Abstract

With technology playing an increasingly important role in the learning environment, educators are under pressure to provide, in a timely fashion, their students with more interactive, online learning materials. Fortunately, there is a range of easy-to-use authoring packages that allow educators to do this. However, the downside to this ability to author materials quickly is that it may result in learning activities being produced that have glossed over or even skipped some key stages in the design process. This need not be the case as using frameworks such as Instructional Systems Design (ISD) and rapid prototyping can ensure that pedagogically-sound online materials can be produced quickly. This article aims at showing how this can be done. First, the ISD model, rapid-prototyping and Gange’s (1985) theory of instruction are outlined. Then, there is a detailed discussion on how the above three concepts have been applied to a set of online learning materials designed and developed for my students.

Introduction

New technology is being increasingly used in the learning environment and online courses have expanded rapidly over the last decade. The traditional, face-to-face classroom is also changing into a high-tech environment. Smart boards and multi-media projectors are common, teachers and students are using computers in the classroom, and learning management systems and Web 2.0 technologies are being used to deliver content. Blended learning—the combination of new, IT-based learning methodologies and traditional learning methodologies—has become a "hot topic" (MacDonald, 2006, p.2) and institutions are encouraging faculty to produce more online learning material. There is a variety of authoring packages, both commercial and free on the internet, which allows educators to easily produce
online learning materials. In addition, the World Wide Web provides educators with a whole range of ready-made materials. However, this ability (and perceived need) to quickly produce online learning materials can result in key stages of the instructional design process being glossed over, which can lead to a mixed-bag of online materials with little relevance to what is going on in the classroom (Sharma & Barrett 2007). But when developed using pedagogically-sound instructional design models, online learning materials can allow educators to mix different teaching materials and tools into an effective, integrated course (Bersin 2004) and “enhance the classroom component of courses, and [give] learners the opportunity to work at their own pace and follow their own interests” (Sharma & Barrett 2007, p.8).

In this paper, I will discuss the application of "Instructional Systems Development (ISD)" (Dick et al, 2001, p.4), "rapid prototyping" (ibid, p.252) and Gagne's (1985) nine events of instruction to the design of online learning materials. First, ISD and the use of rapid prototyping are discussed. Next, the paper will provide a brief outline of Gagne’s theory of instruction. Finally, the essay provides a detailed account of how ISD, rapid prototyping and Gagne’s nine events of instruction have been applied to a set of online learning materials used with my students.

**ISD Model**

There is no one specific ISD model. According to Dick et al (2001) and Kruse (n.d.[a]), there are over 100 versions of the model. However, all versions typically have the following stages: analysis, design, development, implementation and evaluation (ADDIE). In addition, the model is not a new invention; it is believed to have originated from an instructional design model developed by the United States armed forces in the mid-1970s (Molenda, 2003).

In the ISD model, each of the five stages has an outcome that feeds into the next stage of the process. Dick et al (2001) define the five stages as follows:

**Analysis:** the designer identifies the learning problem, the goals and objectives, the audience’s needs, existing knowledge, and any other relevant characteristics. Analysis also considers the learning environment, any constraints, the delivery options, and the timeline for the project.
**Design:** A systematic process of specifying learning objectives. Detailed storyboards and prototypes are often made, and the look and feel, graphic design, user-interface and content are determined here.

**Development:** The actual creation (production) of the content and learning materials based on the Design stage.

**Implementation:** During implementation, the plan is put into action. Materials are delivered or distributed to the student group. After delivery, the effectiveness of the learning materials is evaluated.

**Evaluation:** This stage consists of (1) formative and (2) summative evaluation. Formative evaluation is present in each stage of the ADDIE process. Summative evaluation consists of tests designed for criterion-related referenced items and providing opportunities for feedback from the users. Revisions are made as necessary.

