Designing effective learning objects

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The use of learning objects (LOs) in education and training has the potential to improve the way instruction is delivered. However, they must be developed using sound instructional design principles and learning theories. The LO definition proposed by this author is 'any digital resource that can be used and reused to achieve a specific learning outcome or outcomes'. The three key words in this definition are digital, reusable, and learning outcome. LOs must be in a digital format to facilitate storage in a digital repository that can be searched and retrieved electronically. They must be designed so that they can be reused in different lessons or courses and different instructional interventions or situations. And, a LO must be tied to a specific learning outcome so that appropriate content and assessment can be included, and the appropriate delivery medium can be identified. The overall goal is to promote learning and improve performance. Hence, it is important to know how students learn in order to design LOs that are effective and that are designed properly and efficiently with the learner in focus (Richards, 2002).

LOs are developed to teach specific learning outcomes in a discipline. LOs are then sequenced to form instructional events for lessons or learning sessions. Students will access and work through the activities in LOs so that they can improve their knowledge and skills and achieve learning outcomes. Students will also use LOs to develop personal meaning from the information presented and to apply the information in real life. Hence, LOs should be developed with the learner in focus, the purpose of LOs being to make people learn and apply what they learn in real-life settings and in creative ways. Instructors and/or learners will be able to build an instructional plan at any moment by selecting and assembling LOs from a repository (Gibbons, Nelson and Richards, 2002). Instant assembly of learning experiences would facilitate just-in-time learning and training. These are major benefits of using LOs; however, to realize these benefits the LOs must be designed using proven instructional design techniques and should be based on learning theories (Wiley, 2002b, 2002c).

Designing learning objects: Characteristics of learning objects and implications for design

Certain characteristics must be present in LOs to make them beneficial to education and training. They should be as follows:

Revisable

One should be able to revise LOs without affecting other objects (Wiley, 2002a). This requires that the LOs be independent and stand-alone. Discrete learning outcomes should be identified and the LOs should be based on the learning outcomes.

Reusable

Educators should be able to use LOs in multiple contexts and multiple lessons or courses. Wiley (2002a) suggests the use of Fundamental Information Objects, which are independent of context, resulting in a high level of reusability. They must be designed with multiple users in mind and must be tested with multiple users before they are placed in the repository. The readability level and language must be appropriate for different audiences and the presentation of the information and learning activities must be appropriate for different styles of learners. They should be usable in different delivery modes (Barritt, 2002). Users must be able to download them to use offline or copy to other electronic media for convenient access.

Customizable

Learners, educators, and trainers should be able to customize LOs to meet their individual needs. In addition, users should be able to customize lessons by selecting appropriate LOs, based on their needs and styles to build a personalized learning sequence.

Applicable

LOs should be applicable in different instructional settings. These include learning, remediation, just-in-time learning, job aids and enrichment. Learners should be able to access one or more LOs to achieve knowledge and skills outcomes for a discipline. If learners do not have the prerequisite knowledge and skills for a lesson, the learner should be able to access the appropriate LOs to achieve the required knowledge and skills. If a learner fails a lesson, the appropriate LOs should be available to facilitate the successful completion of the lesson. While working on a project or assignment, learners may need to acquire specific knowledge and skills

to complete the project or assignment. For example, a learner working on a research project may have to do a correlation. If the learner has never done correlation before, LO (CAREO, 2002) on correlation can be accessed immediately to provide the just-in-time learning. A worker on the job may be assigned to complete a procedure but does not remember how to complete the procedure or the procedure has changed. The worker should be able to access the procedure from a LO repository to learn the procedure or to compare the procedure with an existing mental model. As learners complete a lesson, they may request enrichment activities. These enrichment activities can be developed as LOs for learners to access at anytime and from anywhere.

