Using the DODDEL model to teach serious game design to novice designers

Mark McMahon
Edith Cowan University

Instructional design is often defined as a complex and ill-structured problem solving process. Research has shown that for novice designers, a clear structure is required to develop expertise goes beyond instruction on the problem solving process. There are many instructional design models that are used to explicate the process. However, there are few in the growing area of Serious Games that provide an adequate level of prescription, while accommodating the broad range of contexts and philosophies that underpin their design and development. The DODDEL Model (McMahon, 2009) has been developed to address this. This paper describes a study involving the implementation of the model with a group of undergraduate students in Serious Game design. Its value as a tool to promote expertise in novice designers is discussed.

Introduction

Novice instructional designers differ in the way that they approach design problems from experts. While experts are able to accommodate the ill-structured nature of design and work with the interconnected elements involved in deep analysis of instructional design problems, novice designers tend not to be able to focus beyond descriptive analyses of problems, have a content focus and move rapidly from problem analysis to solution generation (Goetz & LeCompte, 1973). It is evident that expert designers have a range of skills to draw on in order to effectively solve the ill-structured problems inherent in Instructional Design. The synthesis that underpins these, however, appears to come largely from prior experience such as the ability to recall abstract knowledge as well as the ability to recall practical experiences (Ertmer et al., 2008). For those without such a toolset, guidance is required to assist with the process.

Such guidance must go beyond teaching pure problem-solving approaches to the provision of tools to assist in knowledge organization and the acquisition of schema (Kirschner, Sweller, & Clark, 2006). This may be one reason why Instructional Design models have long served a role in educating novice designers in the creation of e-learning materials. Seminal texts such as Alessi & Trollop's (2001) *Multimedia for Learning* and Kemp Morrison and Ross's (1996) *Designing Effective Instruction* offer models to provide a framework for the Instructional Design process.

Instructional Design models vary as much as the range of contexts, theories and applications that underpins the learning process and are often classified according to such parameters (Ryder, 2007). Some, such as Dick and Cary's (1990) Systematic Model of Instructional Design are highly prescriptive. Others attempt to embrace the ill-structuredness of design and accommodate a broader scope, such as Tessmar and Wedman's (1990) Layers of Necessity Model. Many of these models can be seen as promoting specific learning theories, such as Elaboration Theory (Reigeluth, 1992) or Conditions of Learning (Gagne, 1985).

The area of Serious Games is less well documented. A number of industry models exist for the design and development of games, most of which are informed by the generic ADDIE approach (Bethke, 2003) and there have been some attempts to conceptualise this within the domain of games and learning (Dickey, 2005; Rieber & Matzko, 2001). However, an effective model that provides the structure necessary to teach beginning designers, while facilitating design for different genres from a variety of theoretical orientations has been elusive.

In response to these issues, the DODDEL Model, short for 'Document-oriented Design and Development of Experiential Learning' has been developed. It seeks to integrate the challenges inherent in both Instructional and Game Design through a document-oriented approach to the design and development of experiential learning (McMahon, 2009). The model provides a high level of structure in accordance with the need to provide an organizational framework for novices, while being able to accommodate a range of game types and theoretical approaches.

Features of the DODDEL model

The model is summarised in Figure 1, along with annotations that show the results of the study. The model follows traditional design and development stages (ADDIE) but has some key features that distinguish it from traditional lockstep approaches to design. These are:

- An articulation from a broad design approach to detailed specifications
- Multiple iterations within each stage incorporating dependent elements specific to the learning outcomes, user needs and characteristics, and the learning strategy developed.
- Heuristics to guide the content within each element
- Specified document outputs at each stage of the process.

The model addresses the whole development lifecycle. While not a focus of this particular study, the development phase reflects the needs of the game industry for approaches that allow further revision and refinement and support 'agile' methodologies that are becoming increasingly common (Keith, 2007). Like most Instructional Design models, evaluation is central but in this case it also reflects the need for games to be 'sweetened' through a process of balancing the gameplay. Therefore a prototyping stage is incorporated with game balancing added as another evaluative level beyond traditional formative, summative and impact evaluation.

