participated, there were few submissions from major commercial players in the e-learning industry in Singapore.

   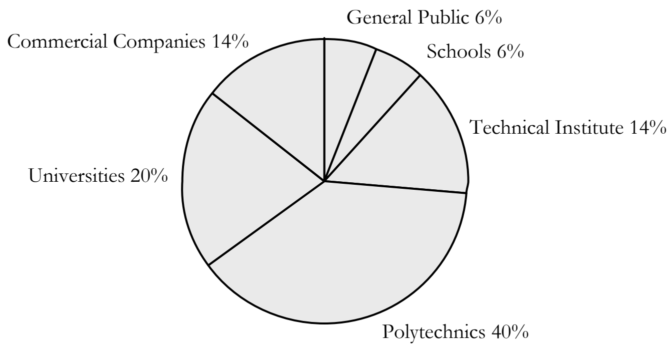

   Figure 1: Participants in Learning Object Competition 2003

   I was appointed as one of three judges who made decisions on the best learning objects submitted for this competition based on criteria which included pedagogical value, interface design and reusability. Subsequently, I presented a keynote address at the Learning Object Conference 2003 in November where the awards were announced and presented to the top entrees. After the event, I kept this collection of learning objects for the subsequent inquiry reported in this paper.

2. The second source of learning objects under review was a small collection developed by some teachers of the Institute of Technical Education and post-graduate students from the National Institute of Education in Singapore, who were studying towards teaching and instructional design qualifications. In addition, this source included a small collection of learning objects which I developed in the context of my own teaching and a prolonged inquiry into design and development of technology-based educational resources. Examples of this small collection of learning objects can be previewed at the http://www.learnactivity.com web site (Churchill, 2003).

The entire collection for review included 175 web-based learning objects from a variety of disciplines. Learning objects from science and technology were the most numerous. Distribution of the learning objects in the collection under inquiry appeared similar to the distribution of the learning objects in the major repositories such as MERLOT (see http://www.merlot.org/) in the US, or Learnet in Hong Kong (see http://www.learnet.hku.hk/). Accordingly, the distribution of the learning objects across disciplines in the collection under inquiry appeared to serve as an indicator of what was happening elsewhere in the world (see Figure 2). Many of the learning objects appear to originate from the context of science and technology teaching and learning. The MERLOT repository enjoys the reputation of being the best collection of learning objects in the world (Zemsky & Massy, 2004). Currently, MERLOTt contains references to 12,525 learning objects (data obtained from MERLOT in March 2005). Learnet is one of the few learning object repositories in the Asia-Pacific region. It references 987 learning objects from around the world (data obtained form Learnet in March 2005). My intention for further study is to explore the content of these two repositories in more detail in order to examine whether the outcomes of the study reported in this paper are replicated elsewhere. This preliminary study focused on a small collection of learning objects in order to explicate an initial classification that could pave the way for further study of larger repositories of learning objects such as MERLOT.

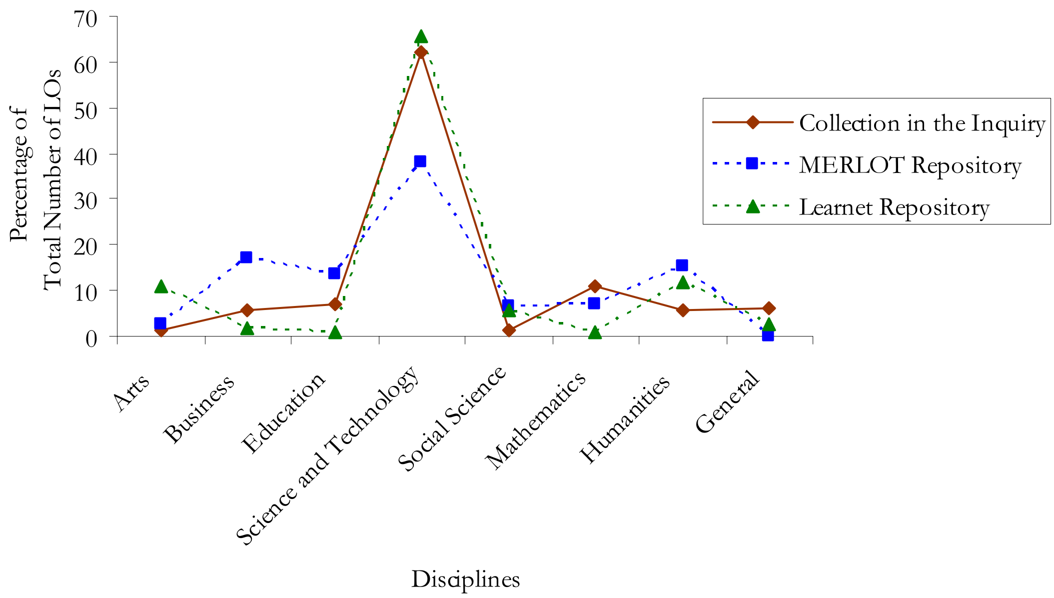

Figure 2: Distribution across disciplines of learning objects in the sample under inquiry