Stand-alone

A LO should be an independent segment of instruction. Chitwood and Bunnow (2002) refer to a LO as a small unit of learning. Before units are designed, thorough content and task analyses must be performed to identify the macro learning outcomes and the micro learning outcomes on which the LOs will be based. LOs must be tied to learning outcomes. After a learner completes the activities, he or she must feel a sense of completion and achieve a learning outcome.

Scalable

LOs should build on each other to form an instructional sequence. A basic LO can be developed initially, which could form the basis for higher-level LOs in the same discipline or other disciplines.

Linkable

Instructors should be able to customize lessons or courses by combining LOs for just-in-time development and delivery (Longmire, 2002). They must be able to combine LOs to build larger units of instruction, and linkable to form instructional events for a lesson or course. To make this possible, LOs should be tagged with the appropriate learning level, difficulty level, outcome and required prerequisites.

Durable

LOs must be designed so that they can be reused many times without becoming obsolete (Barritt, 2002). This requires that LOs be updated constantly as the content changes. As a guideline, content that changes frequently should not be developed as LOs since they cannot be reused and will need constant updating.

Learnable

Learners must be able to complete the LO and come away with a sense of accomplishment that learning has occurred. Sound design principles should be used when developing LOs to make sure students really do learn.

Interoperable

LOs should be accessible using different systems connected to the Internet (Hamel and Ryan-Jones, 2002). This will allow anyone from anywhere to access the LOs irrespective of the hardware or software system.

Cognitive psychology: Implications for design of learning objects

Cognitivists see learning as an internal process that involves memory, thinking, reflection, abstraction, motivation and meta-cognition. Cognitive psychology looks at learning from an information-processing point of view where the learner uses different types of memory during learning. Sensations are received through the senses into the sensory store before processing occurs. The duration of sensory store is less than one second (Kalat, 2002). If information is not transferred to working memory immediately, it is lost. The design of LOs should include strategies to allow learners to attend to the learning materials to facilitate transfer from the senses to sensory store and then to working memory, where the information is processed before entering long-term memory.

The amount of information transferred to working memory is dependent on the amount of attention that was paid to the incoming information and whether there are existing cognitive structures to make sense of the information. LOs must use effective interfaces to attract and maintain attention and provide activities that facilitate the recall of related existing cognitive structures to help process the new information. If the relevant cognitive structures are not present, pre-instructional LOs such as advance organizers should be included as part of the instructional event (Ausubel, 1974).

The duration in working memory is approximately twenty seconds and if information in working memory is not processed efficiently, it is lost and is not transferred to long-term memory for storage (Kalat, 2002). LOs must present the information and include strategies for learners to process the information in working memory. Since working memory has limited capacity, information in LOs should be organized or chunked in appropriate-sized pieces to facilitate processing. According to Miller (1956), since humans have limited short-term memory capacity, information should be grouped into meaningful sequences. He suggests that information should

be chunked into seven plus or minus two meaningful units to compensate for the limited capacity of short-term memory.

After the information is processed in working memory, it is stored in long-term memory. The amount transferred to long-term memory is dependent on the quality and depth of processing in working memory. The deeper the processing, the more associations are formed in memory to the acquired new information. Information transferred from short-term memory to long-term memory is either assimilated or accommodated in long-term memory. During assimilation, the new information is changed to fit into existing cognitive structures. Accommodation occurs when existing cognitive structures are changed to incorporate the new information. LOs must include activities to allow learners to actively process the information to facilitate transfer to long-term memory.

Cognitive psychology postulates that information is stored in long-term memory in the form of networks. Information is stored in the form of nodes and the nodes are connected forming relationships between the nodes. Information maps that show the major concepts in a topic and the relationships between the concepts should be included in the learning materials. According to Stoyanova and Kommers (2002), information map generation requires critical reflection and is a method to externalize the cognitive structure of learners. For a lesson or topic there should be an information map to give learners the big picture before they start the lesson and presented at the end as a summary. To facilitate deeper processing, learners should be encouraged to generate their own information map objects, which could be stored in the LO repository as examples of information maps (Bonk and Reynolds, 1997).

