Embedding visual communication principles in Instructional Design phase of Learning Object creation process

Sameer Sahasrabudhe, Sahana Murthy, Sridhar Iyer
Indian Institute of Technology Bombay, India,
{s1000brains, sahanamurthy, sri}@iitb.ac.in

Abstract: This paper presents a process of redesigning instructional design (ID) template for the ID writers, in which the visual communication (VC) expertise is captured in the form of prompts. In order to capture VC expertise, we first studied the traditional ID creation process and analyzed the decisions taken by the VC experts at various stages in the process. We then identify VC principles that lie at the foundation of these decisions. In our process, we apply the same principles in an alternate manner, so that VC inputs are present in the process, but in a different form, which is useful for the animator. We operationalize VC principles by giving prompts within the ID template, so that the ID writer is able to apply the principles by simply responding to them. There are findings presented, which indicate that the new template was found usable, as compared to the earlier templates.

Introduction

Learning objects (LOs) have become valuable teaching and learning tools in a variety of instructional contexts. Their reusability factor is an exploited not only in online scenarios but also in classroom teaching (Bratina, 2002, Boyle, 2003, Wang, 2008). While there is a considerable debate on the precise definition of an LO, we consider an LO to be "the smallest independent structural experience that contains an objective, a learning activity and an assessment" (L'Allier, 1997). Creating effective LOs having high usability is not simply a matter of programming; it is a collaborative process involving specialized personnel from various domains such as the subject matter, instructional design, visual communication and software development (Weerasinghe, 2007). Communication between these personnel is a combination of text, visual and face-to-face interaction. It is observed that each organization involved in creating LOs, modifies the components of the process to suit their context. Literature regarding LO creation processes is mainly available from organizations creating the LOs (Websites: Excel-soft, US Patents and Enspire). A generic representation of this process is shown in Figure 1, which depicts the team members, documents and the flow of communication. The key team members in this process are the subject matter expert (SME), lead instructional designer (ID expert) and visual communication expert (VC expert). The team also consists of instructional designers (ID) who follow the pedagogical approach decided by the lead ID, the graphic designer (GD) who follows the design laid out by the visual communication expert, and the animators who do the programming to create the LO (Boot, 2008).

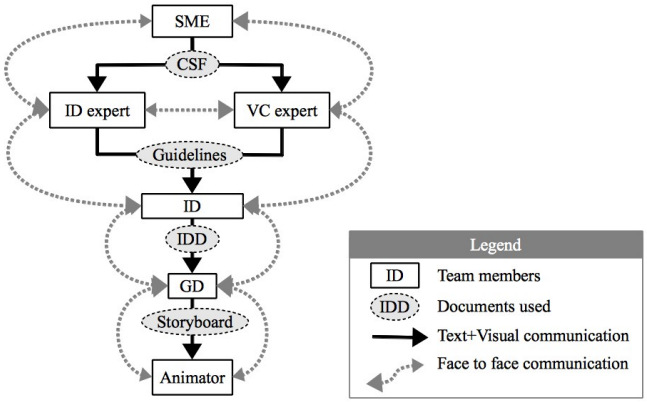

Figure 1: Generic LO creation process with various team members, workflow and type of communications involved

Traditionally, an LO creation process uses documents such as concept selection form, instructional design document (IDD) and storyboard to facilitate communication between the different team members (Boot, 2007). Nevertheless, a large component of the process involves face-to-face interaction between the team members [Figure 1]. While frequent face-to-face communication enables creation of effective LOs in terms of content, pedagogy and usability, it limits the number of LOs that can be created in a given time, especially since the availability of experts is limited. Hence the dependency on face-to-face interaction is a key bottleneck for the rapid creation of effective LOs (Banerjee, 2011). Given the increasing demand for LOs, we believe this commonly followed process is not suitable for scaling up the creation of LOs along multiple domains. The obvious solution of increasing the number of specialized personnel is difficult to implement as it is resource intensive. Often, there is a lack of large numbers of specialized personnel in the required fields.

