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# SCAFFOLDING REFLECTIVE INQUIRY – ENABLING *WHY*-QUESTIONING WHILE E-LEARNING

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This paper presents some theoretical and interdisciplinary perspectives that might inform the design and development of information and communications technology (ICT) tools to support reflective inquiry during e-learning. The role of *why*-questioning provides the focus of discussion and is guided by literature that spans critical thinking, inquiry-based and problem-based learning, storytelling, sense-making, and reflective practice, as well as knowledge management, information science, computational linguistics and automated question generation. It is argued that there exists broad scope for the development of ICT scaffolding targeted at supporting reflective inquiry during e-learning. Evidence suggests that wiki-based learning tasks, digital storytelling, and e-portfolio tools demonstrate the value of accommodating reflective practice and explanatory content in supporting learning; however, it is also argued that the scope for ICT tools that directly support *why*-questioning as a key aspect of reflective inquiry is a frontier ready for development.

*Keywords*: ICT; e-learning; pedagogy; critical thinking; explanation; reflection; question generation; question-answering; QG; Q-A; storytelling.

## 1. Introduction

### 1.1. *Purpose*

The purpose of this paper is to present some focused theoretical discussion on the importance of *why*-questioning during learning while also probing opportunities for ICT-based scaffolding that might support it. Tools that stimulate cognitive engagement and reflective inquiry are identified as providing an appropriate foundation. Historical and theoretical perspectives are introduced to establish context about the evolving theory and practice of e-learning and to underscore the significance of content or discourse that serves an *explanatory* function – in other words, information that is specific to the object of *why*-questioning.

### 1.2. *Scaffolding – an evolving concept*

Prior to the invention of the World Wide Web and the subsequent proliferation of information and communications technology (ICT) that supports learning, education, and training (LET), the concept of scaffolding was used to describe the support and guidance

provided by a teacher to a student to assist in conceptualizing problems and constructing knowledge. It was conceived initially with an "adult to child" emphasis (Vygotsky, 1978; Wood, Bruner, & Ross, 1976). It has now evolved in meaning to also include assistance provided by peer learners and ICT systems in the development of understanding and the construction of knowledge (Cohen, Manion, & Morrison, 2004; Foley, 1993, p. 101). In both meanings, scaffolding is therefore concerned with techniques and tools used to assist in the development and *maturation of understanding* associated with learning. Thus, the "process of scaffolding is much like the traditional definition of scaffolding as a temporary support system used until the task is complete and the building stands without support" (Lipscomb, Swanson, & West, 2004).

It follows from this simple characterization that once understanding or knowledge has been acquired, the scaffolding becomes redundant. However, the Web – or ICT innovation more broadly – has changed this. Through enabling diverse, user-friendly, personalized, novel and sophisticated devices, applications and services, ICT provides support for learning at many levels, including that of the user interface. As such, ICT itself provides scaffolding that may be used and re-used for multiple purposes. Search engines provide a generic example of this in supporting both *resource discovery* as well as targeted *information retrieval*. Numerous other innovations in search engine technology demonstrate a wide variety of scaffolding supports. For example, iBoogie (www.iboogie.com/) is a cluster search engine that organizes results according to conceptual categories that refine a search query, providing navigation cues through clustering of concepts and terms that are semantically related. In this case, the associated concepts and terms may inform the learner or information-seeker of the breadth of a conceptual domain not previously appreciated – thereby providing a useful scaffold. In a different approach, ManagedQ (www.managedq.com/) leverages Google results to queries adding to them a mix of visual cues while organizing results into sets associated with people, things, and places. In this example, visual and conceptual supports extend the domain of cognitive stimulus.

### 1.3. *ICT – enabling or interrupting?*

As a counterpoint perspective on enabling innovations in ICT, and particularly relevant to its application for LET purposes, commentary concerning negative cognitive impact of prolonged use has also begun to emerge in recent years. For example, instead of highlighting scaffolding functions, Carr (2010) characterizes IT as an "interruption technology" that weakens cognitive focus:

> The Internet … wasn't built by educators to optimize learning. It presents information not in a carefully balanced way but as a concentration-fragmenting mishmash. The Net is, by design, an interruption system, a machine geared for dividing attention … What we are experiencing is, in a metaphorical sense, a reversal of the early trajectory of civilization: we are

> evolving from being cultivators of personal knowledge to being hunters and gatherers in the electronic data forest. (Carr, 2010, p. 131)

Such a characterization may well describe some aspects of mainstream usage of the Web but it does not describe all usage scenarios, particularly those learning environments that are designed to contain interaction with specific content and peers. For example, the development of e-portfolio systems and use of wikis that specifically support reflective learning in both personalized and collaborative learning contexts represent important trends (Ajjan & Hartshorne, 2008; Alexander, 2006; Cambridge, 2009; Hallam et al., 2008; Loo, 2012). Intelligent tutoring systems and learning management systems represent other, more established, examples.

