Learning Theory and Learning Objects

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Abstract

This paper applies some of the core principles of learning theory to the design and use of learning objects. It considers three prominent schools of thought: behaviourism, constructivism, and situated learning theory, draws out principles which are of relevance to learning objects, and describes an example which illustrates how these principles might apply in practice. Some particular themes which emerge are:

- Sequencing and narrative: how to link learning objects together in a coherent learning programme.
- Learning Objectives, outcomes and goals: their important role, and the differences between the schools in where they (and other metadata elements) might be located: “intrinsic” to the objects, or in the surrounding environment.
- Context and authenticity of learning - including social context: how learning objects can provide and relate to this.
- The learner’s engagement in the learning process.

Each of the schools is felt to have valid principles which are applicable to learning objects, depending on the domain, and the orientation of the providers.

1. Introduction

Learning Objects currently have a high profile as a significant way forward for learning technology. There has been a good deal of work from a technical perspective, but rather less from the perspective of how learning happens – which one might expect to be primary (c.f.Wiley 2001). This paper addresses this area. From the basis of learning theory, what are the potential features, advantages, and problems with learning based around learning objects? What sort of learning environment and learning objects will enable the advantages to be realised, and the problems addressed?

We will first briefly explain the nature and significance of the “learning object” concept. We will then examine the implications of learning objects from the point of view of three schools of learning theory: behaviourism, constructivism, and situated learning. (To put this in context, an initial brief introduction to each school will be given.) Based on this analysis, an example is worked through, illustrating the applicability of the different approaches to the use of learning objects. Finally, some themes are pulled together, regarding the design of learning objects and the surrounding learning environment and support.

2. Learning Objects

2.1 Definition of “Learning Object”

For this paper, I’d like to define a learning object as:
“A relatively small, reusable resource, through which a coherent, identifiable piece of learning can be achieved.”

A little explanation of this definition may be useful.

Reuse. This is really the essence of learning objects, as discussed below.

How small is small? I suggest that this depends on the level and type of learning – it may be minutes or hours of learning. The reason for the word “small” relates to reuse. A programme of learning is envisaged as made up of a number of learning objects, which can potentially be recombinde in lots of different ways for different situations. Hence a learning object has to be small relative to the length of a typical learning programme in the particular domain: using 2-
hour learning objects to build up 4-hour courses would severely restrict the notion of reusability.

Coherence. What constitutes a coherent learning experience is a question which could be debated at length: it will be touched on later in this paper. For our purposes here, it isn’t helpful to try to nail down the concept of coherence. However, for re-use to work, the object must at some level make sense to the learner in and of itself, giving a sense that something has been learned. Hence the word “identifiable”: this is not meant to be restrictive, but if there is really no way of describing or identifying what might be learned from an object, I would suggest there is little hope of it providing a coherent piece of learning.

Many writers on learning objects state or assume that they must be digital. I would suggest that the distinction between a digital and non-digital resource is often arbitrary and meaningless. Whether a paper is provided to a learner as an online web page (which they will probably print out to read), or a photocopied document makes little difference to the learning process.) However, the availability online of the learning object’s metadata (the structured description or “catalogue information” which supports searching, organisation and re-use) is more significant.

There is significant work in the learning technology community around the standardisation of learning objects, and particularly their metadata. A prime example is the Learning Object Metadata specification of IEEE LTSC (2001). Other significant players are IMS (2001) and ADL – particularly their Sharable Courseware Object Reference Model (SCORM 2001). See Wiley (2000) for further discussion of definitions and taxonomies of learning objects.

2.2 The point of learning objects

Why is the learning object concept stimulating so much interest, research and investment? No doubt part of the interest is to do with commercial bandwagons and hype. However, the substantive reason is “its potential for reusability, generativity, adaptability and scalability” (Wiley, 2000).

In essence, learning objects offer a way to achieve the dream of learning tailored to individual needs. This dream is not new: for example an English Board of Education publication in 1938 spoke of a future where “each child might have its educational system designed for it.” (Gardner-Medwin and Wright, 1938 – quoted in Burke and Grosvenor, 2001). Today, however, it has an urgency generated by opportunity and need. The opportunity is offered by Information Technology. The need arises from the arrival of the “knowledge economy”, where lifelong learning is vital to individual and national success, and knowledge is proliferating and changing at an unprecedented rate.

More pragmatically, early excitement over the promise of online learning to offer more flexible, individualised, accessible and engaging learning has been tempered by the realisation of the enormous cost of producing online learning resources. Reuse of resources is seen as the only way to make widespread provision economically viable.

