INCASE: SIMULATING EXPERIENCE TO ACCELERATE EXPERTISE DEVELOPMENT BY KNOWLEDGE WORKERS

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SUMMARY
INCASE, a web-based electronic learning (e-learning) environment, has been built to enable rapid expertise development in novice-level professional knowledge workers. This paper describes the theoretical underpinnings (constructivist epistemology) behind INCASE and uses a design science methodology to describe its design, construction, instantiation, and validation. The INCASE system addresses a fundamental problem in knowledge worker domains where experience is a necessary component of expertise development and a barrier to the rapid development of domain experts. Copyright © 2013 John Wiley & Sons, Ltd.

Keywords: knowledge acquisition; knowledge transfer; constructivism; expertise development; design science

1. INTRODUCTION
In this paper we describe the design and development of INCASE, an e-learning environment for simulating experience which enables knowledge workers to practise complex problem solving with the ultimate goal of accelerated expertise development. The purpose of INCASE is to allow novice-level professionals to improve their judgement capability through assimilation of domain knowledge foundational to expert decision making. The underlying motivation for the research that resulted in the construction of INCASE lies in the fact that, similar to many knowledge work organizations, the accounting profession continues to face an increasingly severe shortage of experts. This shortage places high demands on the limited number of experts available and creates intense pressure on the major firms to disseminate knowledge through decision-aiding technologies – already widely used in accounting (Dowling and Leech, 2007, 2013) – and to seek methods to accelerate the development of new experts. As a result, substantial effort has been expended among academic researchers to better understand what leads to expertise, why experts are different from novices (e.g. Libby and Luft, 1993; Arnold et al., 2006) and how to facilitate the development of expertise through various interventions (Bedard and Chi, 1993; Bouwman and Bradley, 1996; Rose, 2002; Smedley and Sutton, 2004, 2007; Rose, et al., 2007; McCall et al., 2008).

The specific motivation for the construction of INCASE is to develop and validate a new methodology for rapidly accelerating expertise development by knowledge workers. This acceleration will allow junior-level professionals to improve their decision-making performance, assimilate domain knowledge,
cognitively organize such knowledge more like experienced professionals and take on more complex tasks earlier in their careers. INCASE provides a platform for exploring the acceleration of knowledge acquisition by novice-level professionals and allows for the identification and exploration of techniques for using technology for distributed training of professionals. Compared with the extant literature, the instantiated processes in INCASE represent a significant shift in the way computer-based systems can be designed to facilitate professionals’ knowledge acquisition. The development of INCASE provides an instantiation of constructivist epistemology, namely case-based experiential learning through alternative designs of a computer-based environment’s advanced elaboration and learning facilities.

To illustrate the use of INCASE, an instantiation within the insolvency/corporate recovery domain of the accounting profession is described. The insolvency/corporate recovery domain was chosen for three major reasons. First, there is a shortage of experts in this field of accounting (Ross and Lees 2011). Second, it is a highly complex domain that relies on professional judgement and expertise. Third, it builds on previous research (Arnold et al., 2004a, 2004b, 2006) that tested novice and expert judgements in this field by focusing on how the judgement performance gap might be reduced by facilitating novices’ rapid development of foundational level expertise through accelerated experience-learning using actual cases delivered in an innovative e-learning environment. Since INCASE is a shell for use across judgement-based knowledge worker domains, it could be used very similarly in other knowledge-intensive domains, such as auditing, tax planning, financial analysis or law.

A major factor in the shortage of expert practitioners across many domains is the length of time that is required to gain sufficient expertise coupled with the high demand by many related industries for available experts. Literature on expertise development suggests that as much as a decade of experience is required for an individual to develop expertise in a given decision domain and that effective expertise development involves deliberate practice in the chosen field of endeavour (Ericsson, 2003). Traditional training methods, such as on-the-job training and expert-led lecture/discussion schemes, have shown little capability to accelerate this expertise development process.

In our instantiation we focus specifically on the corporate recovery/insolvency domain, where we have found that on-the-job training is generally characterized by informal, often ad hoc, gatherings where senior practitioners provide brief outlines of recently resolved cases. Other training opportunities that are conducted by professional bodies tend to focus on the provision of guidelines surrounding practice and decision making in areas such as changes in regulations and corporate law. These training sessions focus on the easier tasks, such as providing declarative knowledge that can then be incorporated into daily working practice. The opportunities to gain procedural knowledge rapidly in the area of corporate recovery/insolvency are not readily available through traditional training methods. While exposure to the higher order decision-making processes may be beneficial to junior staff members, this unfortunately does not necessarily lead to an increase in expertise that is necessary to make the more difficult, unstructured decisions. Our approach to the problem of rapid expertise development for novice-level decision makers is to adopt a constructivist-based approach (known as case-based experiential learning) with flexible feedback mechanisms. The development of INCASE was essential to this approach as it is premised on the use of condensed experiences with the goal of case resolution to enhance problem-solving skills by exposure to complex, authentic and context-rich tasks. Constructivist epistemology is characterized by authentic, learner-centred situations that more readily enhance novices’ knowledge construction.

A design science approach (March and Smith, 1995; Hevner et al., 2004; Hevner, 2007) is adopted in the design, construction, instantiation and validation of INCASE. Consistent with this approach, the pertinent constructs and models that are optimal for e-learning within knowledge-based worker domains are coupled with a method for systematized presentation yielding a working prototype. We test
the viability of the prototype through a series of small participant groups. This approach has been more recently described as constructive design, in that the emphasis in design research is on knowledge building rather than the structural character of either the knowledge or theory that is developed (Gregor and Jones, 2007). The focus of this paper is not on the comparative benefits or otherwise of constructivist theories or web-based learning environments. Rather, this paper describes the constructs, models and other features of the INCASE system, setting a foundation for future research that can more closely examine the alternative components embedded within the INCASE system for optimization in promoting accelerated expertise development.