From broad to specific with dependent iterative elements

Given that novice learners tend to jump to specific designs without a complete or thorough analysis, the design stages of the model ensure rigor by an articulation from broad concepts to detailed specifications. Such an approach is also authentic to industry where development may start with an initial feasibility study, leading to a response to a tender or proposal and so on. Most importantly the articulation acts as a scaffold to support novice designers developing understandings of the design process and avoiding the conceptual 'leap' required to actually produce a paper-based product.

Integral to that is the notion of discrete but dependent elements within each stage. Each stage identifies issues that relate to:

- End user experience, which progresses from an analysis of user characteristics and context, through the mechanisms implemented for challenge and feedback, to a definition of the game logic and variables
- Game treatment, which begins with a fundamental statement of a learning philosophy, through a depiction of the game genre and design, to the final templates and interface.
- Learning outcomes, which increase in detail from a basic statement of aims and outcomes, through the description of underpinning concepts and objectives, leading to the structuring of content and interactivity to the final scripts and storyboards.

As an example of the dependent nature of these elements, in the Situation Analysis stage, designers need to articulate a learning philosophy that is congruent with appropriate outcomes. A constructivist approach, for example might not be best suited to behavioural outcomes associated with fire safety. Similarly, outcomes need to be targeted towards achievable levels given the learners' backgrounds and prior learning. The development of the design within each element is inevitably iterative, as constant comparison causes the main tenets of each stage to be refined as the design progresses.

Heuristics and documentation outputs

Within specific stages, certain theories and practices can be used to inform how each of the elements is developed. In defining Aims and Outcomes, for example, Bloom's Taxonomy (Bloom, 1956) provides a useful framework for pitching learning at an appropriate level of information processing. When matched with verb lists (e.g. 'describe' demonstrating knowledge, 'design' demonstrating Synthesis), outcomes are defined that are demonstrable and result from the game experience. Similarly, there are a range of

theories around the design of games and nature of gameplay. Rollings and Adams (2003) for example define 'pure' challenges that underpin most game types. These include logic and inference challenges, lateral thinking challenges, knowledge-based challenges, spatial awareness challenges and so on. With such a framework it is possible to define the basic nature of Challenges and the Feedback within them. Since they are pitched towards cognitive, affective and sensorimotor processes, they are also able to be framed within learning theories and types of outcomes, as well as linking to game genres such as real-time strategy or platform games that can be described within the game approach. At the design documentation stage, such challenges can evolve into more detailed depictions of gameplay. Again, heuristics are available to inform such discussion. Oxland (2004), for example, articulated a series of game principles that provide a powerful lens through which to build the mechanics of the game, defining them in terms of features such as rules, boundaries, goals, and challenges at an applied rather than pure level.

The heuristics inform the elements that are then integrated into a documented output for each stage of the design process. The outputs defined in Table 1 provide a structure for novice designers to communicate their work. The Design Proposal for example may play the role of an internal or external pitch or a response to a tender. At the Design Documentation level, the outputs tend to be less formal than those at the Production Documentation level. Often the Design Documentation has an internal role in communicating the formative design process, while Production Documentation may form the basis of a contractual agreement between clients, developers, subject matter experts and so on. This final highly detailed level of documentation is particularly useful when development is outsourced. Once again there is a clear development from broad to specific within the model. The Module Descriptors, allow designers to tease out the content developed in their structure map for each of the modules. Typically these are table-based, identifying the specific concepts and the accompanying media and interaction in more general terms. So a character interaction for a role playing game may be described in the Module Descriptors, but are then instantiated into actual scripts with the dialogue, decision trees and so on as Production Documentation.

Table 1: Example documented outputs

Stage	Components	Outputs
Situation Analysis	Aims and Outcomes Learner and Context Learning Approach	Aims Outcomes Learning approach End-user attributes Proposed patterns of use Technological affordances and limitations Budgetary issues Existing/competing products
Design Proposal	Specific Concepts Challenges and Feedback Game Approach	Concepts/Objectives Learning strategy Game approach/Genre Nature of challenge Remediation/feedback
Design Documentation	Structure Concepts Gameplay Game Treatment	Game overview Structure/Organisational chart Module descriptors
Production Documentation	Scripts & Storyboards Game Logic & Variables Global Specs & Templates	Visual storyboards Narrative scripts Flowcharts/data flow diagrams Asset lists Variables Pseudocode Global specifications Visual templates Development style guide

Assessing the worth of the model

Figure 1 shows the DODDEL Model itself. The figure has been annotated to demonstrate the results of Action Research that was conducted in the latter half of 2008 at an Australian university. A class of final

year undergraduate students used the DODDEL Model as part of a unit in Serious Games. 20 students, all undertaking a Bachelor of Creative Industries in Game Design and Culture, participated in the study. This small sample provided a basis for the first stage of an iterative process of design-based research (Cobb, 2003) – an approach that accommodates the evolutionary nature of design and the integration of both broad and narrow research aims with a view towards direct application of findings into authentic settings.

