THE le@rning FEDERATION

schools online curriculum content initiative

CONSIDERATIONS FOR LEARNING DESIGN

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FINAL AUGUST 2004

Contents

1 Introduction

The online curriculum content currently being developed by The Le@rning Federation (TLF) draws on the most recent research into how children learn and how teachers can facilitate their learning. Constructivism in particular, including inquiry-based and problem-based learning, informs the design of the TLF's learning objects, the format adopted for the development of digital curriculum materials.

Teachers will choose the learning objects they wish their students to engage with based on curriculum priorities and their students' learning needs. Interaction with learning objects will be only one part of the student's total learning experience. Within this context, the design of the TLF digital resources aims to enhance the learning process and model what is known about good teaching and learning.

The process of developing sound, pedagogy-based digital materials is a new endeavour. As Boyle (2003) in his paper 'Design Principles for Authoring Dynamic, Reusable Learning Objects' states:

> … from a software engineering perspective each learning object should be as cohesive and de-coupled as possible. This greatly facilitates re-use and re-purposing. From a pedagogical perspective, however, there is a need to create an overall coherent learning experience. These design challenges may be in conflict. A key challenge is to resolve the tensions in a creative and productive way.

To meet this challenge the design, development and quality assurance processes employed by The Le@rning Federation are extensive and iterative. At all stages, from concept mapping to publication, the materials are thoroughly interrogated by students, teachers, educationalists and discipline and domain experts.

This paper presents an overview of the key aspects of learning design that should be inherent in TLF learning objects, some examples of learning objects that illustrate key learning design features, and some guidance for achieving best-practice learning design.

2 Design for learning

The Le@rning Federation's framework for learning design

The TLF *Educational Soundness Specification* and the project scoping briefs provide the broad framework for the design and development of each of the TLF's six online content development projects. These documents describe the focus for development in terms of:

- pedagogy – the approach to teaching and learning, including the intended learning strategies for the specified learner activity and learners
- domain and discipline – the knowledge, skills and processes to be covered, along with key ideas in terms of opportunity for experiencing the ways of knowing, representing, expressing and doing within the domain or discipline
- learner profiles – the cognitive, physical and environmental attributes of the target 'audience'.

Educational Soundness Specification

The Le@rning Federation's *Educational Soundness Specification* underpins the development of high-quality, pedagogy-driven digital learning resources and is reflected in the project scoping briefs. The specification has four principles.

1 Learner focus

The principle of learner focus requires that the needs of all students be addressed. The prior knowledge and dispositions students bring to learning are extremely diverse. These differences relate to gender, socioeconomic conditions, race, culture, geographic location, and physical and mental wellbeing.

Students have a variety of preferred learning modes and styles, and these change according to their stage of development and the difficulty of the content, skills and processes under study. The learning objects must address the spectrum of learner capability within a specified developmental period and year level.

2 Content integrity

The principle of content integrity is a critical component of educational soundness. Integrity of content is achieved when the content is authentic or purposeful and when learning object design takes account of:

- the ways knowledge is conceptualised within the domain
- the skills and competencies of the domain
- the ways of communicating both within and outside the domain
- the knowledge and understandings valued by various user groups and communities.

It is imperative that the content is accurate. Accuracy is not achieved only by the absolute representation of fact, although this is important. It is also achieved only when the scaffold on which the learning content and user interaction are built is designed to provide constructive feedback to the user response.

3 Usability

The principle of usability concerns the interaction of the user with the content. At its simplest level the interaction design and pathways must be intuitive and consistent. At a broader level it means that learners should be actively engaged in constructing meaning through their interaction with the material. Importantly, users need to know and understand what they are doing and why they are doing it.

4 Accessibility

The principle of accessibility is about ensuring that the learning objects comply with accessibility standards for students with disabilities and for rural and remote communities. This principle is also concerned with utilising the capacity of multimedia to support students' acquisition of standard Australian English or standard New Zealand English. Learning objects should also provide specific language support for students whose first language is not English and be appealing to and inclusive of students of all genders, socioeconomic groups, ages, races and cultures.

The TLF *Educational Soundness Specification* and the project-specific indicators should be used to inform all learning design considerations.

Key learning design principles

The learning activity must involve the learner in *active* and *critical* learning. As Gee (2004, p 23) states, this involves the user 'experiencing phenomena in new ways, forming new affiliations, and preparation for future learning' and for learning to be critical as well as active, 'to involve the learner in creating and innovating in the domain' – producing new understanding or meaning.

The learning purpose and intent must be made explicit to the learner. This should be evident within the expression of the task and or context for learning being set. The output from a learning object should reflect the learning purpose of the object and be dependent on the student input.

Key concepts for learning and learning outcomes are defined within the TLF *Design Brief* and reflect the project requirements as initially described within the project scoping brief. The learning outcomes – a statement about what the student will know and be able to do – underpins all descriptions of learning activity and therefore the resultant learning design. Importantly, evaluation of content with users is based on the specified learning outcomes and the associated skills, knowledge and process understandings and applications inherent within them. In-school evaluation feedback provides key information to instructional designers and subject matter experts about the extent to which the proposed learning design (instruction, interface, information and interaction design) enables the learner to achieve the specified outcomes and learning objectives.

Educationally sound learning design is most likely to be achieved when due attention has been paid to the intra- and inter-relationships of the four key elements of design: instruction, interface, information and interaction. When this balance has been achieved, the context (interaction and interface) – providing spatial or temporal juxtaposition – together with the content (instructional and information) – a representation and presentation of information and data – will enable learners to make meanings, and will provide a sound basis for good learning design.

