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**Report on the usefulness of an LMS based on the  
IMS Learning Design Specification**

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**Supervised by Dr Kinshuk**

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## Abstract

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Tertiary education providers are increasingly using learning management systems to deliver course information and materials to students. Standards such as SCORM have emerged to enable educators to reuse and share Learning Objects such as electronic documents and software applications; the IMS Learning Design Specification extends this concept by providing a format for specifying the learning activities which learners should undertake in addition to using the Learning Objects.

The purpose of this study was to investigate whether learners and educators perceive that there would be benefits to learners in using a learning management system based on the IMS Learning Design specification. The main questions addressed was whether learners and educators felt that a learning management system which presents course content using the IMS Learning Design Specification would be useful to learners in their studies. The study also asked what potential benefits and disadvantages would such a system create for learners.

The study found that learners and educators felt that a system based on IMS Learning Designs would be useful in their course of study and that the functionality enabled by the Specification such as activities, group work and resource scaffolding would enhance their learning. The following additional benefits of the Learning Design Specification were identified: interactivity, provision of a clear course structure, and providing learners with progress reports.

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## Chapter 1: Introduction

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### 1.1. Project Background

Tertiary education providers are increasingly using learning management systems (LMSes) such as Blackboard, WebCT and Moodle to deliver course information and materials to students, and to present online learning activities to supplement traditional methods such as lectures (Corich, 2005).

Standards such as SCORM (Advanced Distributed Learning Initiative, 2004) have emerged to enable educators to reuse and share Learning Objects such as software applications, video files, and other electronic resources. These standards specify a common format for defining data about Learning Objects, allowing any LMS to recognize the structure of the Object and process it correctly (Downes, 2001).

The IMS Learning Design Specification extends this concept by providing a format for specifying the learning activities which learners are to undertake in addition to the Learning Objects used. This allows educators to reuse and share complete pedagogies and learning plans in a platform-independent format (Tattersall, Manderveld, Hummel, Sloep, Koper and De Vries, 2003).

### 1.2. Purpose of this study

Much of the current literature about IMS Learning Designs focuses on the issues for educators (see for example De Vries, Tattersall, and Koper, 2006; Marjanovic, 2005; and McAndrew, Nadolski, and Little, 2005). Pedagogical benefits to learners, such as improved learning from activity-based structure rather than knowledge transfer, the ability to interact with multiple learners, are claimed (Dalziel, 2003; Koper and Olivier, 2004; Tattersall et al., 2003), but to date little work has been done to identify or prove the potential benefits to learners.

The purpose of this study is to investigate whether learners and educators perceive that there would be benefits to learners in using a learning management system based on the IMS Learning Design specification. Because the concept of “benefits” is wide-ranging and ambiguous, the construct of “usefulness” was chosen as a well-established measurement for the effectiveness of information systems. This choice is discussed in detail in chapter 2.

### **1.3. Research questions**

The main question addressed by this study is:

“Do learners and educators feel that a learning management system which presents course content using the IMS Learning Design Specification would be useful to learners in their studies?”

Other questions addressed are:

“What potential benefits do learners and educators perceive would be provided to learners by the use of a learning management system which presents course content using the IMS Learning Design Specification?”

“What potential disadvantages do learners and educators perceive would be created for learners by the use of a learning management system which presents course content using the IMS Learning Design Specification?”

### **1.4. Benefits of the research**

Despite the large amount of research in the IMS Learning Design Specification internationally, most current research focuses on the development of tools for educators. Although this is important in order to increase the adoption rate of Learning Designs by educators, little work has been done to date to investigate whether the potential benefits of IMS Learning Designs to learners are realised in practice. This study provides an important investigation into this area – unless the advantages to learners provided by IMS Learning Designs outweigh any potential disadvantages, the model should not be used and its long-term adoption rate will remain low, no matter how useful the tools are for educators.

### **1.5. Overview of methodology**

In order to carry out this study, a learning management system was developed based on the IMS Learning Design Specification. Participants in the study watched a brief demonstration of the system and then trailed the system using sample courses which had been set up for the evaluation. Individual interviews were conducted with five participants, and results from these interviews were used to revise the demonstration and survey instrument. Subsequent participants then evaluated the system by completing a written questionnaire. Responses were analysed visually and using chi square tests.

The methodology is described in detail in chapter 3.

## **1.6. Overview of report structure**

The remainder of this report is set out as follows:

- Chapter 2 contains a review of the relevant literature relating to activity-based learning, Learning Designs, Learning Management Systems and the evaluation of information systems.
- Chapter 3 sets out the study methodology in detail.
- Chapter 4 describes the system developed for this study, codenamed Voyager2.
- Chapter 5 sets out the results of the study.
- Chapter 6 discusses the findings and presents conclusions and questions for future study.

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## Chapter 2: Literature review

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### 2.1. Learning Management Systems

Tertiary education providers are increasingly using computer systems to enhance learning (Corich, 2005), both in the classroom as part of a blended learning strategy and to enable distance learning. Learning Management Systems (LMSes) are commonly used to deliver course information and materials to students and present online learning activities to replace or, more commonly, supplement traditional methods such as lectures.

The primary function of LMSes commonly used by tertiary institutions, such as BlackBoard, WebCT and Moodle (Britain and Liber, 1999), is content delivery (presenting the content stored in the system to students), although all provide functions for presenting certain types of activities such as tests quizzes to learners.

Data in LMSes is typically stored in a proprietary format, meaning that educators cannot easily share electronic materials with others outside their institute, and switching to a new LMS involves significant time investment to convert the data to the new format (Jamieson and Verhaart, 2005). Standards such as the Shareable Content Object Reference Model (SCORM) exist to enable the sharing of learning objects (Advanced Distributed Learning Initiative, 2004) by specifying a standard format for storing data about learning objects, using data definition languages such as XML (eXtensible Markup Language). Britain and Liber (1999) found that such standards are supported by some, but not all, LMSes.

Learning Object standards, while valuable, only captures the resources used in teaching (e.g. a text book, web site or software package); the teaching plan, or the activities for which the learners *use* the learning object, cannot be captured. So teachers can share resources, but not the methods with which they are used. The IMS Learning Design Specification was developed to address this gap.

### 2.2. The IMS Learning Design Specification

#### 2.2.1 Overview of the IMS Learning Design Specification

The IMS Learning Design Specification (IMS Global Learning Consortium, Inc., 2003) is published and maintained by the IMS Global Learning Consortium (<http://www.ims-global.org>), a group made up of researchers and developers of LMSes, including Blackboard Inc. and Moodle.

In contrast to Learning Object standards such as SCORM, the Learning Design Specification “enables the creation of a complete, abstract and portable description of the pedagogical approach taken in a course” (Koper and Oliver, 2004). A Learning Design “specifies the teaching learning process...specifically...activities” (Koper and Burgos, 2005). Learning Designs can be thought of as lesson or learning plans; “the smallest unit [of which] provides learning events for users” (Tattersall et al., 2003). The Learning Design Specification is pedagogically-independent (Tattersall et al., 2003), allowing educators to specify whichever activities they see fit (including content-based or knowledge-transfer type activities such as “read chapter 6 of the text book”).

The IMS Learning Design Specification specifies a model for specifying learning designs using XML (eXtensible Markup Language). The Specification provides a format for LMS developers to store and/or present activity-based learning plans. In its primary function, the Learning Design Specification could be used by a technically-minded educator to create an XML file describing their learning designs, which could then be played using a Learning Design player such as CopperCore (Martens and Vogten, 2005). Because not everyone could or would want to create an XML file manually, a lot of current research is focused on building usable authoring tools to provide graphical interfaces for creating Learning Design files, including the Reload Editor (<http://www.reload.ac.uk/>), SLED2 (<http://sled.open.ac.uk/web/>) and Collage (<http://gsic.tel.uva.es/collage>).

From the opposite perspective, the Specification can also be used by LMS developers to develop a Learning Design player – a system which can interpret the XML file and present to learners the activities described therein.

In the current study, the Specification was used to build a system which encompasses both an authoring tool and a Learning Design player, as described in chapter 4.

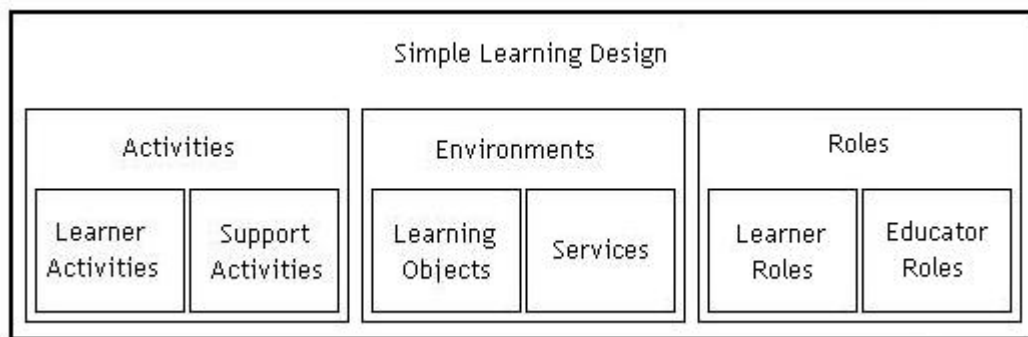
The main pedagogical features of the IMS Learning Design model include (Tattersall et al., 2003):

- the presentation of course materials as activities, rather than content, as described above;
- the facilitation of either individual or group work (or a mixture of both);
- the linking of learning objects (resources needed to complete an activity) to a specific task, allowing scaffolding of information; and
- enabling the monitoring of current runs (current offerings of a course) by educators.

### 2.2.2 The IMS Learning Design model

The IMS Learning Design Specification is very flexible, enabling educators to specify as much or as little as they want to. At the simplest level, as shown in figure 2.1 below, the educator might specify:

- a description of the Learning Design;
- the activities to be undertaken (learning activities and optionally support activities);
- the learning objects (resources) and services (such as email) needed by learners to complete the activities; and
- the roles to be taken by learners and educators (for example, in a project management class the learner may take the role of a project manager and the educator may take the role of their client).



