

Repurposeable Learning Objects Linked to Teaching and Learning Styles

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Abstract

Multimedia learning objects are an essential component of high quality, technology-mediated instruction. Learning objects allow the student to use the content learned in a particular part of a course and; 1. demonstrate mastery of the content, 2. apply that knowledge to solving a problem, and 3. use the content in a critical thinking exercise that both demonstrates mastery and allows the student to place the content within the context of the larger topic of the course. The difficulty associated with the use of learning objects on a broad scale is that they require programming skills most professors and instructors do not possess. Learning objects also tend to be custom productions and are defined in terms of the programming and code terminology, further limiting the professor's ability to understand how they are created. Learning objects defined in terms of styles of learning and teaching allow professors and instructors to develop a deeper understanding of the learning objects and the design process.

A set of learning objects has been created that are designed for some of the important styles of learning and teaching. They include; visual learning, writing skills, critical thinking, time-revealed scenarios, case studies and empirical observation. The learning objects are designed and described in terms that the average instructor can readily understand, redesign and incorporate into their own courses. They are also designed in such a way that they can readily be repurposed for new applications in other courses and subject areas, with little or no additional programming.

Introduction

The interactive technology tools available to distance educators today provide an opportunity to build into the distance course interactive experiential exercises that allow the instructor and the student to obtain a highly accurate image of the student's level of understanding of content throughout the course. The instructor can not only determine whether a student understands some aspect of the content of the course, but also can determine exactly what part of the content the student fails to comprehend. The authoring tools used to create learning objects are complex modular languages that are beyond the comprehension of most course instructors. Some problems, such as multiple choice, are simple enough to create as a template for future use, however, this is not the case for most immersive, multimedia applications. Typically, learning objects are custom creations that are developed by an instructional designer with some input from an instructor (or subject matter expert) and executed by a programmer. The instructor clearly understands the pedagogical purpose and mechanics of the finished product but has little understanding of the manner in which the learning object was designed, from a programming point of view, or executed in code. We tend to describe these learning objects in highly technical programming jargon that can alienate the instructor.

If however we design learning objects in pedagogical terms that instructors understand, they can play a larger and more satisfying role in design of technology-mediated courses. Educators understand the

paradigms of teaching and learning, and design their traditional course presentations to include and utilize them. If learning objects representing the different pedagogical paradigms of learning and teaching are constructed as templates, the time to create new learning object applications would be greatly reduced, by providing a common basic design that is understandable to the instructor and can be rapidly re-purposed for other applications relating to the same learning or teaching style. Design templates for multimedia exercises provide the instructor with the ability to create unique interactive exercises without having to master programming techniques and authoring languages.

TALON Learning Objects

A set of re-programmable learning objects templates representing several models of teaching and learning has been developed. These templates, the TALON (Teaching and Learning Oriented Network) Learning Object system, can be examined at:

<http://www.indiana.edu/~scstest/jd/learningobjects.html>.

Each of the templates represents a particular learning type and is specifically designed so that an existing learning object created with that template can be reconfigured to serve an entirely different subject matter topic with less than 10% of the code needing to be rewritten.

Developing Writing Skills

A common complaint about internet- or technology mediated instruction is the difficulty in developing writing skills in electronic media. In the traditional classroom writing skills are developed through a three-phase process.

1. The instructor introduces good writing skills by explaining and demonstrating examples of particular writing skills.
2. The instructor next provides the students with the opportunity to attempt to master the skills and develop expertise.
3. The final phase in the process of developing writing skills involves the learner demonstrating the various skills and explaining the process and theory of good writing.

The second phase of developing writing skills in a traditional classroom, is perhaps the most important because in this phase the instructor interacts with the student in a substantive way by repeatedly evaluating the student's attempts and giving advice to improve the student's performance. The second phase in most classes is also the most time-intensive and most student-centered. The majority of individual attention by the instructor is provided during this phase. It is this second phase that is often cited as the missing element in technology-mediated instruction, due to the lack of availability of synchronous instruction in many internet-based courses. It is, however, possible to provide substantive instruction and corrective feedback in asynchronous instruction with the use of the "intelligent paragraph" tool. This tool can be used in two forms. In the more intensive format

the tool is used to demonstrate and evaluate particular writing skills in writing skills courses. In other disciplines the tool can be used to evaluate and improve writing skills within that discipline.

The Intelligent Paragraph Template. The intelligent paragraph tool allows the student to create a short essay using statements from a database of statements in an order that demonstrates a particular writing skill or an understanding of the problem at hand. Clearly, successful writing includes both the presentation of statements and putting them in an order that results in a smooth and flowing story line. A simplified flowchart of the intelligent paragraph template is shown in Figure 1. The typical intelligent paragraph problem begins with the presentation of the problem. This can be a discussion of a particular writing technique or a discussion of a particular topic (similar to the text of a short answer essay question). In the next phase a specific problem is presented in text form, culminating in the instructions for the student.