3 Pedagogical approaches and designs for learning

The TLF approach to learning design is underpinned by constructivism, problem-based learning, inquiry (investigative) learning, situated authentic learning contexts and provision of constructive purposeful feedback to students about their learning.

Constructivist learning

Constructivism asserts that we learn through a continual process of constructing, interpreting and modifying our own representations of reality based on our experiences with reality (Jonassen, 1994).

The digital medium is well placed to take this approach. Learning objects can present users with ideas and concepts, and ask them to make comments and predictions, to form hypotheses, to make interpretations based on their understanding and to test them. Users can be presented immediately with the results of their predictions or estimations through feedback mechanisms and are able to refine or rethink their understanding in the light of the response.

Constructivist learning requires changes to learners' experiences. The learning objects need to help students understand concepts for themselves. This can be achieved by designing learning activities in which students solve new problems, research and integrate information, and create knowledge for themselves.

Constructivism is about challenging ideas. In conjunction with an inquiry- or problem-based approach, this type of pedagogy is invaluable in moving students to a more formal understanding of a particular concept, or way of knowing and doing.

Problem-based learning

In *Learning to Solve Problems*, Jonassen (2004, p 2) states 'Content, the coin of the education realm, is relatively meaningless outside the context of a problem'. Learning is an active process and the underlying premise of problem-based learning is that one learns more by actually doing rather than being told how to do it (Harper & Hedberg, 1997). Jonassen (2004, pp 3–6) describes problems as 'varying intellectually in terms of structure, complexity, dynamicity, domain specificity or abstractness'. Obviously, the processes applied to solving the problems will also vary. The extensive problem typology provided by Jonassen comprehensively describes the many varied problem types including: puzzles, algorithms, story problems, rule-using problems, decision making, trouble shooting and diagnosis-solution problems to name just a few that can be designed for the digital environment within a constructivist framework.

Inquiry-based and investigative learning

Inquiry processes should be embedded into the learning objects. We know from research into the ways children learn that students who can ask good questions and investigate the solution to problems have a much deeper understanding. Through experience with inquiry, students learn how to examine critically any given question and come to master fixed subject matter through this process. The roots of inquiry learning lie with John Dewey and the Progressive movement. As Dewey (1933) stated: 'Science is more than a body of knowledge to be learned; there is a process or method to learn as well'.

Starting with the prior knowledge and experience of students, learning objects should be designed to promote:

- framing and focusing questions
- locating, organising and analysing information and evidence
- evaluating, synthesising and reporting conclusions.

The sequencing of activities and the related scaffolding should be designed to stimulate learners towards achieving different 'states' of inquiry:

- thoughtful
- motivational and active
- independent and autonomous
- reflective (providing points for critical reflection and self assessment)
- hypothesizing (applying inquiry to hypothetical issues).

Authentic, situated contexts for learning

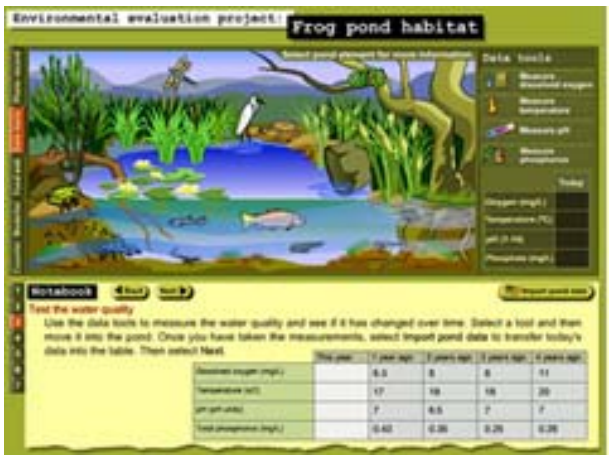
The learning experiences must be at the appropriate level for the users. The experiences need to be challenging enough but based on a good estimate of the users' previous

understanding of the concepts so that all students in the profile can extend their understanding. As Herrington, Oliver & Reeves (2003) profess:

> provision of real and authentic scenario-based problem-solving and investigative activities that motivate and encourage learner participation help the user to engage with the unfamiliar … by facilitating students' willing suspension of disbelief through immersion in a setting' and thereby 'provide the motivation that is needed for initial perseverance.

Example 1 'Environmental evaluation project: frog pond habitat' (Science)

Constructivism is the pedagogical approach underpinning the learning design of the 'Environmental evaluation project: frog pond habitat' learning object.



This learning resource aims to engage the user in a virtual investigation and evaluation of the likely causes for the decline of a frog species. The investigation is designed to model the scientific method that would be applied by researchers in the field.

The structure of the learning activity and the presentation and representation of data and information require users to cognitively process the data and information through scaffolded investigative activities and then to construct a hypothesis. The constructive feedback provides hints, but the reasoning and conclusions reached are based on the users' own direct observations and interpretations of data, thereby enabling them to build on and construct their own new knowledge and understandings. For example, years 5 and 6 students from a Victorian regional school made the following comments about what they had learned after the virtual frog pond investigation.

> I learned that: 1. The Green and gold bell frog has got a lot of predators. 2. Most of the Green and gold bell frog's predators are introduced. 3. Because the Green and gold bell frog lives in places where lots of other animals live they don't have much space to live in. 4. The mosquito fish is a large threat to frogs. 5. If there is a change in the food web most things will change.