Each of the learning objects from this collection was reviewed by a small team of reviewers. The team included two qualified instructional designers who had previously designed learning objects (or what they perceived learning objects should be). One of the two instructional designers was specializing in the field of sciences and technology, and the other in humanities. I was the third member of the review team. A key screen from each of the learning objects was captured, reduced and printed on a sorting card of A5 size. Each card also contained a short paragraph of general description of a learning object. The three of us held several meetings, during which we collaboratively sorted the 175 cards into a set of internally homogenous and externally heterogeneous piles representing characteristic categories of the learning objects. When contradictions emerged, we revisited the learning object and discussed the best possible solution to resolving such contradictions. We used a relatively old classification of computer-based educational material Alessi and Trollip's (1991) - as a starting point in this analysis. Alessi and Trollip suggest that computer-based educational material can be classified into instructional modules or tutorials, drill and practice, simulations and games. A number of learning objects from the collection fell into one of these categories. Only one of the learning objects was identified as game-like. We revisited this learning object and agreed that it should actually be considered as a practice that allows learners to learn to pronounce and recognize certain German language terms. We decided at that stage not to categorize games as a separate kind of learning object.

Very early in the sorting process we came to the understanding that the classification by Alessi and Trollip (1991) was incomplete because a large number of learning objects from our collection remained unclassified. We understood that the Alessi and Tropic categories served the purpose for classification of educational material designed to instruct or engage a learner in practice of certain routine procedures, recall and recognition. Thus, this classification was suitable in the context of traditional instructional materials based on the understanding of learning as a structured process rather than designed to support constructivist practice. Constructivist material is less structured and more open-ended (e.g. allows exploration, analysis and concept formation) and authentic (e.g. presents information and data as it emerges from an original source). These learning objects reflect a strategy for effective organization and representation of data, information, ideas and cognitive resources into interactive visual displays that can be used in learning activities.

The classification we finally agreed upon includes the following categories of learning objects:

1. Presentation object -- an instruction or presentation designed with the intention to transmit knowledge;
2. Practice object -- allows practice of procedures and answering of questions with constructive feedback in place;
3. Simulation -- representation of some real-life system or process;
4. Information object -- visually and interactively structured information display;
5. Contextual representation -- representation of data as it emerges form some context; and
6. Conceptual model -- representation of knowledge of a subject matter expert.

The last three categories in this classification emerged from this inquiry, while the first three were closely associated with the Alessi and Trollip's classification (1991). These types of learning objects are not mutually exclusive and it is possible for a learning object to contain characteristics across these types. Some learning objects which I subsequently noted by exploring other repositories of learning objects appear in the form of "cognitive tools" (Pea, 1985), "mind tools" (Jonassen and Carr, 2000) or "technologies of mind" (Salomon, Perkins and Globerson, 1991). An example of such a learning object is "IrYdium Project:Virtual Chemistry Lab" from Carnegie Mellon University, located in the "Learning Commons" repository of the University of Calgary (see: http://careo.ucalgary.ca/). This kind of tool enables learners to develop knowledge by experimenting with models and scenarios that they construct themselves.

In the next section of the paper, I will discuss and illustrate each of the kinds of identified learning objects articulated from this inquiry. In addition, I will touch upon some points regarding effective design and use of learning objects.

Discussion of the Categories of Learning Objects Further to the Classification

Information Objects

An information object is a digital resource that presents information in textual and multimedia formats. It might range from a single representation to a visual interface of a collection of information from the object or a database. Such information might include technical information, stories, case studies, reports, discussions and interview transcripts or articles. This learning object is an informative rather than instructive resource; that is, an information object does not instruct and reinforce what is correct and what the learners are expected to remember, rather only providing information that learners can explore, evaluate, use and transform within learning activities.

The fundamental question concerning information objects is how to utilize capabilities of contemporary technology to effectively structure and present information to allow users to examine it faster, more accurately and with a greater depth of understanding. Many information objects reviewed were web pages with a lot of textual information, occasional use of visuals and interaction used mostly for the purpose of navigation from page to page. Many visuals had little relevance to the content of the object and served merely to cosmetically enhance the interface. These information objects were often little or no different from print media and many learners would be likely to print these documents for off-line reading. Fraser (1999) reminds us that the "extent to which one has taken advantage of the expanded horizons for communicating ideas with a new medium is the extent to which the material cannot then be reproduced in the older medium". Scanning, retyping and other ways of transporting information from older mediums such as books to equivalent on-line versions does not necessarily facilitate learning to any greater extent and might actually complicate the learning process (for example, reading and comprehending a lot of text from a screen can be more difficult than with a hard copy version of the same material). A learning object architect (my term for a designer of a learning object) must transform information into a more efficient visual and interactive format that utilizes technology to enhance communication and increase opportunities for learning.

Information can be organized in tables, matrixes, mind maps, illustrations, pictures, animations, diagrams, 3D models and by way of other visual elements. Interactivity - e.g., buttons, clickable hot-spots, roll-over spots, sliders, text-entries and drag-and-drops - allow information space to be organized in a way that enables learners to engage in exploring information, changing modes of representations, manipulating certain parameters or configuring options and observing changes in information, and otherwise manipulating the information they are consuming through the interface. Interactivity and visualization allow large quantities of information to be represented and made available for display to a user based on interaction with interface elements. A single interface - that is, a single screen without a change of a page - might act as an intuitive point of access to a large quantity of information. This would allow learners not just to experience interaction and a lot of information in multimodal formats, but also to construct a mental space of information from the learning object and understand how different pieces of information are related. Information might be structured within an information object, or it can be structured in a database. In this case, an information object is composed of two components: the database and the visual interface used to query the database and display information to a learner. Structuring information in a database allows the updating and reuse of information for different purposes; that is, same database might be available for different interfaces.