Building on these perspectives, the following discussion draws upon a wide body of literature that spans storytelling, sense-making, critical thinking, inquiry-based and problem-based learning, learning design, and reflective practice, as well as recent developments in knowledge management, computational linguistics and automated question generation. The question of *how might ICT be used to scaffold learning through supporting reflective inquiry and the probing of explanatory content* is a question that remains open throughout.

## 2. Interacting with Content Online

According to Oliver (2001), in a well-received paper at the time, there are three critical design elements for describing and developing online learning environments – learning tasks (activities), learning resources (content), and learning supports (scaffolds) (Oliver, 2001, p. 3). The relationships or interfaces between each element will vary according to situational context and also determine the effectiveness of such environments. Oliver demonstrates that this abstract model accommodates a wide variety of pedagogical approaches, all of which place varying degrees of emphasis upon different aspects of these elements. Thus, this model is adequate in describing pedagogy that gives emphasis to learning objectives while also accommodating inquiry-based learning in which the outcomes may not be prescribed. But while such models have high utility they can also mask complexity. For example, in the case of both inquiry-based and problem-based learning, questioning is a central activity that can function as both a task and a scaffold (depending upon who is asking the questions). Questioning also arises while sense-making, whether in dialog or during reflection. In some cases (such as a critical review of questions), questions may even function as the "content" or the focus of metacognitive skill development (Barell, 2010, p. 197; Gillies, Nichols, Burgh, & Haynes, 2012).

Developing a more descriptive model, however, is not the aim here. Instead, the following discussion is presented to highlight other key considerations that emerge when *why*-questioning plays a role within all three key design elements in Oliver's model. This is highlighted in the following discussion on primitive questions, storytelling, and the difference between information and explanation. Depending upon context, each of these can function prominently as constituents of *content, activity*, and *scaffolding*.

### 2.1. *Primitive questions*

Questions initiated by *who, what, when, where, why* and *how* belong to a set sometimes referred to as the journalists' questions (Urquhart & McIver, 2005, p. 82). Why this label? For the simple reason that answers to these questions help create a story. More importantly, without answers to *who, what, when,* or *where* there is no news and nothing to report. There are no facts, and there is no information. When answers to *who, what, when,* and *where* are supplemented with answers to *how* and *why* then the storytelling creates interest. When this happens, *information* is accompanied by a component of *explanation* – whether it is hypothetical, rhetorical, or otherwise.

These basic questions can also be considered in a number of other ways, depending upon function. Thus, some of these questions can be seen as functioning more as triggers for explanation (see Figure 1). From an information science perspective *who, what, when,* and *where* collectively form what can be termed the "primitives" of text-based information retrieval because they represent pivotal or "kernel" semantics in the retrieval and discovery of factual or "factoid" information (Evered, 2005; Kunze, 2001; Mason, 2008; Verberne, 2010, 2006). As such, they form the basis of most metadata schemas designed to identify, describe, and manage information resources, whether in physical libraries or in the digital domain. This is because they define the core aspects of provenance and the *aboutness* of content. This core function of factoid information is also important in calibrating how most search engines work – and therefore, has the consequence that most content that is sourced for learning via search engines is derived this same way. It certainly determines the kind of information processed by Google – ranking results according to hyperlink data might represent a profound innovation in search engine technology when first devised but it still essentially represents just another dimension of *aboutness* associated with the content – that is, data that can be objectively extracted from the content or content linked to it. Within the case of ManagedQ, a value-added service to Google search, results to queries are organized into sets associated with people (*who*), things (*what*), and places (*where*) – factual, or objective, information. Thus, while Google and other mainstream search engines might enable learning and knowledge sharing, their core technology function remains that of *information processing* calibrated for responding to *search terms* rather than *questions*. As such, the results displayed for Google queries are (so far) typically non-explanatory in nature – and, queries instigated

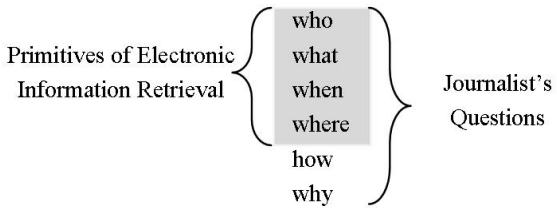


Figure 1. Core questions of information and explanation.

by *why* are therefore not accommodated in an optimum way. This is noteworthy because *why* is also a key question for reflective inquiry.

### 2.2. *Storytelling*

Storytelling, however, involves much more than information processing as it draws upon all available nuance and expressiveness that language has to offer. Importantly, the primitive questions discussed above can be seen as key components in the construction of stories.

