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THE UNIVERSITY OF NOTRE DAME AUSTRALIA

Social interaction in corporate e-learning: When is it necessary?

Abstract

This article examines the role of social interaction in the implementation of an e-learning tool targeted at off-shore site safety in the oil and gas industry in Western Australia. The e-learning tool, essentially a set of self-paced activities and resources, strongly contrasts with traditional instructor-driven safety inductions that are the norm in the oil and gas industry. During 2005, over 200 participants engaged with the e-learning tool, and this article summarises participant and management perspectives on the effectiveness of the implementation strategy, with particular reference to the limited role played by any form of social interaction, including facilitator intervention. It is perhaps paradoxical that the research that spawned this article is firmly grounded in a social constructivist perspective. However, the authors argue that socially constructed learning, particularly in competency-based settings, does not necessarily imply or require social interaction or indeed facilitator intervention. Where learning objectives are limited to uncomplicated understandings, it is suggested that social interaction is not strongly valued in participant or management conceptions of good practice e-learning design. The authors advocates e-learning as a way to stimulate engagement in learning processes that encourage thinking, reflection, re-conceptualisation of ideas and meta-cognition - cornerstones of social constructivism - and argues that e-learning can still be effective in settings that are devoid of social interaction.

Background

This article has arisen from doctorate research that has adopted a single case study method to enhance understanding of how e-learning is implemented in an industry setting. Apache Energy is a multinational oil and gas company that has interests in the North West Shelf of Western Australia. In 2004, Apache Energy made a strategic decision to develop and implement an e-learning tool as a way of enhancing site safety at its operations in the North West Shelf. The company has experienced a period of sustained growth that has resulted in significant development and maintenance activity at its operations in Western Australia. Much of this development and maintenance work is contracted out, with Apache Energy employees undertaking primarily management and supervisory roles. This situation has meant that, increasingly, contractors with limited or no experience in the oil and gas industry are asked to work at off-shore production facilities. Oil and gas production facilities handle flammable and potentially lethal substances at high pressures. The chance of something going wrong in these conditions is low, mainly because of well established safety procedures that are in place. However, a critical component of risk management at an oil and gas facility is to ensure that all contractors are aware of:

- the properties and dangers of working with oil and gas at high pressures and
- safety procedures that manage routine and non-routine work.

Thus, the primary rationale for the development and implementation of the e-learning tool at Apache Energy was the need to provide a rigorous safety induction for a rapidly growing contracted workforce that was increasingly inexperienced in working in oil and gas environments.

In addition to this safety focus, an efficiency driver became increasingly obvious with the growth of the inexperienced, contracted workforce. Contractors attending an Apache Energy oil and gas facility, typically travel by air from metropolitan Perth, 1300 km south-east of the

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North West Shelf, on a 'two-weeks-on/two weeks-off' basis. Flights occur early in the morning and include a short helicopter shuttle with contractors generally arriving at a facility at mid-morning. For those new to a facility, a 4 to 6 hour safety induction would then take place. On completion of this induction, new contractors would make contact with their identified supervisor, receive a job-specific induction and then obtain directions on work priorities. In most cases, these processes would not be completed until late afternoon, and new contractors would have been advised to commence productive work on the following day. From a productivity perspective, the day is lost. In an environment of rapid growth, this was a concern for Apache Energy.

Therefore, Apache Energy sought to develop a leaning tool that offered flexibility for a contracted workforce. This flexibility had to allow for self-paced learning such that individuals could complete tasks at a time that was convenient to their personal schedules and at a pace that was appropriate to them. In this way, learning was primarily conceived as an individual endeavour with little or no social interaction with other contractors or supervisors at the point of engagement with the e-learning tool.

Apache Energy's dual rationale for engaging in e-learning (i.e. efficiency considerations combined with a significant training need fuelled by rapid growth) is typical of many organisations in the corporate sector. For example, in a study of e-learning acceptance levels conducted by the American Society for Training and Development (ASTD) and the Masie Center (2001), it was suggested that efficiency drivers, although an important consideration in corporate e-learning, were only part of the picture. Participants in the study reported that their motivations and the motivations of their employers – what the researcher described as the context for learning - were equally important factors. Certainly the conditions that were apparent at Apache Energy in 2004 were clearly receptive to an e-learning solution. The development of an effective learning tool that could be implemented in a self-paced learning environment prior to contractors attending site, was attractive. The challenge was to build a tool that recognised prior knowledge, engaged participants in authentic activities and problem solving, and ensured that assessment was rigorous and validated.

E-Learning

Broadly speaking, e-learning is a '…continuum of synchronous and asynchronous processes, which include computer-mediated learning, distributed learning networks, web-based learning, teaching aided learning, on-line learning and asynchronous learning networks (O'Fathaigh, 2002:2).

Viewed in this way, e-learning environments and tools constitute a broad spectrum of computer-mediated learning that ranges from real time and place interactions, to delayed interactions that can occur any time and in any place.

The conception of e-learning as a continuum has resulted in it being used as a 'catch all' phrase that encompasses almost all forms of learning facilitated through information and communications technologies (ICT). However, it is clear that the term means different things to different people. For instance, in the Higher Education and Vocational and Technical Education (VTE) sectors, e-learning typically comprises of access to electronic content and online communication facilities, usually through a Learning Management System (LMS) and mediated in either self-paced or group contexts in online or blended forms. Innovators in these sectors are increasingly seeing e-learning as something more than a technical iteration of an

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established pedagogy. For these individuals, e-learning is an opportunity to fundamentally transform approaches to learning, particularly using open source social software like weblogs and wikis (Mejias 2005).