Figure 3 shows an example of an information object.

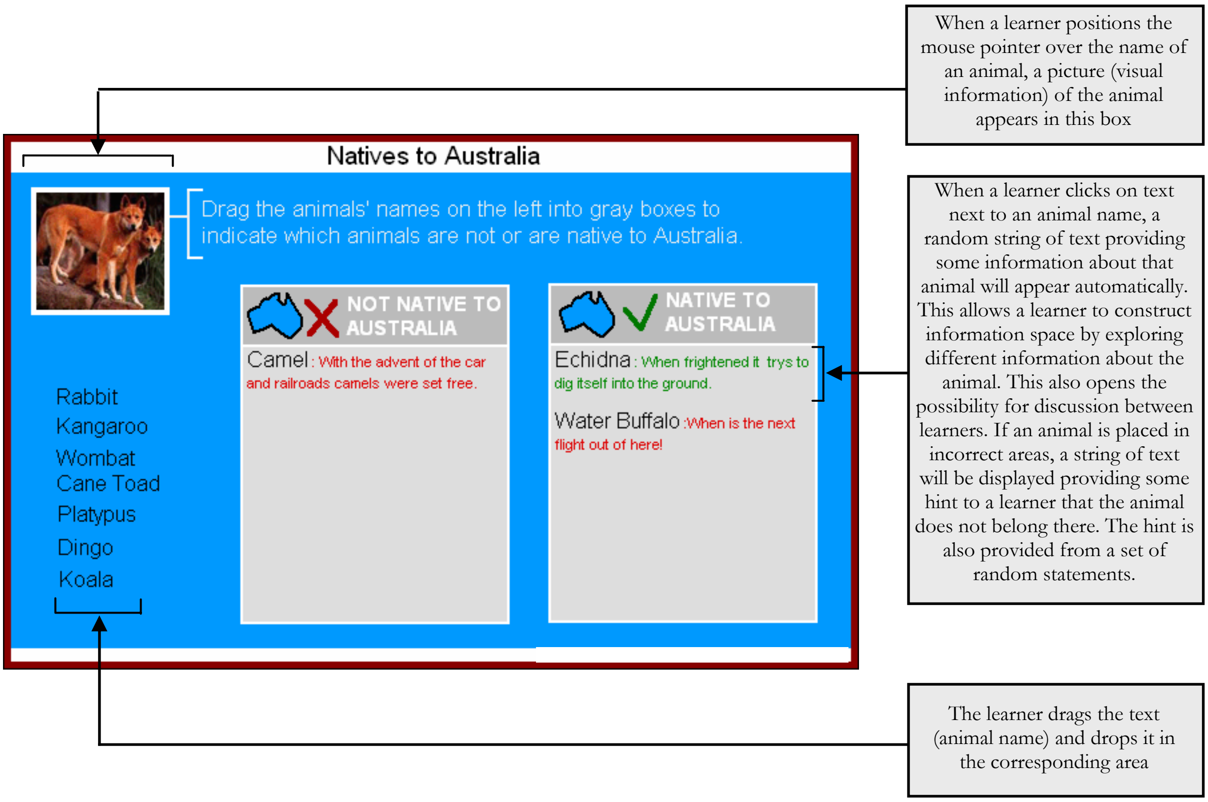

Figure 3: "Natives to Australia" information object

This simple example of an information object contains textual and visual information about native and non-native animals found in Australia. Information about animals is accessed by rolling a mouse pointer over the text comprising the name of an animal and through decisions which include dragging of an animal's name into a corresponding area indicating the animal's origin. The initial story line about Australian native animals was converted through content analysis into an interactive representation that allows learners to explore this information space within the context of some learning activity. The essence of the story was preserved in the information object; however, long lines of texts have been reduced to short key statements that are delivered to a learner randomly.

Presentation Objects

A certain number of learning objects previewed in this study appeared in the format of structured courseware modules presenting content information in a step-by-step manner. These are best described as presentation objects. In this form, the designers of learning objects explicitly aimed to instruct learners by presenting chunks of information and reinforcing the recall of that information through the use of questions. These learning objects appeared to be based on older instructional design models and learning theories (e.g. Dick & Carey, 1990). The content of such objects is usually divided into sections, with learners going through one section at a time. Cisco Systems (2001), in particular, promote this strategy as a suitable approach for design and management of learning objects that could be recombined into new lessons. Another type of presentation object noted included slide presentations with or without talking heads, video or audio-recorded lecturers, instructional video segments and animated instructions. Figure 4 shows an example of a presentation object developed with a software tool that allows easy recording and packaging of presentations for on-line delivery.

