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

Abstract: The traditional LO creation process involves a number of specialized personnel such as the subject-matter expert, instructional design expert, visual communication expert, graphic designers and animators. While each team member brings in his or her own expertise into the process, the creation of high quality, usable LOs relies on frequent face-to-face interaction between the team members. Among these interactions, the ones involving visual elements is critical in the creation of highly usable LOs. However, the dependency on face-to-face communication limits the number of LOs that be created in a given time. In this paper, we propose an alternate, simplified, LO creation process in which the visual communication (VC) expert and the graphic designers need not be present, even though their expertise is present in the process. We capture VC expertise, and embed them into a template that is used by instructional designers (who are not VC experts). We describe the VC principles used, and how we operationalized them into prompts for the instructional designer. We tested the instructional design documents (IDDs) produced via this process by having animators measure their usability on a standardized scale. We found that animators reported high usability for the IDDs which contain visual communication principles embedded within.

Introduction

An interactive, standalone unit with defined learning objective and assessment built into it is a popular type of content in current eLearning domain. This is termed as a 'Learning Object' (LO). LOs are valuable for teaching and learning mainly because of the reusability factor, not only in online scenarios but also in classroom teaching (Bratina et al., 2002, Boyle, 2003, Wang, 2008). There are many definitions of LOs, but the one which we are following is “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. 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. Availability of the literature regarding the processes in the form of research papers is less, but a wide range is made available by the organizations creating LOs (websites given at the end of references). One such process, (which is generic) is shown in Figure 1, depicts the team members, documents and the flow of communication. A generic process requires specialized personnel such as the subject matter expert (SME), lead instructional designer (ID expert) and visual communication expert (VC expert) are required. Then a team 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 et al., 2008).

![Figure 1: Generic LO creation process with various team members, workflow and type of communications involved](image-url)
Traditionally, such an LO creation process uses documents such as concept selection form, instructional design document (IDD), storyboard etc. to facilitate communication between the different team members (Boot et al., 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. Hence the dependency on face-to-face interaction is a key bottleneck for the rapid creation of effective LOs (Banerjee, Murthy, 2011). Given the increasing demand for LOs, we believe that a generic 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 it is scalable. In this paper, we present a process which reduces some dependency on face-to-face communication by capturing the VC expertise into a template. It also merges the IDD and storyboard documents of the traditional process into a single IDD that is passed from the ID writer to the Animator.

![Figure 2: Our LO creation process (showing ID template which captures the VC expertise)](image)

Since VC expertise includes Graphic Design, Interaction Design, Multimedia Design and Animation Design, which deal with decision making regarding visuals, it traditionally requires considerable amount of face-to-face interaction. Our template enables the ID to take VC decisions thereby reducing dependency on the VC expert. Although capturing VC expertise into a template sounds difficult, we show the effectiveness of our template through experiments with ID writers and Animators. We believe that our process can be used for the rapid creation of effective LOs.

**Details of a generic LO creation process**

Various types of LO creation processes are followed by the different organizations which create LOs. A generic process (such as shown in Figure 1) typically has the following team members:

1. Subject matter expert (SME): has the required subject expertise (domain knowledge). He/She decides the topic of the LO, and what is to be shown as the learning activity of the LO.
2. Instruction design expert (ID expert). She/He develops learning objectives, structures the content and learning activities, decides the teaching-learning strategy, and creates assessments.
3. Visual communication expert (VC expert): has expertise in graphic design, animation design, multimedia design and interaction design. He/She decides the overall look and feel of the LO, based on the topics and the teaching-learning strategies selected.
4. Instruction Designer (ID): has basic knowledge of instructional design. She/He specifies the treatment of the topic by executing the guidelines given by the ID expert.
5. Graphic designer (GD): has the basic knowledge of applying visual communication knowledge. He/She details the layouts and interactivity options of the LO by executing the guidelines given by the VC expert.
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 steps in the typical LO creation process are:
1. SME decides 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 ID and VC experts.
2. ID expert decides the overall pedagogical approach of the LO. 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. ID details the instruction design of the topic, along the approach decided by the ID expert. 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+few visuals. This is passed on to GD.
4. 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. The storyboard is a screen by screen documentation of architecture, parameters, acts, events, feedback, and connections. (Mustaro et.al) The storyboard is passed on 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 analyzed above, there are multiple interactions between the various persons in a traditional LO creation process. Of these, the communications that rely on visual elements are particularly critical. Table 1 lists interactions between various team members of the LO creation process, in which visual communication plays a key role.