Although it is not often made explicit, there are two very distinct (though related) scenarios for learning object reuse:
1) Reuse by learners. The objects are available, in an accessible form, so that a learner, perhaps with a modest amount of tutorial support, can construct their own set of objects, with a path through them, to enable their learning goals to be met. This scenario aims to revolutionise the learning process.
2) Reuse by learning providers. Courses of learning are not quite so individualised, but can be constructed quickly and cheaply to meet the needs of a group of learners, from a bank of highly reusable learning objects, thereby making the whole online learning project economically viable. This scenario aims to revolutionise the process of learning provision. A third, even more ambitious scenario is:
3) Generation and reuse by learners, whereby learners become active participants in the construction of knowledge within their learning community.
We will revisit these scenarios in the conclusion.

3. Learning Theory and Learning Objects

I will take relevant principles from each school, and examine the implications for the design of learning objects, and for the support of the learning process using learning objects. There is not space to give a full exposition of each school; rather I will focus on the aspects which I regard as having particular significance for learning objects. The analysis of each school draws particularly on Greeno et. al. (1996).

Historically, proponents of each school have often defined their positions in terms of a critique of another school. However, this does not mean that they actually are mutually exclusive. Behaviourist strategies can be part of a constructivist learning situation, etc. This paper will regard each school as having valid insights into the learning process. In some cases, coverage of ideas under one school, rather than another is somewhat arbitrary. I have resisted getting into arid discussions of the extent to which ideas are truly behaviourist, constructivist, etc., instead using the schools purely to provide an overall narrative structure.

3.1 Behaviourism

Some defining characteristics of behaviourist learning theory are:

- Learning consists of the formation of associations
- It is to be observed and measured in terms of external behaviours of the learner.
- Knowledge can be objectively defined, separate from the experience of the learner (although this is not unique to the behaviourist school: many cognitivists would also take this view).
- The importance of feedback and reinforcement in the learning process is emphasised.

A good deal of the work on learning objects has emerged from loosely behaviourist traditions, including schools of instructional design which take on board behaviourist principles. It is therefore not surprising that many behaviourist recommendations and principles do translate to learning object design quite naturally. (As we shall see, many of these principles are by no means exclusive to behaviourism, but we discuss this perspective first.)

1. Small chunks of learning

This is of course one of the primary features of learning objects. It is favoured in learning objects not only to aid reuse, but also because this is seen as helping the learning process. In behaviourist terms, small chunks allow the presentation of small sets of associations or information, which are manageable for the learner, and on which coherent feedback and reinforcement can be given, within a short interval from the learner forming an association. Small chunks also facilitate the maintenance of the learner’s attention and motivation. In the often-envisioned scenario for online learning objects, of learning happening in small time-slots interspersed with one’s other daily tasks (for example in the lunch break at work), this is even more compelling.

2. Sequencing and overall flow of learning

Behaviourist, and indeed other schools of instructional design, pay careful attention to sequencing. For example, Gagne (1985) suggests that the following learning events are necessary to the learning process:

1. Gaining attention.
2. Telling learners the learning objective.
4. Presenting the stimulus – e.g. displaying the new associations or information to be learned.
5. Providing learning guidance: helping understanding by providing organisation and relevance.
6. Eliciting performance: ask the learner to respond in some form of activity or test.
7. Providing feedback to the learner on their performance.
9. Enhancing retention and transfer to other contexts by providing varied practice to generalise the capability.

Gagne’s events fit well with the learning objects approach, in that they assume a set of defined, distinct learning episodes, each of which has a distinct beginning and end, and a defined sequence of events in the middle. They can be (and indeed often are) used as a checklist for designing individual learning objects.

It would be natural for a learning object to incorporate all nine learning events. Alternatively, certain of the events could be implemented by additional or supplementary learning objects. The concluding assessment (8), and generalisation (9) may lend themselves to this. This is however debatable. The principle of learning objects is that they should be self-contained, so if one subscribes to Gagne’s notion that all nine events should be present in a complete learning episode / object, then additional objects should only be used for supplementary reinforcement, not to provide the entirety of the event. On the other hand, a less strict followers of Gagne might feel that the concluding assessment (8) and generalisation activities (9) may be desirable in some contexts, and not in others, and hence could conveniently be provided by separate learning objects. This may particularly be the case where the concluding assessment feeds in to some form of accreditation. In this case, different accreditation schemes may be used in different contexts, and the assessment object may differ from one accreditation scheme to another.

Event 3 (recall prior learning) may refer to previous learning objects in a sequence, but since learning objects can be re-used in any context, it is not possible to know how prior learning has been delivered to any given learner. This means that the core description of prior learning must be inside the object itself, and references or links to prior objects must only be created when the object is embedded in a specific learning programme. (See (3) below for further discussion).

3. Learning objectives and context
Much work on learning objects takes the position that each learning object should have one or more defined learning objectives. This is a key point, because the capability to string together learning objects to form a coherent programme of learning depends on having an explicit idea of what will have been learned from each object, leading into the next.