However, it is important not to view these stages as just sequential; they are also iterative (Molenda, 2003). Outcomes reached at a later stage can cause modifications to an earlier stage. This continual feedback has been called "rapid prototyping" by Dick et al (2001, p.252) and is seen as improving the generic ISD model. They also state that there are two versions of rapid prototyping. In the first, a light analysis is done, and prototype materials are designed which then go through "quick iterative cycles of formative evaluation and revision to shape the final form of the materials" (ibid, p.253). The second version involves simultaneously analyzing learner needs and designing/developing a draft of the materials, and then fine-tuning the materials as it goes through the latter stages.

Dick et al believe that rapid prototyping has a number of advantages, particularly in current, high-tech design environments. Educators are frequently using new technologies to design and deliver materials, so are unsure as to the effect on their learners. Rapid prototyping allows designers to better visualize the learning materials. In addition, as students use the materials, problems can be identified and fixed very quickly using easy-to-use authoring tools. And as computer-based materials are usually accessed from one common location (e.g. website, learning management system or shared drive), once the changes have been made, the modified materials become instantly available to students, ready for a new iteration of
implementation and evaluation. Finally, by eliminating design flaws at an early stage, the need to make widespread, time-consuming changes later is reduced.

However, there are some possible disadvantages to rapid prototyping. For example, important aspects of the design and developmental stages may be omitted to get materials developed quickly. In addition, problems that are overlooked when designing the prototype will become embedded in the finished materials, decreasing the effectiveness of the learning materials and perhaps resulting in the need for large-scale changes later. Therefore, if using rapid prototyping to design online learning materials, it is important to adhere strictly to pedagogically-sound design frameworks such as ISD, ADDIE and Gagne’s nine events of learning.

Gagne’s (1985) Theory of Instruction

In his book, The Conditions of Learning, Gagne (1985) first outlined his theory of instruction. This theory is based on the “[cognitive] information processing model of the mental events that occur when adults are presented with various stimuli” (Kruse, n.d.[b]). According to Driscoll (1994), the theory can be broken into three major areas: the taxonomy of learning outcomes, the conditions of learning, and the events of instruction.

**Taxonomy of learning outcomes:** Gagne stated that learning outcomes could be broken into five categories: information, intellectual skills, cognitive strategies, attitudes, and motor skills. Each of these categories resulted in different classes of human performance.

**The conditions of learning:** Gange breaks these down into internal and external conditions. Internal conditions relate to what learners know prior to instruction. External conditions deal with the stimuli, or instruction, given to learners.

**The nine events of instruction:** These nine events (see table 1 below) allow the theory to be put into practice and give educators a framework by which to design learning materials.
<table>
<thead>
<tr>
<th>Instructional Event</th>
<th>Internal Mental Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Gain attention</td>
<td>Stimuli activates receptors</td>
</tr>
<tr>
<td>2 Inform learners of objectives</td>
<td>Creates level of expectation for learning</td>
</tr>
<tr>
<td>3 Stimulate recall of prior learning</td>
<td>Retrieval and activation of short-term memory</td>
</tr>
<tr>
<td>4 Present the content</td>
<td>Selective perception of content</td>
</tr>
<tr>
<td>5 Provide learning guidance</td>
<td>Semantic encoding for storage in long-term memory</td>
</tr>
<tr>
<td>6 Elicit performance (practice)</td>
<td>Responds to questions to enhance encoding and verification</td>
</tr>
<tr>
<td>7 Provide feedback</td>
<td>Reinforcement and assessment of correct performance</td>
</tr>
<tr>
<td>8 Assess performance</td>
<td>Retrieval and reinforcement of content as final evaluation</td>
</tr>
<tr>
<td>9 Enhance retention and transfer to the further learning</td>
<td>Retrieval and generalization of learned skill to new situation</td>
</tr>
</tbody>
</table>

Table 1: Gagne’s nine events of instruction (adapted from Kruse, n.d.[b])

In the remainder of the essay, I will discuss in detail how ISD, rapid prototyping and Gange’s nine events of instruction have been applied to a set of online learning materials used with my students.

Analysis Stage

Research setting and students

The materials featured in this paper were developed for Emirati students. These students had recently graduated from high-school and had been accepted for study in a technical college in the United Arab Emirates. However, due to weak English language skills, they needed to complete a foundation year before entering the first year of college. This foundation year not only aimed at improving students’ English language skills, but also aimed at improving their overall study skills.