This learning object provides an effective opportunity for students to participate actively in an authentic scientific process and to develop an understanding of how interpretation of data can directly affect research outcomes.

Guidelines for constructivist design

In attending to these constructivist principles, the TLF aims to create learning objects that:

- create new ways for students to visualise and ‘notice’ processes and phenomena and to manipulate objects and data
- allow students to build on their current understandings and to construct new understandings of the world
- provide a scaffold for learning that points students towards better ways of understanding and representing knowledge (feedback and correctives)
- provide constructive scaffolded feedback throughout the learning experience to support learners in recognising and correcting common misconceptions
- allow different students to use (and develop) different strategies, such as risk taking and risk avoidance
- help learners become more aware of their own thinking processes and learning – through using metacognitive strategies.

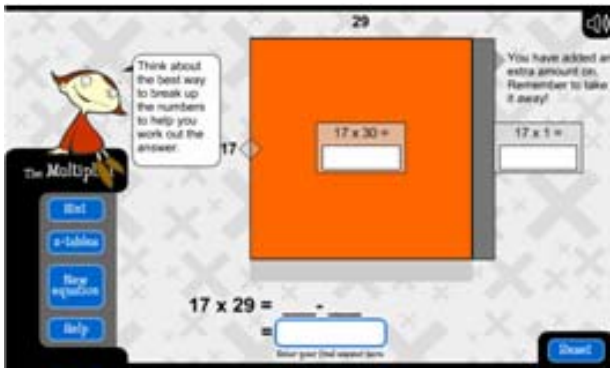
Constructive scaffolded feedback

Timely and appropriate feedback is fundamental to effective learning. Feedback is the key to ‘a good conversation’ (Crawford, 2003) and should be constructive and scaffolded, and require or instigate a cognitive and emotional response. In learning objects, this requires smart computational programming, and prediction by the educationalists of the likely range of user responses to the situation presented.

Learning objects should provide students with situation-critical onscreen feedback to direct their learning. This feedback should support and foreground the relevant reasoning processes in a timely fashion. The use of corrective language such as a ‘best approach’ should include enough support from the activity or task to trigger a changed response from the student after the first attempt. Gradations or ‘levels’ of feedback used in this manner can scaffold and direct the user towards a deeper understanding and resolution of the task and should be presented as encouragement rather than any sense of failure of the task. The emphasis is on achieving improvement. For example, ‘Yes, but have you considered…’ or ‘You might need to look at … again’. Or, at a more sophisticated level, the actual journey through the learning object and progression through the learning activity is directly related to the choices and actions the user takes. However, there needs to be opportunity for the user to improve or correct the progression. Binary (closed) responses, for example, ‘correct’ and ‘incorrect’, to the user action or selection are not generally desired. .

Feedback can be implicit or explicit, but should always be contextual, immediate and logical, and appropriate to the needs of the user to ‘cognitively’ know and understand the strategy, process or convention to be applied to make meaning. (A ha!) That is, where possible direct instruction should be replaced with tasks to be accomplished or problems to be solved that have personal and or situation-specific relevance for each learner in terms of their role or action.

Example 2 ‘The multiplier’ (Mathematics and numeracy)



The suite of learning objects from the first Mathematics and numeracy project concerns number sense and part–whole relationships in number. The approach is to provide students with some possible strategies for partitioning or combining numbers to make calculations ‘in their head’ easier. The students use an exploratory or inquiry approach to investigate for themselves which strategies are effective. Teachers from a New South Wales primary school made the following comments in relation to using these objects in class.

> Great for developing multiplication strategies and excellent for developing mental computation skills . having students use this either individually or in pairs with guidance from the teacher works well.
>
> Teachers are *easily* able to use the object for practice and reinforcement of number groups to 30. As well as developing mental strategies as intended, it also provides concrete visuals that enable the child to calculate the answer.

Example 3 ‘Catch the thief’ (Literacy for students at risk

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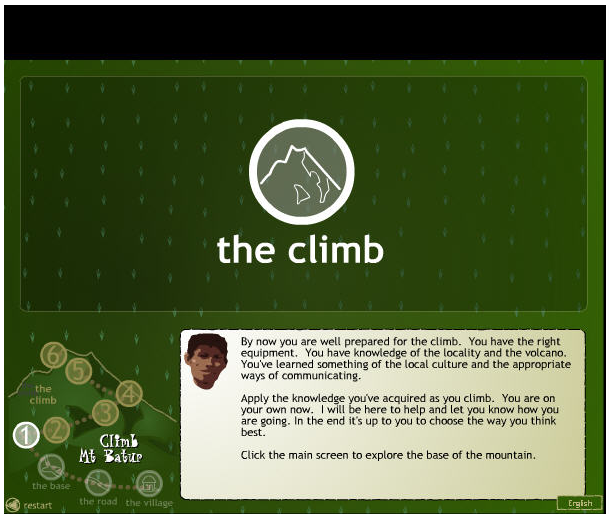
A number of the Literacy learning objects provide very explicit, structured and directed feedback that is also contextual, immediate and logical. This has proved to be appreciated by the learners as is evident in the following student comments about their learning.