Corporate e-learning offers a different slant. Michael Allen, developer of the American Society for Training and Development's (ASTDs) E-Learning Instructional Design Certificate Program, in an interview with Ellis (2004), suggested that e-learning for the corporate sector is generally viewed as electronic transmission of content:

> I find that 99 percent of it all [e-learning] follows the 'tell-and-test' paradigm: convey a block of content through lecture, books, screens, movies, bullet slides, and so forth. Then, give a quiz. (Allen 2004, cited in Ellis 2004, para. 18) (Our addition in brackets.)

Allen concluded that corporate e-learning is often tedious because it focuses on content presentation rather than the learning experience. He argues that corporate e-learning should be purposeful (learners should be able to readily see its value), authentic (directly related to job roles) and include feedback that is meaningful for the learner.

Harris and Volet (1996) have discerned that there are, sometimes, tensions between the worker as a learner and the worker as a productive unit. These tensions can be precipitated by conflicting perceptions between employers and employees of what is seen as important and needs to be known (i.e. what is to be learnt) and how the learning should be mediated. Where boundaries, around what is to be learnt, are strictly defined by the employer, there are sometimes limited incentives to deviate from these boundaries and broaden or deepen learning. Corporate e-learning can be less than engaging where the boundaries around what is to be learnt are not shared (e.g., improvement of customer service skills where participants already see themselves as competent). It can also be argued that any mode of learning (eg. lecture-driven) can be less than motivating if it fails to recognise and tap into the learner's existing knowledge and skills.

In the case of the Apache Energy e-learning tool, the boundaries around what was to be learnt were not only defined, but also readily accepted by contractors. A 'safety first' culture is clearly articulated to contractors, who were in agreement that safety knowledge is valuable. In relation to the mode of learning, Apache Energy attempted to recognise prior knowledge and skills that contractors brought into the induction process and sought to build a flexible, self-paced tool. Decisions on design and content emanated from the combination of competent educational designers and experienced safety personnel with a thorough knowledge of the characteristics, capabilities and needs of contractors. A search for e-learning content in the area of site safety was conducted prior to development, and rejected as characterising Allen's (2004) 'tell and test' model as described above. Apache Energy sought to develop a tool that engaged contractors in the active construction of knowledge, but acknowledged that given the time constraints that contractors faced, in most cases this would not occur in a social context. The primary characteristics of the Apache Energy e-learning tool are:

- activities are designed to engage and challenge contractors to think and reflect about safety issues
- real world examples are provided to give a context for the learning
- learning materials are authentic, being aligned to Apache Energy policies and procedures.
- meaningful feedback is provided for all activities
- a range of activities are provided using multiple forms of media

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- prior knowledge is recognised and there are multiple entry and exit points and ways in which the tool can be used
- assessment is authentic and validated by on-site Safety Advisers.

Social constructivism and social interaction

Most e-learning designs that are considered good educational practice appear to share similar design principles that stem from a constructivist perspective of learning. Constructivism is based on the premise that knowledge is not simply absorbed by an individual, nor can it be transferred from one person to another. Rather, individuals actively construct personally meaningful understandings as they interpret and ascribe meaning to their experiences (Piaget 1963; Resnick 1981; Shuell 1986).

Vygotsky (1978) contends that learning cannot be separated from its socio-cultural context. Even simple phenomena can be difficult to grasp without a common set of symbols that can be applied to speed up the learning process. Such symbols, like language, the written word, pictures, diagrams, and videos etc. are the building blocks of learning.

Crook (1996) suggests that the use of symbols such as language '…leave us experiencing the world in particular ways, reading it in a manner that reflects our own distinctive history of contact with such systems of mediation' (1996:35).

Inherently personal pursuits, like reading a textbook, listening to a lecture or engaging with interactive multimedia are still conducted within the context of a learner's current understandings, and with the use of symbols (eg. language), invite a particular interpretation of the world. Thus all learning is wrapped in a socio-cultural framework to some extent. The logical amplification of this view is that learning is not simply an individual pursuit, even when it may seem to be this way (eg. when a contractor is engaging with an e-learning tool on a one-to-one basis). It also requires interaction both with, and within, one's socio-cultural framework.

These theories have been drawn upon by researchers in the development of e-learning products. For example, Oliver (2001) describes key elements that are crucial to the construction of knowledge within VET e-learning environments (Table 1).

Table 1: Framework for best practice development of e-learning products

Learning design elements	Description	Examples
Learning activities	Tasks, problems and interactions used to engage the learners.	Simulations, computer-based interactions, projects, open-ended problems, inquiry tasks.
Learning resources	Content, information and resources with which the learners interact *in completing* activities.	Web pages, textbooks, web links, case studies, workplace documents.
Learning supports	Scaffolds and assistances to support learning.	Mentors, workplace trainers, forums, discussions, chats.

The elements of learning activities, learning resources and learning supports are intended to support and mediate the learning process as learners engage in non-linear, problem-based enquiries that simulate real-life situations. While the Apache Energy e-learning tool sought to

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incorporate learning activities and learning resources into its design, the actual implementation provided limited social support for learning. An Administrative/Technical Support Officer provided a brief introduction before contractors were invited to engage with the tool and a Safety Adviser subsequently validated the learning that took place. As previously discussed, this approach was adopted on the grounds of:

- efficiency - Apache Energy wanted to move away from an on-site Safety Adviser-led model of induction to an off-site model. The provision of a content-facilitator off-site as well as Safety Advisers on-site, was seen as cost prohibitive.
- flexibility - Apache Energy felt that facilitating groups of learners (e.g. collaborative learning) did not sit easily with the desire to implement a self-paced e-learning tool. Though collaborative learning is not discouraged, it is not built into the design.

Davidson (1992) illustrates that higher order learning is possible in solitary contexts. He cites an example of Pascal, who immersed himself in geometry in secret because his father thought it a waste of time, and achieved world wide recognition. Davidson did concede though, that the rate of knowledge construction, whether developed independently or socially, might vary considerably. This issue of rate is important in the context of this paper, because corporate e-learning seems to value the rapid achievement of competency. Bauer (2001), a senior manager for e-learning marketing in the Internet Learning Solutions Group at Cisco, makes following point.