Rational for the materials

At the analysis stage, five key rational for the materials were identified:

1. **Give students a more personal learning experience:** Prior knowledge of topics makes idea generation easier for students. However, many foundation-level students in the UAE
“have limited prior knowledge … in many fields and subject matters that we might assume would have been acquired in an average high-school background” (Al-Issa and Dahan, 2008, pg. 17). All too often, the materials used in the students’ English classes don’t relate to their real-world experiences; their textbooks tend to be Eurocentric and cover topics about which young Emirati adults have little knowledge. It was desirable to create a set of materials with topics that were familiar to students. This would also help decrease the cognitive load on students, thereby allowing them to concentrate on improving their English language skills.

2. **Provide students with more task-based learning:** The transition from the mainly product-oriented UAE secondary education system to a more process-oriented tertiary education system is difficult for students, particularly those who are academically weak (Glasgow and Fitze, 2008, pg.194). The students in this research, who were lower foundation-level students, fit this profile. Therefore, one of the goals of the students’ foundation year should be to provide them with more process-oriented, task-based learning. This would enable them to develop the skills necessary for their further studies (and eventually the workplace) where they would do a lot of task-based projects. Much of the current learning materials used in the foundation program have students learn just for the sake of learning; it was necessary to create materials where students perform sub-tasks to complete the main tasks.

3. **Provide students with materials that improve their writing skills:** Having taught writing to students from the Middle East for a number of years, it is frustrating to observe them struggle with the process of producing a written text. One reason for this is poor English linguistic knowledge, but another is students’ inability to generate their own ideas and produce real writing based on these ideas. In fact, even when writing in their first language, Arabic, many students find the process of drafting, editing and finally publishing their text very difficult (Cozens and Knowling, 2008). These problems areas needed to be addressed in the new learning materials.

4. **Improve students’ IT skills:** Literacy today requires a range of skills, one of which is the ability to use technology (Solomon and Schrum, 2007). Therefore, in the foundation program, there should be a closer link between the teaching of English and the teaching of computing/IT. Materials that would allow students to simultaneously improve their IT skills and English skills needed to be created.
5. **Help teachers create more interesting, online materials and use Blackboard Vista (BBV) in a more dynamic way:** A common view held by my colleagues was that using BBV (a learning management system) was boring for both themselves and their students. One concern was that it was very static and only useful for multiple-choice type quizzes. Another concern was that it focussed more on the management of learning rather than the learning itself. Therefore, it was necessary to create materials that could be incorporated within a BBV course and would show that learning management systems could be made more dynamic when used creatively.

Having done the analysis and decided on the rationale for the materials, it was now possible to move onto the design and development of the materials.

**Initial Design Stage**

The first concern of the design stage was to ensure that the five key rationale were incorporated within all the materials developed.

**Give students a more personal learning experience:** In 2008, Emiratis were being asked by their leaders to consider national identity. As part of this initiative, our institution encouraged teachers to develop learning materials focusing on Emirati national identity. Therefore, I decided that this would be the theme for the learning materials and picked topics, such as UAE people, places, clothing, food, animals, which were familiar to students.

**Provide students with more task-based learning:** To provide task-based learning, it was necessary to build materials based around authentic academic writing tasks which “emphasize recognition and reorganization of data and de-emphasize invention and personal discovery” (Dyer, 1996, pg. 313, citing Horowitz, 1986). Therefore, the tasks selected would require students to find relevant data and use this data in their own texts. One tool for achieving this is the **WebQuest.** According to Dodge (2001, pg. 7), a WebQuest is

> “an inquiry-oriented activity in which most or all of the information used by learners is drawn from the Web. WebQuests are designed to use learners’ time well, to focus on using information rather than looking for it, and to support learners’ thinking at the levels of analysis, synthesis, and evaluation”.