Constructivism: Implications for design of learning objects

Constructivists see learners as being active rather than passive during the learning process. Knowledge is not received from the outside or from someone, but is created by the individual learner, processing what is received through the senses. Learners should be allowed to construct knowledge rather than being given the knowledge through instruction (Duffy and Cunningham, 1996). A major emphasis of constructivists is situated learning, which states that learning is contextual. Learning activities that allow learners to contextualize the information should be used when developing LOs. If the information has to be applied in many contexts, then learning strategies that promote multi-contextual learning should be used to make sure learners can apply the information in many contexts.

In the constructivist view of learning, learners use their own process to acquire personal knowledge rather than use someone else's process.

Learners are active in the learning process and could build their individual lessons, construct larger modules based on available LOs that are specifically chosen, or even modify them to meet their needs to personalize the information. Designers of LOs must be aware of the need of learners to adapt LOs to meet their needs and realize that learners may want to construct their own LOs based on the notes they make, their summary of lessons, and the research they conduct.

Bannan-Ritland *et al.* (2002) claim that the development of LOs from the perspective of the constructivist philosophy has not yet been considered. LOs must be based on the idea that learners construct knowledge. Instruction must provide the support to facilitate the construction of the knowledge. Learners should be allowed to modify LOs to meet their needs (Bannan-Ritland *et al.* 2002). The modified object should then be tagged as a student-generated LO and appropriate version control should be used. LOs should allow learners to elaborate on the knowledge to create personal meaning and knowledge structures.

According to Brown *et al.* (1989), knowledge should be acquired through enculturation, where learners make sense of knowledge based on how it is used in a practical sense. Enculturation can be promoted by encouraging learners to further develop their own personal LOs after interacting with the prescribed ones. These personalized LOs can be stored in the students' personal directory.

If designed and tagged properly, LOs have the potential to incorporate learner-centred, active, constructivist strategies in a viable system. Bannan-Ritland *et al.* (2002) have suggested a LO system based on constructivist theory. Their system starts at the micro level and then proceeds to the macro level. At the micro level, the LO will take the form of a fundamental LO where the content is context-independent. LOs at this level will be at a low level of granularity and would include items such as short video clips, photographs, graphics, concept maps and facts. At the macro level the objects will be learning activities that combine LOs from the micro level. Learners then will use the larger objects from the macro level to achieve the learning outcomes and to acquire personal meaning from the materials.

Learners should be allowed to generate their individual LOs to obtain personal meaning. During the generation of the lessons, learners process the information at a deep level facilitating transfer to memory and application (Craik and Lockhart, 1972). The LOs repository should have templates for learners to access to generate their own LOs as they go through the learning process. The learner-generated objects can be used by other learners to achieve similar learning outcomes. Learners may also want to generate LOs as a group in order to review, test and approve them. The LO system must be able to handle the learner-generated and group-generated LOs.

Behaviourism: Implications for designing learning objects

Behaviourists looks at overt behaviours that can be observed and measured as indicators of learning (Good and Brophy, 1990). When designing LOs, learners must be informed of what they will learn before they start the lesson. The purpose of the LO must be clear to the learner. This will allow learners to set expectations and to decide whether they have successfully learnt from the experience once they have completed the work assigned in the LO.

After completing a LO, the learner should be able to determine whether the session was successful. Learners need to be able to make this judgement. Therefore, the LO should include an assessment component or should link to another object that has the assessment items for the LO.

Proper sequencing methods should be used when assembling LOs to form an instructional sequence. Learners and instructors must be able to access LOs from a repository and to sequence the objects to meet their needs. The LOs must be tagged appropriately for learners and instructors to build their own sequence. The sequenced LOs then become a lesson with combined LOs for the learning process. As learners go through an instructional sequence, they should be provided with feedback on how they are doing and advised on what to do next. Feedback should be built into LOs, but activated only when required or there should be a feedback object to link back to a LO. The feedback object could give further information or could provide corrective information or action.