An alternate solution could be to modify the communication between the team members in a way that the process is scalable. In this paper, we present a process which reduces the dependency on face-to-face communication. We do so by capturing the expertise of the specialized personnel in the LO creation process within a template, and using the template to standardize the process. The expert addressed in this paper is the Visual Communication (VC) expert, who is responsible for the overall visual design of the LO, and hence is the key person affecting the usability of the LO. Moreover, the VC expert in the traditional process requires considerable amount of face-to-face interaction, since VC expertise involves making decisions regarding visuals on the basis of principles from Graphic Design, Interaction Design, Multimedia Design and Animation Design. We incorporate these principles and operationalize them in the form of prompts and guidelines in a template that is used by the ID. Thus, our template enables the ID to take VC decisions thereby reducing dependency on the VC expert. We show the effectiveness of our template through tests with ID writers and Animators.

Details of the LO creation process

Traditional approach

Various types of LO creation processes are followed by the different organizations which create LOs. Most of these processes such as shown in Figure 1) typically have the following team members:

1. Subject matter expert (SME): has the required subject expertise (domain knowledge). He/She decides the topic of the LO, based on learner analysis.
2. Instruction design expert (ID expert): has pedagogy expertise. She/he decides the teaching / learning strategy, based on the topic of the LO.
3. Visual communication expert (VC expert): has visual communication expertise in domains like graphic design, animation design, multimedia design and interaction design. She/he decides the overall look and feel of the LO, based on the teaching / learning strategy selected.
4. Instruction Designer (ID): has basic knowledge of applying teaching / learning strategies, and may have some domain knowledge. She/he details the treatment of the topic using the selected strategy.
5. Graphic designer (GD): has the basic knowledge of applying visual communication domains. She/he details the layouts and interactivity options of the LO.
6. Animation developer (Animator): has training in software tools required to create animation for the LO. She/he simply executes the instructions given by the ID and the GD to create the LO.

The common steps in a typical LO creation process are:

1. SME decides the topic and creates the Concept Selection Form (CSF). The CSF contains the details of the topic chosen from the subject domain, and the rationale for creating an interactive LO for the same. The CSF is passed on to the ID and VC experts.
2. ID expert decides the overall pedagogical approach of the LO in consultation with SME. The VC expert decides the overall visual design plan. They communicate with SME and each other to create a strategy defining the pedagogy and the visual design approach, which is suitable/appropriate for the chosen topic of the LO. These are passed on to the ID writer.
3. The ID details the instruction design of the topic, along the approach decided by the ID expert. The ID communicates with ID expert and VC expert to create the instruction design document (IDD). This document has a detailed explanation about on-screen text, images, voice over scripts, and interaction to

be shown in the LO, and is explained mainly in the form of text along with few visuals. This is passed on to the GD.

4. The GD translates the IDD into a visual storyboard, along the approach finalized by the VC expert. GD communicates with GD expert and ID to create the storyboard. Storyboard is a screen by screen documentation of architecture, parameters, acts, events, feedbacks, connections, and other information (Mustaro, 2006). This is passed to the Animator.
5. Animator does the programming to convert the storyboard into the LO.
6. Intermediate reviews at every stage of this process ensure that the LO is as per the SME's intent.

As seen above, there are multiple interactions between the various persons in a generic LO creation process. Most of these interactions are face-to-face. The dependency on face-to-face interaction is a key bottleneck for the rapid creation of LOs. As the focus of this paper is reducing dependency on face-to-face interactions related to VC expertise a subset of interactions related to this are listed below:

Team members	**Topics of decisions** (regarding the LO)
SME with Lead ID and Lead VC	1. To decide the pedagogy approach 2. To decide the visual presentation and user interaction pattern
Lead VC with Lead ID	1. Finalizing the visual presentation pattern which is suitable for the pedagogical approach selected
Lead VC with GD	1. Explaining the way in which the visual presentation pattern has to be realized in the final LO 2. Details of the placement and colour scheme to be finalized
GD with ID	1. Exact mapping of the interactive elements
GD with ID and Animator	1. Finalizing the placement and interactivity decisions based on format specified by VC expert. 2. Finalizing animation style and motion

Table 1: Face to face interactions regarding VC expertise in a generic LO creation process.

