Experiencing the Elicitation of User Requirements and Recording them in Use Case Diagrams through Role-Play

Gay Costain
Brad McKenna
Department of Information Systems and Operations Management
University of Auckland
Auckland, 1142, New Zealand
costain@ihug.co.nz, brad.mckenna@auckland.ac.nz

ABSTRACT

This paper describes a role-play exercise used in a second-year tertiary Systems Analysis and Design course, and the quantitative and qualitative analysis of the students' responses to a survey that solicited their perceptions of that role-play experience. The role-play involved students in eliciting user requirements from customers during a Joint Application Development (JAD) session, thus simulating a common industry practice. Each JAD team had to interact to resolve conflicting customer requirements and record in IBM® Rational® Rose® the use cases necessary for a software solution. Completed diagrams were presented to the class using SynchronEyes technology, for review and discussion.

The effectiveness of the role-play method was confirmed by students' perceptions collected in the survey following the exercise. The goal of the survey was to discover if students respond positively to learning about JAD, and use case diagrams, through role-play, and if they believe that they have improved their knowledge as a result of that experience.

Student responses showed enthusiasm for experiential learning in the form of role-play and belief that learning had occurred. After experiencing the role-plays, students were also able to identify some of the limitations in the use of use cases, thus highlighting aspects that would require their future attention.

Keywords: Experiential Learning & Education, Active Learning, Role-Play, Unified Modeling Language (UML)

1. INTRODUCTION

Instructors of systems analysis and design (SA&D) courses endeavor to prepare their students for the job of analyzing live systems in industry. Many SA&D courses leverage lectures and case studies to achieve those goals. However, a student may gain confidence for a future career by being immersed in simulated real-world experiences. In this paper we describe a simulated Joint Application Development (JAD) session that was used to familiarize students with eliciting user requirements for a new system, and the documenting of those requirements in use cases.

Typically SA&D courses teach at least one methodology for developing systems, and that methodology incorporates some form of graphical modelling. In recent years many SA&D courses have featured object-orientation as the dominant software development paradigm, a choice that reflects software developers' positive perceptions of object-oriented (OO) software development (Fedorowicz and Villeneuve, 1999; Johnson, 2000; Johnson and Hardgrave, 1999). Many of the SA&D courses that study the OO paradigm utilize the Unified Modeling Language (UML) to document the static and dynamic features of systems. Although the original authors of UML intended it to be a language to support OO SA&D (Booch, Rumbaugh, and

Jacobson, 1999), one of its original nine diagrams, the use case, is not OO, and could be used to capture user requirements for non-OO software development. UML is being applied in industry, with some diagrams more popular than others. Use case usage is eclipsed only by that of the class diagram (Dobing and Parsons, 2006, 2008).

This paper provides an example of how role-play may be used to simulate the real-world and provide non-threatening practice for students to elicit user requirements during a JAD session, and document those requirements in use cases. The role-play has been successfully applied in second year university SA&D courses. Students were surveyed following the role-play experience to obtain their perceptions of the exercise. The time, effort, and creativity required to develop this exercise was richly rewarded by the positive student responses.

The remainder of the paper is as follows: Section 2 discusses requirements elicitation and use case documentation. A brief description of cognitive theory follows, providing an introduction to experiential learning through role-play. A description of the research methodology, including the tutorial in which role-play is used to introduce the students to the extraction of user requirements from customers, is covered in Section 3. Section 4 provides and discusses the results of the interviews

with the supervising tutors, and the students' survey. Section 5 covers possible limitations of the findings.

2. HOW CAN WE TEACH REQUIREMENTS MODELLING?

2.1 JAD as a Method for Requirements Elicitation
It is crucial that users' requirements be correctly specified in order for software to be successfully delivered. Most introductory SA&D courses present methods such as interviews, observation, and surveys, for gathering requirements, yet, in practice, students are often asked to extract system requirements from written narratives. The eliciting of information from users and the resolution of conflicts are frequently absent, although may be exercised in live project courses which typically occur in more advanced studies. It would be advantageous for students to practice requirements elicitation in a simulated environment prior to being exposed to live situations.

As JAD is a popular requirements elicitation method in industry (Costain, 2008), it is likely to be encountered by students in their future roles as systems analysts. Originally developed for internal use at IBM in the late 1970s, JAD is a facilitated, face-to-face, group session for specifying requirements, typically attended by users, developers, and managers (Duggan and Thachenkary, 2003). 'Developers help the users formulate problems and explore solutions, .. IBM reports that the use of JAD has resulted in 20% to 60% gains in productivity.' (Raghavan, Zelesnik, and Ford, 1994, Joint Application Design, pp. 1).

According to Toro, Jiménez, Cortéz, and Bonilla, (1999), one of the main problems of specifying requirements is to document those requirements in a form that can be understood by both non-computer-literate users and the software developers. One popular form of documentation is the use case model.

2.2 Use Case Model
It is assumed that the reader is familiar with the UML's Use Case Diagram, and the non-UML use case narratives that may be used to provide detail of the expected program behaviour to attain use case goals (Cockburn, 2001). Use case narratives may be customised to suit individual developer's needs (Costain, 2000; Costain, 2008).

In a recent OMG-endorsed survey of analysts who were familiar with both OO techniques and UML, Dobing and Parsons (2006, 2008) excluded component and deployment diagrams, and included the text-based use case narrative as a 'diagram'. The authors found that for overall diagram use on both new projects and system enhancements, the most used UML diagrams were: class, use case, sequence, and use case narrative, in that sequence. As OO is perceived as the prime paradigm for software development (Fedorowicz and Villeneuve, 1999; Johnson, 2000; Johnson and Hardgrave, 1999) it is important that use case, often touted as the over-seeing method for controlling OO development (Jacobson, Christerson, Jonsson, and Övergaard, 1993), be included.

UML's size and complexity have been noted in the literature (Siau, Erickson, and Lee, 2005). However, the proliferation of diagram types should not impede the learning of the first diagram.

There are challenges for students who are learning use case notation and application. Semantic inconsistency exists between the <<includes>> and <<extends>> structures, their differing arrow directions confusing students (Siau and Loo, 2006). Students also struggle with choosing an appropriate granularity for use case identification (Costain, 2000).

2.3 Cognition and Learning
Although we do not fully understand how human cognition works there have been many theories promoted over the years. A number of researchers believe that as humans gain experience in a specific activity they form mental models, or *schemas,* in long-term memory (LTM). A *schema* is a knowledge structure, a stored representation of common aspects between similar situations (Agarwal, De, Sinha, and Tanniru, 2000; Andriole and Adelman, 1995; Détienne, 1995). In problem-solving, the schema whose conditions are the best fit for the problem is retrieved (Détienne, 1995; Rist, 1989).

Anderson's (1983, 1993) theory differs from that of the schema fraternity in that he proposes both declarative memory (factual knowledge) and procedural memory (knowledge manifested in performance). He uses *chunk* as the basic unit of knowledge in declarative memory and *production* as the basic unit in procedural memory. Koedinger and Anderson (1990) relate the previous concepts by stating that schemas could be represented as production rules.

The extent to which information is retained in LTM depends upon how well it has been attended to and processed (Anderson, 1983; Gardiner, Gregg, and Karayianni, 2006). We, as teachers, are challenged to assist the students to form chunks and productions in LTM. During our courses we do not have unlimited time in which students may exercise new knowledge and thus we must impart the knowledge in the most time efficient manner.