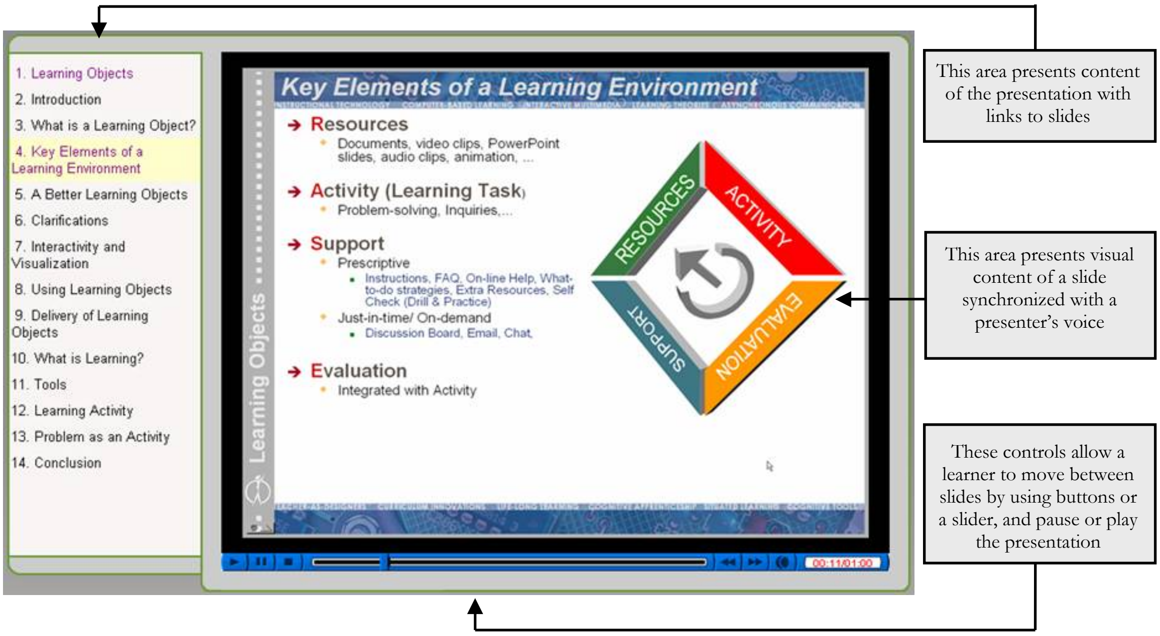

Figure 4: An example of a presentation object

Although these instructional materials are based on older and sometimes outdated learning theories, the fact that they might support learning should not be denied. My argument is that in future we must rethink how we design learning resources in a way that would support contemporary learning theories, fully utilize contemporary technology, minimize development time, and maximize reuse and learning opportunities. However, these existing direct instruction materials might still be used for learning activities. Davydov (1999) suggests that any resource might be used to mediate learning activity if that resource is given an instrumental role in the activity. Thus, in using these resources to mediate learning activates, the resources are given a particular role. Learners do not learn simply from reading and being exposed to information from resources, but they may effectively use the resources as instruments or tools that mediate their actions in learning activities.

Practice Objects

Some of the learning objects in the collection were interactive resources which allowed learners to practice certain procedures (e.g. dismantling a water pump), complete crosswords, drag objects and carry on certain tasks (e.g. dragging a protractor to measure an assigned angle) or answer quiz questions. These kinds of learning objects are best described as practice objects. Although many of these kinds of resources were integrated with presentation objects, our view was that it is appropriate to consider them as an independent category. This would allow a practice object to be paired with other learning object, reused in different activities, used as a learning support resource within a learning activity, used independently by learners for their own purpose, etc. Thus, the use of a practice object does not have to be limited to direct instruction only.

A problem with the previewed practice objects is that most were designed to support recall of certain information by learners while providing limited feedback regarding the correctness or incorrectness of an answer. Often, the practice objects were paired with some instruction, in which case their role was to check whether a learner had managed to remember whatever was delivered by the instruction. In this form, such practice objects were not designed to be used to facilitate extension of learners' current level of understanding (or misunderstanding) or to enable them to build models of their own mistakes. Another problem was that objects which aimed to engage learners to practice certain procedures were too structured in the sense that the entire procedure was broken down into integral steps, allowing a learner to practice in step-by-step manner with immediate feedback on a particular step -- a kind of questioning sequence. This kind of spoon-feeding might potentially limit a learner's opportunity to build a holistic model of their actions. A further problem was the limited use of visuals to illustrate scenarios. In addition, interactivity was often limited. Many practice items were merely text questions requiring learners to press a key on a keyboard as a response.

Ideally, practice objects should be considered as part of a learning process, rather than as some post-learning activity that aims to strengthen learners' recall of information presented by a teacher or resources. Thus, a practice object should be given an instrumental role in an activity. Whatever learners conceptualize from their involvement with a practice object should be utilized to mediate their completion of a learning activity. Here are few recommended guiding principles for designing a practice object such that it supports learning activities:

1. A practice object should be designed to serve as a tool that contributes to completion of a learning activity
2. A practice object incorporates interactivity and visualization and requires learners to engage in some purposeful interaction and decisions;
3. A practice object should provide constructive feedback (which might utilize visuals) that enables learners to reflect on their action and encourages them to further explore digital libraries, the internet, post a question on-line, engage in discussion with classmates, etc.

Figure 5 shows a screen from the "Volume of a Pyramid" practice object. The question in the object requires a learner to approximate the volume of the pyramid presented in the scenario. This pyramid is an interactive 3-dimensional medium that can be rotated and visually examined by a learner. A learner rotates the pyramid and uses the provided ruler to capture its dimensions. The scale on the ruler is randomized. This means that different learners will have rulers of different lengths and that their answers will be different. This opens a possibility for collaboration between the learners, while removing the possibility of copying of answers. Exchanging ideas on the solving of a problem is an important part of the learners' collaboration. Copying of a method and copying of answers are two different things. Copying of a method opens the possibility for learners to learn from each other.