> I learnt you had to think about what the witness said
>
> I learnt how to work with others
>
> I learnt that no matter how long it takes we solved the mystery (never give in)
>
> It was fun at the same time as you were learning

Example 4 ‘Mt Batur’ (LOTE)



In the LOTE ‘Mt Batur’ learning object, the user is immersed in culturally different ways of interacting, using different sets of cultural 'rules'. Feedback is connected to these interactions and implicitly supports students in discovering a 'third place', a place of comfort between their first language and culture and their second (Crozet and Liddicoat, 1999). The feedback is more implicit and connected to the learner’s journey.

Example 5 ‘Sonic space: city’ (Innovation, enterprise and creativity)

At another extreme in the Innovation, enterprise and creativity learning object ‘Sonic space: city’, the feedback is primarily introduced within the context of a reflective exercise.

Guidelines for scaffolded feedback

Based on the intended pedagogical approach to learning, the learning objects should:

- provide students with the capacity to interrogate and manipulate the data and information presented, and require active and meaningful expression – with constructive feedback related to user selections and expressions (Piaget’s emphasis on activity: children should receive feedback from their own actions)
- not make excessive demands on student memory – the memory factor of a task must be taken into consideration (especially for primary school learners), and relevant information should be available (inline) within the object when required to assist students in scaffolding their understanding

- have the potential to introduce ‘memorising’ devices, triggers etc (with appropriate challenge levels) as intellectual tools for future learning application that students could use elsewhere
- provide students with alternative paths through the learning activity – this is often most effective when connected to feedback flows
- use feedback as a mechanism for delivering the content.

4 Design for interaction: application of the theory

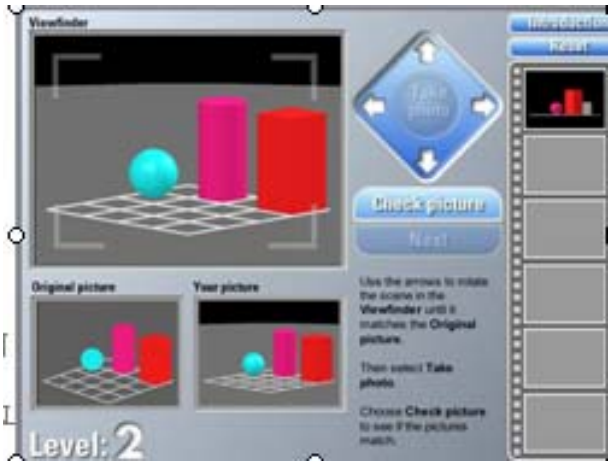
Viewing, listening, thinking and expressing

The basis of constructive interaction design should reflect the ‘conversation’ model. User interaction with the content, and therefore the interactivity, should aim to actively engage the learner in viewing, listening, thinking and expressing. Chris Crawford’s definition of interactivity focuses on re-creating the elements of a good conversation: listening, thinking and speaking (Crawford, 2003). Within the learning design, all three key aspects of a ‘good conversation’ should be evident.

Conversation	Interactivity
Listen	view, explore, listen
Think	interactivity requiring synthesis and critical analysis of data and information presented or provided by the learner
Speak	expressing what the user knows and understands through manipulation of data and content onscreen and or the input of new information, to create a unique output

Interaction design that models particular processes associated with solving problems needs to be appropriate for the age level and cognitive ability of the intended users. Visualisation of phenomena and constructive inline feedback (visual, textual, audible) can support users in developing understanding of new concepts and processes and sometimes, due to the visual representation of data and information, at an earlier age and stage of schooling.

Example 6 ‘Photo hunt’ (Mathematics and numeracy)



This is the case with some of the Mathematics and numeracy learning objects that focus on visualisation and representation. The ‘Photo hunt’ series of learning objects initially targeted

students in years 6–9, but in-school user evaluation demonstrated that students in years 4–6 could adequately work through the visualisation problems. They enjoyed the challenge and could identify relatively easily the 2D representation by manipulating the 3D component. While their use of mathematical language to express what they were doing was less sophisticated, the explanations were exacting.

> Leah, Grade 6 Margate Primary School, Tasmania: 'learn to look at things from different perspectives'
>
> Freya, Grade 6, Margate Primary School, Tasmania: 'Sometimes shapes in one view look different depending on the angle. Computers like a friend to play with them.'
>
> Grade 6, Firbank, Victoria: 'Your eye was able to see the correct answer after more practice.' 'Being able to visualise the rotation in your heads.'
>
> Monna, Grade 6, Fahan Primary School, Tasmania: 'looking at 3D object and comparing 2D photos and rotate 3D up and down, and side to side to get the correct image, fun'

Design for interactivity, based on the 'conversation model', can be seen in a range of different formats in TLF learning objects.

Probe, hypothesise, reprobe, rethink

Gee (2003) provides a four-step process as the basis for how children learn and for expert reflective practice. Within the context of the video game, he describes the process as:

- probe – looking around the environment, engaging in a certain action
- hypothesise – based on reflection while probing, a process of considering what things mean within the situated environment
- reprobes – the player reprobes the world with the hypothesis in mind (testing)
- rethink – the effect is treated as feedback and the player then accepts or rethinks the hypothesis.

Predict, observe, explain

The probe-hypothesise-reprobe-rethink cycle and emphasis on situated learning have been explored in many of the learning objects developed to date, in particular, many of the Literacy for students at risk, Mathematics and numeracy and Science learning objects. An example that highlights the importance of coupling context and content through constructive scaffolded feedback is provided by 'Metal munchers', one of a suite of science learning objects developed for year 5-6 learners. These learning objects all use the predict, observe, explain strategy to model the scientific process.