Figure

re 2-1. The components of a simple Learning Design

At a more complex level as shown in figure 2.2, the educator can design a detailed learning plan, for which the Learning Design Specification uses the analogy of a theatre play. Educators may specify one or more **Plays**, to provide for, say, a semester-long and a block-mode version of the same course. The Play is divided into **Acts**, as it is in the theatre. Each Act, as a good playwright ensures, contains one main **Activity** for a learner. The Act may be a soliloquy, where the learner works alone, or may involve more than one learner, each of whom takes a different **Rolepart**. The Rolepart contains the specific details for the generic **Role** defined in the simple Learning Design (e.g. that of “Project Manager”). The Rolepart is assigned a particular **Activity** from the basic Learning Design and an **Environment** for that Activity, which contains the **Learning Objects** (resources) from the

basic Learning Design and the **Services** (functions such as email and virtual conferencing) that the person will need to complete the Activity.

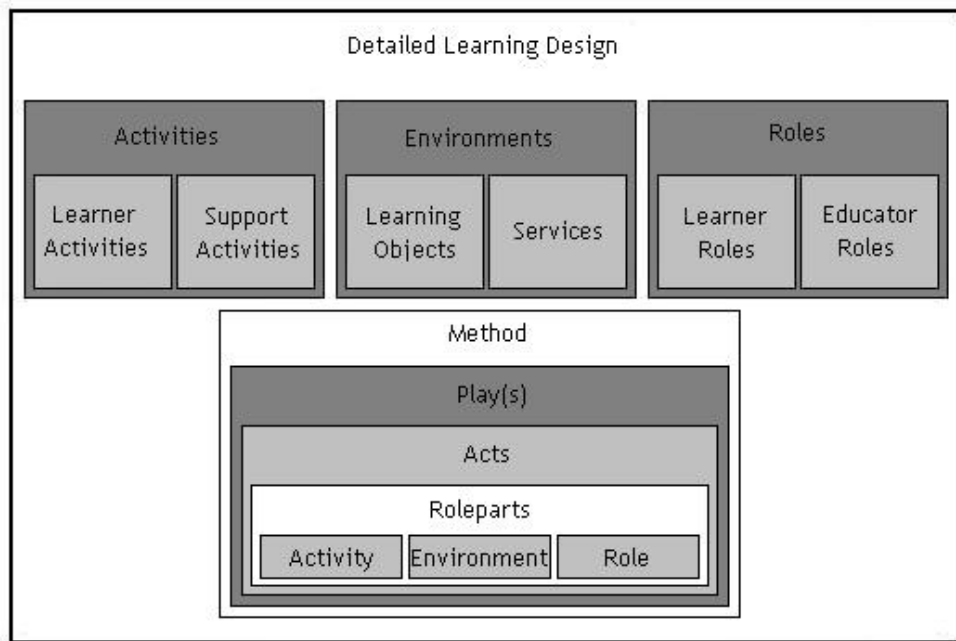


Figure 2-2. The components of a detailed Learning Design

This is the scope of Level A of the Learning Design Specification. Levels B and C of the Specification extend this basic model to provide for personalization (Level B) and notifications (Level C).

The IMS Learning Design Specification describes this model in detail and provides XML bindings for rendering a Learning Design as an XML file. The Specification also describes the functionality needed by a Learning Design player to present these Learning Designs to learners, but does not specify it in detail. This creates problems for developers (Hagen, Hibbert and Kinshuk, 2006), because it is not clear exactly what a Learning Design player needs to do.

### 2.2.3 Learning Design players currently available

The thrust of the existing research is on developing user-friendly authoring tools to address the acknowledged need to make Learning Designs more accessible to educators (Koper, 2006). Learning Design players are not yet receiving as much attention and the technology is therefore less mature.

The first Learning Design-based system was EduBox, developed by the Open University of the Netherlands as part of their development of EML, which later evolved in the Learning Design Specification. It is built on EML1.1, which is similar to, but not identical to the Learning Design Specification (McAndrew et al., 2005). Blackboard Inc., the author of a popular LMS, is currently developing a Learning Design version of EduBox (Blackboard Inc., 2004).

Another pre-Learning Design player is LAMS (Dalziel, 2003), developed by the LAMS Foundation at MacQuarie University. Created before the Learning Design Specification was published, LAMS was based on a draft version of the Specification (Dalziel, 2003).

The CopperCore Learning Design engine (<http://coppercore.org/>) supports levels A, B and C of the Learning Design Specification. CopperCore was developed by the Open University of the Netherlands as a working prototype to demonstrate how Learning Designs can be played (Martens and Vogten, 2005). It is an open-source engine which can be incorporated into other LMSes to facilitate the playing of Learning Designs.

Reload, a Learning Design editor and player (<http://www.reload.ac.uk/>) is being developed by the University of Bolton and the University of Strathclyde, under the JISC eLearning Framework (<http://www.jisc.ac.uk/>). Reload can be used with Moodle, a LMS commonly used by tertiary education providers (McAndrew et al., 2005).

The SLED (now SLED2) player (<http://sled.open.ac.uk/web/>) is an open-source application based on the CopperCore engine, also developed under the JISC eLearning Framework. It is a joint enterprise by the Open University of the Netherlands and the Open University of the United Kingdom.

#### **2.2.4 Results of Learning Design player evaluations**

As pointed out by Burgos and Koper (2005), “most often uses [to learners] are described from a didactical perspective: active learning, collaborative learning, adaptive learning, personalization, dynamic feedback, runtime tracking, ePortfolios and new ways of assessment.” While several studies to date have proven systems based on the IMS Learning Design Specification to be viable teaching tools (Dalziel, 2003; Klebl, 2006; Westera, Brouns, Pannekeet, Janssen and Manderveld, 2005), there are no published in-depth studies investigating the pedagogical benefits actually realized by such systems.

In initial trials at the Open University of the Netherlands using EduBox, students reported that they “appreciated the online courses, in particular the functionalities typically enabled by IMS LD, like personalised flow, tailored feedback and portfolios (Westera et al., 2005). Tutors “commended the course management procedures to arrange course runs, to control student groups, to track the students’ progress and to support the exchange of messages and papers.” The researchers noted that performance was a problem, with 30% of students having low-bandwidth dial-up Internet connections.

LAMS has been used for teaching at MacQuarie University in Australia for several years (Dalziel, 2003). Initial evaluations of LAMS in K-12 school and university environments in Australia, Canada and the UK indicated that LAMS had a “profound impact” on student learning. As an example, Dalziel uses the willingness of students to participate in class discussions: “In one K-12 school pilot evaluation, only 15% of students were willing to discuss ideas in front of their peers in the classroom, but over 80% of the same students were willing to discuss their ideas within LAMS.”

Klebl (2006) implemented lab005, a prototype Learning Design runtime environment created as an extension to Moodle. Usability evaluations showed that university students and teaching staff found a Learning Design-based system usable, and the use of lab005 in teaching situations proves that Learning Designs can be used in blended teaching. Some potential orientation issues were identified. People expected everything to be accessible through the system, and experienced difficulties in interacting simultaneously with “virtual” people and objects (on the computer) and with “real-world” people and objects. Additionally, people experienced disorientation because of the combination of learning objects internal to the system and resources linked from outside the system, and Klebl recommends that links to external resources be clearly marked.

These studies prove that the IMS Learning Design model is a workable concept for students, and raise some potential benefits and issues. The next step is to investigate these benefits and issues and to try to identify others.

### **2.3. Evaluating the literature on the identified benefits**

The studies mentioned above identified the benefits to learners as the facilitation of activity-based learning, group interaction and personalized workflow. The pedagogical benefits of these principles are well established in the literature. These concepts are examined in detail in this section.

### **2.3.1 Activity-based learning**

If the role of educators is solely to transmit subject matter to learners, then all current LMSes, and many other types of content management systems, will admirably fulfil the requirements of tertiary institutions. However, current pedagogical theories advise more than passive transmission. Constructivist theories such by authors such as Duffy and Jonassen (1992) and Bruner (1973) say that learners construct new ideas and concepts based on previous knowledge. Based on these theories, educators should encourage learners to construct new knowledge for themselves (Bruner, 1973). Proponents of one strand of constructivist thinking, *experiential learning* (Dewey, 1916; Knowles, 1984; Kolb, 1984; Rogers, 1969) stress the importance of personal involvement and practical experience in learning. These theories have lead to the development of teaching methods such as Problem Based Learning (Boud, 1985), in which learners are given a problem to solve, with the educator acting as a mentor or guide. Based on a study of current pedagogical models, Merrill (2003, as quoted in Koper and Olivier 2004) summarized the most effective learning strategies as “those that are problem-centred and involve the student in four distinct phases of learning: (1) activation of prior experience, (2) demonstration of skill, (3) application of skill and (4) integration of these skills into real-world activities”.

Such models are not supported by content-based systems which simply present subject matter to learners. This is one issue addressed by the Learning Design Specification. The Learning Design Specification does not require the use of any particular pedagogy, but is flexible enough to allow the educator to implement their own (Tattersall et al., 2003).

### **2.3.2 Collaborative group work and peer-interaction**

The value of group work is well established: Vygotsky’s (1978) theory of social cognition characterizes learning as primarily a social activity; Lewis (1992) cited the Hadow Report of 1931 and Plowden Report of 1967 which both recognised the benefits of group work in education. As noted by (Verhaart, Hagen, and Giles, 2006), group work can provide a more interesting and effective learning context than traditional lectures and helps learners to learn how to work as a team, a skill which is recognised as essential in business today.

Parsons (2004) cited Bourner et al. (2001) who noted that group work can provide “a vehicle through which students can be involved in deep learning, developing their skills experientially contributing to the skills they will need for life long learning”. In addition, several authors such as Chen and Warren (2000) and McLoughlin, (1996) have noted how group interactions facilitate new understandings for the participants, in accordance with Vygotsky’s theories (Lewis, 1992).