The remainder of this paper is organized as follows. In Sections 2 and 3 we describe the problem-solving environment in corporate recovery/insolvency and then the theories underpinning the design frameworks that led to the creation of the INCASE e-learning system. Sections 4 to 8 focus on the design methodology of the INCASE shell and the method of case construction and capture, with reference to the constructs, models, methods and instantiation. In Section 9, we review user feedback from a series of novice decision-maker groups used to validate the instantiation. The tenth and final section outlines concluding thoughts and future research.

2. PROBLEM SOLVING AND CORPORATE RECOVERY

In 1993, Birkett explored the nature of decision making and competencies of practitioners in corporate recovery/insolvency in the Australian context. Birkett (1993) highlighted the nature of the decision-making processes and accompanying requisite skills that dictate various levels of professional competency. Even at the novice level, problem solving is a critical skill in insolvency practice, especially as it relates to the evaluation of options and making specific recommendations regarding a company’s financial viability (Birkett, 1993). Decisions regarding a company’s financial viability are made under conditions where all possible contingencies are not known, significant risks about the outcome exist and decisions need to be made in real time (Collier et al., 1999). These decisions can be contingent on external factors such as whether there are potential buyers for the business. As events unfold and more information becomes available, the decisions are continually reassessed as to the viability of the business (Arnold et al., 2004a). The primary decision task that is made repeatedly in an insolvency domain is whether to liquidate or continue operating (commonly referred to as trade-on) a company in financial distress (Leech et al., 1999). Expertise is critical, as in many insolvency engagements the insolvency professional must absorb any additional losses incurred from continuing the operations of the business (Arnold et al., 2004a).

Problems such as those encountered in an insolvency case vary in terms of complexity, structuredness and dynamicity (Jonassen, 2000). Complexity refers to the number of variables that are involved in the decision-making process; while complex problems usually have more variables, the manner in which they combine contributes to problem complexity. In cases of financial distress, complexity can vary as a result of company size, the number of creditors and debtors, the specialization of the services or products and the number of employees, to name a few. Structuredness refers to the idea first suggested by Simon (1973), that well-structured problems are those where all the information and elements are known and the solutions are knowable and obtainable. Ill-structured problems, on the other hand, are those where solutions are neither predictable nor convergent. Dynamicity refers to the variability of the problem state, such as task factors and the environment, which can change over time. In insolvency/corporate recovery, task dynamicity is of significant importance, as the case changes and develops over time. Initial decisions are usually made based on incomplete information;
and, after further investigation, which may last weeks or months, the situation may be very different. These three sources of problem variability contribute to the challenge of accelerating expertise development in such domains. Jonassen (2000) suggests the construction of the problem space is of primary significance in relation to maximizing knowledge acquisition during experiential problem solving. The problem space is the basic unit of organization of all rational goal-oriented human activity and consists of a set of mental structures that define the space in addition to a set of mental operators controlling the space (Newell, 1980).

3. CONSTRUCTIVISM AND PROBLEM-BASED LEARNING

The major theoretical influence on the design of INCASE is constructivism. Constructivist epistemology is strongly influenced by theory and research that emphasizes ‘the interconnectedness of content, context, individual negotiation of meaning and the construction of knowledge’ (Hannafin and Land, 2000: 5–6). While there is not one single constructivist theory of learning (Hirumi, 2002), constructivist approaches stem from several different research traditions that share the same epistemological foundations and assumptions. Problem-based learning (Barrows and Tamblyn, 1980; Hmelo, 1998; Milne and McConnell, 2001; Hmelo-Silver, 2004), cognitive apprenticeships (Collins et al., 1989), and reciprocal teaching (Palinscar and Brown, 1984) are all examples of learner-centred approaches that have developed from a constructivist epistemology.1

Constructivism is an epistemology since it concerns knowledge and its development rather than the complex nature of reality (Crowe et al., 1996). In professional decision-making activities, knowledge about the consequences of particular decisions is socially constructed, while the actual decision-making process is individualized. Constructivists maintain that reality, meaning and, consequently, knowledge are personal rather than universal. Jonassen and Land (2000: iv) suggest in relation to social constructivism that:

[...]not only does knowledge exist in individual and socially negotiating minds, but it also exists in the discourse among individuals, the social relationships that bind them, the physical artifacts that they use and produce, and the theories, models, and methods they use to produce them. Knowledge is distributed among the culture and history of their existence and is mediated by the tools they use.

Constructivist environments need to support both individuals and groups in their attempts to reconcile different points of view and then construct meaning and knowledge from a collection of various opinions (Hannafin and Land, 2000).

Constructivism proposes that knowledge acquisition is most effective in realistic settings that are situated, anchored and contextually rich. In order to facilitate the construction of constructivist learning environments there must be some environment condensation. The simplification of an environment can compromise authenticity because, as Bednar et al. (1992: 26) suggest, ‘an abstract, simplified environment is not just quantitatively different from the real-world environment but is also qualitatively different’. While some degree of case condensation is necessary, our focus is on the construction of an environment that is as

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1We do not utilize theories stemming from the work of Vygotsky, especially his idea of the zone of proximal development. Vygotsky’s zone of proximal development is defined as ‘the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers’ (Vygotsky, 1978: 86). As we discuss below, more sophisticated explanations of professional learning are relevant to INCASE. Vygotsky’s theories are an early form of scaffolding theory that specifically relate to child learning; we discuss scaffolding below in relation to the design of INCASE.
authentic as possible within the confines of distributed computer technology in order to provide representations of a variety of different insolvency/corporate recovery cases. Our case condensation does not remove any of the rich context with which insolvency practitioners must engage. We condense the amount of time that practitioners must often wait for new information to come to light.