<table>
<thead>
<tr>
<th>Team members</th>
<th>Topics of decisions (regarding the LO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SME with ID expert and VC expert</td>
<td>1. Guided discovery approach should be followed.</td>
</tr>
<tr>
<td></td>
<td>2. Have interactivity such that the LO will respond only to the inputs given by user, and guide them if they are wrong. So, visual design needs to be intuitive enough that the user is invited to interact with the LO, in the manner specified by the ID expert.</td>
</tr>
<tr>
<td>ID expert and VC expert</td>
<td>1. Finalizing the visual presentation pattern which is suitable for the pedagogical approach selected</td>
</tr>
<tr>
<td></td>
<td>2. Have bigger interaction area to accommodate the interaction controls, or have main animation area split in three vertical parts, as the LO has 3 components to be shown.</td>
</tr>
<tr>
<td>VC expert with GD</td>
<td>1. Explaining the way in which the visual presentation pattern has to be realized in the final LO</td>
</tr>
<tr>
<td></td>
<td>2. Details of the placement and colour scheme to be finalized</td>
</tr>
<tr>
<td></td>
<td>3. Decision of the font family for the selected domains</td>
</tr>
<tr>
<td>GD with ID</td>
<td>1. Exact mapping of the interactive elements</td>
</tr>
<tr>
<td></td>
<td>2. Types and size of the buttons, their placement and relationship (what to show if the button is clicked)</td>
</tr>
<tr>
<td>GD with ID and Animator</td>
<td>1. Finalizing the placement and interactivity decisions based on format specified by VC expert.</td>
</tr>
<tr>
<td></td>
<td>2. Finalizing animation style and motion</td>
</tr>
</tbody>
</table>

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

The details in the table indicate that face-to-face interaction between various team members, which involve visual elements, is critical in ensuring high quality usable LOs. However, this dependency on frequent and extensive face-to-face interaction becomes a key bottleneck when the goal is rapid creation of LOs. Given
the increasing demand for LOs, the traditional process is not suitable for scaling up the creation of LOs. Furthermore, when LO creation in multiple domains is involved, scaling the number of team members along all domains may not be feasible. In the following section, we present an alternate process which reduces some dependency on face-to-face communication.

**Our approach:**

Literature shows that the communication between the ID and the animators is a known problem (Boot et.al, 2007, 2008). The face-to-face interaction solves it to certain extent, but becomes resource intensive in case of rapid creation of LOs. In order to devise a solution to reduce dependency for face-to-face interaction, we decided to focus on VC expertise. One of the communication documents we selected was the ID template, as that is used for communication between ID and VC domains.

We selected an ID template used in generic process. Added few VC principles (using very basic prompts), and created IDT 1. To test the usability of the template, we conducted a preliminary user test with animators. Results confirmed the requirement of more VC principles to be embedded. Following the process given in Figure 3 we created a new template-IDT 2. A similar test with the same sample was conducted, and the results show that IDT 2 was (twice, as) usable than IDT 1.

![Figure 3: Methodology followed to create the new template](image)

**First user testing:**

Most of the generic ID templates (Jane, To be added) have a few sections in common. They are: Information about the subject domains, sub domain and topic, learning objectives, and assessment questions with answers. It is seen that the format of instructions regarding the motion of the components in LO, varies in every organization. We added few VC principles to this section of a generic template and created new ID template-IDT 1. Figure 4 shows a screenshot of an instruction slide created for a section on 'Concept details'.

![Figure 4: Sample screen of an instruction slide IDT 1](image)

Some additional features were added to the generic template. Instructions slide with an example was
given for every section (prompts for the ID writer). A vertical line with the section numbers was added to every screen of the template. The section in use was highlighted on this line. This was done to help the user to know how much part of the template is completed, and how much more is remaining (Continuation principle from graphic design and Visibility principle from interaction design).

It was decided that animators would be the sample for the experiment based on the following reasons: The ID writers use the template and create IDDs which are in turn used by Animators. Measuring the usability of the template for the ID writers could be misleading since the IDDs created subsequently may not be usable for the Animators. Hence our target users are the Animators and we measure the usability of the IDDs (created using our template), rather than just the usability of the template itself. Six animators working on Project OSCAR (www.oscar.iitb.ac.in) were selected as sample for the experiment. Project OSCAR is a repository of over 140 LOs, on various topics from engineering domain. The training background (of the animation software) and the educational qualifications of the animators in Project OSCAR 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. Twelve topics were selected for creating IDDs. Care was taken to choose IDDs from different subjects deliberately, to get a feedback for various subject domains. For the user testing, the IDDs created using IDT 1 were given to the animators. Each animator had two IDDs to be evaluated.

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 format of SUS, space was provided to write reasons behind the choices made by the participants. This was done to get some qualitative feedback.