### **2.3.3 Personalised workflow and resource scaffolding**

One barrier to learning a new subject, or a new information system for that matter, is the amount of cognitive load experienced by learners (Sweller, 1988). The Learning Design model allows educators to implement several principles of Exploration Space Control (Kashihara, Kinshuk, Oppermann, Rashev, Simm and Toyoda, 1998), a concept designed to reduce cognitive load on users new to an information system.

The IMS Learning Design model provides scaffolding of resources by allowing educators to provide an environment for an Activity containing only resources for that Activity. In later Activities more resources, or more advanced resources, can be introduced. This is particularly useful for new learners; as they progress through a course scaffolding can be reduced until learners are able to search and select resources for themselves.

Level B of the Learning Design Specification (personalization and conditions) also allows the exploration paths and information seen by the learner to be limited. The Roles, Activities and Acts available to a learner to be customized based on the Learning Designs or Acts already completed, or some other attribute of the learner (such as learning style) stored in their profile (Burgos and Koper, 2005).

## **2.4. Evaluating Information Systems**

In order to assess whether the benefits identified in the literature are realized in reality, and to identify other potential benefits and disadvantages, a suitable evaluation model was needed to evaluate a learning management system based on the Learning Design Specification.

One line of research into evaluating information systems developed through the study of information systems usage. This stemmed from organisations’ desires to predict whether people would use information systems before implementing them, with the aim of reducing the likelihood of a failed and expensive project. From this line of research, the Technology Acceptance Model (TAM)

“has emerged as a powerful and parsimonious way to represent the antecedents of systems usage” (Taylor and Todd, 1995) – parsimonious, in this case, referring to the few variables measured by the model.

TAM was developed from the Theory of Reasoned Action (Fishebein and Ajzen 1975, as cited by Taylor and Todd, 1995), and measures the perceived usefulness and the perceived ease of use of an information system (Davis, 1989). The efficacy of the TAM model has been validated in several comparative studies (see for example Davis, 1996; Segars and Grover, 1993; Straub, Limayem and Karahanna-Evaristo, 1995; and particularly Taylor and Todd, 1995).

In a comprehensive critical analysis of studies which had used the TAM model, Legrisa, Inghanb and Colletterec (2003) concluded that TAM was a useful model but identified three weaknesses of the research to that date – that just over two fifths of the studies (9 out of 22) used students; that “most” were on office automation systems (again 9 out of 22, although a different 9); and that the studies were based on self-reported use of the system rather than actual use, although they conclude that this is a relative indicator of actual use.

A comment on the issues raised –

The majority of the studies analysed were not on students, so a significant number of studies exist which validate TAM with non-students.

Self-reported usage was accepted by the authors as a relative indicator of actual use. Moreover, it is not possible usage, but effectiveness, which is being measured in this study.

Again, the majority of the studies analysed were not on office automation systems, but it is important to establish that TAM is valid for web-based systems and for learning management systems. Lederer, Maupin, Sena and Zhuang (2000) have validated TAM in the context of the World Wide Web (and, for the record, their study surveyed people who use the technology for their jobs, rather than students). It should be noted that this study relates to general informational web sites, rather than learning management systems, but it is still relevant. Moon and Kim's (2001) study also validated TAM for the web, with the added factor of "playfulness" (again, for general web sites rather than the use of learning management systems) which they defined as requiring the user having "concentration", "curiosity" and "enjoyment". This is an interesting similarity to several comments on the need for learning management systems to engage and involve the learner (see for example Merrill, 2003 as quoted in Koper and Olivier, 2004; and Lee, Chueng and Chen, 2005).

Lee et al. (2005) used TAM to evaluate an Internet-based learning management system and found the model to be valid in that context. Interestingly, though, they found that ease of use was not a significant factor in students' attitudes or intention to use the new system. This differs from Davis' (1989, 1996) findings during the original development and later validation of the TAM model. If Lee et al. are correct, learning management systems may be different to other types of systems in this respect.

Segars and Grover (2005) postulated that two of the factors in the TAM model (effectiveness and job performance) actually relate to a new construct of effectiveness, rather than usefulness. If so, this is also useful to the current study.

As an alternative to the TAM model, Chiu, Hsu, Sun, Lin, and Sun (2005) instead used concepts derived from the work of Parasuraman and others in the area of service quality (see for example Parasuraman, Zeithaml and Berry, 1985). They found that users' decision to continue using an e-learning system is determined by satisfaction, which was in turn determined by perceived usability, perceived quality, perceived value, and usability disconfirmation. "Usability disconfirmation" means that usability exceeds expectation.

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## Chapter 3: Study Design and Methodology

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The primary aim of the current study was to get feedback on the potential usefulness to learners of a Learning Design-based system, as a basis for future study. It was envisaged that findings would firstly provide initial feedback on whether the potential benefits already identified might be provided, and secondly identify additional potential benefits and disadvantages of using such a system.

The secondary aim was to gain feedback on the ease of use, usability and visual appeal of the Voyager2 system. This is important because if the system is unappealing or hard to use, participants may feel that the Learning Design model is difficult to understand. The system itself is therefore a major confounding variable in the study.

### 3.1. Constructs and Hypotheses

The construct of “usefulness to learners” was chosen as a useful facet of the wide and ambiguous concept of “benefits to learners”.

The following hypotheses were developed from the literature and the initial interviews with learners and educators:

H1: Learning Design-based systems, as represented by Voyager2, are perceived by tertiary-level **learners** as being useful in their course of studies.

H2: Learning Design-based systems, as represented by Voyager2, are perceived by tertiary-level **educators** as being useful to learners in their course of their studies.

H3: Voyager2 is easy to use.

H4: The ability of Learning Design-based systems to facilitate group work is perceived as being useful to tertiary learners in the course of their studies

H5: The scaffolding of resources is perceived as being useful to tertiary learners in the course of their studies

H6: The ability for educators to monitor current Runs is perceived as being useful to tertiary learners in the course of their studies

### **3.1.1 Confounding and exogenous variables**

The most significant confounding variable is the linkage of participants' perceptions of the ease of use and/or usability of the Voyager2 system - as one representation of a Learning Design-based system - with the usability of Learning Design-based systems as a whole. Respondents might think "Learning Design-based systems are hard to understand", when in fact they mean "Voyager2 is hard to understand". This was measured in two ways. Firstly, items 6 and 7 were worded "I would choose to use a system based on Learning Designs on a course" and "I would choose to use Voyager on a course" respectively to measure the usability separately. Secondly, if the "ease of use" items (10 – 13) were low, they could be correlated to the "usability" questions (6, 8 and 9). If items 10 – 13 indicated that the respondent found Voyager2 difficult to use, this might cause them to perceive Learning Design-based systems in general as less useful (items 6, 8 and 9).

The perceived ease of use might be affected by respondents' amount of prior technical experience or the amount of tertiary study undertaken. Items 4 and 5 were added to the questionnaire to measure this.

## **3.2. Research Method**

The Voyager2 system was developed as described in chapter 4, as an instrument for this and future studies. Because ease of use is such a significant confounding variable in this study, it was decided that it was important to conduct an evaluation based on trial use by potential users before it is used in teaching, so that the system could be altered to take any feedback into account. This study was chosen as a suitable avenue for this evaluation.

It was decided that a mixture of interviews and questionnaires would be suitable, to allow some in-depth exploration of issues but to also gather evaluations from a larger sample population than would be practical using interviews alone.

Five initial semi-structured in-depth interviews were conducted with learners and educators with the aim of assessing the potential usefulness and usability of the system and identifying any benefits and disadvantages to learners perceived by the interviewees. A secondary aim was to assess the usability of the demonstration and system. A demonstration of the system was presented and interviewees were encouraged to try out the system. An initial version of the questionnaire was then used to guide discussion. Interviews were recorded using a Dictaphone with the interviewees' permission and notes were made by the interviewer.

Information commonly requested by interviewees was included in the system demonstration for questionnaire respondents. All interviewees found Voyager2 easy to learn and understand. Feedback on minor usability issues resulted in some minor changes to the demonstration and system screens.

The system, demonstration and questionnaire were made available on the Internet and potential respondents were emailed. In the email they were asked to watch the demonstration, trial the system and complete the questionnaire.

Ethical approval was granted by the Committee of Human Ethics and Massey University and the Research Ethics Committee at EIT Hawkes Bay.

### **3.3. Questionnaire design and validation**

The TAM model (Davis, 1989) was chosen as the basis for the measurement instrument for several reasons. Firstly, it is an accepted and validated model for measuring information systems (Lederer et al., 2000; Segars and Grover, 1993; Straub et al., 1995; Taylor and Todd, 1995). Secondly, one of the constructs it measures is the perceived usefulness of the information system, which was the focus of the research. Thirdly, it also measures perceived ease of use, one of the significant confounding variables identified above. Also, importantly, as pointed out by (Taylor and Todd, 1995), “ease of use and usefulness are factors over which a system designer has some degree of control”. If results show that the system is perceived as difficult to use, changes can be made to the system for future studies.

#### **3.3.1 Reliability and validity**

Construct validity is well established for the TAM instrument (Segars and Grover, 1993; Straub et al., 1995; Taylor and Todd, 1995; Davis and Venkatesh, 1996; Lederer et al., 2000).

The questionnaire was pre-tested by five respondents. After completing the questionnaire, respondents were asked about the meaning of the question as they perceived it to assess content validity. Some minor wording changes were made to the questionnaire to reduce ambiguity.

The final version of the questionnaire is attached as Appendix 1.

### **3.4. Sample size and selection**

The study sample was drawn from learners currently engaged in tertiary education and tertiary educators.

Interviewees were selected with the aim of interviewing as wide a demographic as possible within the confines of practicality. It was decided that five interviews were to be conducted to provide a range of opinions to inform the development of the questionnaire.

The initial aim was to get at least 50 questionnaire responses, so a sample size of 250 was chosen. Initial questionnaire respondents were chosen from EIT Hawkes Bay, and the study was later widened to include respondents from Massey University.