Students were required to use the model as a basis for a major assignment where they were required to design and document a Serious Game of their choice in groups of two or three students. Data was collected in several forms. Students were required to provide an individual reflection to their lecturer on the process that they undertook and the issues they encountered. They were also required to complete a survey which asked them to identify with a tick or a cross the elements of the model that they found valuable and those that they found confusing or of limited value. The survey also contained short answer questions that asked about the model in more general terms as well as the value of supporting information and the perceived applicability of the model beyond the classroom. Finally, the students' actual designs were analysed and triangulated with the other forms of data to ascertain the potential of the DODDEL model for developing instructional design expertise in novices within the context of Serious Games.

Findings

The Annotated DODDEL Model shown in Figure 1 indicates results that are overwhelmingly positive, with most of the students broadly ticking each of the design stages embedded in the model. The results are shown by the numbered ticks and crosses associated with each element where students expressed either a positive view of the utility of that element (tick) or confusion or discomfort in applying it (cross).

Many of responses did not distinguish between elements within each stage of the model. These are indicated within the central ovals of each stage. When asked to respond overall to the effectiveness of the model all of the students found it useful. The following response was typical:

> The DODDEL Model is very easy to understand. I don't think it needs to change. The Situation Analysis, Design Proposal, Design Documentation is very useful for me to do my work and what step to take first.

Nevertheless some minor issues with the model did become apparent. Some were at the smaller element level, where a few students found some of them confusing. Also, in their written responses to the aspects that they had difficulty with some general trends emerged. These related in particular to some beneficial features of the model such as its flexibility and usefulness as a communication tool to some issues with the clarity of specific elements.

Communication and clarification

One of the key features of any design model is its role as a communication tool. Several of the responses highlighted its value in working with other team members. It was particularly important in exposing the structure of the process and providing a set of stages through which to follow. One student commented, 'The flow was useful because we started with overall aspects of the game and then fleshing out the details of the design from the overall specs made the whole game consistent.' This provided an anchor for students unfamiliar with the process: 'it tells you specifically a lot of the things that need to be looked at while keeping a thread through the subjects, which can help to understand the process better and applying it to your game.'

In fact, the model appeared to provide a basis for most of the interaction between the students, with another student stating, 'It helped in terms of structure, especially during our group assignment. If it wasn't structured in this way then we would most likely not have created decent learning outcomes.' It appeared therefore, that students not only found it a valuable tool for communication but they saw it as key to the success of their final design. It certainly played a large role internally for teams managing the roles and responsibilities in the design and documentation. In follow up e-mails where students were required to reflect on the process and discuss their roles in the design it appeared that the model provided the mechanism for job allocation, with each student taking responsibility for specific sections within it, while using the integral nature of the elements within each stage to cross-check for consistency.

Finally, it was pleasing to see that while the students were novice designers, some could see its value as a communication tool outside the team itself. One student observed, 'It would also help with colleagues who do not understand the concept of game design effectively.'