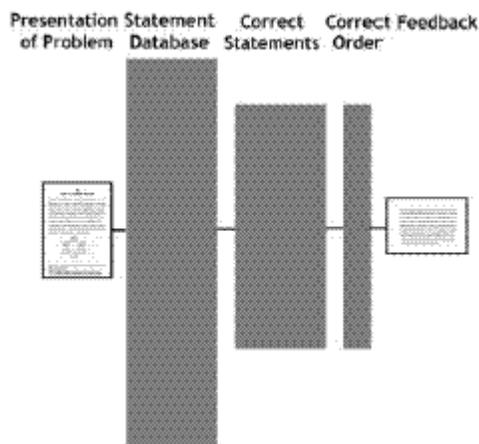


Figure 1. The intelligent paragraph template flow chart.

The instructions might include a question to which the student is asked to respond or instructions with regard to the writing skill to be demonstrated. In the next phase, the student is asked to assess a series of statements from a statement database. This template is best used if the statement database contains a spectrum of statements that contains some statements that are clearly correct, some that seem correct, some that are incorrect, and some that appear to be correct but are not specifically on the topic. The student then creates a response to the question or problem posed by selecting statements that best address the question and placing them in the correct order. After the student has completed the selection and ordering of statements, specific feedback is provided on the paragraph the student created. This feedback involves an assessment of the statements that the student selected and an assessment of the order in which the statements were placed. This kind of substantive feedback is similar to that provided by a competent synchronous instructor. An objective grade based on the percentage of correct statements and their order is also provided to the student, along with an example of a more correct response. The grading can be weighted according to the preference of the course designer or instructor. It is advisable to weigh the percentage of correct statements more heavily than the order. An example of this template is shown at:

<http://www.indiana.edu/~scstest/jd/learningobjects.html>.

In this example a student is asked to begin a short story in each of two writing styles by selecting sentences from a selection in which sentences of each style are included, and put them in an order that creates a flowing story line.

Developing Visual Learning

Visual learning is an important learning style. Some types of content can only be mastered through the visualization of an image in which the content is imbedded.

The Hotspot Template. An example of visual learning is shown in Figure 2. In this example the components of human skin are illustrated and located within a detailed cross-sectional rendering of skin. A student can develop an understanding of the structure of skin by examining this diagram.

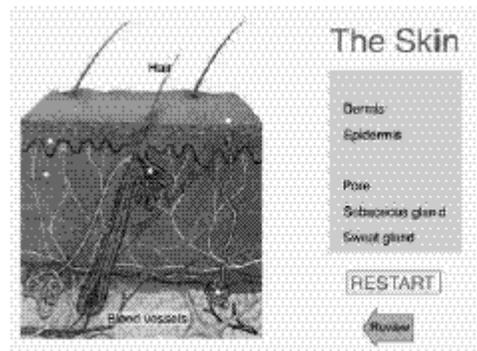


Figure 2. A drag and drop visual learning template.

A critical aspect of visual learning is self-testing. Self-testing can be accomplished by the use of a hot spot template, based on the image in question. The hotspot problem contains target hot spots embedded in the diagram that are connected to a list of labels located beside the diagram. Each hotspot is linked to a particular label. If there are eight hotspots, at least eight labels should be included in the list. It is advisable to include several incorrect labels in the list, in order to decrease the possibility that as more answers are correctly placed, the activity becomes less challenging.

Visual recognition and classification of objects or processes represent another form of visual learning. After the student has developed an understanding of a process or object, visual recognition is a way in which this understanding can be demonstrated. The structure of visual recognition problems varies as a function of the nature of the content to be mastered. In some cases a series of images representing certain objects or processes is presented with a corresponding list of potential answers. The correct answer is matched with the correct image. After the image has been correctly identified, additional layers can be added to the problem.

Presentation of additional, non-visual content can also supplement this visual style of learning by attaching functional information about the components to the learning exercise. Multiple layers can be used to reinforce content mastery in visual recognition problems. The layers are useful to deepen the visual connection between abstract concepts and the image of the resulting structure. Several examples of visual learning templates are shown at:

<http://www.indiana.edu/~scstest/jd/learningobjects.html>.

Developing Critical Thinking Skills

The development of critical thinking skills is one of the most important aspects of the education process. There are a number of ways in which to develop and assess critical thinking. Two types of problems that help develop critical thinking skills are represented by the time-revealed scenario and case study templates.