Tagging learning objects

LOs must be tagged properly to allow instructors, instructional designers and learners to access the LOs whenever they need them (McGreal and Roberts, 2001). The CanCore profiling system for tagging LOs consists of 8 main categories, 15 subcategories, and 36 elements (Friesen *et al.*, 2002). The educational subcategory should be expanded and include elements to tag LOs to specific learning outcomes. This is consistent with Carey, Swallow and Oldfield (2002), who claim that LOs should form a cohesive unit of study to reflect domain knowledge within a subject. They have listed the names of different tags that can be used to mark learning activities within LOs. These should be developed to meet intended learning objectives. Learning outcomes are what drives the development of LOs, and therefore they should be tagged. When tagging LOs according to learning outcome, the appropriate learning level, delivery medium, and target audience should also be marked.

Model for developing learning objects

Programmes and courses of instruction need to be designed into smaller units in the form of LOs to make them flexible and reusable. Figure 6.1 illustrates a sample programme breakdown to facilitate development of LOs. Another method that can be used to identify LOs for development is to analyse multiple programmes, courses and modules and then identify the generic learning outcomes that are common across programmes (Figure 6.2). These generic learning outcomes across programmes and courses should be given high priority for developing LOs.

LOs must be developed and stored in a database to allow access anytime and from anywhere using different delivery media. There are no limits on the size of LOs. Instructors and developers are free to decide on their own sizes for LOs. There is a danger, however, in making a LO too large, as it may become too big to be reusable by others. Other developers may make LOs too small to make instructional sense to the learner. As the name suggests, LOs should result in students learning after interacting with the object. Hence, a LO should have at least three components (see Figure 6.1). The first component is a pre-learning strategy such as a learning outcome, pre-assessment, advance organizer, or overview. The second component is a presentation strategy, which includes the content, mate-
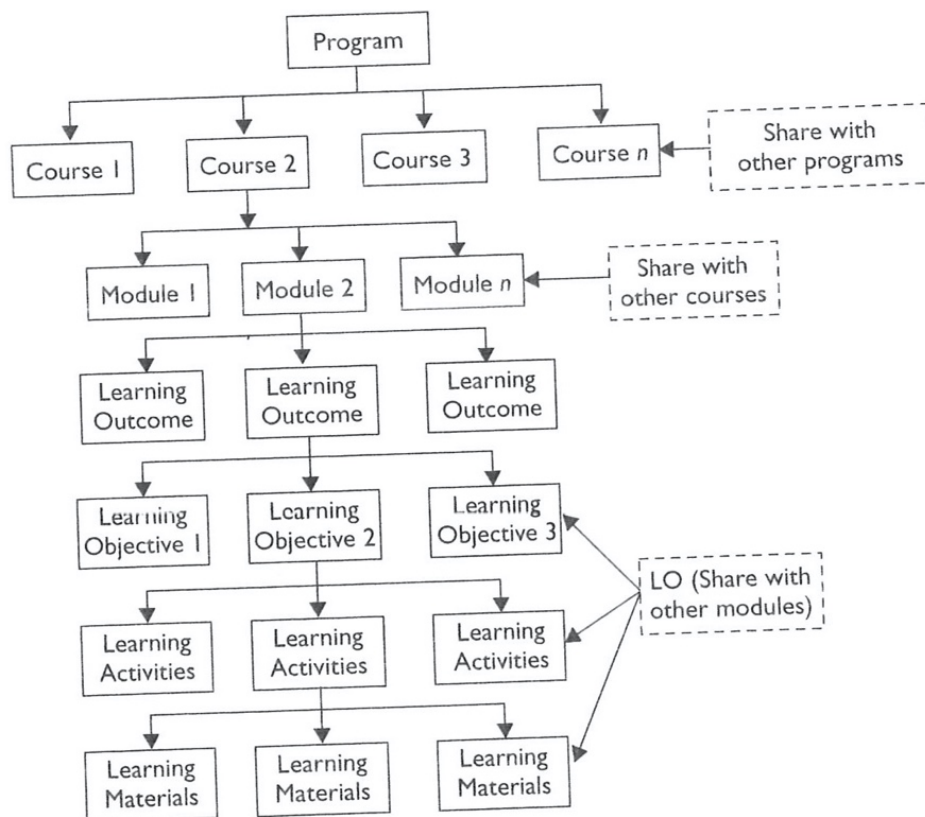