One of the more applicable constructivist paradigms for the underlying pedagogical approach to INCASE is problem-based learning (i.e. case-based experiential learning). Hmelo-Silver (2004) suggested case-based experiential learning should assist learners to construct broad and accommodating knowledge bases, become successful problem-solvers, develop independent knowledge acquisition skills, be more able to work in teams and develop into inspired learners. Case-based experiential learning also encapsulates and best operationalizes a paradigm for knowledge acquisition known as meaningful learning. Jonassen et al. (2008) suggest that, ‘in order for meaningful learning to occur, the task that students pursue should engage active, constructive, intentional, authentic and cooperative activities’. Meaningful learning occurs if all five elements are operationalized rather than the presence of only one or two elements in isolation. Active tasks are those that enable learners to test hypotheses and assume responsibility for the task outcome. Constructive engagement requires learners to accommodate new knowledge into existing knowledge structures so as to enable understanding. Constructive engagement is brought about by the inclusion of activities that require learners to articulate what they think and reflect on their own activities, those of their peers and those of experts. Covington (2000) suggests that all activities are provided meaning by the goals that individuals construct. Learners undertaking activities that are goal directed and consequently intentional should be required to reflect on their actions and revaluate their goals thus further enabling the construction of meaning. Learners should also provide details of their strategies and their conclusions. Tasks must be contextualized and represent a ‘real world’ activity. Jonassen et al. (2008) indicates that learning activities that are contextualized and comparable to real-world tasks are easier to engage and understand; therefore, learning is more easily transferred to similar situations. Cooperative activities require learners to communicate with their peers and fellow learners using a negotiated understanding in an environment that empowers and enables learners to put forward their points of view and to critically examine those of their fellow conversants or team members. In order for professionals to expand their knowledge-base effectively through learning, all these elements must be present. Accordingly, all the elements identified by Jonassen et al. (2008) as necessary for meaningful learning are operationalized in the design of the INCASE system.

Hmelo-Silver (2004) suggests that problem-based learning is a form of focused experiential learning that revolves around exploration, explanation and problem-solving that has some form of connection to the learner. Studies have shown that learners’ skills are enhanced from constructivist approaches such as problem-based learning (Loyens et al., 2007). Research on the effectiveness of problem-based learning is often focused on student learning in tertiary situations (Schmidt et al., 2011) and not in unstructured learning situations such as those experienced by novice insolvency practitioners. Schmidt et al. (2011) provide a comprehensive explanation of problem-based learning in relation to the effectiveness of method to learners’ knowledge acquisition. Hmelo-Silver et al. (2007) and Loyens et al. (2007) provide good, albeit brief, summaries of recent problem-based learning research. Hmelo-Silver (2004) provides a comprehensive description of problem-based learning and indicates that the problem-based learning model was developed in medical education, where it is still widely used. The basic form of problem-based learning revolves around a tutor and a limited set of facts that are then expanded in more detail by the questioning of the tutor. While working through problems, students use a whiteboard to help organize their understanding of the facts, evolving ideas, learning issues and an action plan. This tutorial-type process supports knowledge construction as students are guided through their learning and problem-solving processes (Hmelo-Silver, 2004). We have adapted this approach to the
insolvency/corporate recovery domain in a distributed computer-based environment which eliminates the need for human intervention. Figure 1 shows the stages through which learners proceed when presented with an insolvency case, as implemented in INCASE.

The problem-based learning process details the stages through which learners proceed when presented with a problem scenario. The process involves formulating and analysing the problem by proceeding from the problem scenario to the identification of facts and then generating and testing hypotheses. This leads into the self-directed learning phase, which involves identifying knowledge gaps, applying new knowledge in order to recognize the knowledge acquired for application to new problem scenarios (Hmelo-Silver, 2004). At various stages in the problem-based learning cycle, there are steps that involve elements of the meaningful learning paradigm. Problem scenarios must be authentic and contextualized. The identification of facts can be pursued by observation and manipulation, but also by cooperative and conversational means. Hypothesis generation should be cooperative and conversational. The self-directed learning phase is driven by the reflective and articulative elements. We now move to discuss how this is operationalized in the INCASE system below.

4. PROBLEM-BASED LEARNING AND SCAFFOLDING

Fundamental to the success of problem-based learning is the provision of guidance. Constructivist learning theories have been variously criticized, most notably by adherents of cognitive load theory (Kirschner et al., 2006). Cognitive load theory (Sweller, 1988) employs elements of the theory of production systems (Newell and Simon, 1972) in order to illustrate the limitations of working memory on learning during instruction. Cognitive load theory is an instructional technique for managing
working memory so that structural changes in long-term memory (those associated with schema construction and automation) can be facilitated (van Gog et al., 2005). Criticisms of constructivist epistemology usually focus on the lack of guidance offered to learners exploring problem spaces. Based on current knowledge of human cognitive architecture, minimal guidance during knowledge-building tasks is likely to be ineffective (Kirschner et al., 2006). This is relevant for novice individuals who are exploring problem spaces with no or limited previous knowledge or experience. In order to overcome the lack of guidance in some constructivist learning environments that is highlighted by cognitive load theorists, we ensure that learners are given direction in their knowledge construction efforts. The constructivist environment that we have constructed in INCASE has been designed for use by novice professionals who are in the first years of professional employment and have some limited experience in the decision domain (i.e. novice versus naive decision makers). The intended users of the INCASE instantiation for insolvency/corporate recovery will have completed tertiary education in accounting and be working as junior accountants.