Behaviourism suggests that each piece of learning should have a defined objective or outcome¹. Furthermore, the outcomes will be observable and measurable in terms of the learner’s behaviour.² Finally, each new skill or piece of knowledge learned should build on previously acquired skills / knowledge.

This frames perhaps the critical question for learning objects: how can learning objects be combined to form a coherent programme of learning? A library of “bite-size chunks” of learning is all very well, but there is a lot more to providing a satisfying learning meal than just stringing together a set that seem to fit.

¹ “Outcome” implies a degree of measurability, and a notion of the outcome being achieved (or not) by the learner. “Objective” does not necessarily carry this baggage. Other than this, I would regard them as variants of the same thing.
² To give one example of how this can be structured, Gagné (1985) classifies types of learning outcome in more details, along with ways of demonstrating or testing their achievement. For example:
   • Understanding of concepts can be demonstrated by labelling or classifying things.
   • Understanding of rules can be demonstrated applying them to a specific situation.
   • Problem solving skills can be demonstrated generation of solutions or procedures.
   • Verbal information can be demonstrated by stating it.
   • Motor skills can be demonstrated by physical performance.
   • Attitudes can be demonstrated by preferring options.
The usual answer is that this depends on having an explicit idea of what will have been learned from each object – i.e. learning outcomes - and what a learner needs to know to embark on the object – the pre-requisites. This is highly congruent with the behaviourist perspective of the previous paragraph.

Armed with this (in theory!), there are three complementary options for achieving coherence:

- The learning programme constructor provides a coherent sequence by matching the outcomes of one object to the pre-requisites for the next.
- The learning object states at the beginning what its pre-requisites are, so that the learner can self-assess whether they are ready for it.
- The learning object gives the learner a "pre-test" to determine whether they actually possess the pre-requisite skills or knowledge. In either case, if they do not possess the prerequisites, they could be pointed to objects which provide these, before coming back. (See the discussion of mastery learning below.)

Of course, achieving this formulation is far from easy. In essence, it depends on:

- Achieving a broad enough coverage of the knowledge required to engage with an object, without the list becoming impractically long.
- Formulating learning objectives and pre-requisites in sufficiently standardised format for them to relate together even when the learning objects are from different sources.

The achievement of such a framework of pre-requisites and learning outcomes is one of the significant research challenges for learning objects.

4. Feedback after each chunk of learning.

One benefit of the behaviourist conception of learning outcomes as measurable behaviours, is that learners can be given positive feedback if they have achieved the requisite outcome, or if not guided to repeat the learning, as described in the next section. In general, this would be achieved by post-tests after each chunk of learning. This is at the heart of some behaviourist approaches to individualised learning some as the Keller Plan, Individually Prescribed Instruction, and Program for Learning in Accordance with Needs (Saettler, 1990).

This translates naturally to online learning objects, since it is relatively easy to implement "objective" tests online, giving feedback on whether the skill / knowledge has been learned or not. The model is that the associations or information being learned are defined, and that learners can be tested through "objective" questions (such as multiple-choice). The right answer indicates that the associations have been made correctly: the wrong answer indicates that they are incorrect.

5. Repetition and Reinforcement as appropriate

Feedback from "objective" tests, as described in (4) above, can provide the basis for the learner moving on to the next learning object. They would move on if they got all answers, or more than a threshold number of answers, correct, indicating that they had formed the associations correctly. On the other hand, incorrect performance would indicate that the associations had not been formed correctly, showing the need for more learning of this chunk. This could be achieved through the information being presented in a different way, using same learning object, or a different one.

One behaviourist approach - mastery learning – underlies the materials of one of the largest commercial providers of digital learning materials, and proponents of learning objects – NetG (2001). Mastery learning can be summarised as "Pretest, teach, test the result, adapt procedure, teach and test again to the point of actual learning." (Originated by Morrison in the 1930s - Saettler, 1990).
Motivation can be seen as localised to the task - through immediate “rewards”, such as “well done” signals. This is relatively easy to build into learning objects, and online learning in general – at least in a crude way.

7. Knowledge is objectively available
In behaviourism, knowledge is seen as objectively defined, distinct from the experience of the learner. Learning consists of acquiring it. This has something in common with many cognitivist schools, which also believe in “objectively correct” knowledge, whilst analysing it as internal cognitive structures, rather than externally observable behaviours. Jonasson (1991, online)

This position enables one to think of knowledge as divisible into chunks, which can be represented in correspondingly chunked learning objects. Whereas, if one sees knowledge as residing in the interaction of information and learner (or information, learner, and situation!), one needs to consider more the interplay of learning object, surrounding environment and learner. (See 3.2 and 3.3 below.)