Figure 6.1 Program breakdown for identification of learning objects

rials and activities to achieve the outcome for the LO. The content includes facts, concepts, principles and procedures in the form of text, audio, graphics, pictures, video, simulations, or animation. Where appropriate, some of these activities could be learner-generated while others could be instructor-provided. The third component is a post-learning strategy in the form of a summary or a post-assessment to check for achievement of the learning outcome (see Table 6.1).

Table 6.1 Components of a learning object

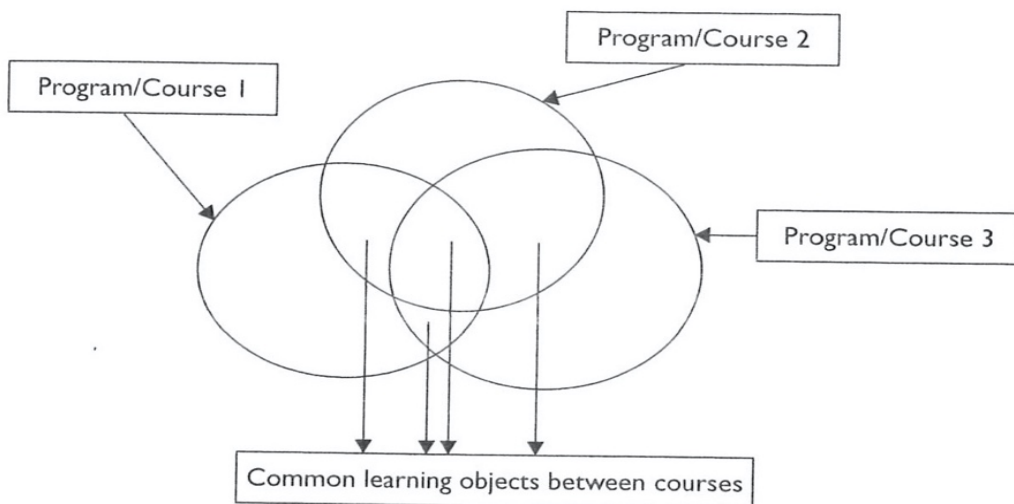| Learning objects components	Micro-strategies
1. Pre-learning strategy	Learning outcome
	Advance organizer
	Overview
	Pre-assessment
2. Presentation strategy	Presentation of information
	Elaboration of information
	Embedded questions
	Demonstration
	Practice exercises with feedback
3. Post-learning strategy	Summary
	Post-assessment

Figure 6.2 Identifying learning objects between programs and courses

Conclusion

The use of LOs in education and training has the potential to revolutionize the way instruction is delivered; however, this will be possible only if they are designed and tagged properly to promote learning and maximize their access. The design of LOs must keep the learner in focus and

must be designed using sound instructional design principles. A major challenge is how to make LOs universal, since anyone may access the LOs from anywhere in the world. Some issues that still need to be explored are as follows:

- Who designs the learning objects?
- Who revises the learning objects once they are in the repository?
- Who makes the decision to retire a learning object?
- When should a learning object be retired?
- What content is most suitable for learning objects?
- Who is responsible for quality control and accuracy of the information in learning objects?
- Who owns the learning objects?

As the use of LOs increases and the field matures, intelligent agents should be developed within the LO system to match and adapt LOs to meet individual learner needs during the learning process (Richards, 2002).

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