### **3.5. Data collection and storage**

Interviews were recorded using a Dictaphone with the interviewees' permission. They were then transcribed. The tapes are stored in a filing cabinet in a restricted-access office, which is entered using an electronic security card (swipe card). The transcripts are stored on a secure server.

Completed questionnaires were emailed to the author. They were then printed and stored in the same filing cabinet, and the original email was deleted. This meant that there was no record of who had submitted which questionnaire.

At the end of this study the interview tapes will be wiped and electronic copies of the transcripts and questionnaires will be deleted. Paper copies of the transcripts and questionnaires will be kept in the same filing cabinet.

### **3.6. Strengths and weaknesses of the method**

The use of in-depth, face-to-face interviews allowed use of the demonstration, system and questionnaire to be observed and for interviewees' responses to be discussed in greater detail. The technique can result in unexpected insights, allows the in-depth exploration of issues raised during the interview and is useful in clarifying concepts (Hair, Babin, Money and Samouel, 2003).

The use of a web-based system and questionnaire as a secondary method meant that data could be collected from more people, spread over large geographic distances, in a relatively short time frame. This meant that a larger sample of tertiary learners and educators could be studied, rather than being limited to the small sample available in Hawkes Bay. The method limits the respondents to computer users with access to email and the Internet, but this effect is unlikely to be large for this sample population.

Non-response bias must be considered. The questionnaire was distributed through academic institutions and research affiliates with the hope of engaging the interest of the recipient. The demonstration had to be quick and engaging and the questionnaire must be short, or respondents would lose interest—it is very easy to click the “close” button on a web page.

The complexity of the setup of a Learning Design-based system means that respondents could not register themselves in the system – they had to be enrolled in courses to be able to evaluate the features of the system. To get around this, a limited number of pre-enrolled “students” were created, and respondents were given these login details. This meant that it was not possible to track who had accessed the website, preserving anonymity, but making targeted follow-up of those who had looked at the system (or not looked at the system) impossible. It also meant that a sample student’s data was changed by people “playing around” in the system – this was what was intended, but people using the same login later could not play as much. This problem was overcome by a nightly reload of “clean” student data.

Straub et al. (1995) found that actual usage of a software package differed from self-reported usage. More so, whether people perceive that it would be useful to them, and whether they would find it so in practice, may be different things. While not addressed in this study, future studies based on the use of Voyager2 in classroom situations are planned to address this weakness.

As a proof-of-concept study, this study measures only the perceived usefulness and ease of use based on trial use; it does not measure these constructs under conditions of actual use in a programme of study, nor does it measure whether Learning Design-based systems actually lead to “better” learning in practice. These will be questions for future studies.

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## Chapter 4: The Voyager2 Learning Management System

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The architecture and database which underpin Voyager2 are based on the system developed by Hagen, Hibbert and Kinshuk (2006), which was codenamed Voyager. However all parts of the system were redesigned and developed from scratch, to allow for modifications suggested by the development of the initial system. The learner functionality in Voyager2, which in Voyager was only broadly designed as a concept, was redesigned from the Specification, and is significantly different from the original Voyager concept. In Voyager2 the learner functionality is fully implemented, which it was not in Voyager.

Voyager2, like Voyager, is a web-based system written in HTML and PHP, with a MySQL database back-end.

### 4.1.1 Development of a new engine

Although several Learning Design players exist, and the CopperCore engine could be used to build a Learning Design player based on proven technology, the decision was made to build a new and independent system for the following reasons:

- The resulting system would not be limited by the existing technology; if feedback showed that a certain new feature was needed, or that an existing feature was difficult to use, changes could be made quickly;
- an independently-designed system would behave in different ways; at a later date it could be compared to existing Learning Design-based systems to test relative usability of different design concepts; and
- the building of a system would be an important learning step for the author, ensuring a thorough understanding of the Learning Design Specification, and the benefits and problems in its implementation.

### 4.1.2 Compliance with the IMS Learning Design Specification

Voyager 2 implements the data model and the workflow set out in the Specification as closely as possible, except for the changes necessary to the data model to implement the object-relational model defined in the Specification in a relational database and some additional changes needed to

implement the described workflow. The decision to use a database rather than the XML files defined in the Specification is discussed in Hagen et al. (2006).

## 4.2. The Voyager2 Database

Like Voyager, the Voyager2 database adheres as closely to the IMS Learning Design Specification as possible, with extensions added only to provide functionality described but not implemented in the Specification. These extensions are discussed in detail in section 4.3 below.

When implementing Voyager, Hagen et al. (2006) found that the conversion of the object-relational data model in the Specification to a relational model required the addition of many “joining tables”, resulting in a large number of tables and the creation of a lot of data for a relatively simple learning design. This was seen as a potential problem if used in a live learning environment in even a moderately-sized university.

This finding was affirmed by the development of Voyager2. The full implementation of Runs (multiple course offerings over time), which are described but not specified in the Specification, necessitated the addition of even more tables, increasing the problem. The sample data, which has only 6 students, 5 courses and one learning design per course, comprises 546 records. The extrapolation method applied by Hagen et al. (2006) was used to give an indication of the possible size of the database in real use. This calculation is based on the 1,104 distinct courses offered each year by EIT Hawkes Bay, a small regional polytechnic. In total, these courses amount to 25,054 teaching weeks. If it is assumed that in each course only one Learning Design is created per course for each teaching week, and only 6 students are enrolled in each course, this results in 13,679,484 records, before the learners have started to use the system. In reality, even a moderately-sized university will have many more students and many more courses, and may create several learning designs for one week. And these figures are only for the first semester; as courses are redeveloped these figures will increase.

### 4.3. The Learner Suite

As in Voyager, functionality was divided into an Educator Suite for creating Learning Designs and managing Runs, a Learner Suite for playing Learning Designs, and a Collaboration Suite for exporting and importing Learning Designs. At present, only the Learner Suite functionality is fully operational.

The Learner functionality matches the description provided in the Specification as closely as possible. When learners are ready to start an Act they choose a role part, which has been assigned a specific activity. When all role parts have been filled, the learners involved in the Act can “play” the learning design (complete the assigned activity, using the resources provided by the educator for the particular role part). It is possible to facilitate group work using this model – groups of learners effectively put on their own production of the play or, more specifically, of the current Act that they are working on.

Because a course is run many times (for example, every year or every semester), the Specification allows for multiple Runs of learning designs. Effectively, a “run” is an iteration of a learning design, an actual offering of the course or teaching of the lesson.

The user interface does not use the “theatre” analogy used in the Specification, although it implements the same functionality. The theatre analogy is a useful model for envisaging how many learners could work together or separately simultaneously, and for envisaging how people could do different activities within a group. However, Hagen et al. (2006) found that both educators and learners found the model difficult to understand at first, increasing the cognitive load of using the system. It is not an analogy used by other learning management systems, lowering skill transference, making the system harder to learn for new or infrequent users. It was noted that the theatre analogy is not used in EduBox or CopperCore. These systems use a “workflow” analogy, with learners being presented with the Acts in the form of a “to do” list. This analogy was chosen for the Voyager2 learner interface, in order to provide an interface which used a design metaphor with which learners were more likely to be familiar, so that the unfamiliar “theatre” terminology of the model would not be a confounding variable when evaluating the potential usefulness of the system.

The Specification concentrates mainly on the way a learning design should be developed and written, and only briefly describes how it should be “played”. In order to implement a system which learners could use the following functionality had to be developed from the brief description in the Specification:

- the implementation of multiple “runs” (offerings) of learning designs, with learners maybe being enrolled in more than one run of a learning design (for example, if they repeat a course);
- the specification by the educator of particular role parts a learner may take;
- the ability for learners to work in groups or individually on a task (as specified by the educator);
- the sending of “notifications” or messages to learners and educators (specified in level C of the Specification);
- the ability for learners to play a Learning Design (i.e. to make use of resources and services provided, to complete the assigned Activity); and
- the ability for educators to monitor Runs, including learners’ progress and role parts taken.

In addition to this, of course, functionality was needed for educators to create learning designs and plays for learners to play, and set up specific Runs.

The following sections explain how these pieces of functionality were implemented in Voyager2, as the Specification had to be extended to enable implementation.

#### **4.3.1 Implementing Runs**

In order to allow for multiple Runs, or iterations of a learning design, the following tables were created:

- Run, which specifies which Play is to be used, and
- RunPerson, which is used to enrol a person into a course.

The data model for this functionality is shown in figure 4-1.

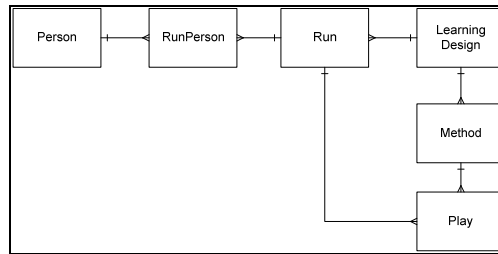


Figure 4-1. The Voyager2 data model for Runs

When setting up a Run, educators specify when the Run will start and end, and which people will be part of the Run. They may also specify a start and end date for a particular person which is different to the general Run start and end date (e.g. for a student who may start late, and/or may be allowed an extension at the end).

When learners see the list of all Learning Designs and Acts they need to complete (displayed as a “to do” list, as shown in figure 4-2), they are actually seeing a list of all the Learning Designs and Acts for the Runs in which they are enrolled, and which are currently playing (for which it is after the Run start date or their own start date, and before the Run end date or their own end date).

Figure 4-2. To Do list showing current Runs and the Acts in the Learning Design.

### 4.3.2 Specifying Role Parts

In order for an educator to be able to specify which role parts a learner could take, as described in the Specification, the table vPossibleRolePart was created. When enrolling a learner into a run, the educator chooses the role parts the learner may play.

When a learner chooses a role part for a particular Act, they are only able to take the role parts which are in the list set up by the educator (see figure 4-3, below).



Figure 4-3. The “Choose a Role” screen.