8. Active learning
It is important for the learner to actively participate in the learning process. In behaviourism, this is conceived of a practising the associations laid out in the materials by the experts. It is relatively easy to build this model of active learning into learning objects (and indeed into online learning in general), since the associations to be practised are assumed to be known and defined. Also, where appropriate, feedback can be given, and the learner’s next piece of learning can be informed by their performance in the exercise, as discussed in (4) and (5) above.

9. Transfer
See the discussion under 3.3.

We have seen that learning objects fit very naturally with a behaviourist view of learning. The principles that we have discussed are also important to other schools. Some of the features, such as small chunks, careful sequencing, feedback and appropriate repetition, would be applied in much the same way. Others would be treated in somewhat different, or extended ways, and we shall discuss these below.

3.2 Constructivism
Some defining characteristics of constructivist learning theory are:
- Learning is an active process of constructing knowledge, based on one’s current cognitive structures, interacting with external inputs. Hence the learner will have a central, self-managing role.
- Knowledge is internal, based on the individual’s cognitive structures, and ways of relating to the world.
- There is an explicit notion of the level at which a learner is operating: whether conceived in terms of Piagetian levels, Bloom’s cognitive taxonomy, level of abstraction, or in other ways.
- The employment of learning for problem-solving and reasoning is an explicit concern.
- Metacognitive processes, including planning one’s learning and reflection on it, are important.

We will discuss the principles which are treated differently in constructivism and behaviourism: sequencing, overall flow, learning objectives and context. From a constructivist point of view, the learner’s engagement with learning, and reflection play a major role in contextualising learning, and we will also discuss these.
1. Sequencing and overall flow of learning

Laurillard et. al. (2000) take narrative as a crucial organising principle for learning. Narrative is described as the overall set of threads that hold together “traditional” learning materials, such as books, lectures, films. Narrative provides a macro-structure, and nested structures within this, providing the necessary navigational cues, as well as a linear flow of argument. “Traditional” materials are more linear than computer-presented learning materials tend to be, so lend themselves more to single or hierarchically nested narrative flows. There is a need to formulate equivalent narrative structures for computer-presented materials.

Laurillard et. al. use the conversational framework (Laurillard, 1993) to devise a narrative framework which is applicable to a non-linear medium, such as a multimedia CD, or (in general) a learning object or other online material. For successful learning, control of the narrative should be balanced between the material and the learner (and where applicable the teacher). Laurillard et. al. suggest:

- Goals and sub-goals, which can be selected by the learner, but on which they are constantly kept focussed.
- Actions set up and revised by learners – and completed through interaction with the materials. Completion includes relating their work to the goal or sub-goal which they selected.
- Feedback from the materials to stimulate reflection.
- Model answers with which learners are asked to compare their work to help keep them focussed on reflection.
- A notepad for learners to articulate and refine their answers

For learning objects, this conversation and constructed narrative flow could be within a single object. There is also a need for an overall – possibly higher-level - narrative which extends across the set of objects in a learning programme. As Laurillard et. al. say: “The chronological development of the learners’ construction of the narrative takes place within a larger context - the teacher's lesson, the sequence of lessons in this part of the curriculum, the school, their longitudinal educational experience, etc.”

There are correlates for these contextual features in online learning – the sequence of learning objects in the learning programme, etc.. The way these contextual features play out in practice, to provide a top-level narrative which is effective (or otherwise) for different online learning situations seems an important topic for research.

The establishment of goals and sub-goals has important links to the discussion of learning objectives. Goals can be seen as essentially the same as learning objectives. This would suggest that the learning objectives may be set by the learner for a particular learning episode: possibly in interaction with the learning object: selecting them from a menu of possibilities. This reinforces the point made in 3.2(2) below, that for constructivists, learning objectives are not necessarily a fixed property of the learning object.

The notepad (and the location of learner actions in general) sits at the interface between the learning object and the surrounding environment – for example a learning management system (LMS). The same applies to the establishment of learning goals / objectives. This question of location is an important one, to which we will return in the conclusions.

2. Learning objectives and context

In a behaviourist model (and indeed in many cognitivist models which take an “objectivist” view – Jonasson (1991), what someone learns from a learning object is essentially a property of that object in isolation. The learning object is designed to teach x, y or z – and that’s pretty much what it will teach, whenever it is used successfully. The learning objectives may be multiple, and stratified, but they are purely a property of the learning object.

This is not the case from a constructivist viewpoint. The learning objectives depend on the context of learning, so must be definable in the context of use of the learning object.

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1 This would imply reasonably large learning objects – but this is not necessarily a barrier.
This implies that learning objectives “supplied with” a learning object by the publisher or author must be conceived of as guidance on how the object might be used. They do not necessarily specify what the learner will have learned if they successfully engage with the learning object. This level of learning objective must be specified when the learning object is embedded in a context, for example a specific learning programme / course. They will typically be the learning objectives that the actual learner is shown and engages with.