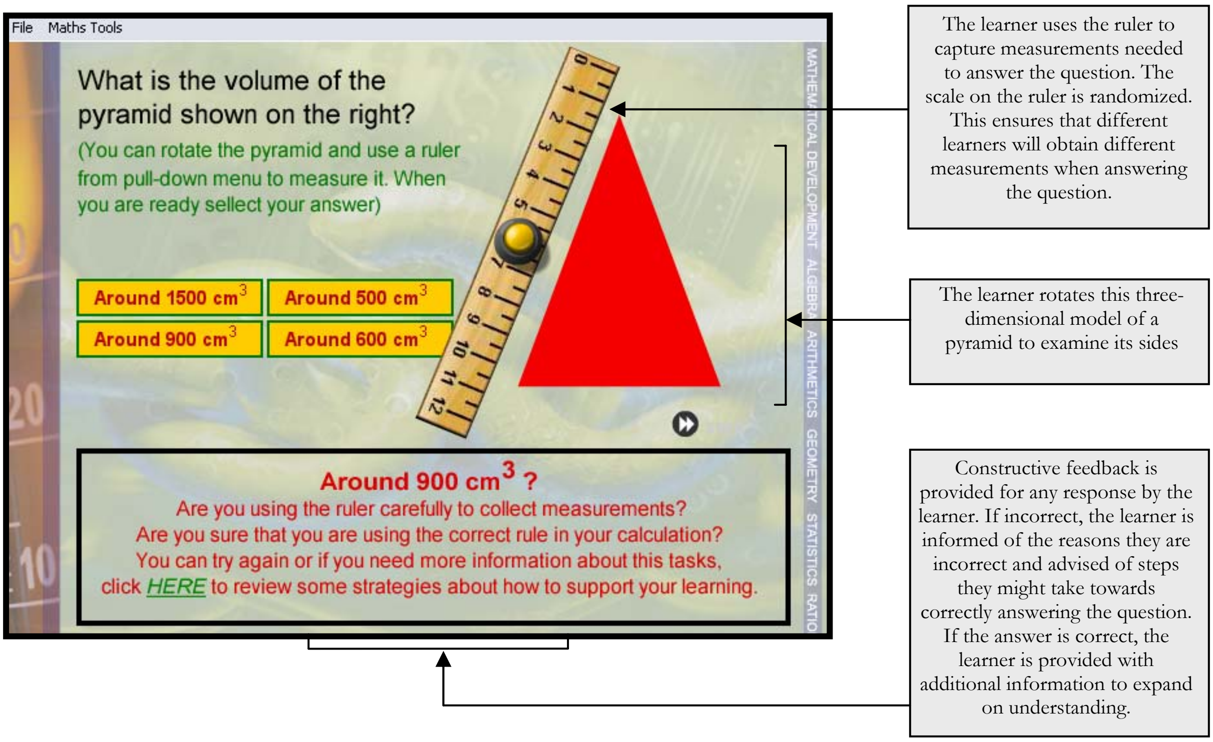

Figure 5: "Volume of a Pyramid" practice object

Educational games might also be considered as practice objects because they can promote persistent practice of certain actions and thinking exercises until a degree of competency or understanding is achieved. Although the possibility is open for games to be considered as a separate category of learning objects, I understand a game primarily as a particular human activity rather than a particular kind of resource for learning.

Simulation Objects

Early in our review, we identified a number of simulation-like learning objects. These objects are interactive visual displays representing some real-life system or process: e.g. a simulation of a microscope or a simulation of electricity consumption in a household. A simulation object allows a learner to explore, usually by trial and error, the operational aspects of a system, carry on a task that the system supports, and develop a mind model of that system's functionalities. In some cases, learners learn how to use a real system through a simulation (e.g. drive a locomotive or use a digital multimeter). Although cognitive fidelity is often high in simulations, development of skills is hardly ever completed and learners must usually move to a real system to complete their practice to genuine competency level. However, by the time a learner shifts to the real system he or she would already have constructed a mind model of the system's functionalities and operational possibilities. This is particularly effective when learning to use the real system requires an understanding beyond being able to operate it (e.g. understanding how a system works) and when the real system is expensive, unavailable or available in limited number, or learning to operate it is costly and possibly dangerous. A simulation might also involve dynamic processes such as manufacturing processes, financial flows and energy consumptions. In this case, a learner might manipulate certain parameters as he or she learns to manage that process.

Individuals are likely to mistake anything interactive and visual for a simulation. All forms of interactive learning objects have things in common. Wartofsky (1979), in fact, suggests that all artifacts are connected to each other in some way. As all kinds of learning objects are created with contemporary technology, they will utilize interactive and visual affordances for representation, and it is possible to design a single learning object that will contain elements of different types. Interactivity and visualization create an illusion that they are the same. However, I suggest that a simulation is a technology-based representation of something real rather than abstract imagination, an idea or representation of knowledge in the head.

Figure 6 shows a screen from "Digital Multimeter" simulation object. This interactive learning object allows a learner to explore use of a digital multimeter instrument by collecting different measurements for Voltage, Current and Resistance. A learner also explores correct positioning of probes in the circuit. Besides the main purpose of this simulation object (learning how to use the instrument), a learner might also collect different measurements of Voltage, Current and Resistance and explore relationships which exist between these parameters in order to derive understanding of a relationship known as Ohm's law. This opens the possibility for an activity itself to define the kind of learning object "Digital Multimeter" might be considered to be. However, primarily this learning object is a simulation object.