> Reaching competency quickly is what counts now - not the thickness of the book, the length of the class, or the number of people in the seats. On the road to competency, a person may have formal training, do private study, read a white paper, listen to a seminar, or attend an event. The point is, did they come out competent, sooner rather than later? (Bauer 2001, cited in Galagan 2001:1).

Cisco Internet Learning Solutions group claims significant successes on both efficiency and effectiveness indicators as a result of implementing a comprehensive competency-based e-learning system. Galagan (2001) reports that in the manufacturing section alone, savings of $1 million per quarter are derived from e-learning implementation. No description of implementation practices was given, and no data was provided on the quality of learning that the approach generated. However, the use of the system, which is characterised by the development of small chunks of knowledge that can be understood by employees in context, adding value to their work performance, suggests some level of effective learning is taking place.

The suggestion that corporate learning solutions should serve the purpose of facilitating rapid competency achievement fits with the design of the Apache Energy e-learning tool. The tool allows contractors to target and learn specific content that they are unfamiliar with or, based on their existing knowledge about certain things, skip the content and access the assessments to test the accuracy of this knowledge.

It is established, then, that both higher order learning and rapid learning can be achieved independently. However, are there circumstances, particularly in corporate e-learning, where independent learning can stall?

Vygotsky (1978) contends that there is a ceiling to independent learning. He conceived that there was a zone of proximal development (ZPD) which represented the point at which adult guidance or collaboration with others was necessary to create new horizons for learning. The ZPD is defined as:

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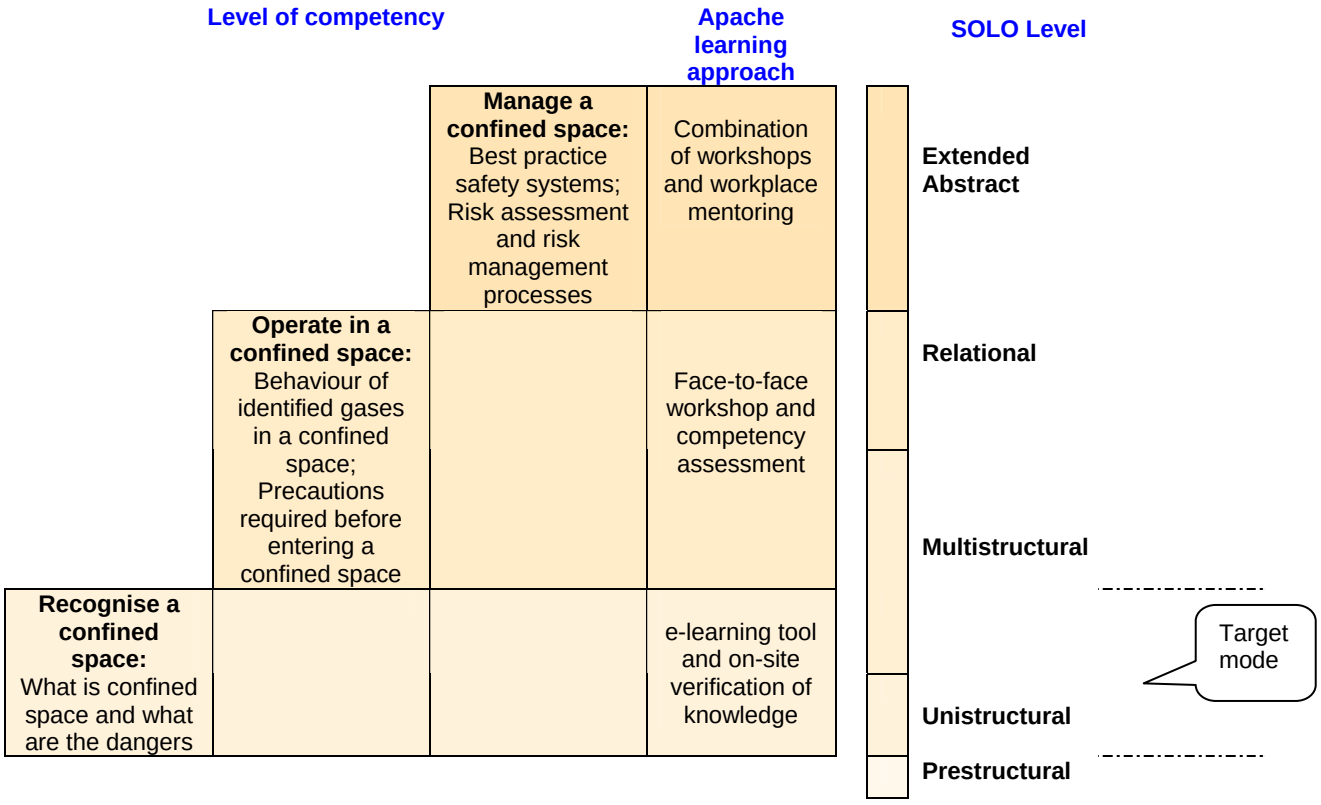
The actual developmental level as determined by individual problem-solving and potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers (Vygotsky 1978:86).

Standards of competency, in themselves, place a ceiling on learning. These can represent tacit or explicit agreement between employer and employee on what needs to be learnt. In many cases it is well within the capabilities of individuals to achieve competency by working alone. This situation is illustrated in Figure 1 with specific reference to the Apache Energy competency of 'Recognising a confined space'.