Challenges in traditional approach

Literature shows that the communication between the ID and the animators is a known problem (Boot, 2007, 2008). The face-to-face interaction solves it to certain extent, and the ID gives certain basic pointers regarding the visuals in the LO, via the traditional ID Document (IDD), for example, what should be the look of a certain machine in the LO. However, the ID is unable to give detailed inputs regarding the visuals to be shown in the final LO. For example, the ID might mention that users are to be given four interactivity options, but will not mention whether these should be in the form of radio buttons or a drop-down menu. It is the VC expert who makes decisions about the suitability of such options for the visuals. These decisions are visual in nature, and occur frequently in the LO creation process. Therefore there is a need for multiple face-to-face interactions between the ID and animator, and animator and VC.

Our approach

Our goal is to reduce the dependency on face-to-face interaction, to scale the LO production process. For this, it is most worthwhile to focus on VC knowledge, since that is the one which involves maximum requirement of face-to-face interaction. The animator is expected to apply some VC knowledge to make decisions about the visuals in the LO, such as the choice of colour scheme, shape of the call outs, type of motion and so on.

In order to determine to what extent information regarding visuals is present in a traditional ID document, we first tested if an ID document, created using a traditional ID template (IDT1) contains sufficient visual information. The goal was to test if an animator is able to make these decisions only on the basis of the IDD (without face-to-face communication with the VC expert). This template contained some basic applications

of visual communication principles, to scaffold the ID writer's task of creating the IDD. We found that the traditional IDD contained insufficient information for the animator regarding the details of the visuals. Based on the results, we modified the ID template which the ID uses to create the IDD. We then re-tested IDDs created using the modified ID template (IDT 2).

To capture detailed VC expertise in IDT 2, we first analyzed the decisions made by the VC, and identified the domains and the principles within the domains which the VC uses in order to make these decisions. We applied the principles to devise new prompts and guidelines regarding visual communication, to be included in the modified ID template IDT 2. We show our process in Figure 4.

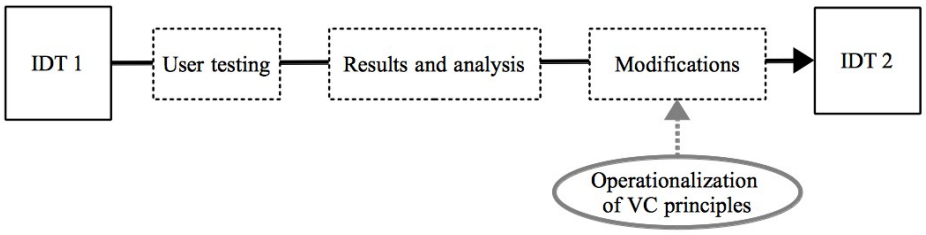

Figure 2: Methodology followed to create the new template

User testing of ID template 1 (IDT 1)

The ID template we used (IDT 1) had the following sections: Information about the subject domains, sub-domain and topic, learning objectives, instructions for creating the animations and assessment questions with feedback. These sections are common in most traditional ID templates. There were features in this template to aid the ID writer. An 'instructions slide' with an example was given for every section. A vertical line with the section numbers was present in every screen of the template. The section in current use was highlighted on this line. Figure 2 shows a screenshot of an instruction slide created for a section on 'Concept details'.

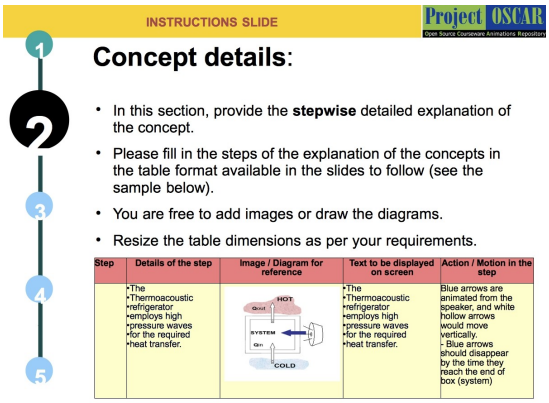

Figure 3: Sample screen of an instruction slide IDT 1

The target users of the IDD created using IDT1 are animators who use the IDD to program the LO. We determine the effectiveness of the template by measuring the usability of the IDDs created using the template. Our sample consisted of six animators working on Project OSCAR (www.oscar.iitb.ac.in). Project OSCAR is a repository of over 140 LOs, on various topics from engineering domain. The educational qualifications of the animators in Project OSCAR and the training they receive in using the animation software are equivalent to the animators in other organizations involved in LO creation.