The approach taken in INCASE to mitigate cognitive load and to provide guidance has been influenced by scaffold theory. Scaffolds are defined as ‘temporary supporting structures provided by tools or individuals to promote student learning of complex problem solving or reasoning’ (McNeill and Krajcik, 2009). Hmelo-Silver et al. (2007) provide a number of empirically based design guidelines for incorporating effective scaffolding techniques to support learning. Hmelo-Silver (2006) suggested that scaffolding should fade over time and return at points later so that the learner can succeed without support. Scaffolding can be implemented in a learning environment to make discipline-specific thinking and strategies explicit so that learners are exposed to expertise which is made visible through, amongst other things, questions. We use models of expert behaviour to guide learners in focusing on specific questions and reasoning. Scaffolding makes key aspects of expertise visible to novices through the use of questions that structure knowledge acquisition. Models of expert performance for novices to emulate are important methods of prompting them to use particular reasoning strategies. This approach has been shown to be effective for secondary school students, but no studies to date confirm the usefulness of this approach for novice professionals (Chinn and Hung, 2007). The complex nature of the cases presented to novices in INCASE requires the use of scaffolding so that novice decision makers are more readily engaged in sense making, and managing their investigatory and reasoning processes. INCASE also requires learners to reflect on their proposed solutions.

The constructivist approach described above enables the more effective staging of the level of difficulty of the cases presented to individuals. This is important as it helps to avoid the problems that might be encountered by cognitive load. Novices require more complex case representation to facilitate cognitive schema construction. These individuals will also need to reconstruct problem-solving schema in order to facilitate the incorporation of new knowledge. The approach adopted in the INCASE system is that novices undertake training based on authentic tasks which gradually increase in complexity, systematically extending procedural knowledge from case to case. Allowing novices to engage with the most difficult problems in a completely unstructured manner could lead to an expertise reversal effect where learning becomes far less effective or even dysfunctional (Kalyuga et al., 2003). Our approach of gradually increasing complexity helps ease cognitive load and encourages steady acquisition of procedural knowledge.

INCASE also addresses elements from recent research on complexity of memory. Miller (2011) highlights recent misconceptions common to casual observers in cognitive psychology regarding memory and the application of theories regarding memory to learning experiences. She alludes to the fact that poorly translated information on current trends in the academic literature on memory cause the casual observer to come away with no useful ideas, or even incorrect ideas, about promoting learner knowledge acquisition. Miller (2011) suggested that four general principles should be distilled from the
complexity of memory research that can be applied in university settings to enhance practice-based pedagogy. Two of these elements are important for INCASE. The first element is attention. Activities that are interesting and engaging that promote focus will lead to stronger encoding in the learners’ memory. The second element is the notion that frequent testing, if conducted appropriately and at the right time, aids in ensuring memory encoding and, thus, knowledge acquisition. Karpicke and Blunt (2011) demonstrated that requiring learners to recall knowledge is a very beneficial knowledge acquisition activity. In INCASE, we have provided novices with opportunities to test their knowledge of insolvency practice against the requirements of a real case. Users are required to suggest the appropriate course of action at the particular stage in the case.

In the following section we discuss the construction of INCASE and the operationalization of the components of case-based experiential learning. The design of INCASE also incorporates concepts from the meaningful learning paradigm and applies scaffolding techniques for the systematic presentation of authentic case descriptions.

5. BUILDING INCASE AND DESIGN SCIENCE

In our construction of INCASE we have combined the design science paradigm outlined in Hevner et al. (2004) and further discussed and refined by Iivari (2007) and Hevner (2007), with the design science approach in the educational literature, especially most recently Phillips et al. (2012). Hevner (2007) discusses design science as three inter-related cycles of activity. The relevance cycle according to Hevner (2007) begins design science research. The relevance cycle takes account of people, organizational systems and technical systems and the manner they interact in order to identify possibilities for improvements that can be produced utilizing technology. The rigour cycle is important as it provides the link to previous scientific methods in order to expand the scientific knowledge base. The design cycle iterates between construction, feedback and further development. Hevner (2007) argues that the essence of design science is the scientific evaluation of artefacts. Hevner’s three cycles parallel well with Phillips et al.’s (2012) view that in the construction of e-learning systems the process can be decomposed into four main phases: analysing requirements, specifying the design, development and implementation. Phillips et al. (2012) further indicate that each stage evaluation can lead to revisiting an earlier stage. Design-based research in the area of e-learning is a relatively new approach (Phillips et al., 2012) and could benefit from the more advanced information systems design science research.

Our design plan for the instantiation of INCASE for insolvency/corporate recovery required both the design of an e-learning environment (generalized instantiation) and the development of insolvency cases (specialized instantiation). Accordingly, the design of INCASE proceeded through several stages which are briefly described below.

1. Design of the learning environment. This phase proceeded with the identification of salient literature bearing on the design of learning environments, particularly from a constructivist perspective. The most appropriate infrastructure for managing and presenting cases was identified.
2. Current training baseline. For this project to be successful, a training baseline was necessary so that researchers could utilize case material in such a way that was appropriate to the level of the users of the system. This phase involved discussion with large accounting firms and the Insolvency Practitioners Association to discuss their own training activities.
3. Case material. The major accounting firms provided materials for the cases based on actual insolvency cases. Expert practitioners (partners) were asked to provide comprehensive case descriptions.
The creation of the learning materials for key issues in insolvency/corporate recovery was undertaken based on the actual cases. This will be discussed briefly in section 6.3 dealing with constructs.

4. The development of the learning environment was conducted by customizing the infrastructure to manage and present the case material.

5. INCASE was tested at various stages with participant groups to validate the usefulness of the approaches adopted and to establish the success of the instantiation.

6. THE STRUCTURE OF INCASE

INCASE consists of three distinct web-based application modules. The first is the case management application to manage and organize the case material. Cases that are able to be broken into stages are appropriate for INCASE. Cases must be designed to engage novices in the activity of sifting through information and proposing a solution at particular stages of the case. The process of case acquisition for this instantiation of INCASE is described in Section 8. To maintain the generalizable use of INSOLVE across various knowledge-based domains, the system must allow cases to be configured from case-specific information, including text, images and video files that can be loaded into the system. The case management application allows administrators to upload newly created material, to structure learning tasks that are organized in the context of a specific case and, when needed, to assign users to learning groups for virtual collaboration within learning tasks. Tasks can be stand-alone activities, such as the provision of information, quizzes or case-based tasks. In particular, the assessment of whether learning has occurred can be configured in the INCASE system individually even when learners are assigned to learning groups.