Provide students with materials that improve their writing skills: As with most skills, writing doesn’t improve overnight. At least one semester (18 weeks at our institution) would be needed to achieve this, so eight modules of materials (see Figure 1 below) would be required. Each module would be completed over a two-hour (double) period and would focus on improving students’ process writing skills. The modules would be done at two-week intervals. During this two-week interval, students would do activities aimed at providing them with the English linguistic knowledge necessary for successful completion of the next module. In addition, each module would need to be designed based on Gagne’s (1985) nine events of instruction so would contain activities that gain students’ attention, inform them of objectives, stimulate recall of prior learning, present the content, provide learning guidance, elicit performance (practice), provide feedback, assess performance and enhance retention and transfer to their further learning.

Improve students’ IT skills: Using WebQuests would also give students opportunities to improve their IT skills as they would be required to use the internet, use interactive HTML files, produce documents in Microsoft Word, post to electronic journals and comment on the journals of their classmates.

Help teachers create more interesting, online materials and use Blackboard Vista (BBV) in a more dynamic way: The use of WebQuests and electronic journals would hopefully encourage teachers to develop similar activities. As these materials would be accessed via BBV, it would show teachers that BBV could in fact deliver more dynamic learning activities.

Design and development of the prototype
Having ensured that all the needs of the analysis were met, it was now necessary to start designing the materials. However, time would be an important factor at this stage. The analysis and initial design was done just before the start of the semester. It was hoped to have students finish the first module of the materials by the end of week 2 of the semester. The only way to achieve this was to use rapid prototyping. A prototype was designed and developed for the first module of materials. The plan was for students to do this module in week 2. As it was being implemented, it would be evaluated and changes made to the prototype design as necessary. Module 2 would then be developed based on the amended prototype.
Despite the limited time, it was still necessary to ensure that the prototype was pedagogically-sound. Therefore, some form of design framework was needed on which to base the prototype. Gagne’s (1985) Nine Events of Instruction was used as this framework.

1. **Gain attention:** In the classroom, an image or word on the board is often used to introduce a topic and gain the students’ attention. This approach was also applied to the prototype. Students accessed the prototype by clicking on an image of Abu Dhabi. However, the image was also used to elicit information about Abu Dhabi and to get the attention of the whole class. (Figure 1 below shows the menu page of the materials after all eight modules had been developed.)

![Figure 1: the index page icons](image)

2. **Inform learners of objectives:** Having gained the attention of the class, it was easier to inform them of the learning objectives of the prototype. This was done both verbally and by using an introduction page on the prototype (see figure 2 below). In addition, after completing all eight modules, a general introduction was added to the menu page of the materials (see figure 3 below).

![Figure 2: module introduction](image)

![Figure 3: index page introduction](image)
3. Stimulate recall of prior learning: Recall of prior learning had already been done on the menu page. However, this was reinforced by adding a picture-matching activity to the prototype (see figure 4 below). After doing this activity, a class brainstorming activity was done which helped students associate new information, English words for the things in the pictures, with prior knowledge, the corresponding Arabic words. Doing the online activity and brainstorming was important as it facilitated the learning process.

![Figure 4: picture-matching activity](image)

4. Present the content: Once again, to facilitate learning, the content was presented in manageable chunks. Figure 5 below shows two short, related activities that were presented to students after doing the picture-matching activity. These activities were part of a WebQuest, where students did a series of tasks in which they found information on the internet and, more importantly, used this information to produce a paragraph. Dodge (2007, n.p.) also states that WebQuests should be "wrapped around a doable and interesting task that is ideally a scaled down version of things that adults do as citizens or workers". The activity below reflected this as it was a scaled down version of something students would have to do as part of their academic studies once they finished the foundation year.
5. **Provide learning guidance:** The final objective of the prototype was to have students complete a text about the topic, *Dubai*. The activities in figure 5 above provided the students with learning guidance so that the final goal was achieved satisfactorily. Activity 1 helped them find information on the internet. Activity 2 showed them how to put the information into their own texts. This learning guidance was important as quite often foundation programme students just copy and paste from the internet when asked to produce texts based on internet research.