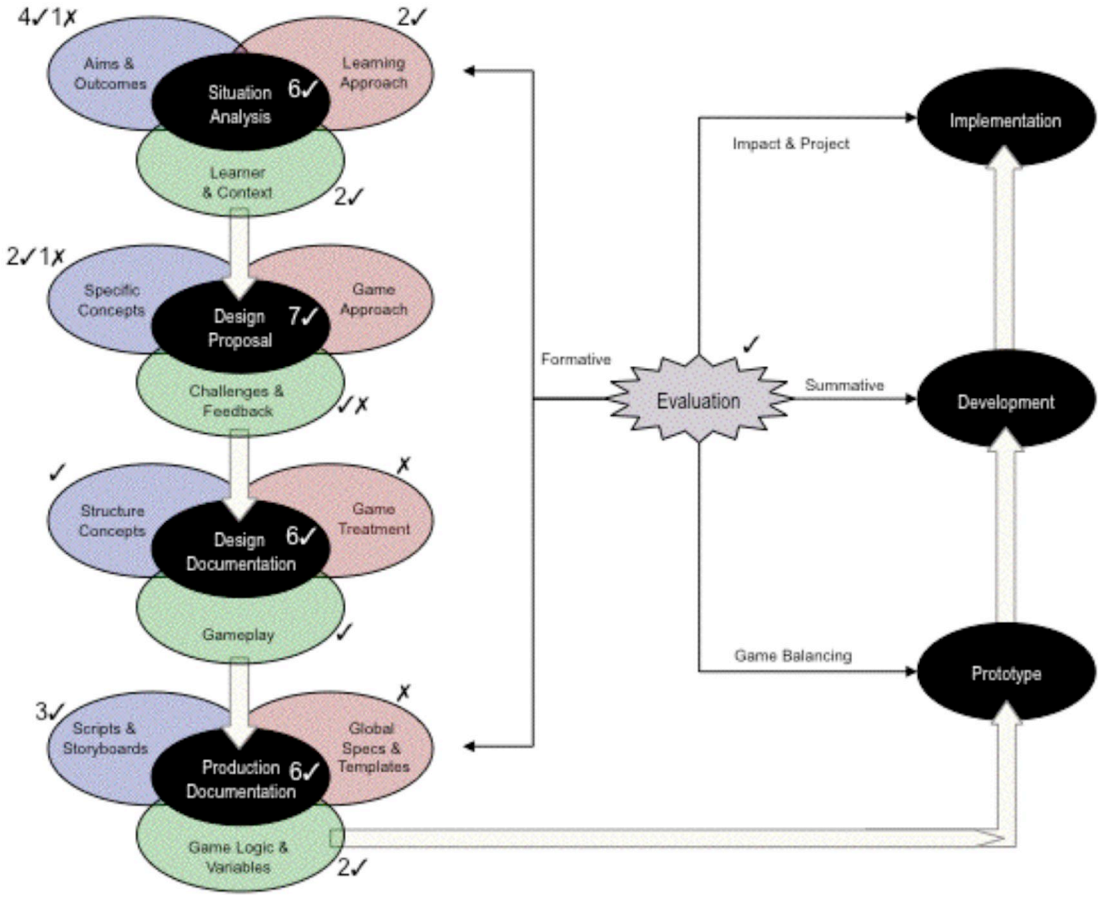

Figure 1: The DODDEL model with annotations

Flexibility and scalability

Ensuring that the DODDEL Model could be adapted to a wide range of products and contexts was an important consideration during its development. A key aspect of this research was to explore the extent to which it was perceived as flexible and scalable by novice designers, and the value of that in terms of designing a range of products.

It certainly provided enough detail, though this itself proved problematic for one student:

> The only problem with this model that I can identify is that there is no limitation for the amount of detail. Someone can complete this model in a simple form whereas someone else can complete the same model in a complex form.

In that sense it appeared that the model achieved its aims, though it does raise questions regarding the level of detail required to effectively document design. In the small teams in which the students were placed, there was a tendency to place expectations that were abnormally high for the level of detail in production documentation. Students were required to produce sample documentation that was essentially a paper-based prototype of the game. For those students who were experienced in interactive media development it was considered to be overkill as students felt it duplicated the prototype development process. For those without development skills, however, it was a necessary stage to ensure that the design was communicated at a high enough level of detail to provide a contractual basis for development. The detail within the production documentation stage of the model resulted in two of the students contending that it was most suited to larger projects.

The most accurate measure of the flexibility of the model was evident in the types of products that students designed. The final submissions demonstrated a broad range of games, from small web-based platform games, through more complex strategy games to online simulations. In the post-submission reflection, all of the students felt that the model was appropriate to the type of game they were developing.