The Time-Revealed Scenario Template. In a time-revealed scenario, the learner is presented with a situation that evolves as a function of the student's decisions and actions. The student is provided with a real-life or hypothetical problem with multiple layers, arranged in a tree-

like structure. At every level of the tree the student is asked to make a decision that dictates the direction the student moves along the tree structure. Depending on the number of layers in the problem, the number of outcomes can be high, and a reality-based, complex problem can be created.

The first step in the time-revealed scenario problem is to present the student with a problem or situation in which he or she is asked to assess the situation and recommend an action, bringing the student to the second level. Intelligent feedback is then provided, and the student is shown the effects of the action taken and asked to recommend additional action based on the changes in the situation due to the first level of action recommended. As the student continues to make decisions at each level, based on mastery of the content material and the intelligent feedback provided after each decision, he or she moves towards one of the possible outcomes of the problem. An example of the first level of a time revealed scenario problem is shown in Figure 3. In this problem, the student is a newly elected mayor who is presented with a complex environmental hazard and is asked to take action.

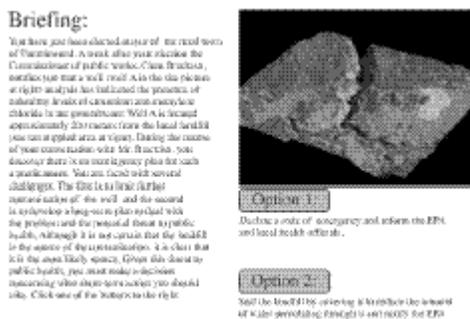


Figure 3. A time-revealed scenario template.

One of the benefits of the time-revealed scenario problem is that it presents content to the student in a realistic fashion in an environment in where the student has control over the outcome and can be shown the results of his or her activity on the environment. Trial and error activity is often a useful way to learn because it is a learning activity that leaves a memory behind in the form of an experience-based map of the content learned and potential outcomes within that content area.

The Case Study Template Another useful tool in developing critical thinking skills is the case study template. In this problem, the student is presented with a problem based on a case study of an actual phenomenon or experience and is asked to evaluate data pertaining to the situation or the parameters that appear to control the phenomenon or situation. The culmination of the problem is to make a decision or recommend action based on evaluation of the parameters of importance in the case study. An example of a case study is illustrated in Figure 4. In this case study, the student is asked to evaluate the suitability of a site for the location of a hazardous waste site, after evaluating all of the parameters of importance in site location and examining data sets and observations about the site.

A case study exercise may be layered in a fashion similar to the time-revealed scenario problem or may be presented as a single layer with multiple data sets to be assessed by the student in the order that seems logical to the student. In those cases in which the data sets are linked in a manner that requires the student to examine them in a particular order, it is advisable to create the case study problem in a layered fashion.

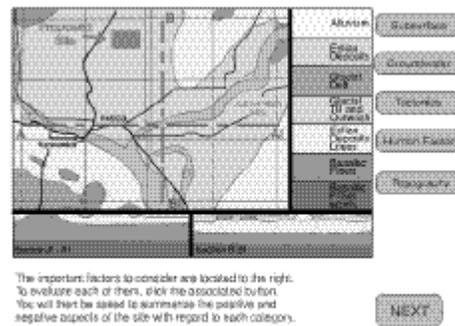


Figure 4. The case study template allows the student to collect and use data to solve a problem.

Examples time-revealed scenario and case study templates are shown at:

<http://www.indiana.edu/~scstest/jd/learningobjects.html>.

Developing Experiential Learning Skills

Much of what we learn is through empirical observation of events in which we are involved. The world is a laboratory and we are the observers. We experiment by observing how certain phenomena are connected in cause and effect relationships. When we can control the parameters that affect a process we are able to learn quickly how that process works. The laboratories scientists set up are an attempt to recreate the processes we observe in the real world in a way that can be controlled and observed by researchers and students in the laboratory. We develop, through empirical observation and experimentation, a working model or hypothesis of that which we study.

Technology-based virtual laboratories present a great opportunity and a number of potential pitfalls. The opportunity to simulate real processes or systems that allow the student to manipulate and observe them is a powerful teaching tool. Virtual laboratories permit us to create in technology what would cost a great deal to create in real laboratory settings. However the pitfalls are daunting. Some processes are difficult to model without tactile feedback, which is extremely expensive to provide through technology. Others are difficult to recreate in technology because the process or phenomenon is difficult to visually present on the Web or on a CDROM. Some natural systems are so complex that it is not possible to recreate them without computers with high bit rate connections or excessive memory. Other processes are so qualitative that they are difficult to simulate in a quantitative problem. Finally, there is a temptation to oversimplify virtual laboratories in order to make them more tractable from a programming point of view.