Example 7 ‘Metal munchers’ (Science)

This learning object has been designed with years 5–6 students in mind. However, it requires some fairly sophisticated understanding of both the scientific process and the scientific knowledge under investigation. Without good teaching practice and therefore effective integration of the learning object into a learning program, the power of the predict, observe, explain teaching and learning strategy may be undermined due to the low level of scaffolding to help the learner know the extent to which their understandings, interpretations and decisions are viable.

Predict, observe, explain learning activities require quite sophisticated cognitive processing. Where this is to be the underlying pedagogical approach of the learning object, the following characteristics should be evident within the interaction and information design of the learning activity for users in years 3–6 and possibly for some in years 7–8.

- To ‘predict’ something rather than guess, users need some factual or experiential basis. Similarities and differences between phenomena or ideas must be made explicit, visually and or audibly.
- ‘Observe’ should require the user to identify what they have seen or heard. For younger students, premeditated responses that can be selected with appropriate constructive feedback is required.
- The ‘explain’ can be more problematic still. The explanation can only be of a few types. Either students can explain in terms of prior knowledge: the learning resource provides this information prior to requiring the explanation and scaffolds the user to reflect on it through feedback at the time when they are formulating explanations. Or they can explain using some classification: the interaction design provides premeditated schema from which the user selects the ‘best’ response, and the constructive feedback provided is based on their selection and highlights relationships accordingly. Alternatively, models and analogies that reflect the most appropriate response may be presented and students select these to help compile an explanation and thereby make the explanation follow some logic.

Predict, observe, explain activities can be a powerful constructivist tool if the students are:

(a) provided with context-dependent hints, and

(b) given a sequence of scaffolded choices.

The summation of thinking and knowing should be presented for each stage of the predict, observe, explain for students to reflect on. Many of these structural ideas in terms of content presentation in relation to learning of processes, are just as significant across most learning settings.

Example 8 ‘Patrick Brennan: Ned Kelly, the man and the legend (Studies of Australia)

For example, the theme for the Studies of Australia learning objects is ‘Shaping Australian identity’. Users, through characters based on real individuals situated in time and place in Australia, are invited to explore the key issues, attitudes and influences that have shaped Australian identity through a situated role. They actively interrogate a variety of rich data and information sources and, with various learning tools, analyse and interpret events, opinions and actions, so providing a way of reading history in relation to the shaping of Australian identity. Structured and constructive hints assist the user to organise the information and data for an analysis and synthesis of key points and ideas to support a position or to make a decision.

Models, simulations and scenarios

Learning is a social and participatory process. Students have long been engaged in simulation or ‘make believe’, and use this sense of play to position themselves outside immediate and personal experience but within a ‘familiar’ and feasible context.

> Identifying the concepts of storytelling and narrative as critical determinants of communication have been shown to provide a context to enable the potential of interactive learning environments. (Sims, 1999)

Learning objects can offer such opportunities for ‘practice’ in approximations of ‘environment’ or scenarios. Enabling the student to have a role in this scenario further reduces the cognitive distance required to engage with the activity.

A major issue to consider in interaction design is cognitive distance – what points of connection does the learning object interface and interactivity offer students? Ideally, the user should be identified as the first person as they are then required to play an active role. There is a dependency on them for progress and a sense of ownership and responsibility. Students require motivation, not just through the media (video, audio, images etc) but these should be considered and consciously designed as rigorously as any other pedagogical dimension. Therefore, learning object design should:

- represent credible activity and problem solving within realistic situations resembling the contexts in which the knowledge that the users are learning can be realistically applied (Herrington, Oliver & Reeves, 2003)

- be sufficiently robust for most purposes, and provide teachers with the ability to simplify them by having students set variables – 'It's not just wind' and several other science learning objects provide examples of how this can be achieved

- provide (as appropriate) the means for teachers or students to adapt the content to local contexts
- aim for approximation of authenticity (suspension of belief – providing points of connectivity for learners and user presence)
- for all instances of user input, ensure the required data input is meaningful and directly related to the learning purpose of the object

Game-like behaviours

> In any domain – whether playing video games or learning some branch of science – the learner can learn in such a way that no real appreciative system is operative. In this case, the learner just does what he or she is told in a rote way. On the other hand, the learner can be actively enough involved in learning the domain to form an appreciative system that norms and guides his or her thought and action in the domain, but this system can remain largely unconscious and not reflected on in any very overt way. This is active but not yet critical learning. (Gee, 2003)

Games (gameplay) are inherently experiential. Those who play games engage multiple senses. For each action there is a reaction, feedback is swift, learning is often by trial and error: hypotheses are tested and users learn from the results (Oblinger, 2004).

Gee (2004, p 90) describes video games as:

> exemplifying the nature of meaning as being situated and embodied … as capturing and allowing players to practice – a process that is the hallmark of 'reflective practice' in areas like law, medicine, teaching, art and any other areas where there are expert practitioners.

Games have many attributes of effective 'learning environments'. For example, games include elements of urgency, complexity, learning by trial and error and scoring points. They also support active learning, experiential learning and problem-based learning. Games make it possible to use information in context, are inherently learner centred and provide immediate feedback (Oblinger, 2004). Therefore:

- Gameplay should include levels that require developmentally justifiable and qualitatively different reasoning skills based on sound pedagogy.
- Learning objects should endeavour to provide students with 'scores' that reflect the learning purpose. Learners should be gradually challenged with greater levels of difficulty in a progression that allows them to be successful in incremental steps.