Figure 1: Apache Energy's approach to building knowledge about confined spaces in relation to the SOLO Taxonomy (Biggs and Collis, 1989)



The Biggs and Collis (1989) SOLO (Structure of the Observed Learning Outcome) Taxonomy is used to show that there is a progression in Apache Energy's approach to facilitating competency in the area of confined spaces, particularly as this relates to strategies for social interaction. Biggs and Collis suggested that there is a consistent sequence to the way learners interact with tasks. This sequence is broken down into 5 levels of abstraction. Each learning task or sequence of tasks has a 'target mode' that equates to the level of abstraction required for that task or sequence. At Apache Energy, in competencies that require higher levels of abstraction (eg. manage a confined space), more attention is given to social interaction as a strategy for achieving a target mode of extended abstract behaviours. Conversely, in the competency covered in the Apache e-learning tool, 'Recognise a confined space', there are relatively low levels of abstraction required - a target

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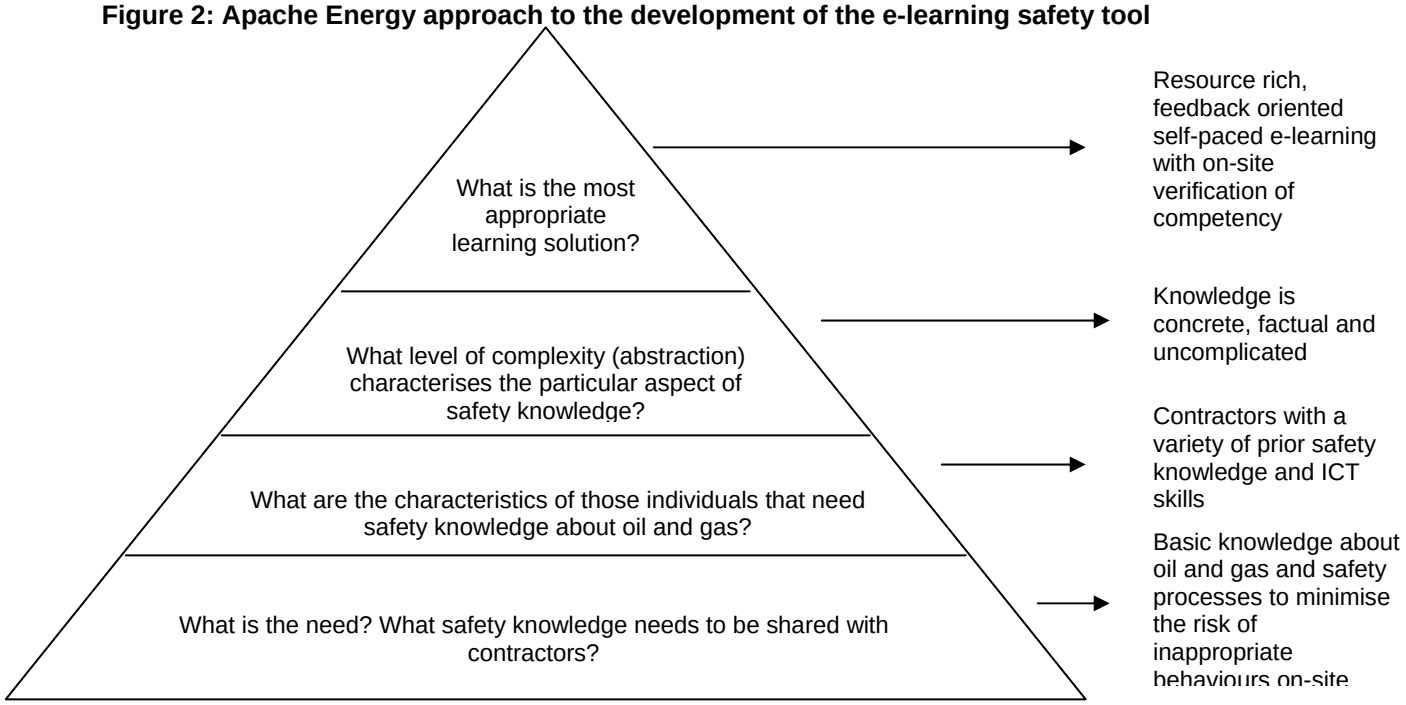
mode of unistructural or multistructural is adequate. Consequently, no social interaction is included in the design.

In its approach, Apache Energy demonstrates an understanding that there are circumstances where independent learning can stall, and that these circumstances are usually manifested when learning is built around concepts that require higher levels of abstraction.

The potential of social interaction to create new, or deepen existing, understandings, particularly in ICT-based adult learning contexts, is not at issue in this article. Formal and informal interaction with peers and expert guidance through a facilitator has been shown to improve learning outcomes in a range of settings (Cholewka & Rose 2003; Salmon 2000). However, a more pertinent question is whether social interaction is necessary or desirable in some corporate e-learning settings where demonstration of competency is about uncomplicated understandings, such as what personal protective equipment should be worn at an oil and gas plant or how to correctly complete a permit form.

Apache Energy took a position that adopting e-learning strategies that encourage social interaction, other than a brief technical introduction, is superfluous to the needs of most contractors. However, as discussed, the organisation supports and facilitates social interaction at more complex levels of abstraction. This 'needs-based' approach to developing and implementing learning solutions is illustrated in Figure 2 with specific reference to how the Apache e-learning safety tool evolved.

Figure 2: Apache Energy approach to the development of the e-learning safety tool



On the one hand, this 'needs-based' approach ensures that learning solutions are relevant and focused on the requirements of both the company and the contractors that work with the company. It is evident, though, that the approach imposes boundaries around the learning process. For instance, there are limited opportunities for:

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- incidental or unplanned learning that may be stimulated by informal social interaction and
- deeper levels of engagement with activities and content through research and discussion.

It is pertinent at this point to highlight Reeves (1999) distinction between learning *from* computers and learning *with* computers. The Apache Energy e-learning tool is an example of learning *from* computers, where the software is specifically designed to stimulate knowledge construction. Situations where learning can emerge from interacting *with* computers are those where computers are set within a broader learning context and can be used, for instance, as a mechanism to analyse, research and report. It is probably unfair to expect the Apache e-learning tool to deliver outcomes for which it was not designed.