The second of the management modules is the supervisor interface. This is primarily utilized for the operation of learning sessions, which consist of a set of tasks and user identifiers for learners who are to undertake the tasks. The session supervisor is able to start one or more sessions in real time. Once a learning session has been started by the learning supervisor, all components of the learning session are locked by the system. The interface also allows the supervisor to monitor the learners during the learning sessions. Using this module, administrators are able to respond to queries from learners through use of a chat feature so that any issues can be resolved in a manner that does not disturb other learners in laboratory settings and facilitates distributed learners who are offsite.

The third module is the user application that is accessed by the learners in order to interact with the tasks, including relevant case material. The database associated with the INCASE system tracks all user interaction with the system, including a timestamp. This information can be accessed by researchers for interpretation and analysis. The information about user interaction is stored in the Microsoft SQL server database operating underneath INCASE. The data from the database can subsequently be accessed via native SQL. Each learner accesses the user interface with their unique identifier, which is recorded against each interaction with the system.

The case information available to learners is completely configurable within the INCASE system and the nature of the scaffolding required is dependent on the complexity and difficulty of the case at hand and the nature of the particular learning experience required. In our specific instantiation of the INCASE learning system to facilitate training in insolvency/corporate recovery, the information is presented to learners in a manner that reflects the cognitive model of insolvency/corporate recovery as described by Leech et al. (1998) which was developed using 23 insolvency experts (18 partners, 3 managers from major accountancy firms and 2 bankers). This underlying model was used to guide organization of the display layout for the case information within the INCASE shell. The screen
displaying case information is divided into four sections: case heading, case information menu, task heading and information panel (see Figure 2).

6.1. Case Heading
The case heading section provides details of the case name and the current stage (point in time) of the insolvency engagement. This information helps reinforce the temporal nature of the events.

6.2. Task Heading
The task heading part details the current task (sometimes a problem) presented by INCASE. It allows the learner to navigate to the next task in the stage after reviewing all the available information. The heading also provides time information that can be mandatory (users are required to move to the next task at some predetermined time interval, inducing a potential time pressure) or optional (users are provided a gauge of expected time to completion but can continue working when the time runs out, reducing potential time pressure), and can be set as a counter (increasing – perceived to induce less time pressure) or an expectation (decreasing to zero – perceived to induce more time pressure).

The different modes of timing that can be utilized by the learning module designer/administrator will have various effects on the manner in which learners engage with the system and case information. In this instantiation of INCASE the timer has been used as a countdown and is used to indicate to learners the amount of time recommended for the current task. The timer can be set so as to replicate significant time pressure. The ability to identify and distil salient information rapidly is one of the hallmarks of expertise and a recognized constant state in accounting decision domains.

Figure 2. Sample screen from INCASE, showing layout.
6.3. Case Information Menu

The case information menu organizes the case following the cognitive model of insolvency/corporate recovery (Leech et al., 1998). This organization of information reflects generic knowledge about cases. This is one of the major scaffolds of the INCASE system. The case information is presented under headings that correspond to the construct of the cognitive model. Presenting information to learners in this way so as to not overburden cognitive structures is particularly important. Some amount of cognitive load is required in order for learners to create new memory schema. Creating an environment where learners are not overloaded but are able to negotiate and interact with a diverse range of information media is important. Criticisms of constructivist-based learning techniques have focused on the lack of guidance offered to learners (Kirschner et al., 2006). In order to assist in the reduction of cognitive load for advanced learners, the presentation of material under the specific headings is of great importance. It enables learners to be able to begin to construct schema that are similar to that of experts.

6.4. Information Panel

The information panel displays case information selected from the case information menu. Learners can toggle between a description of the current task or the case information. They are also able to chat with the session supervisor should they have any issues.

7. EDUCATIONAL COMPONENTS OF INCASE

There are five major components of INCASE that equate to the five elements of meaningful learning. In order to present cases in INCASE, we have replaced the tutor, one of the requirements of case-based experiential learning, with the case information menu described previously. The other major component of case-based experiential learning, the whiteboard, has been replaced by the participant chat. Learners utilizing the chat feature are able to articulate their ideas under the structured information category headings to promote robust discussion and hypothesis testing (Baker et al., 2002). Learners also use the same terminology to describe key concepts and information categories. All information necessary for the learners to organize their knowledge in a manner similar to experts is provided. Our scaffolding takes the form of the Case Information menu (shown in Figure 2, and explained in section 6.3). All the case information is presented under the menu items and allows users to quickly toggle between the various information sources. At the end of each case stage, learners are able to reflect on their understanding of the information. Reflection includes providing a typed explanation of the factors leading to the learner’s decision and what led them to a given decision outcome. This adds accountability to the process and the categorical organization of the information promotes the learner to mentally organize and synthesize the concepts. The conclusions of learners can be evaluated against those of an expert which provides feedback on knowledge deficiencies; this equates to the ‘identification of knowledge gaps’ step in the problem-based learning cycle discussed earlier.

2The cognitive model described in Leech et al. (1998) forms the basis of the intelligent decision aid INSOLVE that was used to undertake the research which found differences between novices and experts (Arnold et al., 2004a, 2006). INSOLVE is a knowledge-based expert system that provides expert recommendations when provided with case information. Thus, it could be used in conjunction with INCASE for this purpose. INSOLVE is, of course, quite different to INCASE. INCASE is a shell or repository to store case information for learning purposes and has no reasoning power.
7.1. View Information (ACTIVE/AUTHENTIC)

The first element presented to learners is the task that offers them an opportunity to explore and engage in the comprehension of all the information that would normally be available to expert insolvency practitioners. The presentation and organization of this case material is discussed later in the section describing models. The initial ‘View Information’ task screen is presented in Figure 3.