- Within the context of ‘gaming’, the aim is to promote engagement through enjoyment and challenge. As one student commented, it’s ‘cool school’. It is not possible to compete with Xbox or other video games but it is possible to use some of the motivators to ensure engagement and stimulation and an emotional and cognitive response.
- Providing a means by which two students working on the same computer can input into an object should be considered, particularly in ‘games’-based learning objects. For example, ‘Force interactive’, a Science learning object, has been designed for students to use individually or with another player, and it encourages peer interaction, social negotiation and comparison (and moves students away from egocentric thought – Piaget).
- Instructional ‘games’ must have higher motivational stimulation, and must have a criterion for achievement or ‘winning’.
- The ‘rewards’ within activities should relate to the learning purpose of the activity.

Example 9 ‘The eyeball challenge’ (Science)

This learning object provides an example of gameplay. It is designed to explore the following key ideas:

- Different animals have different visual systems
- Different visual systems convey different information, which enables the animal to be more successful in its habitat.

In developing this learning object to the beta stage, a lot of effort went into researching information relevant to the user about the structure and function of the human eye, and the human eye in comparison with the eyes of other animals. A context for using the most appropriate eyes to solve the challenge is provided within the gameplay. However, user evaluation determined that success within the game context did not necessarily depend on the user having any real understanding or needing to use the eye facts information provided. It was possible to succeed by trial and error, albeit in a potentially longer timeframe. The following suggestions were made to ensure a more direct coupling of the gameplay (context) with the content to be learned.

1 Feedback that points the user to the eye information is required. Ideally, this would be when the user is selecting from the drop-down menu, for example – if the user selects bees’ eyes for a fish eye puzzle then the feedback should state what is consistent or different between the two types of eyes, if anything, as a hint. This might help refocus the user on the content related to structure and function of the eye, which is after all what the learning object is about (implicit and intuitive).

2 Alternatively, introduce a penalty, for example points earned for getting correct selection, points lost for each wrong selection. This would ensure that the learner thinks about using the eye facts information to some extent before selecting the eyes to use to solve the puzzle. Importantly, this is not the same as a timer. This is about performance and is the basis of gaming. The user is motivated or is always trying to better their performance and in this instance knowing more about the eyes would assist. This provides motivation versus functionality that just causes frustration because it focuses on motor skill. The best games are focused on cognitive skills, not motor skills (explicit).

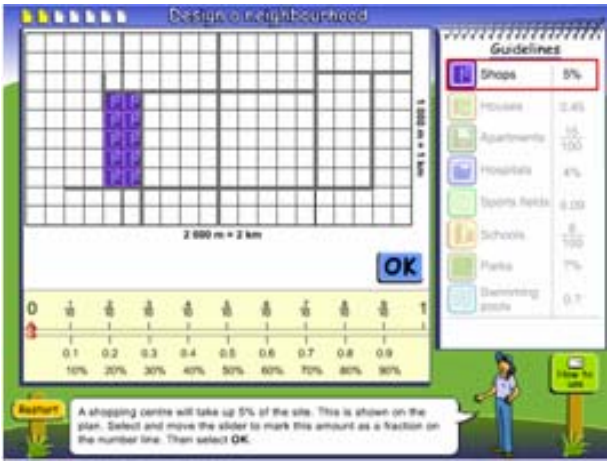
5 Guidance for instructional design: structural and instructional elements

Information design (content)

Information (or content) within the learning objects can be realised in many different forms: text, audio, animation and visually through graphics and the interface itself.

The information design should allow students to succeed without requiring them to use only language to articulate their understandings. It should provide a novel presentation of content that uses the visual impact of the multimedia to its full advantage. That is the content should be presented via the interface, through instruction and feedback and via the user interaction.

Example 10 'Design a neighbourhood' (Mathematics and numeracy)



The representation and presentation of the data and information contained within the 'Design a neighbourhood' learning object involves the student in manipulation, application or evaluation of the information and knowledge presented. It is important that students do not just reach the end point, but engage with the process by which they reach it, and search for the best way to go about it. Further, the level of sophistication and nature of the conceptual demands in terms of information and data presented and the interaction and interface design should reflect the age of the students who will engage with the content, and their cumulative learning

Example 11 'Who's for dinner?' (Science)

This learning object requires students to develop a strategy for each animal in the simulation. Even where the student cannot articulate the strategy, success depends on it, and consequently the learning object achieves its objective.

Instruction relating to the learning activity must be inline with the content and information on screen that the user needs to interrogate so they can interact with the learning activity. Instructions can be presented as text, animation, picture or a combination. Audio may be required in some instances.

Interface design

The instructional value of illustration cannot be overlooked. Graphic visualisation of ideas and phenomena can attract attention, aid retention, enhance understanding or create context, and can often do a lot more than simply explain content.

Context can be provided through the user interface thereby gaining the attention of students which is a precondition to any kind of learning (Gagné & Briggs, 1979). Sometimes the simplest design can be the most stimulating and motivating, providing cognitive stimulation versus aesthetic appeal. Think about the many times you witness a child opening a present from within a box – and then playing with the box.

Interface design should also be student-centred, that is, it should reflect and relate in terms of imagery that is associated with the life experiences and interactions of the age group. When considering the user experience, interface designers should also recognise the following requirements.