It has been demonstrated empirically that 'what a reader sees is largely a matter of what he or she has learned to look for' (Petre and Green, 1993, p.69) which emphasizes the importance of training. Anderson (1983) believes that choice of a particular production set is influenced by the learning mechanisms that give rise to it. Thus how we teach content is important not only to ensure that there is sufficient exercising of the concepts within the available time, but that students learn how those concepts should be applied in the real world.

2.4 Students as Adult Learners
'Accumulated life experiences differentiate children from adults, they also differentiate one adult from another.' (Caffarella and Barnett, 1994, p.30). The ages of our students range from 18 upwards. Many attended university straight from high school and lack business knowledge. In our courses we have observed students who do not know what an invoice is. We cannot assume that all students have a wide variety of established schemas from which to leverage new learning.

Adults differ in their preferred method of learning. McLoughlin (1999, p.2) defines learning style as 'adopting a habitual and distinct mode of acquiring knowledge'. An important objective of education is to help students build their skills in both their preferred and less preferred styles of learning (Felder, 1993).

2.5 Active Learners
Both Kolb (1984), and Felder and Silvermann (1988) in their respective learning style models, include a category for 'active learners'. Kolb (1984) provides a Learning Style Index (LSI) which measures a person's relative emphasis on each of his four modes of the learning process. These four modes include: an orientation towards concrete experience, towards reflective observation, towards abstract conceptualization, or towards active experimentation. Felder and Spurlin (2005) believed that the active/reflective dimension from the Felder-Silverman Learning Style model was analogous to the active experimentation dimension in Kolb's (1984) Learning Style model.

Active learners, as defined in the Felder-Silverman Learning Style Model, learn better by trying and doing things, and prefer working in groups (Felder 1993). Soloman (1999) is reported in Fowler, Allen, Armarego, and MacKenzie (2000) as having found from a survey that 80% of students are active learners. Fowler et al. (2000) found only 57% of their software engineering students were active learners, and Senapathi (2004) found 53.8% of her software engineering students and 59% of students studying an earlier offering of the SA&D course in which we applied our role-playing activities, were active learners.

The compatibility of a student's learning style with the lecturer's teaching style, supplemented by the native ability and prior preparation of the student, affects how much a student learns in class (Felder and Brent, 2005). Active learners do not learn much in passive situations, such as in most lectures (Felder and Silverman, 1988). Of course it is not advisable to concentrate on only one specific learning style when presenting a course. Students exhibit a variety of learning styles, and it is beneficial to expose them to their lesser preferred styles in order to prepare them for the real world. The best an instructor can do is satisfy each diverse student learning style at least some of the time (Felder and Brent, 2005). If it is consistently found that over half of the students in software engineering/SA&D classes are active learners it is unfortunate if that method of learning is absent from those courses.

Active learning techniques are also desirable as they are highly motivational (Feinstein, Mann, and Corsun, 2002; McCarthy and Anderson, 2000).

2.6 Experiential Learning
In experiential learning students learn from their experiences (Lewis and Williams, 1994). The traditional method of a teacher imparting 'knowledge' in front of a class, and the class exercising that knowledge in text-based exercises and case studies only goes part way to establishing useful cognitive productions that can be applied to real-life examples. Students benefit from immersion in interactive environments that replicate situations that they might encounter in their careers (Feinstein, Mann, and Corsun, 2002).

Experiential learning has been successfully applied in the form of role-playing in a wide variety of disciplines, including accounting (Specht and Sandin, 1991), history (McCarthy and Anderson, 2000), business ethics (Brown, 1994), economics (Alden, 1999), geography (Maddrell, 1994), tourism management (Armstrong, 2003), marketing (Gremler,

Hoffman, Keaveney, and Wright, 2000), selling and purchasing (O'Hara and Shaffer, 1995), requirements elicitation (Raghavan, Zelesnik, and Ford, 1994), and computer science (Andrianoff and Levine, 2002; Biddle, Noble, and Tempero, 2001, 2002; Börstler and Schulte, 2005).

2.7 Role-Play
According to Feinstein, Mann, and Corsun (2002, pp. 3), 'Role-playing allows participants to immerse themselves in a learning environment by acting out a role of a character or part in a particular situation. … The participant interacts with others who are also role-playing'. The authors stress that it is important that the instructor ensures that all participants possess some introductory level of understanding, in order to perform appropriately during the role-playing. It is not suggested that lectures be replaced. Lectures can form a useful introduction to content, providing factual information to be remembered (using Anderson's [1983] declarative memory), such as UML notation.

Role-plays expose students to the possibility of a variety of solutions (Richardson and Kleiner, 1992). Performances of different instantiations of a well exercised and tested role-play can vary, depending upon the behavior of the participants (Brown, 1994).

McCarthy and Anderson (2000) discovered that in exam questions answered a fortnight following an exercise where students learned via playing multi-cultural roles, the role-playing groups performed significantly better than a control group that experienced traditional teacher-lead discussion. Specht and Sandlin (1991) compared the performance of students who role-played a loan committee, to traditional learning, and found no short-term differences in knowledge retention. However, six weeks later, the role-players' retention had not significantly changed, whereas the retention by the control group showed a significant loss. This suggests that role-play can more deeply exercise content to facilitate the creation of productions in LTM.

Role-playing as a method of learning is well suited to activities requiring ***interpersonal interaction*** (Feinstein, Mann, and Corsun 2002; Newstrom, 1980). As elicitation of user requirements usually involves interpersonal interaction, role-play provides an appropriate, safe environment in which students can practice, establish, and exercise cognitive productions.

2.8 Challenges of role-play exercises
Although student perceptions have been found to be positive (O'Hara and Shaffer, 1995), role-plays also have disadvantages. They are time-consuming to prepare (Alden, 1999; Armstrong, 2003; Maddrell, 1994; Richardson and Kleiner, 1992). Students may feel threatened by them to the extent that learning is impaired (Richardson and Kleiner, 1992). It is important that the fact that the student is playing a role is constantly acknowledged (Armstrong, 2003). 'The freedom afforded by playing a stranger, and attributing extreme positions to that individual, allows players tremendous scope of exploration into the nuances and conflicts inherent in any complex situation, without exposing the player's own beliefs' (Brown, 1994, pp. 106).

All participants must be adequately briefed (Feinstein, Mann, and Corsun, 2002). A lack of familiarity with a context

may result in the students experiencing fear and anxiety, causing them to withdraw from an exercise.

Role-players may receive feedback from other role-players that is not representative of the real world. Feinstein, Mann, and Corsun (2002) warn that responses in role-plays may reflect the player's emotional, cognitive, and physiological reactions to the context, to the activity around which the role-play is structured, or to other participants.

Use cases feature in the Biddle, Noble, and Tempero, (2001, 2002) role-plays, but their role-playing involves interaction between the user (actor) and the system. Raghavan, Zelesnik, and Ford, (1994) applied role-play to requirements elicitation but the findings were documented in writing, not use cases.

3. RESEARCH METHODOLOGY

3.1 Introduction to Research Methodology
This section outlines the research methodology for this study. The Walter and Marks (1981) phases for experiential learning are introduced, followed by a description of how each phase was implemented for our role-play. A description of the data sample and its collection follows.

3.2 Phases for experiential learning
3.2.1 Introduction to Phases: Walter and Marks (1981) proposed six phases for the experiential learning process: planning, introduction, activity, debriefing, summary, and evaluation.
Planning includes the designing of the learning activity involving a model of reality, and the preparation of the required materials to be handed out to students.
Introduction involves the students receiving an initial introduction to the concepts that are to be experienced.
Activity describes how the students carry out the learning activity.
Debriefing is lead by the instructor, following completion of the activity.
The instructor *summarizes* the results of the debriefing.
Finally, the experience should be *evaluated* to assess its success and possible improvements.