Prior to the first user testing, of the experiment, the ID writers were given IDT 1 for creating IDDs. Ten topics were selected for creating IDDs. Care was taken to choose IDDs from different subjects deliberately, to get a feedback for various subject domains. IDDs were distributed randomly between the animators.

The tool used for getting the feedback was a System Usability Survey (SUS) form (Brooke). SUS is used widely by researchers for testing usability for various advantages it has over other data collection tools (Bangor et.al). Appropriate adaptation of SUS form (as per our context) was done as per the guidelines mentioned by the creators. In addition to the Likert scale rating of SUS, animators were asked to provide reasons for their choices. This was done to get qualitative feedback.

Results of user testing of IDT 1

The mean of the SUS scores was 36.75. According to the practitioners of SUS, a product is considered to be usable if it's SUS score is greater than 68 (Sauro, 2009, 2011). Since, the average SUS score of the IDDs created using IDT1, is less than the recommended score of SUS, we can conclude that these IDDs are not usable.

The additional qualitative data collected along with the Likert scale choices offered in SUS, is further useful in determining the problems regarding IDT1. These problems are:

1. lack of detailed visual information
2. lack of information regarding the relationship between the components of the LO to be developed
3. less information available on the functional aspects of the components

The analysis shows that, most of the problems mentioned are about inadequacy of visual information. Our approach to solve this problem is to capture the expertise typically given by a VC expert and embed it into the ID template itself. The next section explains the method we have developed to capture VC expertise into a ID template.

Creating a revised ID template

Capturing VC expertise into a template

Figure 4 shows the method we followed to create our template.

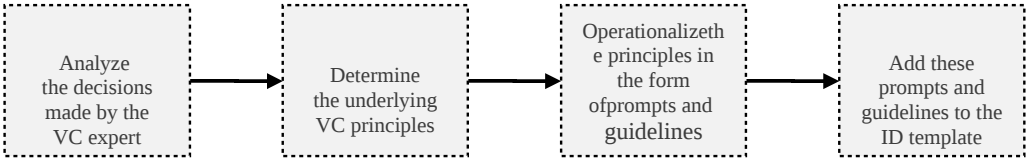

Figure 4: Steps for creating our template

The steps in which we achieved this are as follows:

1. We began by analyzing the role of the VC expert. At the beginning of a typical LO creation process, the VC experts take important decisions regarding the visual look and feel of the LO. These are based on the details provided by the SME. The initial decisions are taken mainly at a macro level where the look and feel of the LO is decided.
2. We studied the rationale behind the decisions made by the VC expert, and determined the underlying principles which were considered for taking the decisions. These principles are from various domains of visual communication namely, graphic design, interaction design, multimedia design, and animation design.
3. The shortlisted VC principles are operationalized in the form of prompts, and guidelines.
4. These prompts and guidelines are inserted in the new ID template. Certain sections of the ID template were modified to apply the above principles. The IDD created from this template now

contains the design decisions, which can be implemented by the animator.

These prompts and guidelines offer scaffolding to the ID writer and ensure the application of the VC principles, even with reduced face-to-face interaction with the VC expert.

Table 2 provides details of our method at various stages:

Actions taken by the VC experts in traditional process of LO production (Rationale behind the decisions taken)	**Principle/s considered for deciding the action** (From graphic, multimedia, animation or interaction design)	**Applying the VC principle/s in the new ID template**
ALL the components to be shown in the LO (Placement planning, and space allocation planning in the screen design. Overall range of the components to be shown)	Staging Visibility	New section: Master Layout Prompts: List of components Prompts: Images of ALL the components listed
Functionality of each component (Motion of a particular component)	Timing	Prompts: information about each component mentioned in master layout
Relationship between the components (Interdependency between two or more components)	Mapping	Prompts: information about each component mentioned in master layout
Layout for the LO (where to place the sections like: interactivity, animation, textual information, etc. Overall look of the LO)	Balance Proximity Figure and Ground Continuation Unity	Sample editable design: animator can edit according to the requirement
Parts/segments of animation in the LO (Animation layout/components change for the segments)	Chunking Mapping	Prompts: Multiple Master layouts to explain each of the segment individually Prompts: Use the numbering of master layouts for the respective animation description