### 4.3.3 Enabling group or individual Activities

This functionality required a significant extension to the Specification data model and the functionality described in the Specification. The following additions were made to the data model:

- The fields vMaxNumGroups, vMaxInGroup and vMinInGroup were added to the Act table (the “v” prefix denotes a field added to the Specification and specific to the implementation of Voyager2).
- If the task is individual, the educator sets vMaxNumGroups to 0, and vMaxInGroup to 1.
- If the whole class is to work in one group, the educator sets vMaxNumGroups to 1.
- Otherwise, the educator sets the number in a group – for example, if the class is to work in groups of 3 or 4, the educator sets vMinInGroup to 3 and vMaxInGroup to 4.

If the Act is to be done in groups, the learner chooses a group and a role part within the group at the same time. For individual activities or where the whole class works together, they only choose a role part.

On the main screen, learners are shown their role part and the assigned activity. They are provided with links to the services and resources which the educator has provided for their role part for this Act, as defined in the Specification.

In addition to the functionality described in the Specification, at the bottom of the screen learners see the role parts of other learners in their group, and can communicate with group members using the chat and messaging services described in the Specification, as shown in figure 4-4, below.

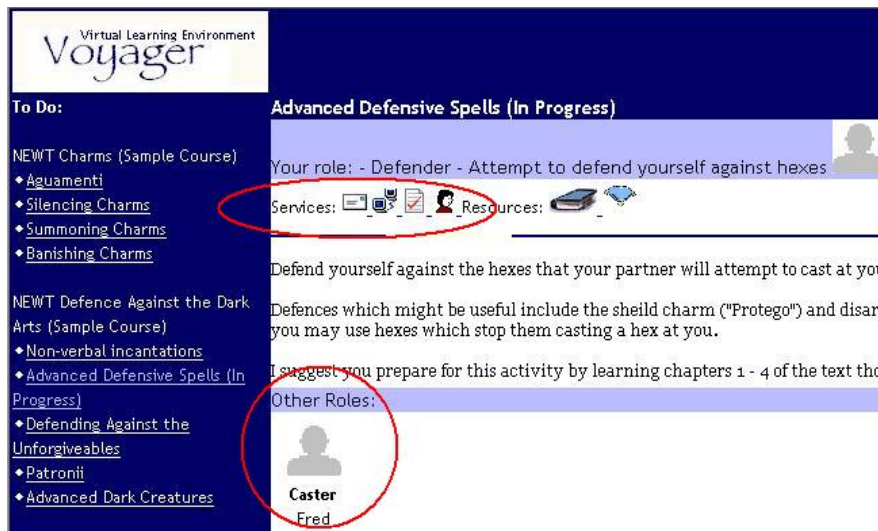


Figure 4-4. Other Roles

#### 4.3.4 Notifications

Level C of the Learning Design Specification envisages notifications. These are implemented in Voyager2 as messages, using the table vMessage. Messages can also be used as an email system between system users.

Learners and educators see messages to them and to all users when they log in and from the "View Messages" page. They can send messages to any Voyager2 user or to all users (see "Global Services" in section 4.3.7 below).

Currently notifications are sent to all group members when a new person joins their group and when all role parts in a group have been filled, meaning that they can now play the learning design. Level C of the Specification allows for educators to set up notifications at certain parts of the Learning Design – this has not been implemented in the current version of the system.

### 4.3.5 Playing Learning Designs

The Specification refers to the learner using the system to do the proscribed Activities as “playing” the learning design. To do this, the learner uses the screen shown in figure 4-5, below. To implement the workflow described in the Specification the following extensions were required:

When the learner chooses a role as described above, the vRolePartPlayed table records the role part chosen and the date and time it was chosen (for monitoring purposes). For group activities, the group ID is also stored, with a record created in the vGroup table for each new group created.

When a learner is ready to do the activity, they click the “Start” button which makes the services and resources available and records the date/time in the vRolePartPlayed table for monitoring purposes. The learner can then use the resources and services to complete the activity.

When the learner has completed the Activity they mark it as completed by clicking the “Done” button. This records the finish date and time in the vRolePartPlayed table for monitoring purposes and the learner sees the Act status as “Complete” in the main screen and to do list. Resources and services remain available once the Act is complete, so that the system doesn’t “take away” resources which the learner might want to refer to later.



Figure 4-5. The Learning Design player screen

### 4.3.6 Monitoring Runs

As described in section 4.3.5, Voyager2 stores the role part and group a learner chooses, and the date and time they chose the role part, started the activity and marked the activity as complete. This allows educators to find out the following information:

- Who has chosen a role part and who has not.
- Who has started or finished a particular Act, and who has not.
- Which role part a learner took and who they worked with.
- What activities a particular learner has started and finished.

This provides educators with a wealth of information about learners' progress, enabling them to provide help if needed. They can see who is working ahead or falling behind so that they can provide other tasks, resources or help. It can also provide insight into a learner's working habits – for example, they may have started lots of activities and finished none, suggesting a scattered approach to learning, and maybe the need of some help (or maybe just that they haven't marked Acts as completed once they finished).

#### **4.3.7 Other extensions to the IMS Learning Design Specification**

The following functionality was not described in the Specification but felt to be necessary and so was implemented in Voyager2:

- Courses

An educator may use one learning design for the whole course (as in the sample data) or may use several or many learning designs (e.g. one for each class). A way was therefore needed to group learning designs together so that learners would understand them. Voyager2 uses a “course” to do this, as a standard most educators and learners would use. This is implemented using the vCourse and CourseLearningDesign tables. An educator creates up their learning designs, then sets up a Course, and specifies which Learning Designs will be used in the course. A Learning Design may be used in more than one course.

- Global services

When setting up the sample data it was found that the same services were needed in almost all Acts for all Learning Designs – namely chat and messages. Therefore a “global services” environment was created for services which should be displayed in every Act.

- “Submit A File” service

One service additional to the Specification is to submit a file, which can be sent to another learner (e.g. a group member for collaboration) or an educator (e.g. to a teacher, tutor or mentor for marking or feedback).

- Terminology used in the learner screens

As discussed above, the user interface did not use the “theatre” analogy used in the Specification. The terminology used in the learner screens is as follows:

- Current Runs are shown as headings in the To Do list. The Acts of the Play chosen for that Run of the Learning Design are shown as tasks under the heading.
- The term “resource” is used instead of “learning object”.
- Learners “start” an Activity instead of “playing” a learning design.
- The term “role” was thought to be a good metaphor even without the theatre model, and is used instead of “role part”.

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## Chapter 5: Study Results

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### 5.1. Interview Results

Five individual interviews were conducted. The interviewees were:

- A male postgraduate student in his 50's who is also a tertiary educator at a diploma and Bachelor's degree level in the area of Information Systems;
- A female undergraduate student in her 50's who is also a tertiary educator at a certificate level in the area of computing;
- A female postgraduate student in her 40's in the area of Library and Information Science;
- A male learner in his 30's currently participating in workplace-based training in the Security Electronics industry; and
- A female learner in her 20's currently studying for a diploma in the area of Office Administration.

These interviewees cover a wide range of the demographic groups measured in the questionnaire.

#### *Usability*

Interviewees were observed while they watched the demonstration and trailed the system. Several asked for clarification about the concept of Learning Designs, so the explanation in the demonstration was revised. Apart from that there were no major usability issues identified. Several interviewees made suggestions about possible changes to the interface, which were noted for possible future development. Two interviewees asked what they should do to trial the system, and were talked through using the main functions. Because of this a short exercise was created to walk questionnaire respondents through the main parts of the system.

#### *Usefulness*

All interviewees were very enthusiastic about the usefulness to learners of a system like Voyager2, although for different reasons. The reasons given by respondents were:

- Activities are perceived as being more interesting and engaging than just reading Powerpoint slides and documents (4 respondents). However several interviewees noted that the activities had to be “good”, which they said meant that it suited their learning style and needs. Activities which the learner feels have no educational value are boring and felt to be a waste of time.
- The group work facilities allowing people to work together while in different places and at different times (3 respondents)
- The ability to access information from any location at any time, which is a benefit for working people and mothers at home (3 respondents), but not a feature related to learning designs;
- The provision of the resources that learners need to do the task, to save time and confusion (3 respondents). However the educators cautioned that this would be a disadvantage if done too much, as the learners would not learn to research for themselves.
- The ability for educators to include a range of activities to suit the interviewee’s personal learning style (3 respondents).

#### *Ease of Use*

All interviewees reported that Voyager2 was very easy to learn and understand. Two interviewees reported that all systems with “layers” of information take a little time to understand, and that Voyager2 was no better or worse than most. One comment was that for the first course it might be a bit more difficult, but after that it was easy. One interviewee reported that once they had used the system for a few minutes, the technology became “invisible”; they no longer noticed it.

#### *Activity-based layout*

Both learners and one interviewee who is both a learner and educator felt that the activities would interest them more than a list of topics. One learner thought that activities would engage learners more, and maybe keep them going for longer.

One educator was concerned that students would be less self-directed. They also felt that some learners might just want access to the resources, and see the activities as a barrier to learning.

All interviewees felt that the activity-based layout was no more difficult to understand than a content-based layout.

#### *Benefits of Resource Scaffolding*

One interviewee had returned to tertiary education more than 20 years after leaving secondary school. They felt that the resource scaffolding would have been particularly beneficial to them when they first started out again, as they had felt overwhelmed by the amount of information, and unsure as to how to find and then narrow down the information relevant to their assessments. Several other interviewees also reported that they felt that the resource scaffolding would be good for new learners. One interviewee said that they wouldn't want to log in and see "here are 10 books that relate to your project", and have to work out what was relevant where; when they went into an activity they wanted to see only the relevant resource for that activity.

Two interviewees reported that they like to see the "big picture", and may feel constricted by resource scaffolding once they were familiar with the material. They asked for a "library" feature whereby you could view all resources for the course, as well as the resources linked to each activity. Another interviewee also requested this feature so that they could go back to check a resource later, and not have to go through all the activities to find out which the resource was in.

One educator felt that resource scaffolding was useful, to a point, because it was important for learners to learn how to find relevant resources for themselves.