Specific issues with elements within the model

As Figure 1 demonstrates, a small number of students had difficulty with specific elements within the model. Challenges and Feedback, Game Treatment, Global Specifications, Aims and Outcomes, and Specific Concepts were specifically mentioned. These could be described as dependent elements in that Aims and Outcomes lead into Specific Concepts and Game Treatment articulates through to the Global Specifications and Templates. One of the problematic aspects for a few students appeared to be in clearly differentiating between the general and more detailed stages. As discussed above, the flow from broad to specific was highly valued by students. Nevertheless, having to actually articulate their design as levels of documentation was a difficult task for some. Some students felt there was duplication between elements at different stages. The Game Treatment, for example, was seen by one student as similar to the Game Approach. It was evident therefore, that this student had difficulty distinguishing between the articulation of an approach to games within a genre and more defined visual and narrative concepts relating to the characters, game world and so on.

One of the students found the distinction between Gameplay and Game Treatment confusing, while a another had difficulty understanding the nature of Global specifications and Templates. Such issues did not appear to relate so much to the model itself as to how well the students understood it. Inevitably, the model is only as effective as how well it is communicated and the issues that arose are ones that are typical of novice designers. Students without a background in software engineering often have difficulty distinguishing between global forms of documentation such as interface specifications and character designs compared to the elements that are individually scripted such as specific question items, interactions and cut scenes. Similarly, Aims and Outcomes have proven to be problematic for students without a background in education studies. This became evident in a couple of final designs that failed to distinguish game-based outcomes from learning outcomes. A tendency to include detail at too early a stage was also typical among the novice designers. This explained a perceived sense of duplication between Game Approach and Treatment, where students provided graphical concepts at the earlier stage of the process. The majority of Game Design and Culture students combine their studies with a second major in Graphic Design therefore a tendency to work visually in refining ideas was manifest even in the earliest group discussions.

Overall, issues with the elements were minor and few actual suggestions for changes to the model were made. One student did suggest that the concept of Gameplay would better be served by describing it as Game Mechanics. While the decision not to use that term was a deliberate one in order to demonstrate how it is a more discursive form of documentation compared to the Game Logic and Variables, students acceptance and ongoing use of the term suggests a change may be appropriate. Ultimately, however, the value of the model seemed most dependent on how well it was communicated and in this sense, the supporting material played a major role.

The importance of supporting information to apply the model

Students were provided with a copy of an article describing the DODDEL Model. One question that was asked of the students was the extent to which the accompanying article assisted in applying the mode to their assignments. All of the students stated that it was essential to being able to use the model, with one stating, ‘It explains it in a well thought out way that addressed the key issues necessary to understand the key elements behind the various stages of the model.’ Another contended it ‘was quite detailed [and the] examples are very useful in helping me understand.’ The article was provided along with a presentation explaining the concepts within the model and this too was valuable.

While the response to the supporting material was overwhelmingly positive, an attempt has been made to further explicate the design process within the model. One student’s comment highlighted an opportunity to further enhance it:

> The article was useful, as was the Powerpoint presentation but for a quick reference to using the model a middle level of detail would be better. The ppt didn’t cover enough while the article required too much reading to be convenient.

Accordingly, a further level of detail has been integrated into the model. Specifically the information regarding forms of documentation shown in Table 1 has been added to the reading to provide a summative reference for students. A further level is planned that will incorporate a range of heuristics to act as prompts for each element within the model.

Recommendations and conclusion

The implementation of the DODDEL Model among a group of undergraduate students in Game Design and Culture proved highly successful, both in terms of the design documentation produced and the students' perceived value of it. Importantly it appeared to provide the flexibility, scalability and scaffolding required to design a range of products. Findings relating to the nomenclature of some stages of the model and supporting information have been added to it to further enhance its capacity to communicate the key stages of Serious Game Design and provide a reference for students engaged in the process.

It must be noted that the implementation of the model occurred primarily with the design stages of the creation of Serious Games. While evaluation, for example, was discussed in depth as part of the process and the principles were reinforced in class activities, students were not required to conduct an evaluation or develop or implement the final product as part of their main project. This may explain why some of the responses appeared quite naïve when focusing on the other aspects of the model. For example, one student noted 'I had some problems grasping the small arrows. Evaluation doesn't seem that hard so maybe it could be simplified?' Another picked up on the concept of using a project post-mortem to improve design processes and suggested that another stage be added after implementation called 'Project Evaluation' despite the fact that impact and project evaluation are stated as evaluation forms for the implementation stage. Further research will be conducted with interdisciplinary project-based students to explore its value beyond design and into the development cycle.