The approach to e-learning development and implementation at Apache Energy contrasts with more typical approaches adopted in corporate e-learning, certainly in the oil and gas industry, that generally involve purchasing an 'off-the-shelf' e-learning product and then attempting to implement it. It has been established that there was a good deal of planning in the design, development and implementation phases of the Apache e-learning safety tool. How, then, was it received by stakeholders?

The Apache Energy e-learning safety tool and its implementation

The primary users of the Apache Energy e-learning safety tool are contractors who are generally process operators and/or tradespersons, many of whom have had little formal training since completing school or their apprenticeship. As such, Apache Energy designed an environment that offered literacy-friendly opportunities for users to engage in authentic multimedia experiences realistically situated within the oil and gas industry. The organisation understood that engagement with the e-learning tool requires contractors to be able to converse in English, and provided alternative arrangements for contractors who could not speak English. Apache Energy predicted that contractors would have different levels of prior knowledge and motivations for learning and sought to provide a user-centred design where both "self-selection" of activities and resources and a 'step-by-step' approach were provided. Contractors were also required to complete two assessment tasks:

- a Check your Knowledge test; and
- a Permit to Work test.

These assessment tasks can be completed before, after, or in conjunction with, the learning activities and learning resources provided.

Apache Energy understood that contractors were operating in a time-scarce environment and, via a dedicated e-learning centre, sought to offer opportunities for contractors to gain competency quickly or engage with the resources at a deeper level. As a senior safety professional at Apache Energy stated:

> We wanted to give flexibility to the people themselves who were turning up so we've implemented it through a learning centre that has been set up specifically for us. The guys come in at their leisure basically at any time during their work day Monday through to Friday. (A01, 2005, pers. comm., 9 June)

Further, when contractors attended the e-learning centre, it was important to Apache Energy that there was a quick and seamless learning process available to contractors:

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> Arriving at the strategy I think it was more a case of how can we make this as easy as possible to get people through. (A01, 2005, pers. comm., 9 June)

The tool was divided into two components. The first component is a broad based introduction to the risks associated with working at an oil and gas facility. The second component focuses on Permit to Work systems that operate in the oil and gas industry. Each component provides opportunities to interact with learning activities, learning resources and an assessment. The navigation is such that learners can access any aspect of the tool in one or two clicks.

Learning Activities

In light of the objective of affording contractors opportunities to reach competency quickly, learning activities are essentially short exploratory sequences, cast as simulations or self-tests, that are integrally related to primary safety concerns at Apache Energy. The function of the activities is to encourage learning by doing and attention is give to graphical and written feedback so that safety concepts are understood and reinforced. For example, the fire simulator encourages learners to explore the consequences of various ignition sources (eg. cigarette, camera) in an environment where natural gas could be present, and also under safe conditions.

Learning Resources

Audio visual presentations (eg. offered as short authentic documents or reports and simulated newspaper articles) constitute the learning resources in the program, in that they provide background and introductory content for each segment of the tool. Also contained in these introductory segments are safety hints, glossary items and real world examples. An example of a typical 'real world' example is the North Sea's Piper Alpha disaster (1988) which is used as a case study in the e-learning tool. A presentation on the disaster is provided, and participants are invited to consider the events leading up to an explosion and consequent fire that ran out of control. The important learning outcome, from the perspective of the e-learning tool, is to make distinctions between Piper Alpha's degraded Permit to Work system and the Permit to Work system currently operating at Apache Energy.

Facilities

Six computers are provided at the e-learning centre giving access to the e-learning tool. There is a sufficient amount of audio-visual material in the e-learning tool and headsets are worn by contractors as they work through the various activities, resources and assessment items. Administrative and technical support is also provided.

Figure 3: The e-learning centre

Contractors generally engage with the tool in a self-paced manner over a 4-6 hour period.

Assessment

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To enable contractors to access the e-learning tool off-site, Apache Energy set up an e-learning centre in metropolitan Perth. As contractors engage with the two assessment items embedded in the tool, results are collected, stored in a database and automatically emailed to the appropriate oil and gas facility on the North West Shelf. Safety Advisers at Apache Energy use the e-learning tool in a diagnostic fashion. When contractors arrive at the facility, the results of the two assessment items have already been analysed by the appropriate Apache Energy Safety Adviser. The Safety Adviser looks at areas where there is a perceived knowledge gap and, if necessary, works through issues on a one-to-one basis. If participants passed the assessment items off-site, the Safety Adviser confirms that contractors are equipped with basic safety understandings through targeted questioning, and if necessary re-engagement with one or more assessment items for verification.

The methodological approach underpinning this research is a case study, whereby the implementation of an e-learning tool and the subsequent learning to emerge have been interpreted through an in-depth analysis of data collected by way of:

- interviews
- questionnaires
- observation
- artefacts
- test scores.

While over 200 contractors engaged with the e-learning tool in 2005, the findings reported in this paper have emerged from a sample size of 30 individuals.

Findings

The outcomes arising from the implementation of the Apache Energy e-learning safety tool can be described both in terms of the quantitative and qualitative data collected. Apache Energy's overall objective was to develop and implement a rigorous safety induction process using a flexible e-learning tool. Critical success factors include the ability of the tool to:

- mediate the required safety knowledge
- help diagnose gaps in safety knowledge and
- provide learning opportunities in ways that are flexible to contractors.