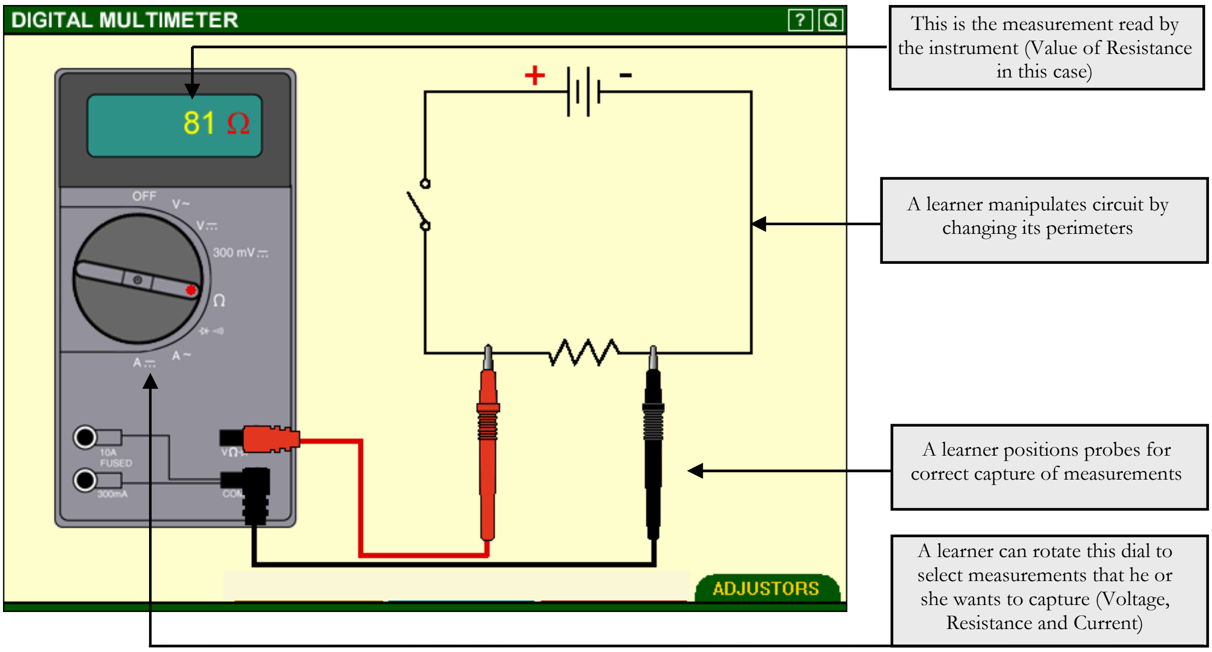

Figure 6: "Digital Multimeter" simulation object

Conceptual Models

Some of the learning objects in the collation were initially perceived as simulations because of the high level of interactivity and dynamic visualization that they provided. However, these learning objects did not represent any real system or process. Rather, they appeared to be models of certain concepts and relationships as held in the minds of their designers. They might be considered an emerging category of learning objects -- Conceptual Models -- because they essentially crystallize the concepts and experience of learning object architects.

An example of a conceptual model, "Exploring Trigonometry", is presented in Figure 7. This learning object is an interactive representation of a key concept from trigonometry: a trigonometric circle. A subject matter expert, a mathematics teacher in this case, identified this concept as one of the key concepts in his mathematics knowledge. Learners can input different values for angle x and observe changes in values of sine and cosine as they conduct an inquiry. The changes in the values of sine and cosine are presented in multiple representation formats:

1. Numerically, as numbers between 0 and 1

2. Visually, as projections of an arm of an angle along the x-axis (for value of cosines) and along the y-ordinate (for value of sine x) of a trigonometric circle (a circle with radius one unit long)
3. As points along the sine and cosine line on the graph.