Table 2: Identification of decision points of VC expert, and determining the underlying VC principles

Detailed features of IDT2

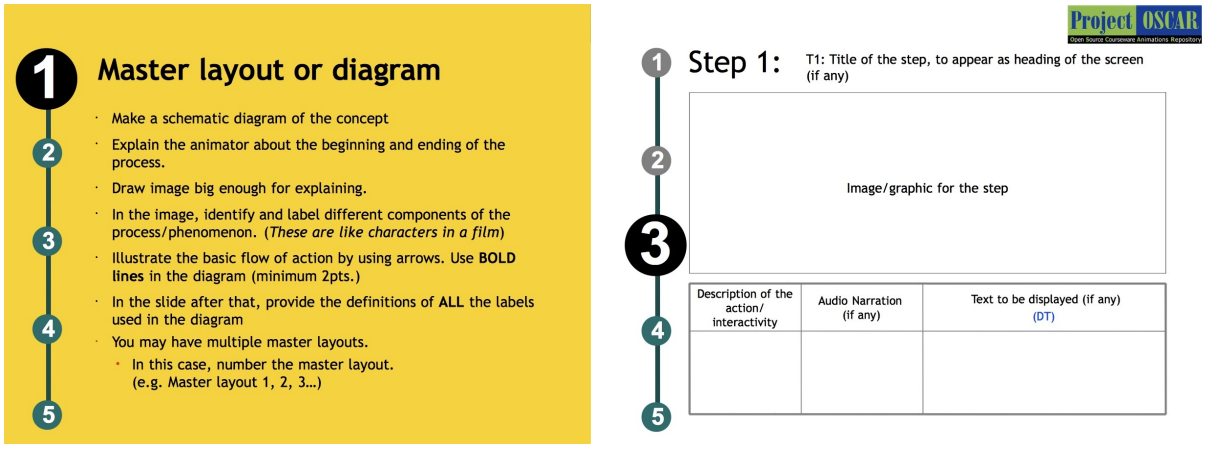

Figure 5: Sample instruction slides from IDT 2

In the new template, some of the sections from IDT1 were retained, some were rearranged, and a few new ones were added. Given below is the list of all the sections and subsections in IDT 2:

1. Information:
    - Title of the LO
    - Brief description of the LO
    - Learning objectives of the LO
    - Names of the authors and their affiliation
    - Master layout
    - Definitions of the components in the LO
    - References (this is part of the information, but placed at the end of the template)
2. Explain the process: Analogy / Scenario / Action / Example to explain the process to the animators
3. Stepwise description of the process: Details of the action in the LO, along with images to support the text
4. Animation design: Sample visual layout is provided to the ID writer. It is customizable.
5. Interactivity and boundary limits:
    - Details of the interactivity section in the LO
    - Assessment questions: MCQ questions to test whether the users have understood the concept

The sections where the VC principles were used to get more detailed information from the ID writers are explained in detail in Table 3.

Sections of the template	**Sample content of the sections**	**How section captures VC expertise**	**VC domains and principles considered**
Master layout (See figure 4)	• Master layout contains an image of all the elements to be shown in the LO and their labels. • In addition the master layout should also depict the positions of the elements along the trajectory of motion, taking care to emphasize the extreme positions of the elements.	• Can see all the components of the LO in their respective proportions and with the expected relationship details • Labels help in identification in further slides • The paths and the extreme positions help the animator estimate the area to be covered by the motion of the elements.	Animation: Staging; Interaction: Mapping and Visibility
Animation design	• A diagram showing the entire layout of the LO, including the positions and relative sizes of the animation area, buttons, text boxes, headers, and navigation controls. • Callouts are used to specify the location (within the template) of the content to be inserted in that section.	• Information about placement and relative size of the components of the LO • Provides a starting point to visualize the LO • Call outs help to find that content within the IDD	Animation: Staging; Interaction: Mapping and Visibility
Step wise description (see figure 4)	• Detailed description of the steps to be followed to create the motion in the LO.	• Prompts the ID writers to add an image at every step. • Recommended that ID writers should use a new slide for each step. Prompts for bigger sizes of images to avoid ambiguity for the animators. This avoids confusion about the flow of action.	Interaction: Mapping and Visibility
Interactivity and boundary limits	• Details of the interactivity section in the LO • Selection of the type of interaction, its range, and expected outcome/s • Details of how users • can interact with the LO	• Information about the range of interactivity options available, is provided to the ID writer to take appropriate decision. • Columns like 'Results and outputs' added for providing more textual details of the interactivity options to the animators.	Interaction: Mapping, Visibility and Feedback