> I keep six honest serving-men:
> (They taught me all I knew)
> Their names are What and Where and When
> And How and Why and Who
> (Kipling, 1902)

While stories of the form "*once upon a time in a far off land there was an ogre who lived under a bridge*", typically contain the four information primitives in the first sentence (who, what, when, and where), close analysis reveals other dimensions. For example, complexity is established as a result of there being a number of instances of *what* that can be discerned (the "land", the "ogre", the "bridge", as well as the sentence – itself a complete statement and therefore a "thing"). Anyone who has ever told such a story will also know that being interrupted by a young child with questions of *how* and *why* is part of the process of the child making sense of things, engaging their imagination, and deepening their comprehension. Implicit in the opening sentence above is also the fact that the *who* is also an actor who *did* things (such as living under a bridge and presumably many other things that can be imagined or are yet to be told). This latter dimension of storytelling aligns closely with Language Action Perspective (LAP), a theory aimed at informing and influencing Information Systems Development (ISD) (Flores & Ludlow, 1980; Lyytinen, 2004). LAP also places emphasis upon the "descriptive fallacy" (Austin, 1962) for ISD, a "misconception that language is used for descriptive purposes only" (Ågerfalk, 2003, p. 12). In other words, LAP argues that language is used to perform actions ("speech acts" such as orders, requests, recitals, explanations, oaths, etc.) as well as to convey meaning through information and communication.

As stories evolve they also typically contain other elements of content – such as conflict, desire, journey, transformation, a dramatic event, an issue that becomes complex upon detailed exposition, or an existential dilemma. The consequences and/or resolution to such elements typically require attention to the detail and unexpected turns within the narrative. Whether the listener or reader is emotionally engaged or objectively detached he or she is also invited to reflect along the way and make sense of the narrative. Thus, storytelling has been recognized as an important means of activating reflection, stimulating inquiry and, therefore, teaching and learning (Neal, 2002; Ohler, 2007; Schank, 2011). Of particular relevance here, Ohler further notes that "In education

[particularly problem-based learning], a quest story becomes a question story" (Ohler, 2007, p. 75). But more importantly to this paper is that stories typically contain (implicitly or explicitly) content that can be elaborated upon in response to a why-question.

### 2.2.1. *Storytelling, Knowledge Management and learning*

From a broad historical perspective, storytelling has its roots long before human societies became literate. In the case of Indigenous Australians, often through song, it has been a primary means of preserving cultural and environmental knowledge from one generation to the next for many thousands of years (Denning, 2001; Dunbar-Hall & Gibson, 2004; van den Berg, 2005). In functioning this way storytelling can be seen as a tool for teaching and learning and a forerunner or natural foundation for Knowledge Management (KM) – which is both an academic discourse and a managerial intervention focused on the value that knowledge and its management bring to contemporary economies (Mason, 2009). This link to KM is significant here because its own evolution provides a metaphor for the design and development of e-learning tools.

In recent decades storytelling has thus been recognized as an important tool for sense-making and knowledge sharing and, therefore, useful for KM (Denning, 2001, 2004; Snowden, 2002b). Since its explicit beginnings approximately two decades ago, KM has evolved from a managerial discourse driven by a theory of reduction (aimed at the "capture" of knowledge) toward a richer academic discourse and organizational intervention informed by complexity and theories of emergence (Nonaka & Takeuchi, 1995; Snowden, 2002a; Wierzbicki & Nakamori, 2006). Importantly, just like learning, KM involves much more than information management and requires conceptual tools that reach well beyond issues of provenance (*who, what, when,* and *where*) and the management of factual information. Building on the earlier work of Polanyi (1966) it is focused more on the interplay of tacit and explicit knowledge and facets of knowledge that also rely on *know-how* and *know-why*. As a consequence, a number of researchers have highlighted the intersection, or even convergence, of ICT systems supporting e-learning and KM (Anitha, 2010; Mason, 2005; Pedroni, 2007; Rosenberg, 2001).

The use of storytelling has also become prominent in recent decades within educational and sociological research. Stories are used as a means to collect qualitative data for what is now termed "narrative inquiry", an umbrella term that describes a range of rigorously defined and related research methodologies (Clandinin, 2007).

### 2.2.2. *Storytelling and rich media*

Following McLuhan's (1964) seminal work on the transformative impact of media upon culture, the evolution of ICT has clearly brought with it application of a rich diversity of media in teaching and learning while also expanding the depth and meaning of the term *content*. Just as search engines have developed rapidly to support efficient searching so too have the digital tools for storytelling. Prior to the invention of the Web the wordprocessor had already revolutionized the way that text could be created, manipulated,

and distributed. In the digital domain stories can now be told in many ways. Contemporary options now include blogs, wikis, YouTube, and social media in general. These developments not only provide new channels for digital storytelling but also signal expanding options for scaffolding learning (McLoughlin & Lee, 2009).

Thus, in the teaching of storyboarding for "new media", Ohler points out the critical function of narrative and that it "is often developed as a result of editing and reflection" (Ohler, 2007, p. 186). In other words, the construction of story – and by inference, conceptual coherence – develops as a consequence of reflection. For Ohler, in an ideal future:

> telling stories would be an important part of how we teach and learn. Storytelling would be appreciated as an effective way to combine academics, thoughtful reflection and analysis, emotional engagement, and active problem solving. (Ohler, 2007, p. 202)

### 2.2.3. *A bigger picture?*

In a similar way to Ohler, though expressed with bolder advocacy, Pink (2006) describes *story* as a fundamental human ability that requires mastering as we navigate our way from the "Information Age to the Conceptual Age" (Pink, 2006, p. 2). Story is an effective way of sharing and remembering information because it connects both our cognitive and emotive capacities – or, in Pink's terms, "story exists where high concept and high touch intersect" (Pink, 2006, p. 103).