Finally, the DODDEL model is yet to be implemented in a commercial or industrial setting. While its amalgamation of existing models suggests it has face validity, further exploration is required to assess its value beyond being an educational tool, particularly given the inherent differences between university and industrial cultures (Larson & Lockee, 2009). Initial findings are positive. When students were asked if they would use the model as a professional in the industry responses ranged from 'Yes, if it ain't broke don't fix it' to much more considered replies: 'Being that there are very few effective models of serious games available and since I have observed the effectiveness of this model at first hand, I will definitely be using this model.'

This research, therefore, provides a basis for further exploration of the role of this and other models in the design and development of Serious Games. Having proven effective as a tool to teach nascent designers the key issues in creating games that are focused on educational and attitudinal outcomes, The DODDEL Model has the potential to provide a framework for industry and educational institutions as they transition from traditional web-based information systems and e-learning to highly engaging and responsive environments.

References

Alessi, S. M., & Trollop, S., R. (2001). *Multimedia for Learning* (3rd ed.). Boston: Pearson - Allyn & Bacon.

Bethke, E. (2003). *Game Development and Production*. Texas: Wordware Publishing Inc.

Bloom, B. S. (1956). *Taxonomy of Educational Objects, Handbook 1: The Cognitive Domain*. New York: David McKay Co Inc.

Cobb, P., Confrey, J., DiSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher, 32(1), 9-13.*

Dick, W., & Carey, L. (1990). *The Systematic Design of Instruction* (3rd ed.). New York: Harper Collins.

Dickey, M. D. (2005). Engaging by design: How engagement strategies in popular computer and video games can inform instructional design. *Educational Technology Research and Development, 53*(67-83).

Ertmer, P. A., Stepich, D. A., York, C. S., Stickman, A., Xuemei, W., Zureck, S., et al. (2008). How Instructional Design Experts Use Knowledge and Experience to Solve Ill-Structured Problems. *Performance Improvement Quarterly, 21*(1), 17-24.

Gagne, R. M. (1985). *The Conditions of Learning and Theory of Instruction*. New York: CBS College Publication.

Goetz, J., & LeCompte, M. (1973). *Ethnography and Qualitative Design in Educational Research*. New York: Academic Press.

Keith, C. (2007). SCRUM RISING - Agile Development could save your studio. *Game Developer, 14*(2), 22-26.

Kemp, J. E., Morrison, G. R., & Ross, S. M. (1996). *Designing Effective Instruction* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.

Kirschner, P. A., Sweller, J., & Clark, R. (2006). Why minimal guidance duirng instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and enquiry-based learning. *Educational Psychologist, 41*(2), 75-86.
Larson, M. B., & Lockee, B. B. (2009). Preparing Instructional Designers for Different Career Environments: A Case Study. *Educational Technology Research and Development, 57*(1), 1-24.
McMahon, M. T. J. (2009). The DODDEL Model: A Flexible Document-Oriented Model for the design of Serious Games. In T. Connolly, M. Stansfield & L. Boyle (Eds.), *Games-Based Learning Advancements for Multi-Sensory Human Computer Interfaces: Techniques and effective approaches*. Hershey, NY: Information Science Reference.
Oxland, K. (2004). *Gameplay and Design*. Essex: Addison Wesley.
Reigeluth, C. (1992). Elaborating the elaboration theory. *Educational Technology Research and Development, 40*(3), 80-86.
Rieber, L. P., & Matzko, M. J. (2001). Serious Design for Serious Play. *Educational Technology, 41*(1), 14-24.
Rollings, A. & Adams, E. (2003). *On Game Design*. USA: New Riders.
Ryder, M. (2007). Instructional Design Models. Retrieved 19 February, 2008, from http://carbon.cudenver.edu/~mryder/itc_data/idmodels.html
Tessmer, M., & Wedman, J. F. (1990). A Layers-of-Necessity Instructional Development Model. *Educational Technology Research and Development, 38*(2), 77-85.

Author: Mark McMahon, Edith Cowan University. Email: m.mcmahon@ecu.edu.au

Please cite as: McMahon, M. (2009). Using the DODDEL model to teach serious game design to novice designers. In *Same places, different spaces. Proceedings ascilite Auckland 2009.* http://www.ascilite.org.au/conferences/auckland09/procs/mcmahon.pdf