6. **Elicit performance (practice):** Having done the above activities, students moved on to the next activity, *Abu Dhabi*, where they practiced the techniques that they had just used. Figure 6 below shows the three activities in the *Abu Dhabi* WebQuest. Activity 1 was the same as previous, but activity 2 was a freer writing activity. Activities 2 and 3 also allowed students to enhance their IT skills by using Microsoft Word, collecting images from the internet and storing everything on their student drive.
7. **Provide feedback:** Feedback was provided in two ways: 1) self-check in activities 1 and 2 in Figure 5 and activity 1 in Figure 6 and 2) teacher feedback on the final text produced in activity 2 above. As the final text was produced in class, students were provided with instant feedback while they wrote and on completion. Observing students work also allowed me to spot common mistakes. Feedback on these mistakes was given in a later class.

8. **Assess performance:** The final writing activity in the prototype, the text about *Abu Dhabi* (see figure 6 above), was used to assess the skills acquired by students.

9. **Enhance retention and transfer to the job:** This couldn’t be judged solely by using the prototype. Hopefully, by the time students finished their foundation year and entered their specialized area of study, the skills acquired by doing the eight modules could be transferred to their further studies.

**Implementation and evaluation of the prototype**

The prototype was implemented and simultaneously evaluated in week two of the semester. As I was present in the classroom when students used the prototype, I was able to evaluate the materials in two ways: personal observation and verbal feedback from students. The evaluation revealed a number of problems. Some of these were superficial, such as typing mistakes and programming errors. These errors were fixed either in class (if minor) or
immediately after the class. However, some of the other errors were pedagogical. For example, a lot of students were having problems with the free-writing activity; it was necessary to add more learner guidance to the materials. It wasn’t a case of just fixing the errors in the prototype. Instead, the initial design had to be changed and these changes would then be reflected in later modules. A similar process was used in the remaining 7 modules.

![Figure 7: ADDIE design used with rapid prototyping](image)

By the time the final module was being developed, a number of design flaws had been identified and fixed. As can be seen from figure 7 above, there was no clear distinction between the five main stages in the ISD process. Instead, Dick et al’s (2001) first rapid prototyping model had been followed. After the analysis, a prototype for module 1 was designed. This prototype then went through a series of quick, iterative cycles between development, implementation and evaluation, during which the materials were modified and after which the design of future modules was amended. This process was repeated for each module, with design problems diminishing with each module. The implementation of the final module was virtually trouble free. In addition, as problems were encountered and fixed in later modules, earlier modules were changed accordingly. Using a trusted ISD process and rapid prototyping ensured that pedagogically sound, error-free online learning materials were produced. These materials were then ready for release to the whole foundation program in the second semester.

**Advantages of using rapid prototyping**

Using rapid prototyping for the online learning materials development had a number of advantages. I had previously developed online reading activities for students, but nothing as complex as the WebQuests featured in this research. Rapid prototyping allowed me to better visualize the learning materials. In addition, it allowed testing of the first module of materials. During this testing, I could see if the materials were achieving the desired learning outcomes.
Problems with students’ usage of the materials, for example, navigation between activities and clarity of instructions, could be identified. Furthermore, implementation time was decreased. Had all the materials been developed first, it would have taken a full semester before students could start using them. Rapid prototyping allowed students to use the materials a full semester earlier. Finally, design flaws, such as insufficient learning guidance, were eliminated earlier, reducing the need to make widespread, time-consuming changes later.

Conclusion
Increasing expectations are being placed on educators to produce online learning materials for their students. While this can be done relatively quickly with easy-to-use authoring packages, the speed at which the materials are produced can often result in key stages in the design process being neglected. However, by using frameworks such as ISD, rapid-prototyping and Gagne’s (1985) nine events of instruction, educators can ensure that their online materials are pedagogically sound and provide their students with motivating learning opportunities.

As new educational technologies emerge with almost alarming frequency, rapid prototyping, in particular, has the potential to become an invaluable tool for educators for a number of reasons. First, it allows materials produced using the new technologies to be visualized better. Second, the effectiveness of the new technologies can be tested with students before committing to large-scale online materials development. Finally, once new technologies have been deemed suitable for online materials development, the quick iterative cycles of the ADDIE model employed by rapid prototyping allows for the continual improvement of online materials.

Bibliography