In the following sub-sections we describe how the current role-play followed those six phases.

3.2.2 Planning the role-play: The role-play prototype was piloted in an OO modelling course offered at a tertiary institute which supported small teacher-lead classes, usually involving 20 to 30 students (Costain, 2000). The participating students were predominantly from industry and had wide experience from which to leverage their learning. Their use case models and narratives were hand-written.

The opportunity arose to use the same role-play exercise at a larger tertiary institute. An updated version was used in tutorials for an SA&D course of 130 enrolled students. Although few students had industry experience, all had passed a prerequisite introductory course. The SA&D course holds three one hour lectures per week for twelve weeks and students choose one two-hour tutorial to attend per week. Tutorials accommodate a maximum of 30 attendees. Although planned by the lecturer, tutorials are supervised by tutors.

Students receive one mark for attending a tutorial and attempting an exercise during that time.

The original role-play notes were improved as a result of input from the tutors who managed the tutorials. Scenario descriptions were reformatted to enhance readability, and the role descriptions trimmed to enable students with English as a second language to readily absorb the information. As anecdotal feedback was obtained following the first occurrence of this revised tutorial, attesting to the success of the role-play and its popularity with students and tutors, it was decided to run it again in the following semester and collect formalised feedback. For this second semester there were 90 enrolled students, a typical distribution of students between first and second semester courses. The exercise was run again in the first semester of the following year with a class size of 136 enrolled students.

The tutorial proceeds as follows: the students are asked to form groups of six people and each group is then asked to role-play a JAD session to enable the requirements for the 5-Round Supermarkets system to be documented in a use case model. Six team members were recommended by Wilkinson (1995) for CRC (class, responsibility, collaboration) card derivation. If the total number of students in the class is not an even multiple of six, the extra students are added to existing groups as systems analysts. A supermarket example was chosen as likely to be familiar for a majority of the students. At the end of the tutorial each completed use case diagram is presented online to the class using the SynchronEyes technology, along with comments about what went well for the group and what the group found difficult, from the perspectives of both the user and the systems analyst role-players. SynchronEyes enables the contents of a student's screen to be projected to the class. Role-play documentation is collected at the end of the tutorial to prevent students from leveraging work from previous tutorials, and to reduce the need for replication as the documentation can be reused.

In the following week's tutorial a suggested solution for the use case model is provided and the class is split into groups, each of which is assigned a use case for which a narrative must be created. The students share their narratives using the SynchronEyes technology, and the tutor, with the aid of the class, summarises the results. The same 5-Round system is used in following tutorials for class and sequence diagram exercises. Thus students are exposed to one consistent system and are able to note linkages between the three UML models and use case narratives.

3.2.3 Introduction to content: Content is introduced during lectures. JAD sessions and conflict resolution are introduced in the 'Information Gathering' section of the course, whilst the UML notation for use cases and use case narratives are covered during the 'Modelling User Requirements' section. During the latter lectures a small narrative case study is solved interactively with the class to produce a use case model, thus introducing the students to the application of the notation prior to the role-playing. At the start of the tutorial, the tutors demonstrate how to record use case diagrams in the IBM® Rational® Rose® CASE tool.

The 5-Round Supermarket Rewards Card System.

The 5-Round chain of supermarkets wish to attract customers by offering a card which customers may use to collect points when they pay at check-out. The plan is to send out rewards in the form of cash coupons when a customer's points attain a certain total.

The SA2Twenty Consulting Company has been approached by 5-Round's management to investigate and implement a computerised solution for this 'Round Rewards' application. SA2Twenty have successfully implemented similar reward systems for other businesses that use a computer platform similar to that of 5-Round.

The 5-Round Information Technology (IT) Manager has arranged for a series of JAD sessions to be attended by representatives of both 5-Round and SA2Twenty. The aim of these sessions is to clarify and record the user requirements for 5-Round.

There will be six attendees at each JAD session – three users from 5-Round and three systems analysts from SA2Twenty.

The 5-Round representatives will be:
   IT Manager
   Marketing Manager (the sponsor for the application)
   Chief Checkout Supervisor.
One of the systems analysts will act as Leader for the JAD session, and another systems analyst will act as scribe. Any other group members will act as systems analysts.

Table 1. Role-Play Scenario

3.2.4 Activity: In the two-hour tutorial the scenario in Table 1 is handed to the students. The student groups elect their JAD leader who is handed the envelopes containing role descriptions and the list of what activities should be carried out during the session (see Table 2).

Group members choose their preferred roles and each member receives the envelope containing their role description from the leader. Each user-role-player receives a brief narrative of what that role requires from the system. At least two of the user roles have slightly conflicting requirements.

Each group gathers around a computer on which their scribe can record the findings.

3.2.5 Debriefing: At tutorial conclusion the tutor leads the discussion and summarizes what went well and what was difficult. It is anticipated that models will vary, and demonstrate variations in granularity, thus highlighting one of the challenges of use case construction.

---

15 minutes:
1. Introduction to IBM® Rational® Rose® – the Computer Aided Software Engineering (CASE) tool used to record the use case models.
2. Form into groups of six and group around a desk with a computer.
3. Appoint the Systems Analyst leader.
4. Appoint the Systems Analyst scribe.
5. As leader you will be given the role descriptions in sealed envelopes. Each member of the group must choose one role to perform but will not receive their role description until all roles are claimed. Each member will only be able to read their own role description.

50 minutes (or sooner if your group is finished sooner – as leader you will make the decision as to when the model is complete – but the time must not exceed 50 minutes):
Extract the requirements and document them in a use case model using IBM® Rational® Rose®.

15 minutes:
Discuss what went well and what was difficult from the perspectives of both the user and the systems analyst. The scribe will record the results in a Word document online.

Presentations:
The remainder of the time will be spent with each group, in turn, having their use case model and findings projected to the class. The leader can elaborate on the findings that are displayed.
If there is more time, a class consensus on what was easy and what was difficult may be derived.

Table 2. Leader's List of Activities for Session

3.3 Hypothesis

We aimed to discover if the students believed that they gained a better understanding of how user requirements are elicited and documented in a JAD session, compared with their understanding prior to the tutorial. Therefore we developed the following hypothesis:

There is significant difference in students' understanding of how user requirements are elicited and documented in a JAD session before and after the role-play tutorial.

3.4 Data sample and collection

A survey was used to assist with evaluating the exercise. Following completion of the tutorial, participants were invited to answer a voluntary questionnaire which asked them about their experiences during the session. Students were placed in the draw for a gift voucher of their choice as reward for completing the survey. The survey took the students approximately five minutes to complete. There were a mix of questions, some with a 5-point likert scale, and some open-ended questions which encouraged students to comment on aspects of the role-play exercise.

For the first semester of data collection, 49 responses were received from a class size of 90 enrolled students (54.4% of the class). For the second, 86 responses were received from 136 students (63.2% of the class). This gave a total sample size of 135 responses.

The questionnaire asked students to specify which role they played during the role-play. The number of responses per role is shown in Table 3.

Role	No.
IT Manager	18
Checkout (CO) Supervisor	18
Marketing Manager	18
Systems Analyst (SA) Leader	30
Systems Analyst Scribe	26
Systems Analyst	25

Table 3. Number of responses per role

The tutors who managed the sessions were also interviewed to gather their opinions on how their sessions went.