Likewise, for Schank (2011) – one of the pioneers of modern Cognitive Science – the art of storytelling is a component of good teaching because it provides a key to engagement and stimulation of the "cognitive processes that underlie learning" (Schank, 2011, p. 45). He goes further by arguing that schooling needs to shift its focus from subject-based and test-based education to teaching these cognitive processes (Schank, 2011, p. 109).

Innovation in the application of ICT in teaching and learning will always be ahead of mainstream practice. The challenge that comes with evolving ICT capabilities is to sync teaching and learning practices with it. Conversely, through only applying conventional practice to the technology available, gaps in our understanding of how effective teaching and learning proceeds may be revealed.

Thus, it follows that storytelling has a role in scaffolding (whether ICT-enabled or not) and has wider application than that of occupying the minds of young children. An important feature of storytelling is that the same story can be told with many variations to the script (as in, for example, classical and contemporary versions of Romeo and Juliet). This feature can be seen as a metaphor for the variations in answers or solutions to complex or "ill-structured" problems in problem-based learning. As Barrell (2010) points out, "realistic, authentic problems – such as pollution of the planet or feeding the hungry – are so complex, messy, and intriguing that they do not lend themselves to a right or wrong answer" (Barrell, 2010, p. 178). This point provides an important perspective on what distinguishes explanation from information: its key role in the

development of comprehension and understanding. Following this it is proposed here that dedicated ICT tools that can facilitate the discovery of explanatory content would be very useful for both teaching and learning.

### 2.3. *Information and explanation*

While storytelling serves many functions and has demonstrated utility in teaching, learning, and research, the purpose of the foregoing discussion is to emphasise that stories need more than factual information to be engaging. Important to the theme of this paper is that a story can be both an object and an artifact of reflection. Perhaps even more importantly is that stories, or content within them, are useful instruments for stimulating and addressing *why*-questioning. In doing so, they draw upon explanatory content as well as descriptive information. For teaching and learning purposes stories represent a genre of content that can be targeted in developing ICT-enabled scaffolds that promote reflection. A key difference between information and explanation is that an explanation only needs to be *plausible*, not factual, for it to be understood. More importantly for learning, developing the ability to explain things is consistent with the development of reasoning skills.

Returning to the focus on *why*: more than any of the other primitive questions, *why* requires a plausible explanation or a rationale as an adequate response – in other words, information coupled with reasoning (Verberne, 2010, p. 10). Thus, *why*-questioning can initiate a shift from routine information processing to engagement of other cognitive functions, such as inquiry, analysis, problem-solving, and reflection. And while explanation and rationale are often part of a good story they are not necessarily its essential or driving components. Thus, in discovering opportunities for ICT-enabled scaffolding that might support reflective inquiry, it is the access to and production of *explanatory* content, as distinct from *descriptive* content, that is of prime interest. A promising research question that emerges is: *what ICT scaffolding innovations might be designed into systems explicitly built to support why-questioning?*

## 3. Reflection and Pedagogy

> Reflection is an important human activity in which people recapture their experience, think about it, mull it over and evaluate it. It is this working with the experience that is important in learning.
> (Boud, Keogh, & Walker 1985, p. 19)

From both philosophical and educational perspectives *reflection* is a cognitive activity that has an *object* (Bell, 1977; Ezio, 1987, p. 253; Kemmis, 1985). While that object could be broadly summed up as *experience* it also typically involves conceptualization itself – or thinking about thinking. In simpler terms, reflection describes considered thinking about *something*, and that something will at times be thinking itself. Depending upon context and circumstances, it will likely be a mix of complex cognitive processes involving recall, discernment, objectivity, identification of facts and issues, checking

assumptions, reconciliation, summarization, synthesis, and pattern recognition, etc. As such, it involves much more than comprehension or the composition of a journal entry – a common contemporary approach to evidencing learning in professional development contexts (Patrick et al., 2009). In situations that require domain-specific knowledge, reflection will also likely involve sophisticated cross-referencing with an established knowledge base (Wang, 2009).

While not all educational theories acknowledge reflection as important for learning most educational literature on the topic has appeared since constructivist theories of learning have emerged (Herrington, Herrington, Oliver, & Omari, 2000). However, Ryan and Ryan (2011) have recently observed:

> Despite the rhetoric around the importance of reflection for ongoing learning, there is scant literature on any systematic, developmental approach to teaching reflective learning across higher education programs/courses. Given that professional or academic reflection is not intuitive, and requires specific pedagogic intervention to do well, a program/course-wide approach is essential. (Ryan & Ryan, 2011)

In response to this situation an Australian Learning and Teaching Council (ALTC) project, Developing Reflective Approaches to Writing (DRAW), was initiated in 2010 with the aim of "developing a systematic, cross-faculty approach to teaching and assessing reflective writing in higher education" (Ryan & Ryan, 2012). Outcomes of this project include a number of successful pedagogical interventions or "teaching designs" that have been developed and tested. Prominent among these, and based upon earlier work of Bain, Ballantyne, Packer, and Mills (1999) involving "5Rs", is the "the 4Rs model of reflective thinking" (Ryan & Ryan, 2012). As its name suggests, this model identifies four key activities that can scaffold reflective thinking and are conceived of as a sequence that begins with reporting:

- Reporting (and Responding)
- Relating
- Reasoning
- Reconstructing

Because the DRAW project is focused on *assessment* of reflection as much as the *teaching* of it then its immediate consequence is upon pedagogy and not on implications for innovation in the design or implementation of ICT. The question that arises from this work in relation to the theme of this paper then, is: *how might the 4Rs model inform the design of e-learning systems and services?* Evidence indicates that implementers of e-portfolio systems for learning purposes already typically recognise the importance of reflection and accommodate it through the provision of designated spaces and tools within these systems – and, within systems already deployed there is activity that is consistent with the aims of the DRAW project (Cambridge, 2009; EAC, 2011; Hallam et

al., 2008). To date, however, the ICT tools themselves within these systems are geared toward facilitating the *documentation* of reflection rather than reflective activity or inquiry itself (Mason, 2011, p. 79).

There are other approaches to stimulating and supporting reflection, particularly in the context of inquiry, that are relevant to this paper (Casey & Bruce, 2011; Hoban, 2006; Land & Zembal-Saul, 2003). In research focused on scaffolding reflection on scientific explanations Land and Zembal-Saul (2003) found that "cycles of explanations" are typical of the learning process as "learners continually revisit and reflect on their understanding, they engage opportunities to revise and reassess what they know" (Land & Zembal-Saul, 2003, p. 65). This observation provides a useful link with *why*-questioning and has an interesting parallel in corporate settings where there also exists evidence of the importance of asking cycles of *why* questions in the quest to achieve better efficiencies. For example, there exists extensive documentation of the practical application of the *Five Why's* in improving efficiencies within the Toyota Motor Corporation (2003) and integration into recent applications of the *Six Sigma* method (iSixSigma, 2008). When confronted with new events within the workplace, particularly those of an adverse nature and not fully understood, staff are encouraged to pursue *why*-questioning to five levels to properly identify root causes.

Whether in contexts of formal learning or workplace performance reflection can therefore be seen as key to the development of explanatory and reasoning skills. Closely related to these skills are critical thinking and problem-solving – skills that have also been identified as foundational "21st century skills" in which *know-how* and *know-why* can be seen as pivotal (Barell, 2010, p. 175).

## 4. Critical Thinking, Reflective Practice and Integrated Reflection

While critical thinking and reflective practice can be defined in different terms (such as analysis and mindfulness) and there exists a significant body of literature associated with each, it is assumed here that they share much in common and both are generally understood as having positive influence upon learning. Neither activity takes place without some kind of critical attention or attitude of inquiry; in many situations they work together; and, *why*-questioning is common to both. The term "integrated reflection" is introduced here to place emphasis upon the range of cognitive activities that can take place during reflection. It is a term informed by the work of Schön (1987) and Wang (2009).

### 4.1. *Critical thinking*

Critical thinking involves cognitive processes often associated with inquiry and analysis and, within formal learning, education, and training contexts, the role of *why*-questioning has long been recognized as a key component in its development (Paul & Elder, 1999; Piaget, 1966; Wellman & Lagattuta, 2004). Inquiry-based learning is facilitated when the learner sets out to make sense of some content through interpretations, reflections, and judgments. Despite this, however, there does not appear to be one commonly accepted

theoretical approach to the conceptualization of critical thinking within the Philosophy of Education with ongoing debates concerning the roles of reason versus skill (Bailin, 1998; Seigel, 1990; Walters, 1994). In Psychology, the debate is to do with whether critical thinking is an aptitude or a skill (McPeck, 1994). Resolution of such debates is not crucial to the theme of this paper – what is important is how critical thinking might be facilitated. Traditionally, this will be understood to be the role of pedagogy; but with advances in ICT and learning design it is likely that purpose-built tools will also serve this role as scaffolding. But as yet, such specific tools have not been identified.

### 4.2. *Reflective practice*

In a similar way, the discourse on reflective practice and its epistemological roots reveals some tensions around "learning through doing" and "learning about" and the appropriateness and timing of reflection on the job (van Manen, 1995). But whether it is during internship or the context of continuing professional development it is now standard practice for practitioners (from professionals to trainees) to engage in a critical examination of outcomes of a learning experience. The mainstream institutionalization of this as an activity (such as keeping a personal journal) that takes place *after* a learning experience represents, however, only a subset of the potential range of cognitive tasks required for integrated reflection.

### 4.3. *Integrated reflection*

Schön (1987) has been credited with first using the term "reflective practice", defining it as "reflection-in-action" and as practice that involves "continuous learning" (Schön, 1987, p. 72). In this conception reflection can be seen as a process that is integral to a wide range of activities associated with learning – such as inquiry, communication, editing, analysis, synthesis and evaluation – and many more, depending upon context. This idea is consistent with the way that continuous professional development (CPD) and/or work-integrated learning (WIL) are implemented in many workplaces (Patrick et al., 2009). Scaffolding reflection-in-action has also gained attention in the development of online learning for at least a decade (Lai & Calandra, 2007; Lyons, 2010; Shannon, Roberts, & Woodbury, 2001; Sporer, Steinle, & Metscher, 2010).

