Achieving incremental successes in courseware development through prototyping

Soo Teong Beng and Liew Seng Seh
Learning Academy
Temasek Polytechnic

The challenges in the early stages of courseware development are of a different nature, and often subtler, compared to those at the later stages. Addressing these challenges requires sensitivity to the process dynamics, besides the technical know-how. This paper is based on an in-progress project to develop self-instructional material for online learning. The project is carried out jointly by Temasek Engineering School and the Learning Academy at Temasek Polytechnic, Singapore. In this project, prototyping is adopted as the developmental model to navigate the project through the early challenges, with the intention of securing incremental small-step successes. Within this developmental model, the paper then describes the intricacies of integrating instructional design principles and evaluation techniques to tackle the challenges of the evolving prototypes. This paper represents the reflections of the authors as practicing instructional designers, and it should interest readers who want to see a stronger connection between the theory and practice of courseware development. The general reader may also find the concept of prototyping helpful, given the constant demand to innovate in the learning contexts, and may well find some applicability for it in their own contexts.

Keywords: courseware development, instructional design, prototyping, self-instructional material

Introduction

The Learning Academy, as a centre for educational development in Temasek Polytechnic, adopts multiple approaches to promote the adoption of online teaching-learning, and to improve its quality. Joint courseware development with the polytechnic schools is one of the approaches. The scope of the project described in this paper is to re-design and develop 22 hours of lectures in a computer networking subject into self-instructional material to be deployed online. The owner of the subject is Temasek Engineering School. The project is part of a larger research initiative by the School to promote self-driven learning among the students through alternative delivery methods, media, and instructional strategies. With the deployment of the self-instructional material online, the overall delivery of the subject will be blended, with face-to-face still remaining as the delivery mode for tutorials and laboratory sessions.

The project will be managed in three phases over two years. This paper covers Phase 1, which was concluded successfully recently. It describes the use of the prototypes to engage the first set of stakeholders, i.e. the course manager, subject matter expert and staff members of the subject. In Phase 2, which is in-progress, the prototypes will be substantially expanded and they will be used to engage the next set of stakeholders, the students. With the early challenges resolved in Phase 1 and 2, the project is expected to proceed speedily to completion in Phase 3.

The primary criteria for success of the project will be improved engagement of the students with the online self-instructional material, compared to existing lecture participation. Indirect benefits expected are better achievement in the semestral examinations, and also greater flexibility in subject deployment.

Early project issues and directions

Key issues

When faced with a request for assistance with instructional development, a needs assessment is usually carried out with the intention to find answers with respect to the optimal performance, actual performance, feelings, cause(s), and the solutions (Rossett, 1995). However in the context of Temasek Polytechnic, the schools typically approach the Learning Academy with the needs established, though not necessarily in a complete and documented format. The Learning Academy will clarify the needs, then focuses on identifying the issues in carrying out the solutions. In this project, the key issues identified were:

- High impact: The project is high impact because of the large number of end users involved (expected to be about 600-700 students). The project was also initiated from the management of the school, thereby increasing its stake significantly.
- High design and development effort is anticipated: The 22 hours of self-instructional material to be developed is a large quantity. This reduces the possibility of the use of off-the-shelf material. The subject matter of the lectures is technical and largely content-driven. The objectives correspond mainly to the comprehension and application levels of Bloom's Taxonomy of learning outcomes. This means creative instructional design is required to give the material the level of interactivity required to engage the students. It follows then that the use of a more sophisticated authoring tool, e.g. Flash, is more likely, instead of rapid development tools such as Adobe Presenter (Breeze).
- An ill-defined courseware development team: As online learning is not the predominant form of learning in the polytechnic, there is neither special funding nor provision of the full spectrum of expertise required for major courseware development for online delivery. Projects are usually undertaken by the staff members themselves, sometimes with the help of the students. Although this approach may be adequate for small scale projects or material developed using rapid development tools, it is unlikely to support the expectations of this project.
- Lack of experience in the use of self-instructional material among the staff members: While the School has achieved some success in implementing self-instructional online learning, the experience is restricted to the language team. The concept of self-instructional material is fuzzy to many. It is reasonable to say that, generally, staff members do not see the distinction clearly between self-instructional and informational material in online learning. Although this is an issue that has to be addressed, it also provides an indirect opportunity for the Learning Academy to engage in staff development in this area.