3.5 Data Analysis

The data analysis for this study consists of both quantitative and qualitative analysis. The quantitative analysis involved a t-test carried out in SPSS to test our hypothesis. The qualitative analysis was used to examine the students' answers to the open-ended questions within our survey. This was done using the Nvivo qualitative software package. Close readings of the text were performed and structural codes created which is an appropriate style of coding for gathering major categories or themes from textual data (Saldaña, 2009).

4. RESULTS AND FINDINGS

4.1 Tutor Interviews

The tutors who managed the role-plays reported that students enjoyed the exercise. A tutor who had supervised two tutorials per semester encountered a group in the second semester that had difficulty with the role-play. Those students had poor English skills. Poor English had not been encountered in the first semester's tutorials.

A second tutor suggested that the students be exposed to a brief video of a JAD session prior to the role-play exercise, in order to better prepare the students for their experiences.

There were also reports that the SynchronEyes software had not worked in some instances in the second semester, posing challenges for the sharing of models with the class.

4.2 Quantitative Analysis

Questions 1 to 10 from the survey will be presented, followed by a graphical representation of the results. For each graph, the mean ($\bar{x}$) and standard deviation (σ) are presented.

Q1: Before the tutorial, I had an understanding of how user requirements are elicited and documented in a JAD session (Figure 1).
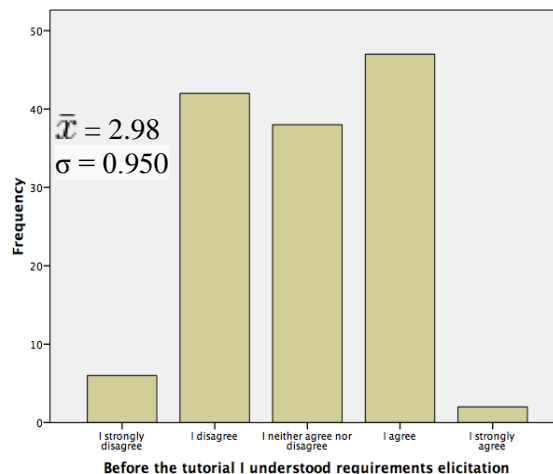

Figure 1. Question 1

Q2: After the tutorial, I had an understanding of how user requirements are elicited and documented in a JAD session (Figure 2).

Before the tutorial, the students perceptions of their understanding of how user requirements are elicited and documented in a JAD session is mixed ($\bar{x} = 2.98$). There is a clear difference after the tutorial ($\bar{x} = 3.92$) with most student's agreeing that they felt their understanding had increased. Based on the results from Questions 1 and 2, a t-test was performed to determine if there were statistically significant differences between the students' perceptions before and after the tutorial. The results of the hypothesis test are shown in Table 4. Overall, the students believed they now had a better understanding of how user requirements are elicited and documented in a JAD session (p-value 0.000).

Therefore we can accept our hypothesis.

| Description of role played | t | df | P-Value | t test results | | | 95% Confidence Interval of the Difference | |
				Mean Difference	Std. Deviation		Lower	Upper
Overall	10.081	134	.000	.94074	1.08424		.7562	1.1253
SA Leader	5.154	29	.000	1.03333	1.09807		.6233	1.4434
SA	5.014	24	.000	1.0800	1.07703		.6354	1.5246
Marketing Manager	5.132	17	.000	1.05556	.87260		.6216	1.4895
SA Scribe	3.275	25	.003	.84615	1.31734		.3141	1.3782
IT Manager	3.198	17	.005	.72222	.95828		.2457	1.1988
Checkout Supervisor	3.220	17	.005	.83333	1.09813		.2872	1.3794

Table 4. Outcome of the Hypothesis Test

$\overline{x} = 3.92$
$\sigma = 0.713$

After the tutorial I understood requirements elicitation

Figure 2. Question 2

$\overline{x} = 3.96$
$\sigma = 0.827$

Opportunity to experience a JAD session

Figure 3: Question 3

We were also interested to determine if there was any difference in students' understanding based on the role that the student played during the tutorial. There are two groups of roles in the tutorial, roles with *active* involvement (Systems Analyst (SA) Leader, SA, and Marketing Manager), and roles with *supportive* involvement (SA Scribe, IT Manager, and CO Supervisor).

We found *very strong* support of a significant difference after the tutorial for students who played *active* roles during the tutorial. These roles were the SA Leader (p-value 0.000), the SA (p-value 0.000), and the Marketing Manager (p-value 0.000). We found *strong* support of a significant difference after the tutorial for students who played the *supportive* roles during the tutorial. These roles were the SA Scribe (p-value 0.003), the IT Manager (p-value 0.005), and the Checkout Supervisor (p-value 0.005). Although all roles reported a better understanding of user requirements elicitation, there was a slight increase in the significance of students who played active roles over supportive roles. We can determine based on this analysis that learning for students who played active roles is more enhanced than those who played supportive roles.
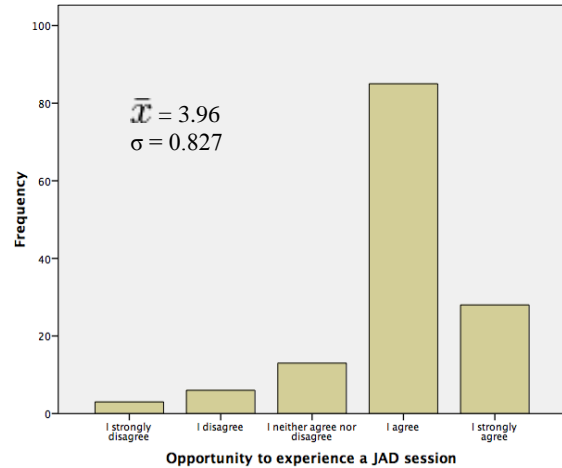
Results for Questions 3 to 10 follow:
Q3: The use case role-play tutorial has given me the opportunity to experience a Joint Application Development (JAD) session (Figure 3).
Q4: The use case role-play tutorial has given me the opportunity to experience eliciting user requirements for a new computer system (Figure 4).
Q5: The use case role-playing tutorial has given me the opportunity to participate in the documentation of user requirements for a new computer system in a use case model (Figure 5).
Q6: The class discussion following the role-play helped me to reflect on the activities (Figure 6).

After participating in the tutorial, the students generally felt positive about all aspects relating to the role-play. Firstly the students believed they had actively participated in a JAD session ($\overline{x} = 3.96$). During the role-play, students were required to elicit the requirements for a computer system. Most students believed this was achieved ($\overline{x} = 3.79$).

$\overline{x} = 3.79$
$\sigma = 0.802$

Opportunity to elicit user requirements for computer system

Figure 4: Question 4

$\overline{x} = 3.91$
$\sigma = 0.885$

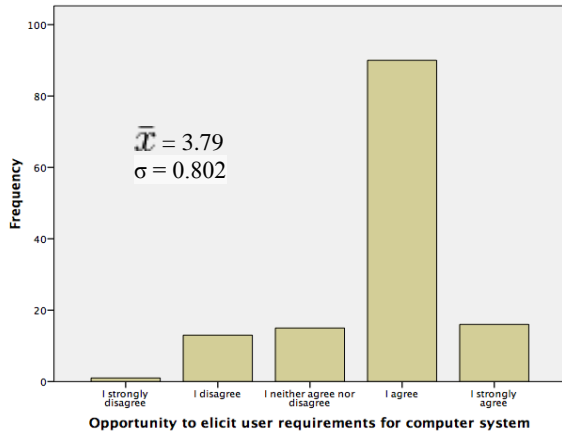**Class discussion helped me to reflect on the activities**

Figure 6: Question 6

To document the requirements, students were required to construct a use case model. Overall students believed that the tutorial had given them a good opportunity to construct a use case model ($\overline{x} = 3.93$). As well as constructing a use case model, the students were required to discuss the model within their group, and, following presentation of their model to the class, with the other groups. The students believed that the class discussion afterwards (with the tutor leading) helped them to reflect on the activities of the role-play ($\overline{x} = 3.91$).