Ability of the tool to mediate the required safety knowledge

The adoption of an e-learning tool at Apache Energy represents a shift in delivery strategy from an instructor-led to a resource-driven system. The organisation was aware that one of the outcomes of the implementation of the e-learning tool is a lessening of time spent with Safety Advisers on-site:

> There is a trade off in that the amount of contact time with our Safety Officer on-site was extremely valuable and in us being able to assess whether or not the person was capable of being a permit holder for example. We still haven't got rid of that because under this current program that we're implementing is that when the person gets to site they still get a very brief site induction because there's still things happening that day, so there is still that interaction going on, not as much as it was before but that's fine. (A01, 2005, pers. comm., 9 June)

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From Apache Energy's perspective, the extent to which these understandings are related to the e-learning tool, as opposed to pre-existing knowledge, is not relevant. The important point is that they have a system in place where contractors can demonstrate their understanding.

Tables 2 and 3 provide the results from the assessment component of the e-learning tool between September and November 2005. The success rate is the number of questions answered correctly as a proportion of the total number of questions answered. It is clear from the data, that contractors have demonstrated a high level of understanding of safety issues (Check your Knowledge test, Table 3) and the Apache Energy Permit to Work system (Permit to Work test, Table 4).

Table 2: Results from Check your Knowledge test: September-November 2005

Question		Type	% Success rate			
			Sept 2005 (n=43)	**Oct 2005 (n=24)**	**Nov 2004 (n=7)**	**Avg Per item**
1	Oxygen displacement	Multiple choice	87.8	90.6	91.7	**89.0**
2	Flammability	Virtual reality hazard selection	97.7	95.8	94.4	**96.8**
3	Pressure	Multiple choice	89.0	89.6	91.7	**89.4**
4	Behaviour	Drag & drop	92.1	91.7	93.3	**92.1**
5	Toxicity	Drag & drop	95.3	98.3	100.0	**96.7**
6	Permit to work	Multiple choice	65.1	71.9	66.7	**67.5**
7	Permit to work	True/false	85.6	81.7	83.3	**84.1**
8	Permit to work	Drag & drop	79.5	85.8	83.3	**81.9**
9	Confined space	Multiple choice	89.1	94.4	88.9	**90.9**
10	Confined space	Drag & drop	82.2	88.2	97.2	**85.4**
11	Confined space	True/false	89.5	89.6	91.7	**89.7**
12	Isolations	Multiple choice	82.0	87.5	91.7	**84.6**
13	Isolations	Drag & drop	79.1	83.3	75.0	**80.1**
Average score			**85.7**	**88.3**	**88.4**	**86.8**

Table 3: Results from the Permit to Work test: September-November 2005

Question		Type	% Success rate			
			Sept 2005 (n=45)	**Oct 2005 (n=21)**	**Nov 2004 (n=8)**	**Avg Per item**
1	Part A - Work to be done	Form completion	87.5	88.1	90.6	**88.0**
2	Hazard identification and preparation	Select graphic	86.7	84.1	83.3	**85.6**
3	Precautions and gas testing	Multiple choice	95.6	100.0	87.5	**95.9**
4	Signing as permit holder	Agree/disagree	83.7	88.9	89.6	**85.8**
5	Permit holder declaration	Form completion	92.6	92.1	95.8	**92.8**
6	Part B - Signing on	Form completion	97.0	92.1	95.8	**95.5**
7	Changing a permit	True/false	85.6	91.7	87.5	**87.5**
8	Change of conditions	Drag & drop	88.9	76.2	75.0	**83.8**
9	Change of permit holder	Form completion	90.4	90.5	91.7	**90.5**
10	Part C - Time extensions	Form completion	86.1	90.5	96.9	**88.5**
11	Events	Select box	84.4	84.9	85.4	**84.7**
Average score			**88.9**	**89.0**	**89.0**	**89.0**

The average success rate for the Check your Knowledge test between 1 September 2005 and 18 November 2005 was 86.8%. The average success rate for the Permit to Work test for the

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same period was 89.0%. It is interesting that an Apache Energy Safety Adviser suggest that these results were low:

> I'm finding that too many people are failing and that does concern me. So we really need to look at why we're failing. (A02, 2005, pers. comm., 2 November)

This sentiment is perhaps indicative of the high standard of safety practices that operate at Apache Energy. There is an expectation that, by engaging with the e-learning tool, contractors should attend site with very few knowledge gaps.

Ability of the tool to identify gaps in knowledge

To discern how effective the e–learning tool has been in identifying gaps in knowledge, the tests scores for 222 contractors that engaged with the tool between 31 May and 18 November 2005 were examined. Interpreting this data is tricky. If the trend showed that contractors continually answered questions correctly, then this could mean:

- they have learnt something and the system work,
- they already knew the answers to the questions before engaging with the e-learning tool,
- they answered questions by a process of elimination, essentially guessing at the most probable response.

If the trend showed that contractors continually answered questions incorrectly, then this could mean that gaps in knowledge are consistently identified. However, it could also mean that the e-learning tool is confusing or that contractors are getting questions wrong because of their limited ICT skills (eg. not knowing how to correctly use a mouse to 'drag and drop'). This perceived problem was put forward by a senior Apache Energy staff member:

> Most of the personnel who are failing the course are tested again when they get to site. They pass the test so the training aspect of the package is not in question. It appears that in creating a varied form of answering – drop and drag, click right answer etc it is causing the problem especially with the not so computer savvy guys. Simple multiple choice throughout may have worked better that is a consistent response method. (A01, 2005, pers. comm., 2 November)

This sentiment, however, was not borne out by the results data, which showed that not passing the test was more related to the content than the type of multimedia used. The results show that the most problematic aspect of the Check your Knowledge test, from a success rate point of view, is a multiple choice item (set of four questions) that deals with contractors' responsibilities in completing a Permit form. Curiously, the most media-rich items (2 and 5) resulted in the highest success rates.