Strategies to address the issues

After the key issues were identified, strategies were put in place to deal with them. These strategies are helpful to guide decisions on project management and the development model. The following strategies were adopted:

- Endorsed the project with a formal agreement between the directors of the School and the Learning Academy. This would help to gain support and priority for the project from the management of both parties.
- Assigned more resources from the Learning Academy to complement the resources from the School. This helped to level-up the skill-sets required for the project success. The necessary skill-sets are: project management, subject matter expertise, instructional design, graphic design, multimedia authoring, and quality control. A full team was then created with the Learning Academy providing for the initial project management, instructional design, graphic design, and multimedia authoring advising. The School will provide the subject matter expertise and multimedia authoring by the students. Both parties will contribute to the quality control.
- Aimed for incremental success by breaking the project into three phases. The use of prototypes in Phase 1 and 2 will feature prominently to set team dynamics, establish project metrics, elicit and communicate views, educate and gain acceptance, and test deployment strategies.

Theoretical frameworks

Courseware development models

Models help to conceptualize representations of concepts by providing simpler representations of more complex forms and processes (Gustafson & Branch, 1997). Therefore, it is not surprising that there is a plethora of models for instructional development, because they are, by nature, complex processes. Seels & Richey (1994) defined instructional development as "an organized procedure that includes the steps of analyzing, designing, developing, implementing, and evaluating instruction" (p. 31). Because a model offers a simpler way for conceptualization and "an organized procedure", adopting it makes the development more amenable to proper project management treatment. However, it is important that a useful model is adopted to guide instructional development, as a misfit renders the model more of a hindrance than a help.

Gustafson and Branch (1997) proposed a classification for instructional development models based on the orientation of the models, which could be: classroom orientation, product orientation or system orientation. Models that fit this project better should be product-oriented, and the two models chosen for this project were Rapid Prototyping Model by Tripp and Bichelmeyer (1990) and the Leshin, Pollock and Reigeluth (1992) Model. The Rapid Prototyping Model, is the main model to guide Phase 1 and 2. It fits well with prototyping as a strategy to achieve incremental successes. By Phase 3, the project dynamics and the instructional design will be more established. The use of prototypes can be minimized and a linear model may be more desirable. The Leshin, Pollock and Reigeluth (1992) Model, which is a more linear model, may serve this final phase better.

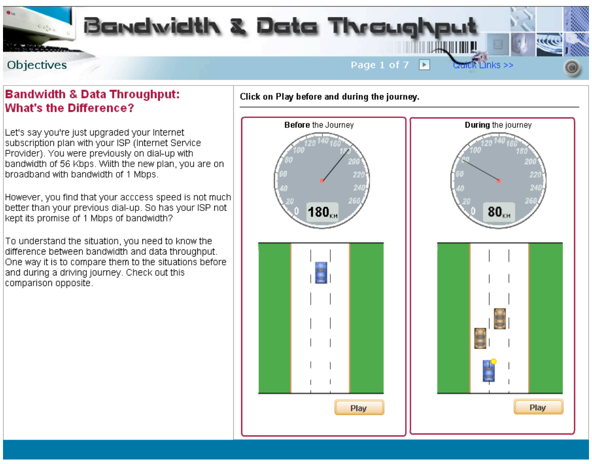
Principles for instructional design

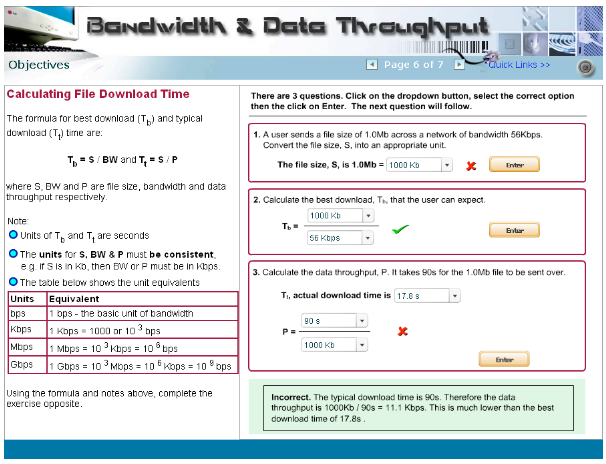
An indirect challenge in this project is to help members of the staff team to move from perceiving self-instructional material as content presentation to that of engaging the learners with the content instead. To achieve this, three instructional design principles are clearly illustrated in the prototypes. They are: instructional alignment, Gagné's events of learning (Gagné, Briggs & Wager, 1992) and Keller's ARCS model for motivation (Keller, 1983).