One educator noted that exploratory learners would get so much more out of exploring other unrelated resources, which would fire their interest in the topic.

#### *Benefits of Group Work*

All interviewees felt that the group work facilities would be beneficial if a learner was in a good group. One interviewee, from the Pacific Islands, felt that the group work facilities would help people from Pacific cultures particularly, as they prefer working in a group to individual activities. They felt that the group work might help to keep people interested, and "maybe keep on track, when they would otherwise drop out".

Two interviewees reported “disappointment” at starting a group activity but having to wait until other people had joined the group. One pointed out that this was a problem for workplace based training, where some learners might not do anything for a while, and other learners would be held up.

### *Benefits of Progress Monitoring*

All interviewees reported that the ability for educators to monitor their progress was positive, if the educators had the time to do it and if it was used fairly. Two interviewees expressed some concern that the information could be used against them. Both stated that it was “not the teacher’s business” how much work had been done. One interviewee used an example of the military, where they could imagine a sergeant-major using the information to yell at a learner who has slower than the others. The respondent also reported that they would not want people to know if they had to do something several times over; that if they were “dumb and had to keep doing it until I got it the teacher doesn’t need to know, as long as I got there in the end”. When asked if they would appreciate a tutor seeing that they was behind and offering help, they replied that it would, depending on the way it was done – and if it was done tactfully, and not in front of the whole class. They also reported that as an educator, they would like the facility herself, to enable her to “keep an eye” on how her students were doing, and offer guidance if any were falling behind. The discussion with all interviewees indicated that the value of this depended very much on how the educator used it, and their responses of educators in the past may have coloured.

One interviewee also pointed out that progression by itself could not be used as assessment; a student could click “done” without having done the task.

One interviewee pointed out that this could be a benefit for the educator; if they can see that people are almost finished they need to put up more activities; if they see that people are only at the beginning they have more time to finish the end activities. They can also see what areas to assess on (for competency-based training) based on what activities the learners have completed; if they can see that people are only part way through, they can assess on that part, and can assess the rest later, or can run “catch-up” classes or put an intensive course on for the activities people haven’t finished.

One educator realized that the monitoring facility could be used to see which students worked together. This could be used to identify groups of unproductive students, or students who don’t seem to achieve well when working together.

The educators pointed out that they may not have time (and some may not have the inclination) to use this; the benefits to learners depends on this.

One educator discussed the idea of displaying all class members' progress like a scoreboard. However they felt that this could either be a motivator or de-motivator. Some learners would try harder, but some would feel that they are so far behind that "it's not worth trying". they also commented that learners who are ahead would probably get teased, however gently; as students tend to recognise who is at the top of the class and will look at the list of assignment results and say "Oh, that's George".

#### *Other benefits identified*

The other benefits to learners that were identified in the interviews were the use as a communication device with educators or with peers, and the ability for a learner to see their progress in the course in terms of activities completed.

One interviewee described Voyager2 as "like a game", and approached it in a excited and interested manner. They reported that taking a role and doing an activity was very much like a game, and felt that it would increase her interest in the course. They also reported that they enjoyed learning with technology.

#### *Other disadvantages identified*

One disadvantage of computer-based learning courses in general that was reported was the lack of resources available after the course is finished. While the respondent had enjoyed using a web-based system during the course because it enabled him to do the readings at home at their own pace, they wanted to be able to refer to some of the information after the course was finished.

The access to computers and the internet was identified as a problem, particularly for workplace-based training. One interviewee said that several of their colleagues didn't know how to use email. They also pointed out that some people in rural New Zealand can't get the internet because of interference with electric fences, and that homes and businesses more than 5kms from a telephone exchange can't get broadband internet access unless they pay for a high-speed wireless internet access, which is expensive. The level of computer literacy of potential learners was raised as an issue by three respondents. Examples provided were people in their 40's and higher who did not have

computers in secondary school, and tradespeople who may not have had a need to use computers since. This is an issue for lifelong learning research.

The reliability of the technology was identified as an issue – the system being down when people want it, and not coming back up until the next working day, or working very slowly when lots of people need it at once, such as just before exams.

One interviewee said that they much preferred paper resources than electronic resources because they can flick through, have two resources open at once, and read the resources on the couch. they said that was their particular preference. One educator said they have learners who just don't like working on computers, and want to print out everything.

## **5.2. Questionnaire Results**

### **5.2.1 Data Analysis**

A chi square test was performed against each question with the null hypothesis that the responses for that question were random (which assumes, over a large enough sample, that the results would be evenly distributed across all responses). The results of this test indicated the probability that the results were not random.

For all questions the data was analysed visually and chi square tests for association were performed to see whether responses were related to each of the type of respondent (educator, learner or both), level of computing experience, level of qualification held, age group or gender. The null hypothesis was that responses were independent of the chosen variable, with the alternative hypothesis that responses were dependent on the chosen variable. In most cases there were not enough responses to produce accurate results, with a chi square test for association needed at least 5 responses in at least 80% of the categories for reliable results (Arsham, 2007).

## 5.2.2 Analysis and Discussion of Questionnaire Results.

### *Demographic Information*

A total of 26 responses were gathered. The breakdown of respondents by type (educator, learner or both), gender, age group, computing experience and level of qualifications held are shown in figure 5-1, below.

Gender	
Female	38%
Male	62%

Type	
Learner	54%
Educator	31%
Both	15%

Age Group	
<20	4%
20's	4%
30's	35%
40's	23%

Level of Qualification	
Certificate - hold	4%
Diploma - hold	15%
Undergraduate Degree – studying	12%
Undergraduate Degree - hold	19%
Postgraduate Degree – studying	15%
Postgraduate Degree - hold	35%

Level of IT Experience	
Little	4%
Moderate	8%
Lots	38%
Studying IT Qualification	15%
IT Professional	35%

*Figure 5-1 Breakdown of respondents by demographic groups measured*

More learners than educators responded, but that is not seen as a problem for this study. Although respondents tended towards the high end of age group, IT experience and qualifications held, there is still some spread amongst the categories and at least one respondent in each category.

### *Usefulness (questions 6 – 9)*

85% of respondents agreed that they would choose to use Voyager in a course (question 6,  $\chi^2 = 161.1$ , d.f.= 6,  $p < 0.001$ ).

12% said they didn't know whether they would choose to use a system based on LDs (question 7), with 8% commenting that it depended on the nature of the course. All other respondents (88%) said they would choose to use a Learning Design-based system on a course ( $\chi^2 = 40.230769$ , d.f.= 6,  $p = < 0.001$ ).

All learners and respondents who were both learners and educators agreed that a system based on LDs would enhance their learning on a course (question 9,  $\chi^2 = 31.615385$ , d.f.= 6,  $p = < 0.001$ ). 8% of educators said they didn't know, and one educator disagreed slightly. The remaining educators (63%) felt that a system based on Learning Designs would enhance learning on a course.

The comments were similar for these three questions, and indicated that the usefulness was perceived for a variety of reasons. Some were relevant to the functionality outlined in the Learning Design Specification: interactive; allowing collaboration; asynchronous collaboration allowing people to participate in group activities at any time; tracking course progress. Comments were made that activities were more interesting than just reading material, and one learner commented that they retain information better and see it's purpose by 'doing things' rather than reading. The flexibility to cater for the respondents' own learning style was noted as a benefit. Respondents commented that the use of activities and collaboration with peers would encourage participation, probably create and hold more interest in the subject. The use of the group work features was seen as potentially enhancing the interaction in the classroom as well, with people who may not speak up in class maybe contributing more online.

It was noted that whether the use of the system enhance learning would depend on the motivation of the learner.

Other comments which are about web-based learning systems in general: flexible approach in location and time, e.g. for working students, allows you to work at your own pace, an additional resource (3)

One negative comment was from an educator who commented that it was "just another thing that you have to get your head around quite apart from the reason for the course". In a later comment they noted that they was skeptical about e-learning systems in general, but did not explain why.

The responses regarding the time-efficiency of the system were less clear, although 62% felt Voyager would not take more time than it was worth (question 8,  $\chi^2 = 9.5384615$ , d.f.= 6,  $p = 0.15$ ).

Comments noted computer and internet speed and computing experience as potential issues. One commented noted that because respondents were new to the system it might seem to take longer than it would once they were experienced.

A correlation between the usefulness questions is not expected; in Davis' (1986) original model each question was found to be discrete using Cronbach's alpha. The size of the current sample is not large enough to determine whether there seems to be a correlation between these questions in the current study; it is likely, given Davis' analysis and the confirmation of the model by later authors (Davis, 1996; Segars and Grover, 1993; Straub et al., 1995; Taylor and Todd, 1995), that any apparent patterns are insignificant.

In summary, most educators, and all learners who were not educators, felt that Voyager and Learning Design-based systems would be useful to learners on a course.

*Ease of Use (questions 10 – 12)*

Most respondents reported that Voyager2 was easy to learn (81%,  $\chi^2 = 71.076923$ , d.f.= 5,  $p < 0.001$ ), understand (73%,  $\chi^2 = 23.384615$ , d.f.= 5,  $p < 0.001$ ) and use (85%,  $\chi^2 = 32.615385$ , d.f.= 5,  $p < 0.001$ ). According to the TAM model (Davis, 1986), these three components are discrete variables which together make up the construct of "ease of use". Therefore it can be assumed that the majority of respondents found Voyager2 easy to use. The frequency distribution of the responses to each of the ease of use questions are shown in tables 5.1, 5.2 and 5.3 below.