$\overline{x} = 4.28$
$\sigma = 0.816$

I enjoy learning by doing

Figure 7. Question 7

$\overline{x} = 3.93$
$\sigma = 0.769$

Opportunity to document user requirements in a use case model

Figure 5. Question 5

We were also interested to determine if the students enjoyed learning by doing, as well as their opinion on role-play as an effective method of learning. Lastly we were interested to discover what the students thought of the role-play exercise. The following questions were asked.

Q7: I enjoy learning by doing (Figure 7).

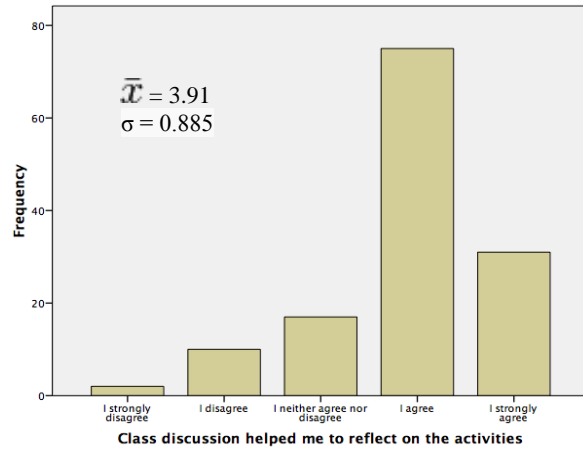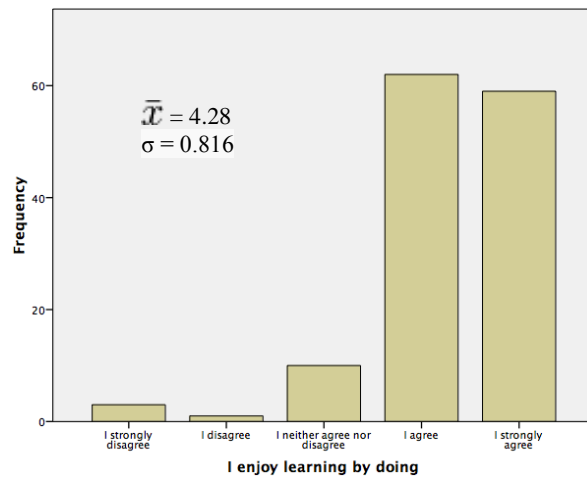**Q8**: I find role-playing an effective method for learning (Figure 8).

$\overline{x} = 4.04$
$\sigma = 0.909$

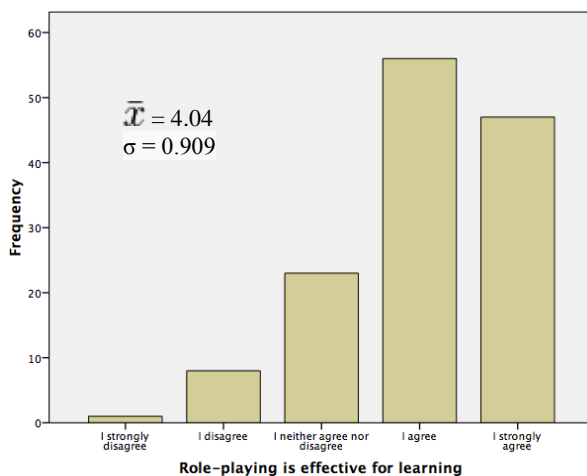**Role-playing is effective for learning**

Figure 8. Question 8

Q9: How did you find participating in the tutorial? Very Demanding / Reasonably Challenging / Not Demanding at all (Figure 9).
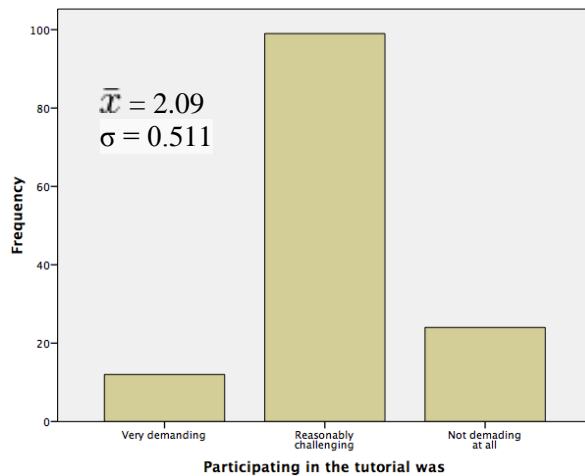

Figure 9. Question 9

Q10: How did you find participating in the tutorial? Boring / OK / Fun (Figure 10).
Overall the results were positive. The majority of students enjoy learning by doing ($\bar{x}$ = 4.28), and believed that role-play is an effective method for learning ($\bar{x}$ = 4.04). Lastly, the students thought the tutorial was reasonably challenging, as opposed to very demanding or not demanding at all. Most students also thought that the tutorial was either OK or fun, as opposed to boring.
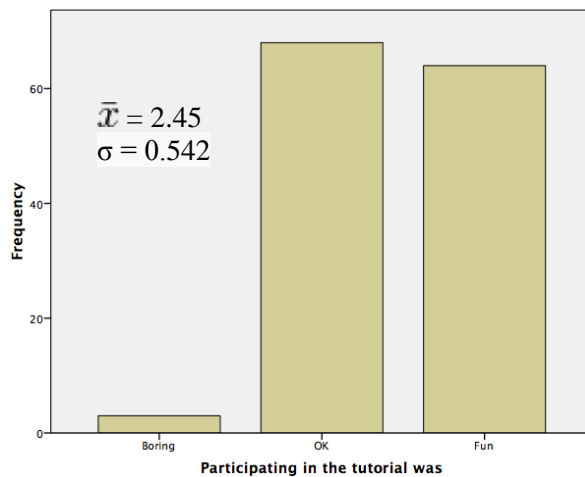

Figure 10. Question 10

In order to gather further information about these aspects, students were asked a set of open-ended questions. These are presented in the next section (qualitative analysis).

4.3 Qualitative Analysis
The following results based on our qualitative analysis of the students' textual responses to the open-ended questions will be illustrated with examples from the students' responses.

4.3.1 Problems with use case modeling: The first open-ended question asked the students if they have any problems with aspects of use case modeling. Of the students who answered this question, 44 said "yes", while 85 said "no". Of the students who responded "yes", the most common area of difficulty was the concept of <<include>> and <<extend>> relationships.
"*I was also initially confused by the <<includes>> and <<extends>> notation*"

"*extends and includes relationship can be quite confusing.*"

The concerns with <<include>> and <<extend>> relationships also related to which type to use under certain conditions, how to apply the correct notes to the relationships, and the direction of the arrows.
"*I'm not exactly sure what to write in the note for the extend and include arrows, my friend was trying to explain it to me, for the one arrow that linked to enter employee details(includes) she wrote 'add employee details' but i thought well that is kind of obvious, but for another example she wrote 'according to standards', that was for an extends, so is it for an include you write what you do to include it? and for an extends you write the condition upon which it is extended to??*"

"*There are some aspects that i still don't understand, like what specifically goes into the use case and the direction of arrows.*"

The next most common problem relates to the actors in the model. There was no problem in identifying the actors to be included, the issue was determining if an actor was a primary or secondary actor, or determining the associations between actors and use cases.
"*It think that it is confusing when to distinguish an actor as either primary or secondary.*"

"*Some of the concepts are quite challenging - I.e. where to connect up some of the use cases with the users.*"

Another major issue we discovered was the students' difficulty in determining the granularity of use cases, or how to define a use case within a particular model.
"*I find it challenging to determine the granularity or level of detail that each use case should model.*"

"*It's hard to work out what the use cases are and how to link them at times.*"

"*Figuring of what use cases to model and what to leave out.*"

Other difficulties with use case modelling that students' raised in their responses related to their struggle to determine the systems requirements, the many different acceptable ways to produce a use case model, the idea that drawing

models does not come naturally, and the requirement of the students' to deal with unfamiliar situations. One student also reported confusion between use case modeling and Entity Relationship modeling which is taught in a separate course.