Instructional alignment refers to the alignment of the learning objectives, content, instructional strategies and assessment. The objectives, which should be measurably defined, serve as the starting point. The objectives are then used to determine suitable content, instructional strategies and assessment methods. This principle of alignment is central to the design of any instructional material.

Based on a cognitive model for learning, Gagné termed instruction as a set of events external to the learner designed to support the internal processing of the learning (Gagné, 1977, 1985). This set of events is commonly referred to as the nine events of Gagné, they are: gaining attention, informing learners of the objective, stimulating recall of prerequisite learning, presenting the stimulus material, providing learning guidance, eliciting the performance, providing feedback about the performance correctness, assessing the performance and enhancing retention and transfer (Gagné, Briggs & Wager, 1992). With the exceptions of "recall prerequisites" and "transfer learning", which may or may not be evident, all the other events are designed into the self-instructional material. Incorporating the events help to enhance the self-instructional capacity of the material, besides improving the richness of the learning experience. In providing guidance to the learners, micro-strategies appropriate to the content are used. A simple example is the use of an analogy to introduce a concept or the use of scaffolding in applying the concept or a relationship. Table 1 illustrates some events at work in a topic of the self-instructional material.

Table 1: Applying the events

<table>
<tr>
<td>The screen below illustrates the events, gaining attention and giving guidance. The analogy helps to gain attention for a start, and also guides the learners to the concepts to be learnt subsequently.</td>
<td>The screen below illustrates the event giving guidance though scaffolding. Prerequisites are given, and the learners are guided stepwise to the final answers.</td>
</tr>
<tr>
<td>


</td>
<td>


</td>
</tr>
</table>

Keller's ARCS model for motivation (Keller, 1983) is a practical guide to increase the motivation capacity of the self-instructional material. The acronym ARCS represents the four components of motivation in his model, namely: attention, relevance, confidence, and satisfaction. The components that are applied most to the self-instructional material in this project are confidence and satisfaction. Among the techniques used are: chunking the content into small topics of no more than 10 screens where possible, providing scaffolding in the learning activities, and using a reasonable variety of interactive techniques to sustain the learners' interest. The small topics are organized into modules and embedded into a well-defined course structure created in the Learning Management System.

A fourth tacit design consideration, though not of prime concern in this project, is the reusability of the material from the teaching-learning perspective. Boyle (2003) proposed that learning objects should be cohesive (an object should serve a discrete learning outcome), minimize coupling (avoid interweaving of content with other objects) and pedagogically rich (offer a rich and effective learning experience). Incorporating the three instructional design principles discussed earlier is a way to achieve the characteristics described by Boyle, although, in his paper, Boyle carried the concept of reusability object to a much lower level, i.e. the learning events.

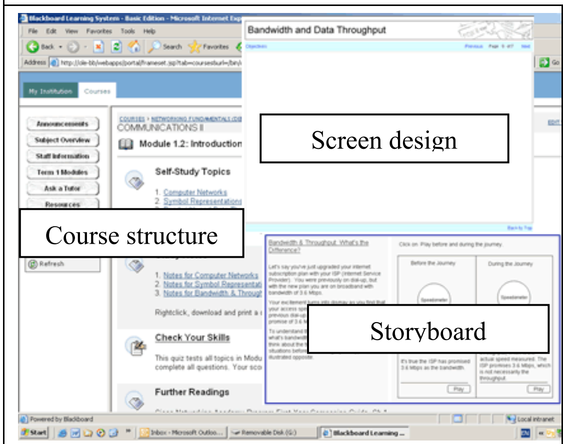
Evolution of the prototypes

Retain or discard?