	Type			Grand Total
	Both	Educator	Learner	
Slightly disagree	0%	4%	0%	4%
Neutral	0%	8%	0%	8%
Slightly agree	4%	15%	19%	38%
Generally agree	12%	0%	31%	42%
Don't know	0%	4%	4%	8%
Grand Total	15%	31%	54%	100%

Table 5.1: Frequency distribution for question 10 ("It would be easy for me to learn Voyager")

	Type			Grand Total
	Both	Educator	Learner	
Generally disagree	0%	4%	0%	4%
Slightly disagree	0%	8%	0%	8%
Neutral	4%	8%	4%	15%
Slightly agree	8%	8%	12%	27%
Generally agree	4%	4%	38%	46%
Grand Total	15%	31%	54%	100%

Table 5.2: Frequency distribution for question 11 ("I find Voyager easy to understand")

	Type			Grand Total
	Both	Educator	Learner	

Generally disagree	0%	4%	0%	4%
Slightly disagree	0%	4%	0%	4%
Neutral	0%	4%	0%	4%
Slightly agree	4%	15%	15%	35%
Generally agree	12%	4%	35%	50%
don't know	0%	0%	4%	4%
Grand Total	15%	31%	54%	100%

Table 5.3: Frequency distribution for question 12 (“I would find Voyager easy to use”)

Comments indicated that the screen layout was logical and consistent, with logical workflow and clear instructions, and similar to other learning systems they had used. Some comments were that the demo made it clear.

Ease of use was identified as a major confounding variable for this study. Because most people found Voyager easy to use, this variable can be ignored for this study.

#### *Visual Appeal (question 13).*

While 73% responded that the Voyager screens were visually appealing (62% “slightly agree” and 12% “strongly agree”,  $\chi^2 = 41.846154$ , d.f.= 5,  $p = < 0.001$ ), 19% slightly disagreed (8% were neutral). The comments provided the respondents who disagreed pointed to lack of accepted web design practice such as scalable font size, colour contrast for the visually impaired, and types of navigation links. This suggests they may have experience in web design so be talking from knowledge rather than impression, but their comments are valid. The frequency distribution for this question is shown in table 5.4 below.

Visual Appeal	
Somewhat disagree	19%
Neutral	8%
Somewhat agree	62%
Strongly agree	12%

Table 5.4: Frequency distribution for question 13 (“I find the Voyager screens visually appealing”)

Comments suggested improvements, which have been noted for possible future redesign, including accessibility issues such as colour contrast and scalable text. One respondent complained that blue was too right-wing (several other respondents reported that the blue was easy on the eyes, which is the reason it was chosen).

#### *The benefits identified in the literature (questions 14 – 16).*

*a. Group Work (question 14)*

77% of respondents agreed that the facilities for group work would enhance their learning on a course ( $\chi^2 = 30$ , d.f.= 6,  $p = < 0.001$ ). Of these, 46% generally agreed and 27% strongly agreed.

For this question there seemed to be a relationship with the type of the respondent; 63% of educators and 79% of learners agreed that group work would enhance their learning on a course. The frequency distribution is shown in table 5.5 below.

	Type			Grand Total
	Both	Educator	Learner	
Generally disagree	0%	4%	0%	4%
Slightly disagree	0%	4%	4%	8%
Slightly agree	4%	0%	0%	4%
Generally agree	8%	8%	31%	46%
Strongly agree	4%	12%	12%	27%
Don't know	0%	4%	8%	12%
Grand Total	15%	31%	54%	100%

*Table 5.5: Frequency distribution for question 14  
("The group work facilities in Voyager would enhance my learning on a course")*

Most comments expressed the concern that you need a good group. Several respondents expressed frustration that they had to wait for other group members to do some activities. Several respondents felt it was a benefit that a group could be in different places and still do group work. The ability to share information and co-ordinate meetings was seen as a benefit.

*b. Resource Scaffolding (question 15)*

All but one respondent agreed that the resource scaffolding would enhance their learning on a course, with 76% generally or strongly agreeing ( $\chi^2 = 39.68$ , d.f.= 6,  $p = < 0.001$ ). This was the lecturer who admitted scepticism of "this type of learning tool". They commented that they would "prefer to a bit more of the big picture". Several other respondents made similar comments, although they felt that resource scaffolding would enhance their learning. The frequency distribution is shown in table 5.6 below.

	Type			Grand Total
	Both	Educator	Learner	
Slightly disagree	0%	4%	0%	4%
Slightly agree	0%	12%	8%	20%
Generally agree	12%	12%	28%	52%

Strongly agree	4%	4%	16%	24%
Grand Total	16%	32%	52%	100%

Table 5.6: Frequency distribution for question 15  
 (“The resource scaffolding would enhance my learning on a course”)

Several comments said it might be good at the beginning, but needed to let them see more once they got to later activities. Several respondents said that the scaffolding would help to keep them focused on the task at hand.

*c. Monitoring (question 16)*

83% of all respondents agreed that the ability for educators to monitor learners’ progress would enhance their learning on a course ( $\chi^2 = 33.166667$ , d.f.= 6,  $p = < 0.001$ ). Of these, 33% generally agreed and 46% strongly agreed. None disagreed, although 13% said they didn’t know. Several respondents said that it depended if the educator had time to monitor it, and how they used the information. One comment pointed out that the educator could see that I was making mistakes, or was bright and needed more work. The frequency distribution is shown in table 5.7 below.

	Type			Grand Total
	Both	Educator	Learner	
Slightly disagree	0%	0%	4%	4%
Slightly agree	0%	0%	4%	4%
Generally agree	0%	17%	17%	33%
Strongly agree	8%	8%	29%	46%
Don't know	4%	4%	4%	13%
Grand Total	13%	29%	58%	100%

Table 5.7: Frequency distribution for question 16  
 (“The ability for educators to monitor learner progress would enhance my learning on a course”)

There were 2 comments about feeling uncomfortable about “big brother” watching over you. One respondent commented that it could be used as a weapon against you, for example by military trainers. Several comments indicated that if the information was used positively to offer help if needed it would enhance learning.

*Other potential benefits identified by respondents.*

In an open-ended question, respondents were asked what benefits Voyager might provide to learners. In addition to the benefits identified in the questionnaire, benefits listed identified in the area of

group work, collaboration, progress monitoring and access to resources. By far the most comments were regarding flexibility of learning activities to cater for the learners' own preferred learning style.

*Benefits relating to group work*

The fact that Voyager allowed group work in itself was seen as an advantage. In addition, the ability to manage the process of group work, the assignment of roles and the ability to share information and collaborate asynchronously were seen as benefits. One learner commented that the group can work together without being together. The asynchronous collaboration was seen as important for learners who might otherwise get left out, say because they work full time. One comment was that the assignment of different activities to different roles makes it clear what each group member should do.

*Benefits relating to collaboration*

The fact that Voyager encouraged collaboration between learners was seen as an advantage. It was felt that group work could help break down barriers faced by isolated students, and could create synergy which would aid learning. Students could communicate with other students if they are having problems with the course material. One comment made was that the facilities enable students to study online extramurally and get to know others through chat and shared activities.

*Benefits relating to resources*

Several comments found a centralized location of resources a benefit. Several also said that the scaffolding would help them to keep focused on the activity. Several commented that they would also want to ability to look at more resources, as they like to be able to see the "big picture".

*Benefits relating to progress monitoring*

The ability for educators to monitor and give feedback on activity progression and guidance where needed was seen as advantages, as was the ability for learners to monitor their own progression. Many responses commented that this is only a benefit if the educator has time to look at it, and acts ethically, helpfully and tactfully with the results.

*Benefits relating to learning styles*

The ability to access Voyager in any place at any time and to work at the learner's own pace were noted. This was noted as an advantage for people working full time and for mothers at home looking after children. It was also seen as a good way to catch up on missed classes.

Several learners felt that the activities and the interactivity would encourage student participation, and several comments noted that this may stimulate more interest, helping maintain the motivation needed to succeed in study, particularly in distance study. It was felt that it would encourage independence and active learning. Several comments applauded activities over a "file repository".

Providing a clear course structure was seen as an advantage. The flexibility to repeat activities and take different roles was seen as an advantage, with one educator commenting that by taking different roles in the same activity, different angles on a subject could be explored (e.g. learn, do, teach).

Many comments were about Voyager being able to cater for a respondents' own learning style, something they felt other learning systems they had used (Blackboard, WebCT and Moodle were mentioned) could not do. These included activities targeted for a particular user, group activities which people from the Pacifica cultures enjoy, the ability to point to a variety of resource types as a backbone to learning.

#### *Potential disadvantages identified by respondents.*

In an open-ended question respondents were asked what disadvantages Voyager might create for learners. Disadvantages identified related to cognitive load, technological issues, course design and general people issues.

#### *Comments relating to cognitive load*

One educator commented that it was just another thing that you have to get your head around quite apart from the reason for the course, and complicated things which were historically simple. Two respondents noted that the learning needed to know how to navigate the system is an initial additional load, although they felt that Voyager2 was easy to learn. These issues are relevant to all web-based learning management systems.

### *Comments relating to technology issues*

Potential technology issues identified were access to a computer and the internet, internet speed, reliability of the technology platform, server downtime, reliability of the resources provided, pdf and other files needing plug-ins, which might be a problem for people with little computing experience. These issues are relevant to all web-based learning management systems. One other interesting issue raised is that online courses leave learners nothing to refer to after the course.

### *Course design issues*

One educator raised the challenge of integrating web based and face-to-face activities, which was raised by Klebl (2006). Another wondered if the activity focus might create learners dependent on a guided learning framework, and suggested that some learners may need the inclusion of activities explicit encouragement to explore (e.g. resources) by following their instinct or intuition. Several comments noted that activities must be clear to avoid learner confusion. It was noted that activities and resources should be tailored to the varying levels of familiarity with computers and the subject matter that could be expected within a class. Two respondents expressed concerns that the system could be used to replace class time, saying that they found face-to-face contact important to provide a variety in their learning. One suggestion was that face-to-face contact time could be reduced or streamlined, allowing more group work time.

### *People issues*

The most common disadvantage identified was that the group work facilities rely on all group members collaborating, and learners can be held up by others in their group, or by not having enough people in their group. It was noted that the system made it possible for people to not participate. One concern raised is that use of the system may distract students from other course work which was seen as less interesting.