More recently, Wang has proposed "an ontological model that specifies a generic organisational structure of eportfolios in the integrated reflection context" (Wang, 2009, p. 449). In this model, *reflection* features as a dominant ontological category within a structure that includes *learning subject*, *learning objectives*, *learning objects*, *assessment instruments*, and *reflection query*. Wang's conception of "integrated reflection" clearly has a pedagogical focus; however, his model is also explicit that reflection (or its evidence) represents much more than a collection of jottings or journalism after a learning experience and is facilitated by "active learning" (Wang, 2009, p. 455).

Thus, following both Schön and Wang, reflection represents activities far broader than reflective journalism – and *integrated reflection* indicates a range of cognitive activities beyond the recording of reflections, including discernment, critical thinking,

identification of facts and issues, checking, reconciliation, summarisation, synthesis, and pattern recognition, etc. (van Manen, 1995). As such, it represents a broad set of cognitive capacities that could be targeted by e-learning systems designers.

The challenge of achieving integrated (in-session) reflection, whether the session is a unit of e-learning or teaching or some other vocational activity, will ultimately be determined by the context. Where it is appropriate for scaffolding to assist in the process then the design of that scaffolding will be an important factor in determining the outcome.

Dedicated software focused on developing some of these capacities already exists that could be used effectively for e-learning – for example, Rationale™ is software designed specifically to enhance student abilities in forming rational arguments and reasoning skills through identifying fallacies or weakly formed arguments within existing texts. Its website contends:

> Rationale is the most effective software tool for building students' critical thinking skills. It can be used throughout all curriculum programs at tertiary, secondary and primary levels of education … [and] when someone states a contention, we usually ask "why?" Critical thinkers want to know the reasons for and against the contention before they form a judgment.
> (AusThink, 2009)

Combining the threads of the discussion above with that of the preceding discussion regarding primitive questions, Thomas and Brown (2011) identify and provide advocacy for the emergence of a "new culture of learning":

> We propose reversing the order of things. What if, for example, questions were more important than answers? What if the key to learning were not the application of techniques but their invention? What if students were asking questions about things that really mattered to them? (p. 81)

While it will always be important for learners to master the content of a particular discipline (Gardner, 2010, p. 28) the skills of critical thinking and problem solving gained through active questioning and inquiry are now recognised as just important, not only to employers but learners of the 21st century (Bellanca & Brandt, 2010, p. xvi-xxiii) and educators (Rothstein & Santana, 2011). Thomas and Brown's proposition clearly gives emphasis to inquiry and aligns neatly with recent advances in computational linguistics and automated question generation, both of which provide new opportunities for the design of tools to support e-learning discussed in the next section (Evered, 2005; Graesser, Rus, & Cai, 2007).

## 5. Linguistic and Computational Perspectives

### 5.1. *Linguistic versatility*

The versatility of the word *why* is clearly evident from the fact that it is commonly found in questions as well as a range of other linguistic expressions. From a grammatical perspective it can function as an interrogative (simply as *Why?*), an adverb (as in *Why do we sleep?*), as a pronoun (as in *There is no reason why she shouldn't attend*), as a noun (as in *He provided an analysis of the semantics associated with why*), and as an interjection (as in *Why, you're crazy!*). This versatility provides the basic rationale for why it might be useful to classify *why*-questioning (Graesser et al., 2007) prior to embarking on ICT systems design associated with supporting it. This linguistic versatility has the implication that any computational modeling of textual content that contains *why* will need to consider carefully the broader textual context because with linguistic versatility also comes ambiguity.

### 5.2. *Classification and automated question answering*

Evered (2005) provides an analysis in which the explanative function of responses to *why*-questioning is categorized according to three classes of explanation: Causal (*Why E? Because C* (C= cause)); Teleological (*Why E? In order to P* (P = Purpose)); and Gestaltic (*Why E? For these reasons, R* (R = Reasons)) (Evered, 2005, p. 201). For example:

Why did the city flood? *(Because of prolonged and heavy rain)*

Why did she attend driving lessons? *(In order to get her driver's license)*

Why has the Government introduced a new policy on digital copyright? *(There are a number of reasons, including the changing nature of the production, use, and access to content; the need for the legal world to keep pace with technological innovation; and, the rapidly evolving nature of digital content itself.)*