4.3.2 Group work: The next question asked the students if they enjoyed working in groups. Of the students who answered this question, 122 said "yes", while seven said "no". Of the students who answered "yes" to this question, the most common reason for enjoying group work was for the sharing of ideas among classmates. The students thought that it is a more effective way of learning, with the opportunity to bounce ideas around the group.

> *"It helps to have someone you can bounce your ideas off and then get multiple angles on the same situation"*

> *"Also, it helps clarify concepts by exchanging ideas and thoughts - e.g. fellow students might be able to explain [their understanding of] concepts in a more understandable manner."*

> *"It enabled us to pool our learning where we weren't restricted and as such gain a collective view on what needed to be achieved."*

> *"Everyone has their own ideas which they contribute and which you pick up on. I believe this is effective learning."*

> *"Groups help to understand the thing properly different perspective"*

> *"Because different people have different ideas about things. It's interesting to learn what these ideas are and they can provide a new perspective"*

> *"Group learning uses the two minds are better than one principle. If unsure of something other group members may be able to explain it in a way that I understand. Groups also let other members raise points that I would not have thought of."*

> *"By bouncing ideas around, it helps people learn as well as creating a fun and engaging environment."*

However: *"Learning in groups is fun as long as all group members are willing to participate."*

The students also thought that group work created a more realistic situation similar to that of the real world.

> *"Everyone got to participate and was able to create a "real" life situation"*

Other points raised related to the ability to get a deeper understanding during class discussion which raised ideas the students had not considered, the enjoyment of interactive learning, the ability to get to know other students in the class, and it is easier to ask friends for help rather than feeling "embarrassed" to ask the tutor for assistance.

Of the seven students who said they did not like to work in groups, only a few provided a reason why, with comments such as "*I prefer to work individually*", "*groups can be dysfunctional*", and "*wastes time and causes conflicts between group members*".

4.3.3 The tutorial: Students were also asked to reflect on what went well and what could be improved in the tutorial. By far the most common reason students gave for the success of the tutorial was the ability to work in groups, followed closely by the group discussions, both within the groups, and within the tutorial class. This further confirms our previous results concerning the students overall enjoyment of group work.

> *"Everyone worked together to solve the problem. We had some great discussions and I think that you learn quite a lot when discussing a problem with other people."*

> *"Working in a group we were able to complete the lab requirement and learn from each of the individual group members."*

> *"Everyone in the group had participated and worked hard to solve the problems."*

The students also enjoyed the opportunity to draw a use case model by themselves. This was their first opportunity to create a use case model in smaller groups outside of lectures. This helped the students to not only get hands on experience with the creation of a use case model, but also deepened their understanding and provided them with more confidence when modeling.

> *"Being able to complete a use case model all by ourselves, which helped us to learn."*

> *"I was able to gain a greater understanding and greater confidence when establishing a Use Case Model, hoping that it encompassed all the Users."*

> *"We had come up with a lot ways to draw use case model more accurately had fun discussing it."*

> *"Great chance to actually apply user requirements into constructing a use case model."*

Participating in a JAD session was also an important factor towards the students overall enjoyment of the tutorial. It gave the students a better understanding of the true nature of JAD, and how one might be performed in the real world. In lectures, the true value of JAD cannot be adequately portrayed, so the students appreciated getting hands on experience. It also helped the students realize that performing a JAD session is more difficult than they had imagined.

> *"The group discussion had leaded us to actually develop a JAD which we don't have the chances to do in lectures, and before the lab, I thought JAD was very easy, but it is challenging when I have to come up one from a group."*

> *"Demonstrating how JAD sessions would be used in the workplace, and working in groups to achieve the final outcome."*

"The interaction between all the different roles were rather interesting, it forced people to work together and mirrored the real world."

Other key themes which arose from the students responses were that the tutorial provided them the opportunity to learn more about designing a computer system, to use the CASE tool, to give a presentation to the class, as well as learning how to work as a team, getting ideas validated, hearing multiple opinions, learning from each other, and receiving feedback on their models.

When asked about what could be improved in the tutorial, the majority of students said that nothing could be improved and that they thoroughly enjoyed the exercise. However, a few students offered suggestions for improvements. The most common suggestion was to provide more time. The tutorials are conducted within a two-hour time slot without the possibility of going over time. Generally the students were slow in reading the case study in order to properly understand the roles they were playing, and to understand the users' requirements for the system. It also took time to construct the model as for the majority of the students this was their first use case model. One student suggested that pre-discussion is important for the exercise.

"Time wasn't enough, we actually wasted the first hour in the explanation part and figuring out what we were supposed to do."

"More time to really think and come up with the best solution to the case? I guess time constraint can be a problem sometimes."

"We definitely need more time to create a satisfied use case. It took us nearly half hour to discuss the scenario. Pre discussion is quite important."

Students also suggested that there could be more guidance from the tutors, and to make the role descriptions clearer. Often students are too shy to ask the tutor questions, and would rather do nothing than ask the tutor. Further emphasis should be given to students sticking to their assigned roles. Students were instructed not to look at the role descriptions belonging to other students, and hence were required to discuss each other's requirements.

"The tutor checking up on groups and being actively involved, there were often members of the group who were asking questions that no other group member could answer and were too shy to ask the tutor."

"More explanations and emphasis on sticking to your roles, so we can further see how Analysts and clients interact."

"It was, at times, difficult to understand what the entire model was required to do only from what your individual role stated and what you could glean off your other members. Therefore the roles of each person could be defined a bit more clearly and simply. For example we did not know, for on my Systems Analyst description it did not clearly say, that our only point of communication

to the other Supermarket Team was via our Leader. As I couldn't read any others description I couldn't clearly grasp that this was the case. Also, if someone in the group merely failed to take a specific meaning out of what the system needed then that aspect of the model was left out."

It was a misconception that the systems analysts' only point of communication with the users was through the leader.

An interesting suggestion from a few students was to allow the students to swap roles in order to allow a deeper understanding of other ideas and to make the exercise more challenging.

"To be able to swap roles so you get a chance to understand other ideas."

"I think if could switch roles would be more challenging as well."

Other common suggestions were to make the case study more complex, provide some examples of use case models before the tutorial (examples had been provided during lectures and in the text book), offering a reward for the best model, make the role descriptions more realistic while introducing more arguments/conflicts between the system requirements for each role, and using name tags so students could easily remember who was playing each role. It was also suggested that there be fewer co-operative roles, i.e. decrease the number of systems analysts in the group, and add more users.

"Fewer co-operative roles, the systems analysts didn't have to do anything if one was confident enough to do it all themselves."

"Possibly having more roles of people who would be users of the system and less system analysts. in our group in seemed that some of the systems analysts didn't need to do much."