	• limits		

Table 3: Operationalization of VC principles in the new template

User testing of revised ID template (IDT2)

ID writers used IDT 2 and created IDDs. The subjects of the IDDs were same as those chosen for IDT1. The sample (six animators from Project OSCAR), tool (SUS form) and the process were same as the earlier user test done for IDT1.

Results of user testing of IDT 2

The mean of the SUS scores was 68.50. Based on the interpretation guidelines mentioned earlier, this score means that IDT 2 was found usable by the animators. The difference in the SUS scores showed a rise by almost 100% as compared to IDT 1 (Table 4).

	IDT 1	**IDT 2**
12 IDDs	36.75	68.50

Table 4: Comparative SUS scores of IDT 1 and IDT 2

A paired sample t-test (t=4.562) showed that the difference of means was significant at a 0.001 level.

Additional qualitative data collected along with the Likert scale choices offered in SUS, was useful in analyzing the results. Results show that first two problems reported for IDT 1 which were: (i) lack of detailed visual information and (ii) lack of information regarding the relationship between the components of the LO to be developed, were no longer present in IDT 2. This suggests that the operationalisation of VC principles has been effective.

Discussion

The major change in the SUS scores can be attributed to the manner in which VC principles are embedded in IDT 2 [Table 3]. As mentioned earlier, the user of the template is the ID writer. She applies the pedagogy approach (pre-decided by the ID expert) for the topic selected. It is possible that she skips some small details from the point of view of the subject matter or pedagogy (like time details, trajectory in which motion should happen etc.). These small details become bigger decision points for the animator, as he is unaware about the expected results. We have tried to analyze all such details, and provided prompts in the template for the ID writers, so that no detail of visual information gets missed. The design of prompts was based on the VC principles, but communicated in a way that ID writers, who are not experts in VC domains, could provide the required information. As a result, the animators could easily locate and apply the information in the IDD to program the LO. The IDD created on the basis of VC principles provided sufficient information so that they could make unambiguous decisions for the visuals

The other important aspect from the workflow management point is the reduction in the number of documents. The 'stepwise description' section in IDT 2, combines the IDD and the storyboard documents in certain way, that the animators find it easy to follow. In addition, sections like Master Layout with labels and the respective definitions provided add as reference material, which can be accessed anytime if there is a doubt. In a process where face-to-face is frequent, most of these doubts were cleared during the interactions between the team members. It was also evident that dependency on the face-to-face was increasing, as the animators relied heavily on these interactions. Results show that IDT 2 was found more usable and animators were less dependent on the customary face-to-face interactions than the traditional templates.

Conclusion:

In this paper, we have presented a method which can identify VC principles required in LO creation process. These are the principles that underly the decisions taken by the VC experts in a LO creation process. We operationalized these principles to prompts, guidelines and sections of the ID template. Our revised ID template advises the ID writer about the layout, interactivity and other visual options, thereby capturing the guidance given by the VC expert. The prompts such as create a slide per step and emphasize the visual (by making it bigger), translate the efforts of the storyboard artist (GD). Responses to these prompts provide useful information for the animator, who can decide on the important visual aspects of motion and user-interactivity, without needing further face-to-face interaction.

This method of capturing the VC expertise, not only reduces the requirement of the face-to-face interaction time, but also reduces the dependency on the specialized human resource which is a scarcity as mentioned in the beginning. Thus, our process enables LO creation with fewer team members, face-to-face interactions, and the communication documents, thereby leading to an efficient LO creation process.