The task of processing all the information available constitutes the authentic element of the meaningful learning paradigm. Learners are able to interact with a variety of media, including images and videos of important events and activities and to use actual documents that insolvency practitioners would normally be required to analyse. Learners can view interviews with key stakeholders (suppliers, customers, staff and financial institutions), which supports the development of important skills. Novice insolvency practitioners must learn how to acquire and synthesize information from these key stakeholders at different stages in the case (see Figure 4). Learners are able to interact with complex information in a contextualized format: a real-life situation – a task that they would be required to undertake if they were insolvency/corporate recovery experts. Rather than simply abstracting the salient ideas in rules that are committed to memory and then applied to other de-contextualized situations, this format provides a useful context in which to practise those ideas (Jonassen et al., 2008). The learner, while distilling the information (presented either as text, audio or video), needs to use a manual notepad in order to record important points and make calculations in order to access the ongoing financial viability of the company. This activity forms part of the ‘active’ element that is fundamental for meaningful learning. The learners are engaged in tasks where they are required to be both manipulative (making calculations) and observant (taking notes) in this authentic environment which is complex and contextualized.
7.2. Make a Recommendation (CONSTRUCTIVE)

At the end of each stage, a series of opportunities to engage constructively with the case material is presented to learners. We adopted a type of guided approach by requesting that learners formulate their conclusions regarding the case information that they have explored up to the present stage. In order to maximize the learning potential for users, they are provided with an opportunity to recommend a course of action and articulate reasons for the action that they feel best fits the current problem state. Learners suggest the primary resolution for the case at the current stage: either trade-on or liquidate. If the conclusion that learners reach is to trade-on, they are also requested to determine an appropriate method(s) for effecting a trade-on (Figure 5). Learners also provide reasons for their decisions, which encourages articulation and reflection; this activity provides a constructive element necessary for meaningful learning. This engagement is, in essence, what the insolvency/corporate recovery task is all about: the goal is to either trade-on or liquidate. The task of making a recommendation is intentional; thus, learners, who are engaged in deliberate action by attempting to reach a goal will learn more (Jonassen et al., 2008). This process of articulation is an important aspect of both the intentional and constructive nature of learning.

7.3. Consult an Expert

Following the ‘make a recommendation task’ at each stage of a case, learners are presented with the advice of an expert on the current state of the case. This advice can take any of multiple forms. For instance, in this instantiation of INCASE, we have provided text-based explanations. Advice to the
learner can also be provided via video clips of experts explaining decisions, an expert system that allows the user to enter information and generate an expert opinion or a combination of these approaches. Expert opinion was obtained during the case collection and validation process, which is discussed in Section 8. During this process, experts were required to provide extensive notes regarding the best course of action at the various stages of the case. These were then used to assist in the formulation of the cases. During the case validation phase, experts were asked for their specific advice and understanding of the course of action they believed to be most appropriate to the current set of circumstances as represented at the various stages in the case. The advice supplied by the experts at the stages may be presented to learners.

The process of understanding expert advice in this context enhances the learner’s comprehension of the case material and provides instant feedback on the validity of their conclusions as to the appropriate course of action at the stage in question. This constitutes part of the process of reflection, but is also an important method reinforcing the construction of appropriate problem-solving schemata. Meaningful learning through INCASE requires students to reflect on and explain their decisions in light of their expectations which can be compared with those of an expert. This process is known theoretically as reflection-on-action (Schön, 1983).

7.4. Chat

The chat feature in the INCASE system offers learners the opportunity for collaborative engagement with other learners in the problem-solving task. The chat facility is enabled for users at the stage after they have provided a recommended course of action. The chat feature allows learners to discuss their
recommendation with others before they are asked to reflect on their previous recommendation in light of the new information, namely colleagues’ insights and the expert advice. For meaningful learning to occur, interaction between individuals can have a strong positive effect. Part of the rationale is that learners need to be able to communicate their own ideas effectively to other members of the group and be accountable for their own knowledge. Learners need to be able to operate with a common understanding and meaning, and this may involve a level of negotiation and inquiry in order to determine the methods with which they will be able to solve a problem (Jonassen et al., 2008). The chat facility represents the cooperative element of the meaningful learning paradigm (Baker et al., 2002).

7.5. Revise Recommendation

Learners are able to revise their proposed solution in light of expert advice. This phase enables learners to engage productively with their own solutions and the expert’s solution. Importantly, the revision phase of the stage is presented in exactly the same way as the original recommendation phase. The reflection phase is crucial, as it again requires learners to engage constructively with their own solution, the chat discussion (if utilized) and the solution of the expert. The reflection and recommendation parts of INCASE are of fundamental importance to the overall success of this approach to learning. The learning process that is encapsulated by our approach is best described theoretically as a reciprocal intention–action–reflection cycle. Jonassen (2004) indicates that practice alone is insufficient for learning and that meaningful learning is underpinned by this reciprocal cycle. The ability to apply problem-solving skills to new case situations is one of the attributes that distinguish experts from novices.

8. CASE ACQUISITION

In this section we outline the process by which cases were acquired for use in INCASE:

1. Insolvency/corporate recovery partners described details of one or more cases, which were recorded and transcribed. The original documents from the case were also collected.
2. Key information was organized using the constructs from the INSOLVE cognitive model (Leech et al., 1998, 1999). Information deemed sensitive, such as names, places and monetary values, was systematically de-identified.
3. For important events in a case, vignettes were scripted that reconstructed the interplay between major parties, such as the insolvency/corporate recovery partner, the directors and creditors. Videos of the vignettes were created using insolvency partners and their staff as actors.
4. A web-based version of the case was constructed; validation of the accuracy and completeness was undertaken with the insolvency/corporate recovery partner and revised where necessary.
5. The web-based case descriptions and case conclusions were evaluated by an independent insolvency expert (one not involved in case construction) in order to further validate that the cases descriptions were authentic and that the information was sufficient for forming opinions and appropriate conclusions for each stage.