One suggestion was to have interview questions pre-written for the students so they knew the right questions to ask the users. This could be generically addressed in the 'Information Gathering' section of the course.

5. LIMITATIONS

A limitation of this research is the use of a convenience sample, which could reduce the accuracy of our analysis. However, we still believe that results are valid as students generally responded positively to the role-play exercise based on the responses collected in the open-ended questions.

Based on answers to Questions 1 and 2 in the survey, t-tests were carried out to discover if there was a significant difference between the students' perceived understanding of how user requirements are elicited and documented during a JAD session, before and after the tutorial. Responses were obtained from 30 systems analyst leader role-players, 26 scribes, 25 systems analysts, and 18 from each of the user-roles (Table 3). Sample sizes less than 30 can reduce the accuracy of the t-tests. However, as Table 4 (Outcome of the Hypotheses Tests) provides very strong agreement for *active*

roles, and strong agreement for *supportive* roles, and the 'Overall' category provides very strong agreement (p-value 0.000), it is likely that the results are indeed representative.

6. CONCLUSION

The capturing of user requirements is an essential step in software development and one that is frequently carried out by career systems analysts. It is important to prepare our SA&D students for this real world challenge. The role-plays provide an in depth experience for the students who gain greater understanding of the context in which use cases may be applied. Through the group and class discussions the students are exposed to a variety of solutions. They are able to discern the inherent challenges of use cases, such as choice of granularity. The students also gain a greater appreciation of the need for system analysts to apply facilitator skills as recommended in (Olfman and Bostrom, 1992). However, the effectiveness of the exercise will be reduced if team members lack fluency in the language in which the role-play is presented, or refuse to participate.

The strong student perception of increased understanding of how user requirements are elicited and documented in a JAD session, suggests that the tutorial had exercised useful cognitive schemas into the students' LTMs. It was encouraging to find that the method of learning applied to the exercise had a positive impact on the perceived learning. This result further leads us to consider that role-playing is an effective method of learning.

The results indicate a difference in students' perceptions of increased understanding, based on the type of role played (active or supportive). Although the difference is slight, this is an important finding and should be addressed in later iterations of the tutorial. Swapping roles is not a viable solution as a student, following the swap, would be elaborating on existing knowledge rather than discovering it as is the intention. Changes could be made with regards to the role descriptions and/or tutor participation to ensure that all roles receive more equitable increases in understanding.

The students have provided some excellent suggestions for improvements for the future in their answers to the open-ended questions. The suggestion for the provision of name-tags will be implemented in order to provide visual clues within a group as to who is playing which role.

Some suggestions were conflicting as can be expected from a class of students with a range of abilities, motivation, and command of English. For example one response suggested that the exercise should be more complex, and another requested that more conflicts be introduced, yet others complained about lack of time to complete the exercise, and that the role descriptions could be made clearer. The tutors can be encouraged to provide more support for the groups who experience difficulty. It must be stressed that players stick to their assigned roles.

Tutorial duration is fixed at two hours, but more time can be made available for the role-play by issuing, prior to the tutorial, a software exercise to teach the students how to use the CASE tool, which they could pursue in their own time.

One suggestion was to reduce the number of SA roles. In a standard group of six there should be three SAs: the Leader, the Scribe, plus one SA. It is possible where the number of students attending a tutorial is not an even multiple of six that the extra students also become SAs. Some thought will be applied to changing the original SA role to that of a user who could introduce more conflicting requirements.

The role-play tutorial satisfied the need to include active learning into a course where more than half of the students are predicted to be active learners (refer Section 2.5). According to the Felder-Silverman Learning Style model active learners learn by trying and doing, and prefer working in groups (Felder, 1993). Student responses to the open-ended questions confirmed that most students enjoyed working in groups and answers to Question 7 confirmed that the majority enjoyed 'learning by doing'. These preferences demonstrate active learner characteristics.

We encourage other systems analysis and design instructors to apply role-playing techniques in their courses to ensure that the learning styles of all their students are accommodated.

7. ACKNOWLEDGEMENTS

8. REFERENCES

Agarwal, R., De, P., Sinha, A.P., and Tanniru, M. (2000), "On the Usability of OO Representations." Communications of the ACM, Vol. 43, No. 10, pp. 83-89.

Alden, Dave (1999), "Experience with Scripted Role Play in Environmental Economics." Journal of Economic Education, Vol. 30, No. 2, Spring 1999, pp.127-.

Anderson, John R. (1983), The Architecture of Cognition. Harvard University Press, Cambridge,MA.

Anderson, John R. (1993), Rules of the Mind. Lawrence Erlbaum Associates, Mahwah, NJ.

Andrianoff, Steven K., and Levine, David B. (2002), "Role Playing in an Object-oriented World." Proceedings SIGCSE '02, pp.121-125.

Andriole, Stephen, and Adelman, Leonard (1995), Cognitive Systems Engineering for User-computer Interface Design, Prototyping, and Evaluation. Lawrence Erlbaum Associates, Mahwah, NJ.

Armstrong, E. Kate (2003), "Applications of Role-playing in Tourism Management Teaching: an Evaluation of a Learning Method." Journal of Hospitality, Leisure, Sport and Tourism Education, Vol. 2, No. 1, pp. 5-17.

Biddle, R., Noble, J., and Tempero, E. (2001). "Role-play and Use Case Cards for Requirements Review." In D. Cecez-Kecmanovic, B. Lo, and G. Pervan (eds) Proceedings of the Twelfth Australasian Conference on Information Systems (ACIS2001), Coffs Harbour, Australia.

Biddle, R., Noble, J., and Tempero, E. (2002), "From Essential Use Cases to Objects." From L. Constantine, (ed.), *forUSE 2002 Proceedings*, Ampersand Press, Rowley, MA.

Booch, G., Rumbaugh, J., and Jacobson, I. (1999), The Unified Modeling Language User Guide. Addison-Wesley, Reading, MA.

Börstler, Jűgen, and Schulte, C. (2005), "Teaching Object Oriented Modelling with CRC-cards and Roleplaying Games." Proceedings WCCE, 2005, Cape Town, South Africa, July 4-7.

Brown, Kate M. (1994), "Using Role Play to Integrate Ethics into the Business Curriculum a Financial Management Example." Journal of Business Ethics, Vol. 13, pp. 105-110.

Caffarella, Rosemary S., and Barnett, Bruce G.. (1994), "Characteristics of Adult Learners and Foundations of Experiential Learning." New Directions for Adult and Continuing Education, Vol. 62, Summer, pp. 29-42.

Cockburn, Alistair (2001), Writing Effective Use Cases, Addison-Wesley, NJ.

Costain, Gay (2000), "Teaching the Capturing of Functional Requirements in Use Cases." New Zealand Journal of Applied Computing, NACCQ, New Zealand, Vol. 4, No. 2, pp. 19-24.

Costain, Gay (2008), Cognitive Support During Object-Oriented Software Development: The Case of UML Diagrams. Unpublished Doctoral Thesis. University of Auckland, New Zealand.

Détienne, Françoise (1995), "Design Strategies and Knowledge in Object-oriented Programming: Effects of Experience." Human-Computer Interaction, Vol. 10, pp. 129-169.

Dobing, Brian, and Parsons, Jeffrey (2006), "How UML is Used." Communications of the ACM, Vol. 49, No. 5, pp. 109-113.

Dobing, Brian, and Parsons, Jeffrey (2008), "Dimensions of UML Use: A Survey of Practitioners." Journal of Database Management, Vol. 19, No. 1, pp. 1-18.