Closely aligned with this classification is the work of Verberne (2010) whose analysis on *why*-questioning is focused on linguistic structures and components that can inform the design of effective automated question-answering (QA) (Verberne, 2010, p. 17). Question-answering research has its beginnings in the field of information retrieval (IR) during the mid 1990s and now is associated with a significant and mature discourse (Maybury, 2002, pp. 8-11). Verberne's classification identifies four kinds of *why*-questioning after closer discourse analysis and "distinguish[es] the following subtypes of reason: cause, motivation, circumstance (which combines reason with conditionality), and purpose" (Verberne, 2010, p. 27). However, Verberne shows that while such classifications can be helpful they are not sufficient. Importantly, despite her expectation that algorithms focused upon reasoning would likely guide any effective automated answering system, her work on linguistic structure and relation reveals that "elaboration is more frequent as a relation between a *why*-question and its answer than reason or cause" – in other words, *explanatory content* can be seen as the object that *why*-questioning typically seeks. This key finding has helped Verberne develop a number of

related algorithms informed by IR and Natural Language Processing (NLP) techniques that together demonstrate an effective approach to ICT systems design for answering *why*-questioning (Verberne, 2010, p. 102). Despite achieving close to 60% effectiveness in answering *why* questions, Verberne concludes:

> high-performance question answering for *why*-questions is still a challenge. The main reason is that the knowledge sources that are currently available for NLP research are too limited to capture the text understanding power that is needed for recognizing the answer to an open-domain *why*-question. Since this capability is problematic for machines but very natural for human readers, the process of *why*-QA deserves renewed attention from the field of artificial intelligence. (Verberne, 2010, p. 140)

NLP has also been important in research and development of natural language search engines, such as PowerSet (http://en.wikipedia.org/wiki/Powerset_(company)) and TrueKnowledge (http://www.trueknowledge.com/). More recently IBM has led the DeepQA project with its smart computer named "Watson" (Ferrucci et al., 2010). This system uses a "massively parallel probabilistic evidence-based architecture for QA" that decomposes the complexity of the problem into a number of stages and tasks involving question analysis, hypothesis generation, hypothesis and evidence scoring, retrieval of relevant content, and ranking of candidate answers (Moschitti, Chu-Carrol, Patwardhan, Fan, & Riccardi, 2011). But again, there are limits to its effectiveness of answering *why*-questions:

> The expectation is that if there is a good explanation out there Watson can discover, score, and even chain levels of explanation together. However, inferring how and why answers that require deeper thinking may represent a level of intelligence that requires capturing knowledge that is much more difficult to automatically learn. (Ferrucci, 2011)

*Will these advances also deliver new opportunities for integrated reflection and inquiry instigated by why-questioning during learning?* Only time will provide an answer to this question for now; however, there is no reason why the design of ICT could not anticipate such developments given that innovation takes place in multiple domains in parallel. While such research and development activities are highly relevant to the central theme of this paper it is important to emphasise here that in developing ICT scaffolds for why-questioning the aim is not to find pathways to automated answers but to promote and support the inquiry process itself.

### 5.3. *Question generation*

Possibly one of the more promising areas of research currently underway yielding implementation opportunities for ICT tools that might support *why*-questioning is the

field of Question Generation (QG). As Thomas and Brown (2011) suggested above, and others argue (Barell, 2010; Freire & Faundez, 1989; Rothstein & Santana, 2011), it may well be that the framing of questions is more productive for learning in an information-rich context than the responses to them. Thus, Freire and Faundez also argue for the need for a "pedagogy of asking questions" that gives emphasis to the questioning process as something valuable in itself, where the answer may not even be relevant: "thinking about questions that may not always or immediately arrive to an answer are the roots of change" (Freire and Faundez, 1989, p. 37).

As one of the consequences of innovations in ICT, however, the volume of accessible information is at a scale never previously seen with information now being produced through increasingly diverse channels from increasingly many more sources and yielding potentially increasing layers of complexity (Benkler, 2006, p. 5). Thus, Graesser et al., (2008) make the following observation:

> For the first time in history, a person can ask a question on the web and receive answers in a few seconds. Twenty years ago it would take hours or weeks to receive answers to the same questions as a person hunted through documents in a library. In the future, electronic textbooks and information sources will be mainstream and they will be accompanied by sophisticated question asking and answering facilities. As a result, we believe that the Google generation is destined to have a much more inquisitive mind than the generations that relied on passive reading and libraries. The new technologies will radically transform how we think and behave. (Graesser et al., 2008)

Learning how to ask good questions is clearly very important in both teaching and learning. In highlighting this, the 1944 Nobel Laureate in Physics, Isidor Rabi, once responded to a question as to how he came to be a scientist, as follows:

> My mother made me a scientist without ever intending it. Every other Jewish mother in Brooklyn would ask her child after school, 'So? Did you learn anything today?' But not my mother. She always asked a different question, 'Izzy,' she would say, 'Did you ask a good question today?' That difference – asking good questions – made me a scientist. (Barell, 2008, p. 103)

Following this line of argument, Graesser, Ozum, and Sullins (2010), observe elsewhere that:

> Most teachers, tutors, and student peers do not ask a high density of deep questions … so students have a limited exposure to high-quality inquiry. There are a few role models in school environments through which students can learn good question asking and answering skills vicariously. This

> situation presents a golden opportunity for turning to technology to help fill this gap. (Graesser et al., 2010, p. 125)

Through developing intelligent tutoring systems and tools that can create well-formed questions from collections of relevant content it therefore seems likely that new opportunities are not far away for ICT that is better able to support *why*-questioning, and, as a result, support integrated reflection and deeper inquiry during e-learning.