Safety Advisers indicated that considering contractors' scores was a useful diagnostic tool:

> If I have someone who has failed I can click through to find out where he did go wrong. I find that useful. (A02, 2005, pers. comm., 2 November)

Further, on-site verification was seen as an ideal way in which to complete the learning process:

> That's how you complete your feedback loop. You've got people who have done the introductory session and by you now standing in front of them you're ultimately completing that feedback loop for them. (A03, 2005, pers. comm., 2 November)

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> When they've physically got a form in front of them and they've actually got to write something, I've actually got them turn it over sign my name and that's what I want to see them do. (A02, 2005, pers. comm., 2 November)

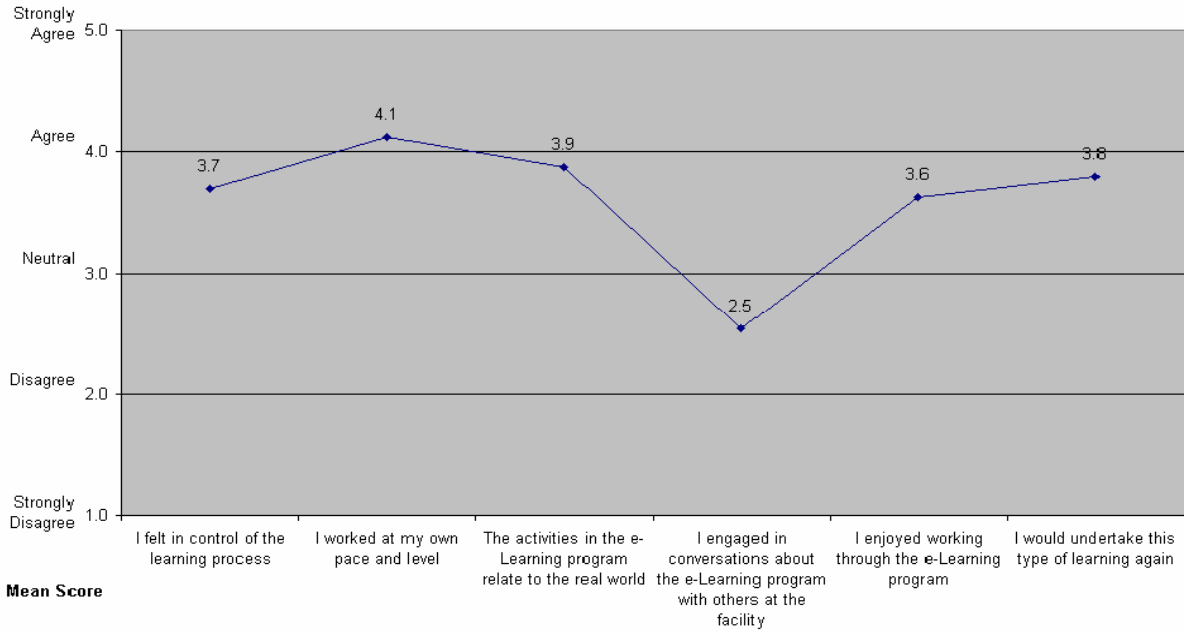
It is evident that social interaction is built into the learning process albeit as an acknowledgement and affirmation strategy rather than a more explicit learning support mechanism. The issue of whether the knowledge obtained through engaging with the e-learning tool is retained beyond the short-term memory (i.e. deeper learning has occurred) is an interesting one, which will be investigated in subsequent phases of the study.

Ability of the tool to provide learning opportunities in ways that are flexible to contractors

Interview and questionnaire data corroborate a view that the e-learning tool has been well received by contractors. Figure 4 provides data (n=40) pertaining to questions about autonomy and enjoyment. It includes an item on interaction with others at the facility.

It is clear from responses to the questionnaire that contractors found the e-learning tool to be authentic, self-paced and reasonably enjoyable. It is also clear that there was a tendency not to interact with others at the facility. When questioning contractors during the interviews, it was suggested that this was contingent upon established the social/professional relationships of those that were in the e-learning centre at the same time.

Figure 4: Satisfaction with the Apache Energy e-learning tool on aspects of autonomy and enjoyment



Most of those interviewed were unconcerned by the lack of opportunities for social interaction:

> Face to face is good but this one is better because you can go back and listen to what they're saying [using the audio components of the tool] instead of asking the teacher. You get that and kind of holding up the class. (C11, 2005, pers. comm., 9 June) (Our additions in brackets)

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Contractors generally felt that the e-learning tool was actually more engaging than lecturer-driven inductions:

> I think it keeps you more alert. When you've got a lecturer I guess you sort of sometimes wander away and look out the window, but with that you've got the earphones on, you've got the computer and it's a lot more hands-on. It's you and the computer. It's more of like a one-on one sort of thing than a lecturer with a group of people. So your attention is very much focused on the software. I thought it was really good. (C03, 2005, pers. comm., 9 June)

> I think its better. Face-to-face inductions are usually limited to half a day of someone sort of presenting. This is more intense, for a shorter period… I think it probably forces you to take a bit more notice of the detail. (C09, 2005, pers. comm., 9 June)

A few contractors suggested that intervention by a trained facilitator may have worked better:

> I think you do need a facilitator if someone wants clarification. Some of those real world things were quite interesting to read those. And maybe some other resources that a facilitator would be aware of if someone's interested. Make it more a learning environment and to encourage people to do this and not just to get on site, but because it is an interesting thing to do. (C14, 2005, pers. comm., 26 August)

Furthermore, in response to the question of whether collaboration with an instructor or facilitator was necessary, an Apache Energy Safety Adviser commented:

> I think that's what we're missing, I think that's the biggest thing we're missing, if a guy goes in there on his own, then he's on his own, literally. If he goes in with a mate… then I could lean over… and say how do you do this. (A02, 2005, pers. comm., 2 November)

The flexibility of the e-learning tool in terms of time and pace was tempered somewhat by the linear way in which the tool was presented to contractors by the Administrative/Technical Support Officer:

> I've seen various e-learning products. Some of them have really good software that is easy to get through, others could do with a bit of tweaking and have a bit of improvement on it. People who are computer literate whiz through it no problem, other people are a little bit more challenged and find it a bit harder. Most people sitting down on an e-learning module just want to be able to go and click one page to the next page, to the next, to the next until they're finished. They don't really want to have to move around too much. (A04, 2005, pers. comm., 9 June)