As mentioned earlier, each case involves several stages to simulate an insolvency/corporate recovery case which develops over time with information becoming available at various stages. All of the cases were divided into stages that appropriately represented the points at which insolvency/corporate recovery experts needed to make key decisions about future company viability. The temporal nature of
insolvency practice is one of the drivers of case organization. An insolvency practitioner seeks information from a wide range of information sources so as to make a more informed decision regarding company viability. The learning environment is more conducive to learning and, consequently, more successful if the complexity and richness of the case are represented in an authentic manner that allows the learner to feel embedded in the situation and to feel as if they have experienced the actual events. It should be noted that this learning system is not a form of case learning. These cases are not archetypal cases; rather, they offer learners an opportunity to interact with a broad variety of facts and information (including videos from interviews with management) from authentic representations of actual cases.

9. VALIDATION OF THE INSTANTIATION: FEEDBACK LOOP

A critical component of the design science research approach is feedback from users who test prototypes during the instantiation of the design (Hevner, 2007). To validate the design of INCASE, several different groups were used based on the stage of the design cycle.

Initially, a mock-up of a sample case was completed using publicly available archival information on the widely publicized Ansett Airlines insolvency case. This allowed the researchers to test the case development prior to beginning the interviews with solvency practitioners to develop the more robust cases of interest. This allowed the research team to debate form and delivery systems during the original design of INCASE with the discourse being driven by constructivist epistemology while maintaining a consciousness of the aesthetic issues in interface design. Inputs from colleagues and postgraduate students were solicited at this early stage of design exploration. The case mock-up was refined and further reviewed.

Based on the research team discourse and the solicited feedback, the research team settled on a design and initiated the physical development of the INCASE e-learning management system and the data collection for case development. The initial working prototype system was developed to the point that the user interface and student modules were completely functional, but the underlying database for recording all user entry and the management modules were still under development.

At this point, a half-day session was organized with approximately a dozen participants consisting of a roughly equal mix between more experienced insolvency practitioners (seniors and managers) and novice insolvency practitioners with less than 2 years’ experience. The experienced participants were critical for achieving two outcomes. First, from a design research perspective, we needed their feedback on the completeness of the cases in terms of sufficiency of information for appropriate decision making at an engagement level and the sequencing of information. Second, from a practical perspective, we needed the experienced participants to develop a belief in the learning strategy such that they would be willing to send large numbers of novice staff to subsequent lengthy training sessions in order to validate the final system. Participation by novice staff was needed to verify that the case information was accessible and digestible by a novice-level decision maker. The feedback was overwhelmingly positive. At the same time, there was feedback that helped in refining the interface and making final design decisions related to clock timing, expert feedback and video resolution.

Based on the feedback, the design of INCASE was refined, the case set-up slightly modified, the video resolution enhanced and broken into smaller components, and additional cases were developed with an eye towards simpler cases to start out novice training and more complex cases to push the boundaries at the end of training. Overall, 15 cases were constructed for use in insolvency/corporate recovery training. These cases were then presented to an insolvency expert to develop the expert opinions and feedback. Nine of the cases were subsequently selected for use in training sessions based
on the expert’s feedback related to information quality and based on the expert coming to the same
conclusions as had been derived during the actual insolvency engagements (i.e. liquidating the
company, trading the company on until it could be sold as a complete entity, trading the company on
until it could be stabilized and returned to the directors, etc.).

At this point, the final instantiation of INCASE had been developed as discussed throughout this
paper and a rigorous validation process was undertaken. Novice insolvency professionals, defined as
those having less than 2 years’ experience, were solicited from a large number of insolvency firms,
including both Big Four and non-Big Four accounting firms. Participation was solicited for one of four
training sessions that were scheduled with each training session lasting three full days. Participants
were solicited from Melbourne and Sydney, along with the surrounding regions. A total of 61 partici-
pants were able to participate in three full days of training, spread fairly evenly across the four sessions.
Four sessions were held so that different functionalities of the INCASE system could be validated. All
users experienced the vast majority of the functionality, which was altered across cases within each
session. However, the different sessions were needed to evaluate the viability of the system when used
in group learning versus individual learning settings. We also tested alternative modes of expert opinion
presentation, with two of the sessions getting a textual write up of our expert’s decision and two
sessions using the INSOLVE expert system to generate an expert opinion (only cases were used where
INSOLVE would generate the same recommendation and rationale as the independent expert).

To assess the goal of developing a system that would facilitate expertise development, we adminis-
tered a test at the beginning of the first day and then administered the same test at the end of the 3 days.
Participants were not aware ahead of time that they would be taking either test. The test was developed
using questions from the insolvency certification exam administered by the Insolvency Practitioners
Association. Questions were carefully selected to capture a range of knowledge levels, including some
basic definitional questions reflective of declarative knowledge as well as questions dealing with more
complex initial problem-solving strategies. The overall findings strongly support the theorized effects
for the system design – test scores for the 61 participants significantly increased from an average pretest
score of 56% to a post-test score of 68% (p < 0.0001) after just nine cases over a 3-day period based
solely on encoded memory, since participants were not studying any other materials (see Table 1).

Further validation testing was conducted by soliciting participant feedback. Numerical feedback was
solicited through a series of seven-point Likert-scale questions rating the benefit and the ease of use of
the system. The benefit questions focused on the benefits of the Consult an Expert, Make a Recommenda-
tion, Chat (group learning only), Revise your recommendation, and Reflection and yielded an average
rating of 4.92/7. The ease-of-use questions focused on the same five components and yielded an average
score of 5.32/7. Overall, participants found the various components to be beneficial and easy to use.