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## Chapter 6: Discussion of Results and Conclusions

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### 6.1. Discussion of interview results

Interviewees strongly felt that Voyager2 would be useful in their studies, and the interviewees who were both learners and educators felt that it would be useful for their students. The provision of activities was seen as being more engaging than simply providing resources, and the ability to provide a wide range of activities, rather than being restricted to certain pedagogies, was seen as an advantage. The group work facilities were also seen as an advantage, although interviewees noted that they could be held up by other group members. The resource scaffolding was seen as an advantage, especially for new learners, although comments were made that for holistic learners, who like to see the “big picture”, would need to see a wider range of resources to stay motivated. The ability for learners to monitor their own progress was seen as an advantage, but concerns were voiced over educators monitoring learner progress if it was not used sensitively.

One additional benefit identified was that the taking of roles was like a computer game, which two interviewees found very engaging. The other benefits identified were relevant to most web-based learning management systems – that the system is a record repository and a good communication device for communicating with educators and peers.

The disadvantages identified are relevant to all web-based learning management systems, and not specific to system based on the Learning Design Specification. The main issues raised were the access to a computer and the internet, internet speed, reliability of the technology, access to course materials after the course, and issues for learners who do not like to use computers.

### 6.2. Discussion of questionnaire results

The questionnaire results were similar to the interview results, with many of the comments made in the interviews also being made in the questionnaires.

The questionnaire results prove all the hypotheses put forward in this study.

A high proportion of learners felt that Voyager2 and other Learning Design-based systems would be useful in their course of study, and a high proportion of educators felt that Voyager2 and other Learning Design-based systems would be useful to their students. Importantly, a high proportion of learners felt that such a system would enhance their learning on a course.

Respondents reported that Voyager2 was easy to learn, understand and use. This is important, because increased cognitive load was seen as a potential issue for Learning Design-based systems (Hagen et al., 2006). While some respondents raised this concern, they were in the minority. This finding also means that reservations about the usefulness were unlikely to be caused by a feeling that the system was hard to use.

Although potential issues were raised in each of the areas, respondents felt that the group work facilities, resource scaffolding and progress monitoring would enhance their learning in a course.

Many of the additional benefits identified can be realized by many types of web-based learning systems, and are not specific to learning designs. These include the provision of a central resource repository, flexibility for the learner to use the system at any location and time, and the ability for learners to work at their own pace. These findings are therefore relevant to researchers looking at any type of learning system.

The purpose of the Learning Design Specification is stated as providing a pedagogically-independent standard for specifying learning activities using any pedagogy, and allowing for collaborative peer-interaction (Tattersall, 2003). The interview and questionnaire responses provide support for these aims, with learners responding that they feel that the provision of activities, the group work and collaboration, and the ability for an educator to provide different types of activity, would enhance their learning on a course.

Other benefits which were identified and are specific to systems based on the Learning Design Specification are:

- the interactivity of such a system, even on individual tasks, which was seen as being interesting and engaging;
- the ability to collaborate with peers on tasks, both synchronously and asynchronously;
- the provision of a clear course structure, and a record of progress through it; and
- the resource scaffolding reducing cognitive overload for new learners, and helping to keep more experienced learners focused.

These findings provide more support for the researchers wishing to show the benefits to learners of using a Learning Design-based system.

The potential disadvantages identified apply to any web-based LMS: access to a computer and the internet, internet speed and the reliability of the technology.

Concerns which relate specifically to Learning Design-based systems are the challenge of integrating web-based and face-to-face activities, possible learner dependence on a guided learning framework, and possible learner confusion on how to do an activity. These issues can be avoided through attention to course design.

Potential issues with group members are present in all group activities, and are not inherent to Learning Design-based systems. This is an area that will need to be managed by educators and by learners themselves. This may be more difficult to do on the internet, as wayward group members can choose to not respond; on the other hand, some learners felt that it would be easier to manage groups online, as asynchronous becomes possible if one group member is not available at the same time as the others. Some respondents felt that the clear definition of roles within the group would also be an advantage in managing groups; informal groups often have poorly-defined responsibilities.

### **6.3. Limitations of the study**

One of the major limitations of the study is the small sample size, which makes statistical analysis unreliable. There were few respondents with little computing experience, which might have affected the Ease of Use results.

Comments provided in the Usefulness questions indicated that the reasons for respondents perceiving the system as useful may not have been specific to Learning Design-based systems (e.g. the flexibility of location and time). A question for further research might be the benefits that a Learning Design-based system provides compared to a content-based system.

As a proof of concept study, this study is based on the perceptions of learners and educators after trialling the system, rather than on actual classroom use. Future studies focused on the benefits and disadvantages for learners of actual classroom use of a Learning Design-based system would be useful.

### **6.4. Reflections**

When planning the study, it was decided that the questionnaire should be distributed during the summer break to avoid any ethical issues surrounding the use of my own students as subjects. At the time I did not think about how I would find students to respond to the survey; the interpretation of the Privacy Act at EIT prohibits the use of student email addresses for sending out questionnaires, and due to the implementation of a new computer network at EIT over the summer holidays students did not have access to the email or the online learning systems. In the end responses were sought through personal contact with students as they enrolled in their courses, and this meant that most of the respondents were business or computing students, who I had personal contact with. With hindsight I would have distributed the questionnaire during the mid-winter semester break, avoiding the same ethical issues but allowing the distribution of questionnaires via EIT's online learning system. This issue meant that in-depth statistical analysis was not possible due to the small sample size.

One drawback is the number of students available to be studied; in an international university there would be several hundred students in a class, whereas we have about 20 in a class at EIT. International colleagues were contacted, but they had just surveyed their students for their own studies, and no responses were gathered.

Prior to this study I had felt mildly skeptical about the benefits to learners of the application of the Learning Design Specification, and felt that the additional layers of complexity created by multi-role workflows would increase cognitive load for learners, which might be a significant disadvantage. This study shows that multi-role workflows can be implemented in a way that was easy to understand.

## **6.5. Conclusion**

Despite the small sample size the study provided some interesting results.

From a narrow perspective, the positive results on the ease of use of Voyager2 mean that system design can be discounted as a confounding variable in future studies.

From a wider perspective, the five hypotheses proposed in this study were all proved:

- Learning Design-based systems, as represented by Voyager2, were perceived by tertiary-level learners and educators as being useful in their course of studies (H1 and H2);
- Voyager2 was perceived by respondents as being easy to use (H3);

- The ability of Learning Design-based systems to facilitate group work was perceived as being useful to tertiary learners in the course of their studies (H4), although concerns about group member reliability, inherent to all group work, were raised;
- The scaffolding of resources was perceived as being useful to tertiary learners in the course of their studies (H5); and
- The ability for educators to monitor current Runs was perceived as being useful to tertiary learners in the course of their studies (H6), if the information is used sensitively.

In addition, the following benefits of Learning Design-based systems were identified:

- the interactivity of such a system, even on individual tasks, which was seen as interesting and engaging;
- the provision of a clear course structure; and
- a record of progress through the course for the learner's own benefit.

The disadvantages identified were relevant to all web-based learning systems and not specific to the Learning Design Specification.

If an educational institute is to implement a Learning Design-based system, it is important that the potential benefits to learners outweigh any disadvantages. The results of this study confirmed the benefits already discussed in the Learning Design literature and identified some new ones. The disadvantages identified are common to all web-based LMSes, and many can be managed. The tentative conclusion from this study is therefore that the potential benefits to learners seem to outweigh the potential disadvantages identified to date. Classroom trials would be needed to test these findings to see if the benefits are realized in practice, and whether any other disadvantages are experienced.

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Appendix 1 – Final Version of Questionnaire

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**DEMOGRAPHIC INFORMATION (Please circle or highlight the most appropriate response)**

1. I am  
a:

	Lectur er	Stude nt
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3. Age group :

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4. Level of highest qualification (circle most appropriate):

	Certificate	

5. Level of computing experience (circle most relevant):


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**PERCEIVED USEFULNESS (Please circle the most appropriate response)**

6. If Voyager was available but not mandatory, I would choose to use Voyager on a course.

Strongly Disagree	Generally Disagree	Slightly Disagree	Slightly Agree	Generally Agree	Strongly Agree	Don't know	Why?
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7. I would choose to use a system based on Learning Designs on a course.

Strongly Disagree	Generally Disagree	Slightly Disagree	Slightly Agree	Generally Agree	Strongly Agree	Don't know	Why?
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8. Using a system based on Learning Designs take more time than it's worth.

Strongly Disagree	Generally Disagree	Slightly Disagree	Slightly Agree	Generally Agree	Strongly Agree	Don't know	Comments:
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9. Using a system based on Learning Designs would enhance my learning on a course.

Strongly Disagree	Generally Disagree	Slightly Disagree	Slightly Agree	Generally Agree	Strongly Agree	Don't know	How?
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**PERCEIVED EASE OF USE**

10. It would be easy for me to learn Voyager.

Very Difficult	Somewhat Difficult	Neutral	Somewhat Easy	Very Easy	Don't know	Comments:
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11. I find Voyager easy to understand.

Very Difficult	Somewhat Difficult	Neutral	Somewhat Easy	Very Easy	Don't know	Comments:
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12. I would find Voyager easy to use.

Very Difficult	Somewhat Difficult	Neutral	Somewhat Easy	Very Easy	Don't know	Comments:
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## GENERAL QUESTIONS

13. I find the Voyager screens visually appealing.

Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree	Comments:	
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14. The group work facilities in Voyager would enhance my learning on a course.

Strongly Disagree	Generally Disagree	Slightly Disagree	Slightly Agree	Generally Agree	Strongly Agree	Don't know	Comments:	
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15. The resource “scaffolding” (showing only resources relevant to the current task) would enhance my learning on a course.

Strongly Disagree	Generally Disagree	Slightly Disagree	Slightly Agree	Generally Agree	Strongly Agree	Don't know	Comments:	
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16. The ability for educators to monitor learner progress would enhance my learning on a course.

Strongly Disagree	Generally Disagree	Slightly Disagree	Slightly Agree	Generally Agree	Strongly Agree	Don't know	Comments:	
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17. In your opinion, what benefits might Voyager provide to learners/students?

18. In your opinion, what disadvantages might Voyager create for learners/students?

19. Are there any other comments you would like to make?