These “delivery” learning objectives may be free text, created by the person who puts together the learning programme – for example the teacher. On the other hand, they may be taken from the definitive, structured set of learning outcomes for the programme being delivered. This would fit the good practice recommendations for modular learning prevalent in UK Further Education (for example), whereby the means of delivery (for example learning objects) are separated out from the definition and assessment of what is to be learned (the learning programme and accreditation). (Framework for Credit - FEU, 1995.) It also fits certain widely used qualification frameworks – for example in the UK, NVQs and GNVQs.

In system terms, if the learning objectives depend on the context of delivery, rather than being a fixed property of the learning object, this implies that they will be held in the environment which surrounds and delivers the learning objects. This may well be a learning management system (LMS). We will return to this question of location in the conclusions. At the same time, these context-specific learning objectives will be of great interest to other teachers who may wish to reuse the learning object, and hence should be open to querying in repositories of learning objects. In fact, the context of use of colleagues may well be of more interest to them than a set of learning objectives ascribed by the publisher.

3. The learner’s engagement, role in contextualisation, and reflection

We have discussed how one of the key problems for learning objects is how to sequence together many objects to provide substantial learning experiences which are coherent. Whatever the solution to this, it is likely to be aided by an active and reflective role for the learner in relation to their overall learning programme. In the constructivist view, this is seen as beneficial in any case, but becomes even more pressing if learning is delivered through learning objects.

Whereas a behaviourist might tend to see the responsibility for formulating coherent learning programmes as lying with the course constructor – typically the teacher or instructional designer, a constructivist would tend to place some of this responsibility with the reflective, mindful learner.

All experience is that this level of meta-cognitive learning skills is unlikely to just materialise. Learners will need support in this: in particular in actively engaging with the questions:

- What do I expect to learn from this object?
- What do I need to already know, or be able to do (pre-requisites), in order to engage with this object?
- Do I have this understanding / skill, or do I need to engage with other objects first, in order to achieve it?
- How does this object fit into the overall sequence of my learning?

Typically, learning objects recognise this need, and provide some support, at least for the first two questions, through:

- Informing learners of the learning objectives and pre-requisites or through:
- Testing whether learners have the pre-requisites at the start of the object, and whether they have achieved the objectives at the end of the object. (This is the approach for mastery learning, for example, as described above in 2.1(5).) It might be achieved through a pre-test at the start of the object itself, or through distinct “diagnostic objects” whose results are used to point the learner on to appropriate learning objects. In addition, in some cases, learning objects may help with the third question, by pointing learners to other learning objects which enable them to achieve the pre-requisites.
Constructivist theory envisages that the learner is actively involved in a cycle of setting (or at least engaging with) learning objectives, engaging in the learning activity, and reviewing and reflecting on the learning. Small, discrete learning objects are appropriate for this, as it is easier to reflect on a small chunk of learning and actively embed it in your own knowledge constructs, than it would be for a large chunk.

A constructivist learning object designer might give particular weight to the active establishment of learning objectives, and reflection on the learning. Whilst establishment of objectives and review are also significant to a behaviourist, the learner's role would be seen as less active. For a behaviourist, it would be more a case of understanding and recapping an overview of what the object is teaching. In a constructivist view, on the other hand, the learner has the primary focus in establishing what they wish to learn, and how this will fit in with their existing constructs, then reflecting on how their constructs have expanded. The learning object should be encouraging them to do this, rather than telling them what they will learn / should have learned. This very much fits the notion of mindful learning, as propounded by Langer (1998).

"Reflection objects" may help with this. The "Progress File" project of the UK Department for Education and Employment (DfEE) (DfEE online), although paper-based rather than online, provides examples of such objects: “templates” or forms, which provide an interactive format for learners to assess their current skills, learning goals, etc.. Coombs and Smith (1998) discuss the incorporation of reflective tools and templates in learning environments. In a full object-based learning environment, such objects might be embedded in an appropriate sequence with information objects, assessment objects, etc..

This links to work on “reflective practitioners” (Schon 1987) particularly in professional development and performance support. In this context, the practitioner's reflection may be primary, and individual learning objects may be pulled in to support this as and when appropriate.

3.3 Situated Learning

Some defining characteristics of situated learning theory are:

- Learning is essentially a social process.
- Learning through peripheral engagement (“apprenticeship”) in the authentic practices of the community is stressed.
- Knowledge is seen as a set of tools and (social) practices which can be actively applied in particular contexts, rather than a fixed set of concepts.
- Since the authentic context is critical to learning, the notion of transferability of learning from one context to another is more problematic than in the behaviourist or constructivist view.