Results of IDT 1: The mean of the SUS scores was 36.75. According to the practitioners of SUS, score above 68 is considered as above average and below it is considered as below average in terms of the usability of the product (Sauro, 2009, 2011). This score is lesser than the recommended good score of SUS which can be translated to the statement that: IDT 1 in its current form is non usable for the animators.

Analysis: The additional qualitative data collected along with the likert scale choices offered in SUS, was further useful in determining the problems regarding IDT1. These problems were:

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. This also means that embedding more VC principles (in the template) would make the IDDs (created using the template) useful. The next section explains the method we have developed to capture VC expertise into an ID template.

**Capturing VC expertise into a template**

The analysis of the preliminary test made it evident, to add more VC principles in the template. Figure 5 shows the method we followed to create our template.

![Figure 5: Steps for creating our template](image)

The steps in which we achieved this are as follows:
1. It is seen that, in the beginning of a generic LO creation process, the VC experts take some 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 (and have an overlap on LO creation) viz. graphic design, interaction design, multimedia design, and animation design.

3. In order to implement the design decisions in the form of instructions to the animator, the shortlisted VC principles are operationalized in the form of prompts, rearrangement of sections, addition of new sections etc. in the new template.

4. This operationalisation is done in such a way that in the absence of the VC experts the ID writer has scaffolding which ensures the application of the principles, even in the absence of the face-to-face interaction with the VC expert.

Table 2 summarizes the method:

<table>
<thead>
<tr>
<th>Actions taken by the VC experts in a generic process of LO production (Rationale behind the decisions taken)</th>
<th>Principle/s considered for deciding the action (From graphic, multimedia, animation and interaction design)</th>
<th>Alternate way to apply the principle/s (New template)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL the components to be shown in the LO (Placement planning, and space allocation in the screen design. Overall range of the components to be shown)</td>
<td>Staging: Drawing all the sequence of actions of the characters in a shot in one frame Visibility: Objects required in the scene should be seen, and the ones not required should not be</td>
<td>New section: Master Layout Prompts: List of components Prompts: Images of ALL the components listed</td>
</tr>
<tr>
<td>Functionality of each component (Motion of a particular component)</td>
<td>Timing: achieve slow and fast motion on screen by adding or reducing the number of frames.</td>
<td>Prompts: information about each component mentioned in master layout</td>
</tr>
<tr>
<td>Relationship between the components (Interdependency between two or more components)</td>
<td>Mapping: Relationship between controls and their effects in the world</td>
<td>Prompts: information about each component mentioned in master layout</td>
</tr>
<tr>
<td>Layout for the LO (where to place the sections like: interactivity, animation, textual information, etc. Overall look of the LO)</td>
<td>Balance: Placing visual weight evenly on each side of an axis Proximity: Elements near each other will be considered as together. Figure and Ground: Distinguishing between the foreground and background in a visual field Continuation: Eye's instinctive action to follow a direction derived from the visual field Unity: visual connection beyond mere chance that they belong together</td>
<td>Sample editable design: animator can edit according to the requirement</td>
</tr>
<tr>
<td>Parts/segments of animation in the LO (Animation layout/components change for the segments)</td>
<td>Chunking: All information should be presented in small digestible units. Mapping: Relationship between controls and their effects in the world</td>
<td>Prompts: Multiple Master layouts to explain each of the segment individually Use the numbering of master layouts for the respective animation description</td>
</tr>
</tbody>
</table>

Table 2: Identification of decision points of VC expert, and determining the underlying VC principles
Detailed explanation of the features of IDT 2:

After understanding the decisions and the principles considered by the VC experts, we analyzed for a way in which they can be incorporated in the template. We achieved the new template by following these steps:

1. The sections (of the template) which have the visual information were further classified into subsections.
2. Instructions (in the form of prompts to provide the required information) were created and placed in the beginning of each section as Instruction slides (see figure 6a and 6b).
3. A colour code (yellow background) was created for the instruction slides to separate them out of the other slides.