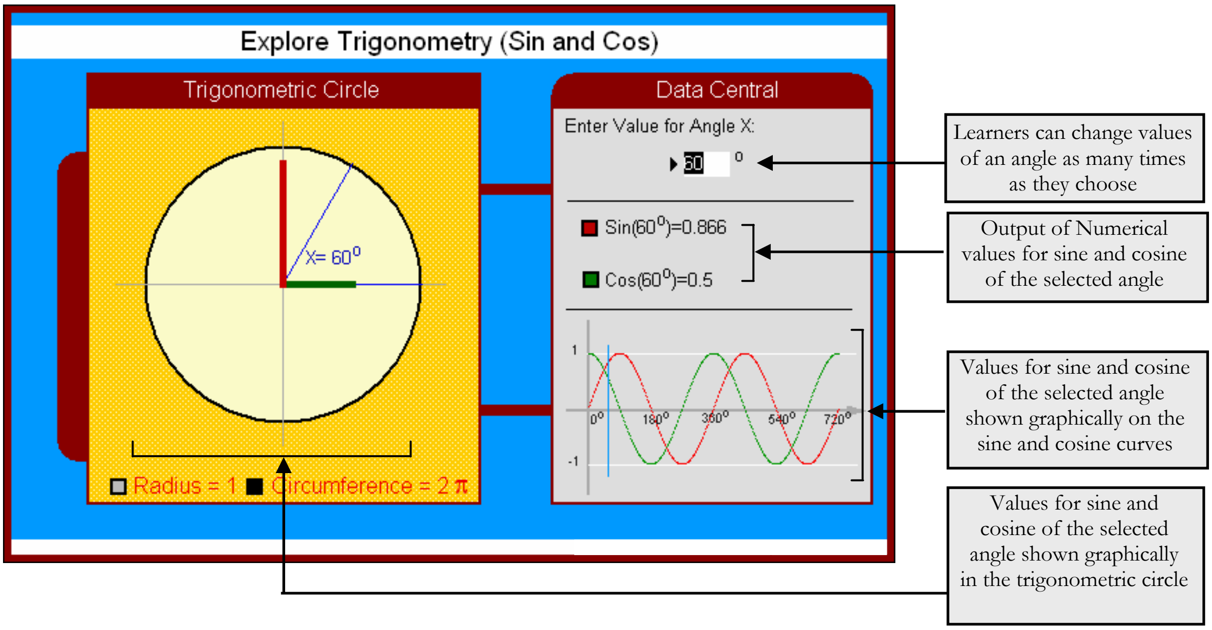

Figure 7: "Exploring Trigonometry" conceptual model

Previous research with visual educational material introduced a conceptual model (see Mayer, 1989). However, limitations of traditional non-interactive technologies and tools made these conceptual models not much different from print-based diagrams, images, drawings and charts. Now we have powerful technology-based tools that enable us to add critical dimensions to the design of conceptual models -- interactivity and dynamic visualization. Interactivity and dynamic visualization allow creation of conceptual models that crystallize subject matter experts' cognitive resources and experience and potentially open opportunities for more effective internalization by learners in new ways. My thinking here is influenced by the theories of Vygotsky (1978); however, I intend to call on further research in the future to explore this idea of a conceptual model as a representation of cognitive resources and experience.

We can explore our knowledge and experience, and construct temporary and lasting mind models of a plane of consciousness of anything from simple propositions such as "a triangle has three angles", relationships such as "effect of globalization upon local economy", to very complex networks of concepts such as battlefield plans and engineering designs. We use and modify these models when we make decisions, interact with people and artifacts, present our ideas, solve problems, create tools, innovate and construct new knowledge. These models are articulated on a plane of consciousness and underlining them are our higher and biological psychological functions mediated by cognitive resources (Vygotsky, 1978). Subject matter experts have well-formed cognitive resources, they are aware of their historical formation both at personal and societal levels and can effectively bring them to the plane of consciousness. They have internally classified the resources, which they rank according to significance, can relate them to other resources, and understand the use of these resources in the context of their culture of practice. Subject matter experts create conceptual models constantly by writing, articulating formulas, building tools etc; however, these representations are often abstract and difficult for novices to internalize. Technology allows creation of different kinds of models that potentially open new opportunities for sharing human knowledge and experience crystallized in artifacts. Internalized cognitive structures are reconstructed from interaction with the world (people and artifacts) where knowledge matures in contemporary form through cultural and historical development of human consciousness (Vygotsky, 1978).

While design of an information object is a process of organizing information, design of a presentation object is a design of instruction; design of a simulation object is design of a representation of a real system or process into interactive and visual displays; design of a conceptual model is a process of articulating and representing cognitive resources of a subject matter expert. A conceptual model is a representation of a cognitive resource that was recognized in the mind of a subject matter expert as a useful conceptual structure that aids decision-making, disciplinary problem-solving and disciplined specific thinking. Interactivity and visualization, in this case, allow representation of cognitive resources in dynamic format, which would be difficult and often impossible to effectively represent with other kinds of learning objects or previous media.

In designing a learning object, a learning object architect must examine what he or she knows, and how he or she sees this knowledge in his/her "mind's eye" (consciousness) and uses it in his/her world. "Knowledge in the head", or cognitive resources rather than any information from books and other sources, is the focus for a learning object architect. This is a problem for traditional instructional designers who are not usually subject matter experts, but rely upon documents and other evidence to design instructional material. To design a conceptual model, a learning object architect must either experience and construct it in his or her mind or be able to effectively articulate such models through interaction with a subject matter expert. The first option is difficult because no concept is an isolated cognitive resource, since it relates to many other concepts held by the subject matter expert. Learning and examining a single concept carries the inherent risk of not being able to note relevant knowledge structures in a way that the subject matter expert will be able to do. The learning object architect begins the process by examining his or her knowledge in search of important concepts and relationships in relation to a discipline or culture of practice to be represented as conceptual models. This process can be mediated by external factors such as similar designs by other people, tools, reference material and discussion with colleagues, but essentially it is the learning object architect who must examine his or her cognitive resources. The design decisions might be further mediated by pedagogical knowledge, creativity and drive for innovation. Slowly, as a learning object architect begins to consider capabilities of technology for representation, he or she will create rough sketches, which will slowly evolve into blueprints ready to be passed to a technical person to develop (unless the learning object architect is capable of carrying on with this task). I prefer to think of a teacher-as-designer of a learning object as a learning object architect. Architects design plans but they do not build buildings. Similarly, a teacher functioning as a learning object architect designs a plan for development of a learning object - he or she might oversee this development, but his/her technical skills limitations must be supplemented by people who are trained in this area.