- Students should not have to expend cognitive effort thinking about how to interact with the learning object and should be able to focus on content.
- Graphics should be sophisticated – careful visual design is essential. 'Schooley' levels of imagery should be avoided.
- Entry screens into learning objects and transition screens need to be intuitive. Designers should consider ways of generating system prompts for the user.
- It should not be possible for students to navigate through the object using random button selection or other strategies that do not require engaging with the learning purpose of the object.
- Learners should be provided with a means of returning to the start of the activity (bypassing instructions and examples), and another means of returning to the start of the object.
- Students should have the choice of navigating using a mouse or through the keypad.

Text

For learning objects, onscreen text should be minimal in most instances. However, where text is required, consider the following points.

- Text instruction within the learning object (other than for Literacy learning purposes) should be limited to single sentences, dot points or short paragraphs, and be accessible in a context-sensitive manner. Where text is important, the interaction design should require the user to 'read' it in order to proceed.
- It is essential that content information required for students to structure their thinking about the concept or ideas being presented – for example, the background information about a particular chemical reaction – be placed at the relevant point in the activity. Hint screens to scaffold student learning add to the immediacy of feedback, but should be contextualised with the content being explored.
- Text materials in the body of the learning object should be restricted to information required for completing the activity.
- Where text is required for initial instruction, it should be no more than a paragraph. Students either do not read or do not retain this information. Navigational instructions if required are more useful to students while they are navigating, and therefore remaining inline with the content.

In most circumstances text input boxes are not appropriate and, if used, should result in some material change in the behaviour of the object. While taking notes for reflective purposes is useful and can be meaningful, the challenge is to create enough flexibility for data entry, alongside assistive prompts or hints, to make it meaningful. Premeditated 'canned' data can work effectively as models for meaning making and considered interpretations and expressions.

Where user input is desired it should be editable. It should be possible for students to reflect on their previous work and modify their data throughout the object when new information becomes available to them. It should also be possible to navigate easily through the program without losing data.

Audio

Audio within learning objects is generally required to provide:

- sound and or atmospheric effects consistent with the context for learning
- an authentic 'voice
- literacy support.

Judicious consideration of the amount of audio required to ensure engaged and effective learning needs to be balanced with alternative means of representing the same information. For example, would a visual clue or representation be just as effective? 'Read to me' text may be required in objects for early years' learners and or literacy objects. However, visualisation of data and information through animation is preferable. Where audio is used it must be possible for the learner to directly control the audio, that is they can turn it on or off and can replay it.

Sound files should be used for effects in ways that promote the learning purpose and context and that help to situate the learner. However, sound must not be the only means of communicating information.

Learning objects should not have any global controls for sound. The user must be able to control, that is activate and deactivate, each and every instance of sound inline with the screen information they are interacting with.

'Read to me' and instructional audio should be limited to early years' (and some Literacy) learning objects and be complemented with visual representation. This might take the form of short sentences or text labels on a diagram, animation or picture.

Graphics and animation

Navigation in learning objects should use intuitive graphics rather than text wherever possible. Interface and information design should focus on the use of space and movement to enhance visual learning.

Good quality graphics and animations should be used in preference to photographs. Photographic realism is important within certain contexts but does not necessarily require a photograph. However, it is important to ensure that the simplification of graphics to reduce information or file size does not reduce the value of the graphics as learning resources.

- Graphic output should be supported by text (or numbers) rather than the reverse wherever possible.
- The sophistication and nature of graphics should reflect the age of the students who would engage with the content.
- Illustrations also have an instructional role – they aid retention and provide interest and an alternative mode of representation instead of text: 'picture says a thousand words'. Illustrations can provide visual clues and stimuli that students are not able to generate on their own.
- Good quality animations should be used in preference to video clips. If necessary, the animations could be supported by photographs.
- Animations require user control – start, stop and replay – or at least, if it is important for the animation to play automatically, that once it has played the user can replay and stop at their leisure.
- Animations should be used to illustrate processes rather than simply replace text, and vivid clear colour used in graphics for younger children.
- Humour should be encouraged. Students enjoy quirky humour that can be displayed in animations of facial expressions, sound effects and the like. This need not get in the way of learning.

Keyboard, mouse and typing

Students will tend to integrate the use of mouse and keyboard to navigate and manipulate onscreen information. And there should be a choice. A large amount of typing by the user is not encouraged. Where a learning object requires the learner to input predictions, observations and explanations, this should be structured and directed in such a way that they are not fundamentally spending most of their time on keyboard skills rather than activities associated with the learning purpose.

Students demand control. The more control they have over events on the screen the more effective is their learning experience.

Quit and exit

This functionality is not required. Users should only be able to quit and exit learning objects by closing the browser.

Help

Instruction and navigational information should be explicit within the interface and interaction design, and not located in a separate file. This is the case for all navigation, including keyboard navigation, unless it is considered to be so extraordinary that extra information is needed – and then it should be more like a tutorial or like (dare I say it) MS Paper Clip, in that it is responsive to the user interaction. Therefore Help is not required to be a separate icon and file.

Rollover and hover text

This is not required on navigational icons and buttons. Either make the button visually representational or indeed use text on the button.

Where the user is required to use the information associated with a button or icon they must be able to select the icon to obtain this further information on a ‘pop up’, and then the user must be able to deactivate and close the ‘pop up’.