As the prototypes evolve, decisions on retaining or discarding them have to be made. To retain means to carry over the prototype or some of its elements over to the next iteration, and usually the new prototype will show a strong resemblance to that of the previous one. The opposite is to discard, and the next one may look completely new. Jones & Richey (2000) termed prototypes that are retained as "executable" and those that are discarded as "scope or visual" prototypes.

Both the 'retain' and 'discard' approaches were used in this project. Decisions are based on the intentions and the functions of the prototypes. Prototypes that are used to gain acceptance of ideas, and which require heavy investment effort should be retained, if possible. Examples are interactive objects to illustrate instructional strategies. Prototypes that can be created quickly, and used primarily to elicit opinions and preferences, are usually done with the intention to discard. Examples are screen design, visual, navigational elements and course structuring in the Learning Management System. The target stakeholder may also play a part in the decision-making. Where the stakeholders are familiar with the ideas the prototypes seek to convey, visual prototypes will suffice. Table 2 shows an example of how a prototype is put up at an early iteration in Phase 1. It then evolved into a more sophisticated prototype and was used to engage the staff members of the subject.

Table 2: Evolving the prototypes

<table>
<tr><td colspan="2">Iteration 1</td></tr>
<tr><td>
</td><td><u>Intention</u>
To gather feedback on the course structure, and to discuss instructional design ideas.

<u>Target stakeholder</u>
The course manager and the subject matter expert.

<u>Approach</u>
Mainly discard. The stakeholders are sufficiently knowledgeable about design ideas, so quick visual prototypes are sufficient. These were used with the intention to discard.
• The course structure is constructed in the Learning Management System.
• The screen design of a topic appears as a simple HTML mock-up page.
• The storyboard is crafted in PowerPoint to illustrate the teaching-learning ideas.</td></tr>
</table>

Formative evaluation

Formative evaluation is done with the intent to improve (Scriven, 1991), and therefore lies at the heart of prototyping. In an analysis of various rapid prototyping models evolved from demonstration projects, Jones and Richey (2000) noted that rapid prototyping de-emphasizes summative evaluation but stresses formative evaluation. However, it should be kept clearly in mind that prototypes are only a means to an end. Although the emphasis is on formative evaluation, they should be planned with the view that the final material stands a better chance of undergoing a successful summative evaluation eventually. For example, when appropriate stakeholders are not engaged in the evaluation, the final material may fail to be accepted eventually. The main factor for planning is the intention of the prototypes and the stakeholders to be involved, which then determine the appropriate techniques to be used. There are many well-documented techniques in the literature, such as those described by Jonnassen, Tessmer and Hannum (1999). Table 3 summarizes the formative evaluation done at the two major iterations in phase 1.

Table 3: Formative evaluation in phase 1

Iteration 1	
Intention	To gather feedback on the course structure, and to discuss instructional design ideas.
Stakeholders	The course manager and the subject matter expert.
Techniques	Informal reviews.
Rationale	• Specific and in-depth feedback from the stakeholders are required. • To understand the stakeholders' views, especially in relation to instructional design ideas.
Outcomes	• Some rearrangement and restructuring of the course elements in the LMS were needed. • The stakeholders concurred with the design strategies expressed in the storyboard.
Iteration 2	
Intention	To test the screen navigation, gain acceptance on the instructional design, and to elicit feedback on further concerns or suggestions on the instructional design.
Stakeholders	11 staff members of the subject
Techniques	• Unobtrusive observation • Quality check by the staff members on the instructional design, using an adapted version of the instructional design standards from the American Society for Training and Development's (ASTD) E-Learning Courseware Certification (ECC) Standards. • Focus group discussions, in two smaller groups of 5-6 members.
Rationale	• The unobtrusive observation was used to test the navigational usability and function. • The quality check aimed at establishing the instructional design quality of the materials with the stakeholders. • The focus group discussions aimed to elicit further views on the quality of the instructional design.
Outcomes	• All stakeholders completed their assigned topics without any help or difficulty. • Of the 11 members of the staff team, eight passed the instructional design quality of the prototype, based on the scoring procedures in the ECC Standards. • Instructional design quality issues did not surface noticeably in the focus group discussions. The conversations veered towards deployment concerns, such as "Will the students do it?