Actually, a number of schools fall within, or are related to this approach. Greeno et. al. (1996) label them as “pragmatist-sociohistoric” or “situative”. They have important differences, but would share the characteristics identified above.

Some of the principles which we have considered previously would tend to carry over to the situated learning view. However, learning objectives and context are seen very differently. In addition, a particular social / community view of learning is emphasised.

1. Authenticity, Contextualisation and Transfer

One of the key concerns of situated learning theory is the “authenticity” of learning. The context of the learning is seen as an essential element of the learning. Hence, the ability to manipulate fractions for placing bets, for building houses, or as a classroom paper exercise are seen as three different things. Learning to do it in one context does not automatically mean the learner will be able to do it in the other contexts. “Context” or “situation” here includes the social context (the nature of the community in which one is learning), as well as the physical or domain context (building, betting, programming computers etc.). And of course the two aspects – social and physical/domain - tend to be interlinked.
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Learning that is outside a social and physical context (for example abstract exercises in a book) would be criticised as "ersatz", and leading to learning which cannot be effectively applied in the real world. Of course this applicability to the "real world" is a prime goal of almost all learning.

Not only this, but it is usually important that learning is transferable, i.e. applicable to a variety of contexts, including new and unenvisaged ones. As Laurillard (1993) argues in her discussion of Brown et. al.’s (1989) paper on situated learning, effective learning requires not only the learning of concepts and procedures, but knowing when to and when not to apply those concepts and procedures, and why they are to be applied. Situated learning theorists are not necessarily arguing that transferability is impossible, but that it requires that a variety of example contexts are used in learning, and that incorporating these multiple contexts is one of the key challenges for good teaching practice / learning object design.

“Our argument is that to the degree that abstractions are not grounded in multiple contexts, they will not transfer well. After all, it is not learning the abstraction, but learning the appropriate circumstances in which to ground the abstraction that is difficult.” (Brown et. al 1989)

This highlights a requirement that learning objects cover:

• Concepts / procedures / skills.
• Their application in a number of contexts.
• An explicit notion of when they should be applied and when

Furthermore, it will help if the learning objects make it explicit which of these is being covered at which point, as Langer (1998) stresses in her discussion of mindful learning.

One approach is for all this to be covered in a single learning object. Another possibility, perhaps more in tune with the spirit of learning objects, is for a number of objects to be involved: perhaps one which covers the core concept, several applying it in different contexts (engaging the learner in thought about why it is applicable), possibly some covering situations where it should not be applied, or is one option among many, etc..

Objects which address generic principles (e.g. "using Excel spreadsheets") can generally be re-used in many different learning programmes. The more contextualised the objects (e.g. "using Excel spreadsheets for keeping accounts", "using Excel spreadsheets for keeping accounts for sports clubs") the more situated the learning, but the harder the objects are to reuse. One way forward with this is to have some generic objects and some “contextualising” objects, which act to situate the learning for the learner. The objects would need to be designed and linked so that learners feel they are situated in their own context (e.g. “using a computer to help run a sports club”), with the generic content hanging off this. As opposed to (for example) being asked to learn the generic principles first, then having some “situated” case studies and exercises tacked on to apply and test the learner’s understanding.

To support this, and other approaches to contextualisation, one could assign metadata to particular learning objects (though not prescriptively) as being relevant to particular communities of practice, allowing the set of learning objects / learning programme that is built up to be more situated and authentic for that community.

2. Learning Objectives and Plans

Activity theorists, such as Nardi (1996) would regard human intentionality, manifesting as plans, as being central to learning. Learning occurs when plans are enacted. Both the plans themselves, and their enactment, can be more, or less authentically situated. A large part of the effectiveness of a teacher, or of learning objects and the environment in which they are embedded, lies in the degree to which they enable plans to be enacted in a timely and authentic fashion. (Or, following Brown et. al. (above) we might say in "a variety of authentic fashions": the variety of contexts facilitating transfer.)

Here, I would suggest that plans have the achievement of learning objectives as their goals. So, in this account, learning consists of the learner:
• formulating, perhaps with guidance, their learning objectives,
• forming (again perhaps with guidance) a plan (hopefully an authentically situated plan) to enable these objectives to be achieved, and
• marshalling learning objects and other resources to enable the plan to be enacted.
As with constructivism, this implies that learning objectives “supplied with” a learning object are indicative guidance on how the object might be used. Furthermore, use of the learning objects alone will not necessarily enable the objectives to be reached. A learning object may play only a supporting role in enabling an objective to be reached, or the objective may be reached through (for example) the interplay between learner, teacher, peers and learning object.