Duggan, Evan W., and Thachenkary, Cherian S. (2003), "Higher Quality Requirements: Supporting Joint Application Development with the Nominal Group Technique." Information Technology and Management, Vol. 4, pp. 391-408.

Fedorowicz, Jane, and Villeneuve, Alain O. (1999), "Surveying Object Technology Usage and Benefits: A Test of Conventional Wisdom." Information & Management, Vol. 35, pp. 331-344.

Feinstein, A. H., Mann, S., and Corsun, D.L. (2002), "Charting the Experiential Territory." Journal of Management Development, Vol. 21, No. 10, pp. 732-744.

Felder, Richard M. (1993), "Reaching the Second Tier. Learning and Teaching Styles in College Science." Journal of College Science Teaching, Vol. 23, No. 5, pp. 286-290.

Felder, Richard M., and Brent, Rebecca (2005), "Understanding Student Differences." Journal of Engineering Education, Vol. 94, No. 1, pp. 57-72.

Felder, Richard M., and Silverman, Linda K. (1988), "Learning and Teaching Styles in Engineering Education." Engineering Education, Vol. 78, No. 7, pp. 674-681.

Felder, Richard M., and Spurlin, Joni (2005), "Applications, Reliability and Validity of the Index of Learning Styles." International Journal of Engineering Education, Vol. 21, No. 1, pp. 103-112.

Fowler, L., Allen, M., Armarego, J. and MacKenzie, J. (2000), "Learning Styles and CASE Tools in Software Engineering." In A. Hermann and M.M. Kulski (eds), Flexible Futures in Tertiary Teaching. Proceedings of the 9th Annual Teaching and Learning Forum, 2-4 February, Perth.

Gardiner, J.M., Gregg. V.H., and Karayianni, I. (2006), "Recognition Memory and Awareness: Occurrence of Perceptual Effects in Remembering or in Knowing Depends upon Conscious Resources at Encoding, but not at Retrieval." Memory and Cognition, Vol. 34, No. 2, pp. 227-239.

Gremler, D.D., Hoffman, K.D., Keaveney, S.M., and Wright, L.K. (2000), "Experiential Learning Exercises in Services Marketing Courses." Journal of Marketing Education, Vol. 22, pp.35-44.

Jacobson, I., Christerson, M., Jonsson, P., and Övergaard, G. (1993), Object-oriented Software Engineering: A Use Case Driven Approach (Rev.ed.). Addison-Wesley, New York.

Johnson, Richard A. (2000), "The Ups and Downs of Object-Oriented Systems Development." Communications of the ACM, Vol. 43, No. 10, pp. 69-73.

Johnson, Richard A., and. Hardgrave, Bill C. (1999), "Object-Oriented Methods: Current Practices and Attitudes." Journal of Systems and Software, Vol. 48, pp. 5-12.

Koedinger, Kenneth R. and Anderson, John R. (1990), "Abstract Planning and Perceptual Chunks: Elements of Expertise in Geometry." Cognitive Science, Vol. 14, pp. 511-550.

Kolb, David A. (1984), Experiential Learning: Experience as the Source of Learning and Development. Prentice Hall, Englewood Cliffs, N.J.

Lewis, Linda H. and Williams, Carol J. (1994), "Experiential Learning: Past and Present." New Directions for Adult and Continuing Education, Vol. 62, Summer.

Maddrell, Avril M.C. (1994), "A Scheme for the Effective Use of Role-plays for an Emancipatory Geography." Journal of Geography in Higher Education, Vol. 18, No. 2, pp. 155-162.

McCarthy, J. Patrick, and Anderson, Liam (2000), "Active Learning Techniques Versus Traditional Teaching Styles: Two Experiments from History and Political Science." Innovative Higher Education, Vol. 24, No. 4, pp. 279-293.

McLoughlin, Catherine (1999), "The Implications of the Research Literature on Learning Styles for the Design of Constructional Material." Australian Journal of Educational Technology, Vol. 15, No. 3, pp. 222-241.

Newstrom, J.W. (1980), "Evaluating the Effectiveness of Training Methods." The Personnel Administrator, pp. 55-60. As reported in Richardson and Kleiner, (1992).

Olfman, L. and Bostrom, R. P. (1992) "Innovative Teaching Materials and Methods for Systems Analysis and Design", Database, Spring, pp.7-12.

O'Hara, Bradley S., and Shaffer, Teri Root (1995), "Details and Student Perceptions of an Experiential Program for Personal Selling and Purchasing Classes." Journal of Marketing Education, Vol. 17, pp. 41-49.

Petre, Marian, and Green, T.R.G. (1993), "Learning to Read Graphics: Some Evidence that 'Seeing' an Information Display is an Acquired Skill." Journal of Visual Languages and Computing, Vol. 4, pp. 55-70.

Raghavan, S., Zelesnik, G., and Ford, G. (1994), Lecture Notes on Requirements Elicitation. Educational Materials CMU/SEI-94-EM-10, March, Software Engineering Institute, Carnegie Mellon University.

Richardson, James D., and Kleiner, Brian H. (1992), "The Relevant Effectiveness of Different Training and Development Methodologies." Management Research Review News, Vol. 15, No. 10, pp. 23-26.

Rist, Robert S. (1989), "Schema Creation in Programming." Cognitive Science, Vol. 13, pp. 389-414.

Saldaña, Johnny. (2009), "The Coding Manual for Qualitative Researchers." Sage Publications, London.

Senapathi, Mahalakshmi D.V. (2004), A Framework for the Evaluation of Case Tool Learnability in Educational Environments. Unpublished Masters Thesis. The University of Auckland.

Siau, K., Erickson, J., and Lee, L. (2005), "Theoretical Versus Practical Complexity: The Case of UML." Journal of Database Management, Vol. 16, No. 3, pp. 40-57.

Siau, Keng and Loo, Poi-Peng (2006), "Identifying Difficulties in Learning UML." Information Systems Management, Summer, pp. 43-51.

Soloman, B. (1999), A private communication as cited in Fowler et al., (2000).

Specht, Linda B., and Sandin, Petrea K. (1991), "The Differential Effects of Experiential Learning Activities and Traditional Lecture Classes in Accounting." Simulation & Gaming, Vol. 22, No. 2, pp. 196-210.

Toro, A.D., Jiménez, B.B., Cortéz, A.R., and Bonilla, M.T. (1999), "A Requirements Elicitation Approach Based on Templates and Patterns." http://wer.inf.pucrio.br/WERpapers/artigos/artigos_WER99/toro.pdf, Last viewed 13/11/2009.

Walter, G.A., and Marks, S.E. (1981), Experiential Learning and Change: Theory, Design and Practice. Wiley, New York.

Wilkinson, Nancy M., (1995), Using CRC Cards: An Informal Approach to Object-Oriented Development, SIGS Books, New York.

AUTHOR BIOGRAPHIES

Dr Gay Costain was a Principal Lecturer at Auckland

University of Technology prior to joining the staff at the University of Auckland in 2000. Gay specializes in lecturing systems analysis and design, and database management systems courses. Her research interests lie in the areas of graphical modeling and human cognition in software development, and in experiential learning.

Brad McKenna is a PhD student and instructor at the University of Auckland, New Zealand. He teaches an introduction to systems analysis and design course. His research interests are in the areas of usability, design, and assessment of mobile services, Information Systems development, Location-Based Services, and User Interface design. His PhD is focused on social movements within virtual worlds.

Information Systems & Computing
Academic Professionals

STATEMENT OF PEER REVIEW INTEGRITY

All papers published in the Journal of Information Systems Education have undergone rigorous peer review. This includes an initial editor screening and double-blind refereeing by three or more expert referees.