At the end of the training, a debriefing session was conducted to gather qualitative feedback from the
participants. Participants consistently indicated that the training was much more valuable than the
instructor-led training they normally received. Frequently, the fatigue and fade out that came during

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest score (%)</th>
<th>Post-test score (%)</th>
<th>Increase (%)</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group/expert</td>
<td>62.08</td>
<td>65.23</td>
<td>3.15</td>
<td>0.0470</td>
</tr>
<tr>
<td>Group/INSOLVE</td>
<td>55.27</td>
<td>63.52</td>
<td>8.25</td>
<td>0.0031</td>
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<tr>
<td>Individual/expert</td>
<td>50.30</td>
<td>60.31</td>
<td>10.01</td>
<td>0.0005</td>
</tr>
<tr>
<td>Individual/INSOLVE</td>
<td>55.16</td>
<td>61.36</td>
<td>6.20</td>
<td>0.1410</td>
</tr>
<tr>
<td>All groups</td>
<td>55.96</td>
<td>62.83</td>
<td>6.87</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Table 1. Participant pretest and post-test knowledge scores for training sessions.
instructor-led training was noted, while they felt fully engaged with the active learning approach of INCASE. Participants also noted the benefit they saw from getting a view of the full insolvency/corporate recovery decision process instead of the narrower baseline tasks they normally completed in engagements. They felt they had a much better understanding of how their work fits into the bigger decision process of the engagement. Negative feedback was minor and rarely related to INCASE itself, but rather the testing process – the fact that their ability to work at their own pace was hampered by having to wait in between cases for others to finish or feeling a bit rushed if they were the last person in the room still working on a case.

The one notable exception was the group chat. Here, there was a notable difference between what we could classify as learning-oriented and team-oriented participants versus task-oriented solo workers. The learning-oriented and team-oriented participants were quite positive about the chat and the opportunity to discuss the cases, but the task-oriented solo workers found the chat distressing. The task-oriented solo workers would finish the case quickly rather than studying the information and reflecting on decisions. As a result, they would have to wait for the rest of their group to complete the stage so they could chat. One participant kept leaving the room after finishing the case without awaiting group members to enter the chat and discuss the case. This highlights the difficulty in using group learning sessions, particularly with multistage cases which are reflective of a long engagement unfolding over time. We opted to keep the time clock such that individual learners could run over time allocations and spend as much time as they wished, as we wanted to facilitate the learning-oriented participants. The learning group component may work better with fixed clocks that force the user through the case on a time schedule, but this could hinder more thoughtful, learning-oriented participants. This is a constraint that training coordinators would need to carefully consider in group formation, participant preparation and case structuring parameters, such as the flexibility of the time clock.

On an overall basis, the instantiation of INCASE can be considered highly successful. As reflected in Table 1, learning increased for every group, although the small sample size limited the significance of the gain for the individual sessions using INSOLVE. Overall, the knowledge gains were highly significant across the sessions as a whole and the participant feedback was highly positive on the constructivist epistemology.

10. CONCLUSIONS AND FUTURE RESEARCH

This paper has described (1) the rationale for the building of INCASE, a novel, e-learning, web-based environment that facilitates knowledge acquisition in order to accelerate expertise development by novice insolvency accountants (and adaptable to other professional knowledge workers), (2) the construction of INCASE through application of design science methodology and (3) the validation of an INCASE instantiation within the insolvency/corporate recovery domain. INCASE applies distributed computer technology as the underlying architecture for a constructivist-based learning system that facilitates training and expertise development of knowledge workers, making the system equally useful in organizations with numerous professionals completing similar knowledge work in geographically dispersed locations.

This research was sponsored by the Australian Research Council in order to address specifically the shortage of experts in multiple knowledge work domains. The instantiation is within the realm of insolvency/corporate recovery as a demonstration of how it can be applied in one specific knowledge-work environment where such expertise shortages exist. As we continue to evolve into a knowledge-work-driven world, technologies that can accelerate expertise development will become increasingly important.
There are some limitations in the validation portion of our research that should be considered in future research expanding upon that reported here. First, it was difficult to get novice professionals available for 3 days of training. It is possible that the training would be more effective if spread out over several days over a longer period of time, and most certainly extended time to cover more cases would likely enhance the knowledge acquisition and expertise formulation. On the other hand, a concentrated experience where the focus is on training without other distracting job commitments, as was done in our sessions, may be the preferred mode. Second, we did not test the technology in a truly distributed setting. The sessions were completed in laboratories, although the Sydney sessions were run simultaneously on the same days with sessions in three different rooms providing some indication of the robustness of the technology in a distributed environment. Additionally, participants were not allowed to speak with each other despite being in the same room. Still, the fact that participants could see others in the same room working and sometimes finishing more quickly could have an effect on the process—either motivating to perform better or motivating to finish quicker and perhaps reduce learning. That is an empirical question that remains unanswered. Thus, additional validation testing of the instantiation could shed additional light on usability dimensions of the technology.

Our research demonstrates the feasibility of one such methodology for using technology to accelerate experiential knowledge acquisition. Future research should explore other methodologies for facilitating expertise development and should consider attributes within the INCASE model that may be fine-tuned to maximize the knowledge transfer capabilities. Future research should also examine whether the different types of expert advice affect the level of learning. The active involvement of providing information coupled with the explanation capability of the expert system has the potential to further facilitate novices’ abilities to structure concepts and grasp how experts organize information during decision making. Exploring a range of such artefacts that may improve the experiential knowledge acquisition of novices will only increase the value of technologies such as that demonstrated in INCASE.

ACKNOWLEDGEMENTS

We gratefully acknowledge financial support from the Australian Research Council, and participation by many accounting firms in Australia. We would also like to thank three anonymous reviewers for helpful and informative comments.

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