Glossaries

If there is an educational need for a glossary or further explanation of words, phrases and terminology introduced in the learning object that cannot be adequately defined within the context of use – including illustration, animation and audio – then the presentation of the new words, terms or phrases should include an illustrative example (picture and or animation), and audio to support pronunciation. A dictionary definition will not usually suffice. This is to ensure that meaning making is scaffolded.

Learning design checklist

Here is a brief checklist to be used throughout the learning design process.

Does the activity support the achievement of the learning outcome?

What is the role of the user in the context being set? Would this activity be more suitable if undertaken as an offline activity?

Does the activity innovatively exploit the media?

Further considerations

Does the activity support the project's pedagogical approach?

How does the role of the user relate to the scenario or context and the learning activity?

Is the activity appropriate for the users' age and level of schooling?

What is the user going to know and be able to do?

Why does the user need to do it?

Is there opportunity for the user's active participation in constructing 'new knowledge, understanding, skills'?

Does the learning design initiate engagement?

Does the multimedia initiate engagement?

Will the activity sustain engagement for the time required to complete it?

6 Content development methodology

To ensure that the pedagogy implicit in the resources does indeed enhance the user's learning is no mean task. It takes time, carries risks and brings to bear the skills of multidisciplinary teams. All TLF development teams include subject matter experts experienced in the content and approaches embedded in the resource. Instructional designers are vital for interpreting the scripts and ensuring that learning purpose, usability, navigation and interaction with the ideas contributes to the learning. Writers who are experienced in the multimedia environment interpret the discipline matters into engaging and relevant experiences across the target student profiles.

The teams also include the engine drivers of multimedia: programmers, graphic artists, sound artists and producers. These people are responsible for realising the ideas presented by the writers, subject matter experts and instructional designers.

TLF's multidisciplinary team approach of including expertise from both content and technical domains is designed to maximise the skills and knowledge of each, resulting in digital resources that optimise the benefits of both.

Instructional design

The role of the instructional designer is one of mediator between learning design and 'system'. It is a role that requires skills of interpretation to enable effective translation and treatment of the content within the media. The computational basis of the media (system) should be challenged when applying systematic approaches to instructional design. The interaction design and therefore system functionality when based on the attributes of a 'real conversation' should consider the range of diverse responses a user might have to the information presented to them. A formulaic response that relies on binary configuration or prescription might be relevant for components of the learning activity, but in general the 'system' responses to user action should be guided more by considered reflection on what the learners are supposed to achieve in the learning object.

The development process

Design

Design briefs are developed by the TLF education design team. This team consists primarily of subject matter experts and education specialists. The briefs are developed from the project scoping brief, which describes the focus for learning object development. Each brief should clearly:

- define the learning objective and outcome
- describe the nature of the learning activity and strategies for learning
- describe the learning strategy in the context of the domain and discipline being targeted and in consideration of the attributes of the targeted age group.

Learning object design specifications (LODS) are developed by the instructional designer in conjunction with subject matter experts and others in development team. In relation to the design brief the LODS should:

- describe the flow of learning and interaction design via flow diagrams and wire frames

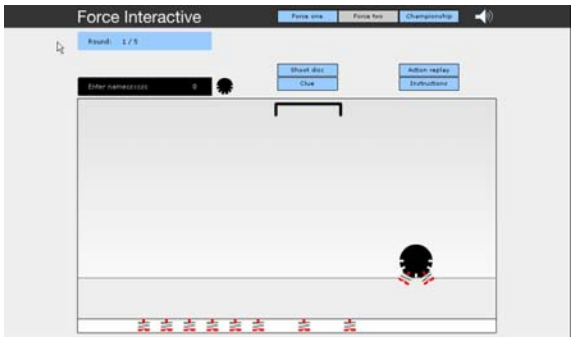
- describe design in relation to content and context (integrated knowledge and instructional and learning strategies, scenarios, situations, etc)
- describe key user interface requirements (considerations of age and culture and navigational requirements)
- describe feedback mechanisms to be employed and levels and type to support the learning strategy and approach – interactivity
- provide an interaction design that focuses on active and critical learning (cognitive processes and feedback links).

Development

Step 1 Prototype

A prototype is developed from the LODS. Team members involved at this stage are the instructional designer and the subject matter expert, the writer if required, graphic artists, creative lead and programmer.

The prototype should contain at least one pathway of learning (illustrative of the whole), including the intended feedback mechanism, sample content, an indication of interface design, placeholder graphics and artwork to indicate style. Examples of prototypes developed for a LOTE and a Science learning object are shown here.



When the prototype has been accepted, it undergoes an educational soundness review and user evaluation in schools.

Step 2 Script

The script stage involves the writer, with input from the subject matter expert and the instructional designer. The writer produces the script for all onscreen content (screen text, audio) and describes content in relation to all visual representation (images, animations, video etc). A full structural multimedia editorial review of the script is undertaken by the TLF.

Step 3 Functional specifications

The functional specifications are developed by the instructional designer and the technical writer. The functional specifications must:

- describe each onscreen event in terms of user action
- delineate accessibility requirements.

A technical review of functional specifications is undertaken by TLF.

Step 4 Beta version

The beta version of learning object is produced with all content complete. All interaction, including navigation and feedback, should also be complete. All third-party IP must be included and signed off. Audio is placeholder only.

The beta version is reviewed technically, editorially and educationally.

Step 5 Conformance and UAT version

The conformance and user acceptance testing (UAT) version has all content and interaction complete, and audio and metadata finalised.

The reviews undertaken at this stage are technical, editorial, educational and user acceptance testing.

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