References

Banerjee, G., Murthy. S. (2011). Model for Rapid, Large-Scale Development of Learning Objects in Multiple Domains. In *Technology for Education (T4E), 2011 IEEE International Conference*, Vol., no., pp.163-170, 14-16 July 2011, doi: 10.1109/T4E.2011.33

Bangor, A., Kortum, P., & Miller, J. (2009). Determining what individual SUS scores mean: Adding an adjective rating scale. Journal of Usability Studies, 3(4), pp. 114-123.

Boot, E. W., Nelson, J., Van Merriënboer, J. J. & Gibbons, A. S. (2007). Stratification, elaboration and formalisation of design documents: Effects on the production of instructional materials. In *British Journal of Educational Technology*. 38: 917–933. doi: 10.1111/j.1467-8535.2006.00679.x

Boot, E. W., van Merriënboer, J. J. G., & Theunissen, N. C. M. (2008). Improving the development of instructional software: Three building-block solutions to interrelate design and production. *Computers in Human Behavior*, 24(3), 1275-1292. doi:10.1016/j.chb.2007.05.002

Boyle, T. (2002). Design principles for authoring dynamic, reusable learning objects, In *Australian Journal of Educational Technology 2003*, 19(1), 46-58 (June).

Bratina, T.A., Hayes, D. & Blumsack, S.L. (2002). Preparing teachers to use learning objects. *Faculty and Staff Development*, November/December.

Brooke, J. (1996). SUS: a "quick and dirty" usability scale. In P. W. Jordan, B. Thomas, B. A. Weerdmeester, & A. L. McClelland, *Usability Evaluation in Industry*. London: Taylor and Francis

Chapman, B. L. (2008). Tools for Design and Development of Online Instruction, Book chapter from J. Michael Spector et.al (Ed.), *Handbook of research on educational communications and technology*

L′Allier, J. J. (1997). Frame of Reference: NETg′s Map to Its Products, Their Structures and Core Beliefs. NetG. Retrieved from http://web.archive.org/web/20020615192443/http://www.netg.com/research/whitepapers/frameref.asp

Mustaro, P. N., Silveira, I. F., Omar, N., Maria, S., Stump, D., Presbiteriana, U., & Sao, M. (2005). Structure of Storyboard for Development of Interactive Learning Objects, In Alex Koohang, Keith Harman, (Eds.) *Learning objects and instructional design*, Chapter 9, pp. 253-279. Informing Science Institute - 2007

Sauro, J. (2011). Measuring Usability with the System Usability Scale (SUS)

Wang, S. (2008). Ontology of Learning Objects Repository for Pedagogical Knowledge Sharing, In *Interdisciplinary Journal of E-Learning and Learning Objects*, Volume 4, 2008

Weerasinghe, T., Nishakumari, K. & Hewagamage, K. P. (2007). Gap between theory and practice: Human factors in designing and developing effective e-learning materials for a structured syllabus. In *the Fourth International Conference on*

eLearning for Knowledge-Based Society, November 18-19, 2007, Bangkok, Thailand
http://www.elearning2011.com/eLAP2007/Proceedings/P19eLearningAP_GepBetweenTheory.pdf

Zhang, W., & Spurlock-johnson, J. I. (2007). Can E-learning Replace the Traditional Classroom ? A Case Study at a Private High School, 24, 1-7.

Website for Excel-soft Technologies Pvt Ltd: (accessed on May 3, 2012) http://content.excelindia.com/index.php?option=com_content&view=article&id=48

Website for Patent by Inventors: Shyam K Subramanyan, Abhijeet Prakash Vaidya, Alan C. Brown, David W. Noland, Ravikumar N. Mysore: (accessed on May 3, 2012)
http://www.google.co.in/patents?hl=en&lr=&vid=USPATAPP9863707&id=iH-FAAAAEBAJ&oi=fnd&dq=team+of+ids,+animators,+sme&printsec=abstract#v=onepage&q=team%20of%20ids%2C%20animators%2C%20sme&f=false

Website for: (accessed on May 3, 2012)
Enspire.com: http://www.enspire.com/custom-learning/custom-e-learning/e-learning-development-process

Website for: (accessed on May 3, 2012)
Project OSCAR: http://oscar.iitb.ac.in