3. Communities of Practice, Cognitive Apprenticeship, Individual and Community contexts
Often, the arena of learning is a genuine community of practice: professional training, or performance support. In other cases, the objective is to make the learning environment into an authentic community of practice. For example, a school mathematics class may be regarded as a community of mathematicians, performing mathematical investigations, or a school language class may be “immersed” in the language of study. From this point of view, one could argue that a University seminar is THE authentic setting for the second order thinking that is supposed to be learned at University. Whatever the setting, though, situated learning theorists would argue that social interchange within the community of practice is the primary driver of learning.4

This by no means invalidates the use of learning objects, but it places them in a supporting rather than primary role in the learning process. They would play the role of scaffolding, helping to fill the gap between the current situation of the learner, and the aspired-to situation as a more proficient practitioner.

Scaffolding in learning, like physical scaffolding, can benefit from a component-based (learning object) approach. The concept is that steps of support from where the learner is to where they are going may be quite small components. The challenge is to locate the right learning object for a given learner at a given point, which appropriately fills this gap: or in Vygotsky’s terms fits in the zone of proximal development. The location may be performed by the teacher, the learner, or peers. Of course, location won’t always be from a huge library of learning objects: it may be from a small set of objects supplied as resources for the course. In any case:
• Learning objectives are seen as coming from the learner, rather than from the resource. As with constructivism, the objectives linked with the published resource are indicative guidelines on how the resource MAY BE used.
• A crucial requirement for learning objects is that their metadata enables the right learning object to be located.

4 In this formulation, dialogue and discussion would typically be an important part of social interchange, but the sharing of learning resources would also be viewed as a particular act of social interchange.

4. An example
Let us take as an example a topic in database design, to see how the some of the principles from the three schools, and their application through learning objects, might facilitate the learning process. As mentioned before, the pigeon-holing of principles into a particular school is often somewhat artificial, but is we will still do it for simplicity of narrative.

Let us start with a situated learning perspective. A learner may have as a learning objective the understanding of how hierarchical relationships can be implemented in a database. This objective may be a highly personal one which has arisen from their immediate work / performance support needs. Alternatively, the objective may well be (and in fact invariably would be) a core part of a course on basic database design. Based on this the learner may
formulate a plan (perhaps prompted by the course materials or teacher) to design, build, test and reflect on a small database embodying two or three hierarchical relationships.

“Authentic situation” here would include that the database models a situation which is relevant to them in their work. Or, following Brown et.al.’s recommendations, two or three different databases may be designed, modelling distinctly different situations which are none the less meaningful to the learner.

The resources which could be marshalled to support the enactment of the plan might include:

- Teacher and peer advice and discussion. For example, a design may be formulated, shared, and revised and improved as a result of discussion.
- Learning objects. These might provide a number of necessary resources in order for the plan to come to fruition: for example
  - an explanation of the generalised concept of hierarchical relationships, and their implementation using database tables and foreign keys.
  - links which explain the concepts of tables and keys (which would actually be pre-requisites in this situation).
  - links which give examples of hierarchical relationships in databases.
  - links which explain the mechanics of implementing the design in the particular database system which the learner is using.
  The links here may well be to separate learning objects.
- Teacher and peer support when problems arise – for example when it becomes apparent that the learner's cognitive model of a database table is dissonant with that of actual database theory. (Or we could say with that of the community of practice which designed the current generation of database systems.)

I would argue that that these situated learning approaches are very helpful in this example. Nevertheless, this topic could be (and indeed often is) learned through primarily behaviourist learning objects studied by the learner on their own at their computer, without any of the surrounding situated learning support. Presenting the concepts in small, carefully sequenced chunks, feedback on each chunk and repetition as needed, clear statement of the learning objectives for each chunk, and active engagement in the learning would all help the learning process. In fact, the learning objects themselves may well be very similar for both situated learning, and behaviourist approaches. The differences would be in:

- The presentation of sequencing. The behaviourist approach would be “Here is the sequence of learning objects you need to progress through, with optional reinforcement / repetition loops should you need them”. Whereas the situated learning approach would be “Let's think about how your practice is going to be enhanced, formulate a plan for this, and marshal the resources, from a variety of sources in your community of practice, including learning objects.”
- Learning objectives. The behaviourist approach would be “These are the learning objectives for this learning object. Make sure you understand them, and what their relevance is to you”. Whereas the situated learning approach would be “Let's formulate your learning objectives at this point, and find a learning object that will help you achieve them, in conjunction with your peers and your teachers.”
- Contextualisation. Behaviourists would certainly value relevance to the learner of examples, case studies, and activities. However, situated learning theorists would place more emphasis on authentically situating the learning in the practice of the learner, probably with active learner involvement in this process.
- Social interactions. Again, behaviourists would not discount the value of discussion. However, situated learning theorists would give social interactions, and the community of practice, a more primary role in the learning process.