## 6. Related Work

There are numerous examples of work that has some synergy with the theme of this paper. For example, the Inquiry Project at the University of Illinois is a project focused on the advocacy of inquiry-based learning and it uses the motto: "learning begins with questions" (Casey & Bruce, 2011, p. 77). Of course, no motto covers all scenarios and while learning can clearly take place without questioning – for example, through repetition and memorization – it is through questioning that reflection, discourse, and knowledge construction takes place.

In the area of e-portfolios used in learning, education, and training much has been said and documented about the key role that reflection can play in assisting ongoing learning and professional development (Hallam et al., 2008; JISC, 2008, 2010). An initial review of practice, however, reveals that while a designated space for documenting and collating personal reflections is a typical design feature of most e-portfolio systems very little exists in the way of tools that stimulate reflection, apart from question prompts and templates. Thus, apart from enabling personal journalism through blogs and template approaches to writing, scaffolding tools within e-portfolio systems that encourage the actual process of reflection still appear to be under-developed. The "ontological model [for] integrated reflection" specified by Wang (2009) and discussed earlier indicates a possible way forward.

Looking back to older theoretical models, Bloom's (1956) taxonomy of educational objectives provides an interesting reference point for the theme of this paper. Bloom's original framework identifies six levels of learning represented as a pyramid: knowledge, comprehension, application, analysis, synthesis, and evaluation – with the implication that each level of the pyramid represents a higher order or learning. In this conception, however, "knowledge" is only really a facet of knowledge (i.e. "knowing-*that*" and based upon knowledge of factual content). With comprehension as the next level (being able to describe and explain) it is interesting to note that *description* and *explanation* are conceived at the same level. At all subsequent levels knowing-*why* is a prerequisite. In many ways, while Bloom's taxonomy could be revised to be more relevant to current circumstances it also represents a model that presents the fundamental components of integrated reflection.

## 7. Conclusions

Theory and practice are mutually informing and co-evolve in multiple venues: the development of e-learning is no different and ever since the term was first coined in the late 1990s it has evolved as both an academic discourse and a broad range of practices. In tracking its evolution it is clear that multi-disciplinary and "transdisciplinary" research is required because it is typically involved in what has been termed "Mode 2 knowledge production" (Manathunga, Lant, & Mellick, 2006, p. 365). Such an approach is necessary in order to span the relevant inputs as well as to identify opportunities for future development. It is also arguably the case that the conceptual boundaries that define e-learning as an academic discipline are also emergent (Cooper, 2010). Given that *why*-questioning has been demonstrated as having an important role within learning then this emergent nature of conceptual boundaries is underscored by the related research and development underway within domains such as computational linguistics, knowledge management, inquiry-based learning, metadata for learning resources, e-portfolio systems, natural language processing, and automated question-generation.

This paper has drawn from a diverse domain of academic literature and been explicitly theoretical in pointing to opportunities for ICT innovation that could scaffold *why*-questioning and thereby support integrated reflection while learning. In particular, *explanatory content* has been highlighted as a key concern of *why*-questioning and a core component of storytelling. Significantly, it is identified as not well-supported by mainstream content discovery tools such as search engines.

It also appears to be the case that through better understanding of *reflection* and *reflective practice* during learning that new opportunities for scaffolding these activities using innovations in ICT will follow. Given that the skills of critical thinking and problem solving gained through active questioning and inquiry are now being increasingly recognised by both employers and educational researchers as essential applied learning skills for the 21st century (Dede, 2010, p. 55) then it may be that this latter agenda might drive the ICT innovation pointed to.

With the emphasis upon the role of questioning during learning within this paper, a number of questions are highlighted here as requiring further research:

(1) *What kinds of ICT tools might facilitate the discovery of explanatory content?*
(2) *What ICT scaffolding innovations might be designed into systems explicitly built to support why-questioning?*
*(3) How might advances in automated question-generation inform the development of ICT tools that might sustain deep inquiry?*
(4) *Will advances in ICT that supports natural language processing also deliver new opportunities for supporting why-questioning and integrated reflection during learning?*

These and related research questions arise from the fact that while mainstream search engines facilitate the discovery of content to enable learning and knowledge sharing, their core technology function remains that of *information processing* calibrated for

responding to *search terms* rather than *questions.* A consequence is that the discovery or retrieval of explanatory content is not an activity that is easily prescribed using these tools.

Finally, the following observation and question from Moor (2006) seems appropriate:

> There is a debate in the philosophy of science whether science *explains* nature or only *describes* it. Clearly, laws of nature are only descriptive. They describe by words or by mathematical equations the rules and order of nature. They give an answer to the question how things happen in nature, but they don't answer the question why things happen this way. This descriptive knowledge of nature is enough for any practical purpose, but curious creatures like us are not content with this kind of knowledge. We also want answers to the question *why*.
>
> The question "*why*" is about reason. Reason is not something that exists in nature, at least not in a way that we can perceive by our senses. Reason exists in our minds, in our thoughts. It is beyond the boundaries of our possible knowledge about nature. What tools do we have to deal with what lies beyond these boundaries? (Moor, 2006)

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