While the prototyping developmental model has helped this project to get past Phase 1 successfully, it is not without its dangers. The iterations can get out of hand, and diverse or frequent conflicting views may hinder the progress of the project. Boyle (2006) quoted maintaining time discipline and clear specification of outputs to mitigate failure of on-time delivery. The importance of good project management cannot be under emphasized in a project such as this. In addition, as can be seen in Table 3, this project also targets the stakeholders selectively, according to the intentions of the evolving prototypes.

Conclusion

Of the three phases in this project, the first is the most challenging although smallest in scale. However, the use of the prototyping development model has helped to successfully establish the team dynamics and clarify the instructional design principles with the key stakeholders of this phase. This small success is important as it sets the stage for the subsequent phases. This paper outlines the outcomes of the early analysis of the project and how these then influence the directions of the project, including the decision for adopting a prototyping development model. Guided by this developmental approach, the paper then provides some insights into how the key principles of instructional design and evaluation come together to drive the design of the prototypes. In this way, the paper serves to illustrate a way of bridging the theory and practice of courseware development, and underscores the importance of principles in guiding practitioners.

The project is currently in Phase 2, and the target is to develop about 10 hours of self-instructional learning material based on the prototype arrived by the end of Phase 1. The material will then be used to engage the next set of stakeholders, the students. The intentions are to gauge the effectiveness of the material on the target learners and to test the deployment strategies.

References

Boyle, T. (2003). Design principles for authoring dynamic, reusable learning objects. *Australian Journal of Educational Technology*, 19(1), 46-58. http://www.ascilite.org.au/ajet/ajet19/boyle.html

Boyle, et al. (2006). An Agile method for developing learning objects. In *Who's learning? Whose technology?* Proceedings asclite Sydney 2006. http://papaya.edfac.usyd.edu.au/ascilite_papers/p64.pdf

Gagné, R.M. (1977). Instructional programs. In M. H. Marx & M. E. Bunch (Eds.), *Fundamentals and applications of learning.* New York: MacMillan.

Gagné, R.M. (1985). *The conditions of learning* (4th ed.). New York: Holt, Rinehart and Winston.

Gagné, R.M., Briggs, L.J. & Wager W.W. (1992). *Principles of instructional design* (4th ed.). USA: Harcourt Brace Jovanovich College Publishers.

Gustafson, K.L. & Branch, R.M. (1997). *Survey of instructional development models.* Syracuse, New York: ERIC Clearinghouse on Information & Technology.

Jonassen, D.H., Tessmer, M. & Hannum, W.H. (1999). *Task analysis methods for instructional design.* New Jersey: Lawrence Erlbaum Associates, Inc. https://doi.org/10.4324/9781410602657

Jones, T. S. & Richey, R.C. (2000). Rapid prototyping methodology in action: A developmental study. *Educational Technology, Research and Development*, 48(2), 63-80.

Keller, J. M. (1983). Motivational design of instruction. In C.M. Reigeluth (Ed.), *Instructional design theories and models: An overview of their current status.* Hillsdale, NJ: Erlbaum.

Leshin, C., Pollock, J. & Reigeluth, C. (1992). *Instructional design: Strategies and tactics for improving learning and performance.* Englewood Cliffs, NJ: Educational Technology Publications.

Rossett, A. (1995). Needs Assessment. In Anglin, G. J. (Ed.), *Instructional Technology: Past, present and future.* Englewood, Colorado: Libraries Unlimited, Inc.

Scriven, M. (1991). *Evaluation thesaurus* (4th ed.). USA: Sage Publications.

Seels, B. & Richey, R. (1994). *Instructional Technology: The definitions and domains of the field.* Washington, DC: Association for Educational Communications and Technology.

Tripp, S. & Bichelmeyer, B. (1990). Rapid prototyping: An alternative instructional design strategy. *Educational Technology, Research and Development*, 38(1), 31-44. https://doi.org/10.1007/BF02298246

Soo Teong Beng, Senior Instructional Designer, Learning Academy, Temasek Polytechnic, 21 Tampines Ave 1, Singapore 529757. Email: bensoo@tp.edu.sg.

Please cite as: Soo, T.B. & Liew, S.S. (2007). Achieving incremental successes in courseware development through prototyping. In *ICT: Providing choices for learners and learning. Proceedings ascilite Singapore 2007*. https://doi.org/10.65106/apubs.2007.2541