Moving on to constructivist principles, the emphasis on learner involvement, which we discussed under situated learning, would also be important to a constructivist. A constructivist might start form the observation that effective database design skills do depend on a strong cognitive model of what a database is, and the active linking of new concepts and skills in to that model. The learner would be encouraged to actively, mindfully and reflectively participate in this. A strong narrative thread, with goals and sub-goals would be very helpful for learning this topic, and this narrative might be best constructed in different ways for different learners.
For example, one learner might have a strong understanding of the concept of tables in a database, but be weak at relating this to entities in the world being modelled. Another learner might understand entities well, but not their implementation in database tables. The narrative which links together the learning objects in each of these cases would be different. Learning will be helped by the learning objectives for each object being formulated actively by the learner: e.g. “I understand how to make an abstract model of the departmental structure in my company, but I don’t understand how to build this into a database, using the tables which I’ve learned about. I want to learn how to do this.” Reflection on the process would be useful: e.g. “I think I now understand how to build a hierarchical structure into a database using tables, but I need to practice this by building an example to make sure.” Or: “I’ve now built an example, and it went as planned, except for linking of foreign and primary keys. I need to review the theory and examples on this, to make sure I understand it.”

5. Summary, Conclusions and Recommendations

I suggest that the three theoretical approaches I have considered can feed into learning objects in a complementary way, depending on the domain. Particular themes and recommendations that have emerged include:

1. Contextualisation and Learning Objectives

Perhaps the key challenge for learning objects is how to build coherent and effective learning programmes out of a mass of “bite-sized chunk” learning objects. For behaviourists, this challenge is primarily for the teacher or learning provider constructing a learning programme. For constructivists and situated learning theorists, coherence lies more in the interplay of learner and learning objects. In addition to this, situated learning theorists would stress the social construction of the context within the learning community. In each case, I suggest that part of the answer lies in the metadata, and particularly the learning objectives providing the right level of description, so that appropriate learning objects can readily be located. However, the metadata would be interpreted and used somewhat differently by each school.

2. Layered metadata

To support the constructivist and situated learning perspectives, multiple layers of metadata description may be useful. This would mean that learning objectives (and some other descriptive metadata) can be:
1 – supplied by the author / publisher
2 – supplied by the learning deliverer – e.g. the teacher who develops a learning programme. In this case, they will held in the environment which surrounds the object – e.g. an LMS. In some cases, they may be the learning outcomes prescribed by a specific qualification.
3 – supplied by the learner – i.e. the actual objectives which they held / achieved in learning with this object. (See Wiley, 2001)

All three levels of learning objective are likely to be very useful for locating a learning object, so it will be beneficial to hold them in any searchable repository which is housing learning objects.

3. The boundary between learning objects and the surrounding environment

In an online situation, the immediately surrounding environment may well be provided by an LMS (learning management system). For constructivists and situated learning theorists, part of the coherence of the learning programme lies in this surrounding environment. Constructivists would stress a flexible and interactive narrative thread linking the learning objects together. Also, the learning objectives which apply to each learner are likely to be embedded in the LMS when the learning programme is constructed, rather than being intrinsic to the learning objects. Situated learning theorists may expect the environment to give primacy to social interactions with members of the learning community (for example a teacher and small peer group of learners) with learning objects being pulled in as and when needed by each learner.

4. Different approaches are appropriate for different levels and domains of learning

We have suggested that each of the schools has validity, and to a significant extent, principles from each of the schools can be combined in creating successful learning objects
and programmes. For example, behaviourist principles might be applied to the internal design of a learning object, and it might be employed in a constructivist or situated learning setting. At the same time, it could be that there is some correlation between level and domain of learning and the approach which is appropriate. Higher education practitioners tend to favour a constructivist or situated learning approach. Situated learning also seems appropriate for continuing professional development. It could be argued that behaviourist approaches are appropriate for technical learning. However, our example, where we saw how a technical topic in database design could benefit from constructivist and situated learning principles, is perhaps a warning against over-simplistic application of this.

Some other topics which have relevance to learning objects, but which we do not have space to cover here include preferred learning styles, run-time rules applied to learning objects (Ostyn 2001), and learner participation in building networked communities of learning objects, perhaps using peer-to-peer technologies (Hodgkins (2000), Wiley(2001)).

In summary, this discussion has not formulated any over-arching learning theory pulling together the use of learning objects. Given the diversity of opinion in the area, it would be dangerous, and probably inappropriate to attempt this. However, I hope it has clarified some of the key issues from learning theory applied to learning objects, and suggested some of the areas of work that are needed in order to move towards an understanding of learning objects that is truly grounded in learning theory.

References


Learning Theory and Learning Objects


NetG – see http://www.netg.com (accessed 23/07/01)