Virtual laboratories fall into two distinct categories. In some virtual laboratories a process or system is created through technology, allowing the learner to manipulate the parameters that affect the system and observe how the system changes. Through these manipulations the student develops an understanding of the depth and breadth of the system. In the other type of virtual laboratory the student makes proscribed measurements and draws conclusions regarding some process or system on the basis of those measurements.

The Virtual Physics Laboratory. One of the classic laboratories offered in introductory physics provides students with a glimpse of the concepts of gravity, elasticity, velocity, and acceleration. In the laboratory a video camera and strobe light are set up adjacent to a hard surface. The learner is asked to drop a ball and the camera records the flight of the ball. From the videotape the student can calculate the gravitational force and gravitational constant of the Earth. The learner is allowed to vary any of the parameters affecting the process, including the following: the elasticity of the ball and its impact, the

horizontal velocity of the ball, the strobe interval, the height of the ball when dropped, and the size of the ball. By varying these parameters the learner develops a sense of how gravity functions and can derive the magnitude of the force of gravity on the Earth. The bouncing ball problem is illustrated in Figure 5.

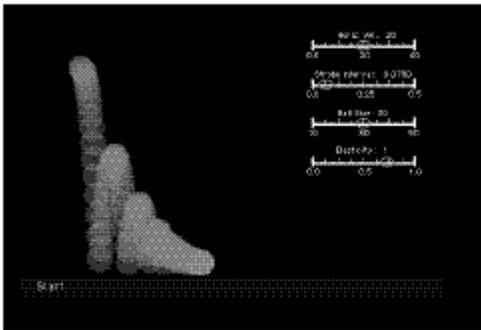


Figure 5. The bouncing ball experiment is an example of the virtual laboratory concept.

In a sense, the learner is equipped with the same information and tools, (although more accurate and precise) that Sir Isaac Newton used when he first developed the principles of gravity and Newtonian mechanics. This virtual laboratory template is shown at:

<http://www.indiana.edu/~scstest/jd/learningobjects.html>.

The Virtual Environmental Laboratory. Virtual laboratories can also be based on very specific problems or questions requiring testing or observation to provide an effective solution. In this type of application the process or system to be analyzed is relatively well known to the learner. The key is to evaluate the specific state of the system or process by making empirical observations or examining data from tests.

In the virtual landfill exercise the learner is asked to evaluate whether a landfill is leaking. In order to accomplish this task the learner must develop an inventory of the chemicals contained in the landfill and compare that inventory to the inventory one would expect from natural groundwater. The best place to develop such an inventory for the landfill is to examine the chemistry of the leachate pond. The leachate represents a concentrate of the landfill chemical inventory since any toxic chemical that is found in the landfill will be present in the leachate. The first step in this problem is to present the problem, as shown in Figure 6.

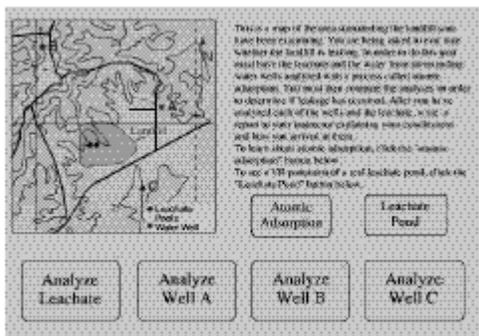


Figure 6. The virtual environmental laboratory.

In the presentation of the problem (see Figure 5) the learner is briefed on the problem; given a map of the area with the landfill, leachate pond, and three nearby water wells; and provided with information buttons. The atomic adsorption button provides an explanation of the method by which the analysis of leachate and groundwater are

analyzed. The leachate pond button leads to a virtual reality tour of the leachate pond. Once the learner is familiar with the problem, the process of analysis of groundwater and leachate can occur. In order to determine if the landfill is leaking, the learner must analyze the chemistry of the leachate and the water from the surrounding water wells. If there is contamination, some of the man-made chemicals found in the leachate should also show up in the water from the water wells. This is determined by comparison of the leachate analysis with those from the other water wells. The template for this laboratory is shown at:

<http://www.indiana.edu/~scstest/jd/learningobjects.html>.

Conclusion

Repurposeable learning objects represent an opportunity to provide the benefits of partially automated multimedia rendering in the creation of technology-mediated instruction. They also allow the instructor to have a more satisfying and fundamental role in course design. It is clear that the learning objects described here are based on a limited number of learning and teaching styles, and that many more can and should be created.