Contextual Representations

A contextual representation is an interactive and visual learning object that allows learners to explore some scenarios and collect authentic data, usually for the purpose of inquiry and problem-solving. For example, learners might collect data about volcanic activity, weather conditions, air pollutants in the atmosphere, population of life forms at great ocean depths, statements of opinion from people, and so on. Engaging learners in collection of authentic data allows them to experience the origins of that authentic data, and explore the context and tools used in data collection. At the same time, they will experience a process of organizing and interpreting data in search of understanding. The presentation of the contextual data might also enable learners to experience problems as they emerge from authentic contexts and allow them to manipulate some aspects of a problem. Usually, a contextual representation represents some imaginary or real place inaccessible to learners because it is distant, time and place dependent, involves danger, is too small or too big to allow data collection, requires sophisticated tools for collection of the data, requires lab conditions, requires expertise and so on.

Figure 8 shows a screen from a "Water Experiment" contextual representation. This interactive learning object allows learners to collect data on factors affecting the quality of water of the imaginary lake presented in the scenario. This data can be used in a problem-solving activity that directs learners to act as environmentalists, investigate the situation and propose a solution to a problem in the form of a report to an environment protection agency.

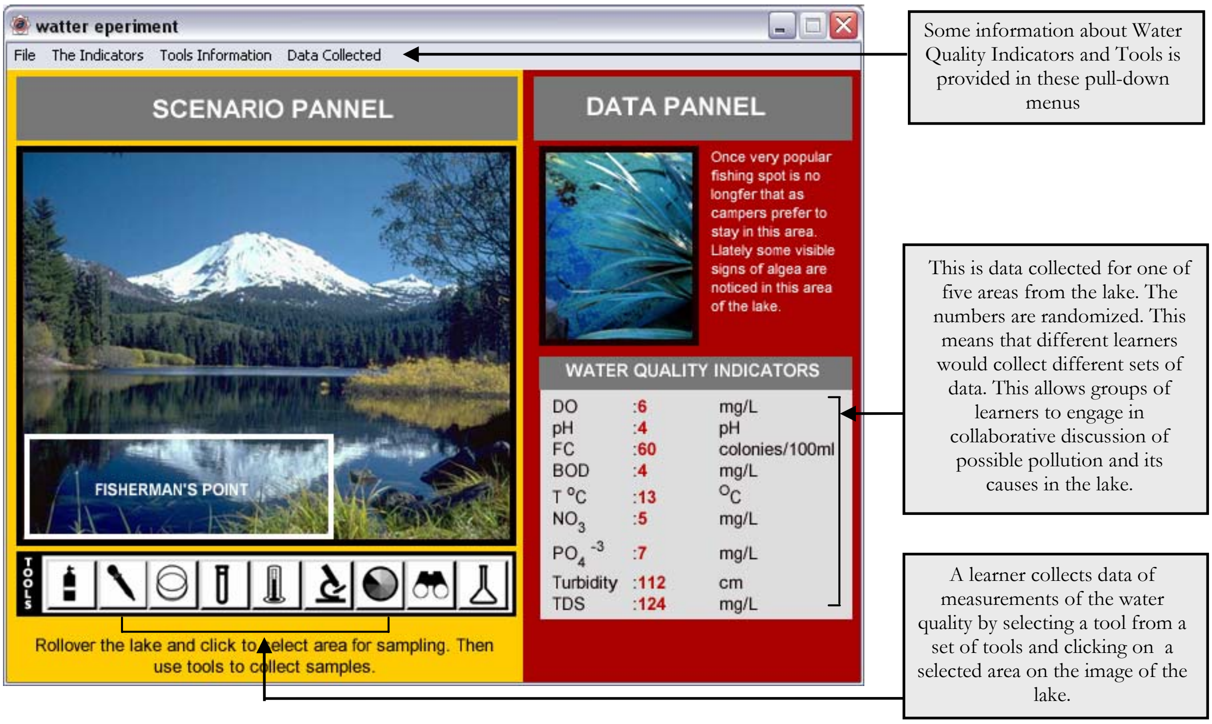

Figure 8: "Water Experiment" contextual representation

Conclusion

This paper introduces and discusses kinds of learning objects explicated through the experience of reviewing a small collection of educational resources developed by part of a teaching and instructional design community in Singapore. Six unique kinds of learning objects are discussed in the paper: presentation objects, practice objects, information objects, simulation objects, conceptual models and contextual representations. The paper opens a possibility for the proposed categories to be challenged or for more categories of learning objects to emerge in further inquiries involving examination of larger repositories of learning objects such as MERLOT. I believe that the most important aspect of this paper is a proposition of a conception model as a particular kind of learning object that is designed based on conceptual resources and the experience of a subject matter expert. I believe that this idea warrants special attention in future research. In the paper, I also present the case for at least two emerging kinds of learning objects to be examined and described. These are objects that reassemble games and cognitive tools. This is an area that remains open for discussion, since it might be argued that games are a particular kind of an activity, while a cognitive tool might be considered a particular activity-enabling technology rather than a learning object. Consideration of an activity in which learning objects are deployed as mediating artifacts is particularly important in the context of effective use and reuse of any kind of learning objects. A well-defined classification of learning objects will support not just design decisions used in the creation of a learning object, but could effectively support teachers' planning of learning activities. An appropriately developed classification could be considered in defining more useful meta-data descriptors for cataloging of learning objects in digital repositories, which can subsequently be used to provide teachers with heuristics for planning of pedagogically sound integration of these objects in learning activities. My final assumption is that an appropriate classification would potentially extend reusability of the learning objects beyond merely what is considered e-learning or on-line learning, to include any other contexts for teaching and learning. However, further studies are necessary to explore these ideas in more detail.

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