![Figure 6a and 6b: Sample instruction slides from IDT 2](image)

Detailed explanation about the sections in IDT 2:
In the new template, some of the sections from IDT 1 were retained, some were re-arranged, and a few new ones were added. The sections where the VC principles were used to get more detailed information from the ID writers are explained in detail in Table 3. 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. Step-wise 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
<table>
<thead>
<tr>
<th>Sections of the template (Only the new/renewed sections)</th>
<th>Sample outcome</th>
<th>How ID section captures VC expertise</th>
<th>VC principles considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master layout (See figure 6a)</td>
<td>Create an image of the elements present in that LO, In addition to this the master layout should also depict the extreme positions in the animation, so that the Animator gets to know the area to be covered.</td>
<td>-Can see all the components of the LO in their respective proportions and with the expected relationship details -definitions help in understanding the subject matter details -labels help in identification in further slides</td>
<td>Animation layout and staging in the classical animation domain. Mapping and visibility principle from interaction design domain.</td>
</tr>
<tr>
<td>Animation design</td>
<td>A layout with empty boxes which are prompted to be labeled It expects the elements to be placed at their respective positions. It also expects the proposed scale of these elements to be depicted, so that the relative proportions and the distance between the elements are clear to the animator.</td>
<td>-Information about placement of the content -Call outs help to find that content within the IDD -Provides a starting point to visualize the LO -Information about the order in which it is to be displayed</td>
<td>Mapping Visibility Staging</td>
</tr>
<tr>
<td>Step wise description (see figure 6b)</td>
<td>Detailed description of the steps to be followed to create the motion in the LO.</td>
<td>-Prompts the ID writers to add an image at every step. -Recommended that the writers should use a new slide for each step. This avoids confusion about the flow of action</td>
<td></td>
</tr>
<tr>
<td>Interactivity and boundary limits</td>
<td>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 limits</td>
<td>-Information about the range of interactivity options available is provided to the ID writer to take appropriate decision. -Prompts for bigger sizes of images to avoid ambiguity for the animators. -Columns like 'Results and outputs' added for providing more textual details of the interactivity options to the animators.</td>
<td>Mapping Feedback: Sending back information to the user about what action has been taken, and what has been accomplished. Visibility</td>
</tr>
</tbody>
</table>

**Table 3: Operationalization of VC principles in the new template**

After IDT 2 was created, ID writers used it and created IDDs. The topics of the IDDs were carefully selected, which were same as selected for IDDs created using IDT 1. The sample (six animators from Project OSCAR), tool (SUS form) and the process was same as the earlier user test done for IDT 1.

Results of IDT 2: The mean of the SUS scores was 68.75. Based on the interpretation guidelines mentioned earlier, this score is just above average. This 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).
Table 4: Comparative SUS scores of IDT 1 and IDT 2

<table>
<thead>
<tr>
<th></th>
<th>IDT 1</th>
<th>IDT 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 IDDs</td>
<td>36.75</td>
<td>68.75</td>
</tr>
</tbody>
</table>

Analysis: The 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 were no longer present in the responses given for the IDT 2. It proves that the operationalisation of VC principles has worked.

Discussion:

The big 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. He/She is translating the pedagogy approach (pre decided by the ID expert) for the topic selected. It is possible that he/she skips some small details from the point of view of the subject matter/pedagogy (like time details, trajectory in which motion should happen etc.). These small details become bigger decision points for the animator, as he/she is unaware of 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 (non VC domain) ID writers could know what information is required, and suffice. As a result, the animators found most of the answers to their queries within the template, and that too in a manner in which they can locate and understand easily. The instructional design template ensures that visual communication principles are followed by all instructional designers. The instructional design document is then developed into the learning object by the animators, who also follow the VC principles embedded in the IDD. The learning objects are thus inherently based on VC principles - graphic design, interaction design, multimedia design and animation design - which form the basis of high usability.

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 a possibility, 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. These changes in the structure of the template made it more usable and less dependent on the customary face-to-face interactions than the templates which were used in generic processes.

Conclusion:

In this paper we have presented a simplified process for creation of learning objects, in which fewer team members are required. As shown in Figure 2, the reduced numbers of team members, face-to-face interactions, and the communication documents enable the entire LO creation process to be faster. We have described a method to capture visual communication expertise, and embed them into a template that is used by instructional designers. This method of capturing the VC expertise, not only reduces the requirement of the face-to-face interaction time between the instructional designers and graphic designers, but also reduces the dependency on the specialized human resource such as the visual communication expert. We have presented an instructional design template, which advises the instructional about the layout options thereby translating the guidance given by the VC expert. The prompts to create a slide per action, with emphasis on the visual translate the efforts of the storyboard artist (GD). The instructional design document created on the basis of our template provides adequate information for the animator, who can decide on the important aspects of motion and interaction without requirement of face-to-face interaction. The final LOs created, thus have their foundation in visual communication principles right from the first step of the process.
References


Pollyana Notargiacomo Mustaro, Ismar Frango Silveira, Nizam Omar, 'Structure of Storyboard for Interactive Learning Objects Development, Chapter 9, from the book 'Learning objects and instructional design' by Alex Koohang, Keith Harman, published by Informing Science Institute, Pages 253-279.


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

Websites referred:

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