The Administrative/Technical Support Officer also had a view that social interaction in the e-learning centre was potentially distracting rather than a positive attribute of the learning process:

> You find it also sometimes disruptive, because like I say they will be in different phases of it and they will start going on to other kinds of conversations so something

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> that would take them three hours will probably take them four or five hours and you can also find that they are not necessarily giving the correct information to each other because they don't know the software. In an effective e-learning package you wouldn't really need that anyway. An effective tool would be something where you just sat down and put the headsets on and worked through in a methodical fashion. (A04, 2005, pers. comm., 9 June)

Although facilitating a speedy learning process was important to Apache Energy, this linear view of e-learning is not consistent with the design of the tool and highlights a point of fracture between intended design and its implementation.

For Apache Energy, flexibility equates to providing a range of options to access the e-learning tool and ensuring that the tool is intuitive enough to enable contractors to acquire and/or substantiate knowledge acquisition at a pace that is appropriate to them. There appears to be an acknowledgement that the level of facilitation, at the moment, is inadequate, particularly for those who are not comfortable with computers who may prefer an 'easier' face-to-face method of induction:

> Well I've never really been into the computer thing. I suppose I am a computer illiterate really, I wouldn't even know how to turn them on… I've been to heaps of inductions, you know, going from Alcoa inductions to BHP inductions and Western Mining and all sorts, and you're always communicating with whoever is doing the induction. And I find that that can probably be an easier method rather than clicking here and clicking there and wondering where you went wrong. (C07, 2005, pers. comm., 9 June)

Overall, there was a good deal of support for the way in which the Apache e–learning safety tool was implemented. Contractors generally exhibited high levels of motivation to learn something from the experience. Biggs and Moore (1993) attribute significant levels of motivation to two factors:

- the extent to which the activity is valued; and
- the extent to which a learner expects success.

Every contractor that was interviewed valued the safety ethic. It was 'functionally important' in their immediate lives (Biggs and Moore 1993:257) However, expectations for success varied, and it was mainly contractors with limited ICT skills that tended to be least motivated, possibly because they felt that this prejudiced their chances of success.

The challenge for Apache Energy is to put in place mechanisms that build ICT confidence quickly, so that levels of motivation fuelled by common conceptions of the importance of safety are not degraded by the e-learning tool.

Conclusions

This article has argued that Apache Energy has adopted an appropriate implementation approach for an e-learning tool targeted at uncomplicated understandings in the area of site safety. This approach questioned social interaction as a critical aspect of the implementation strategy, but argued that a self-paced, resource-rich e-learning environment would be most beneficial to the primary target audience (contractors). It has been shown that the decision not to facilitate groups of inductees or to explicitly encourage interaction amongst contractors, has attracted support from safety personnel at Apache Energy and also from contractors themselves, who are operating in time-scarce environments, and who are

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required to attend many safety inductions as part of their role as contractors. However, the onsite component of the safety induction has advantages both for staff at Apache Energy, for verification of competency, and for the contractors themselves who are provided with opportunities for their learning to be acknowledged and affirmed.

One of the initial concerns of Apache Energy was that contractors would not have the necessary levels of self-directedness to engage with the tool in a meaningful way. This was a valid concern and one which is supported by research into flexible learning in competency-based settings. For example, Smith (2001), in a study of apprentice preferences for learning, concludes that there is an overwhelming orientation towards strong direction and social support amongst this cohort either from trainers or peers. The Apache e-learning tool, however, has not proven to have posed an engagement problem for most contractors. This may be because contractors are only required to interact with the e-learning tool for a relatively short period of time (4 to 6 hours), and most contractors felt motivated by the content and the attributes of the tool, and their ability to control the pace of their learning.

The e-learning tool is clearly not for everyone. There is a concern that the level of facilitation provided does not meet with the expectations of some contractors, particularly those with limited literacy and computer skills. Although the tool sought to be literacy friendly and contained a good deal of audio media to compliment textual material, those with limited experience with computers found it time consuming to get acquainted with the navigation of the tool and build confidence. Similarly, those with low literacy skills found it more time consuming to read and understand instructions. In many cases, those with low literacy skills were also inexperienced in using a computer. This cohort is at most risk of rejecting the tool. For these contractors, facilitation might help to build confidence.

There are tensions between the intended design and its implementation, and this is certainly evident in the way in which the tool has been developed to cater for prior competency (eg. non-linear with multiple entry and exit points), and the perceptions of administrative/technical support staff about what constitutes good practice e-learning (more linear and structured). In observing how contractors interacted with the tool, it is clear that the non-linear features of the tool are not introduced. One area for improvement in the implementation is to provide a more comprehensive introduction to the e-learning tool. This would help the experienced contractors to be more strategic in their approach and also serve to soften the impact of the ICT environment for contractors with limited literacy skills and computer experience. Another option may be to design an up-front self-assessment instrument that may help contractors to choose how best to interact with the tool.

Contractors were generally supportive of the flexible nature of the e-learning tool in terms of their ability to choose a time that was appropriate for them. Some went further and queried why the tool was not provided online, affording increased opportunities for access anytime, anyplace.

This article is intended to provoke thought about the circumstances under which social interaction can add value to the learning experience. Contractors that work in the oil and gas industry come from a variety of backgrounds and exhibit a range of prior experiences, knowledge and skills as well as learning styles and preferences. Contractors and staff at Apache Energy exhibit different attitudes on the extent to which social interaction should be integrated into the e-learning approach. However, it is clear that, for many, well designed,

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self-paced activities and resources that are sensitive to prior knowledge and can be validated on-site, are fit for the purpose of providing an effective safety induction in the oil and gas industry.

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