THEORIZING *WHY* IN E-LEARNING – A FRONTIER FOR COGNITIVE ENGAGEMENT

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ABSTRACT

Asking why is an important foundation of inquiry and fundamental to the development of reasoning skills and learning. Despite this, and despite the relentless and often disruptive nature of innovations in information and communications technology (ICT), sophisticated tools that directly support this basic act of learning appear to be undeveloped, not yet recognized, or in the very early stages of development. *Why is this so?* To this question, there is no single satisfactory answer; instead, numerous plausible explanations and related questions arise. After learning something, however, *explaining why* can be revealing of a person's understanding (or lack of it). What then differentiates *explanation* from *information;* and, *explanatory* from *descriptive* content? What ICT scaffolding might support inquiry instigated by *why*-questioning? What is the role of reflective practice in inquiry-based learning? These and other questions have emerged from this investigation and underscore that *why*-questions often propagate further questions and are a catalyst for cognitive engagement and dialogue. This paper reports on a multi-disciplinary, theoretical investigation with a view to informing the broad discourse on e-learning by identifying a specific frontier for design and development of e-learning tools. Probing *why* reveals that versatile and ambiguous semantics present the core challenge – asking, learning, knowing, understanding, and explaining *why*.

KEYWORDS

Scaffolding, inquiry, *why*-questioning, reflection, understanding, cognitive engagement, cognition in education

1. INTRODUCTION

In introducing any topic of investigation it is usually helpful to understand *why* it is presented and *what* its key drivers are; a listener or reader often finds it helpful to understand the context of an investigation in order to make some initial sense prior to embarking on giving it further attention. Such context can also be described in terms of motivation, purpose, rationale, and/or justification for the work – or as "advance organizers" (Ausubel, 1960). Perspectives that emerge from responding to questions help to explicate some context – e.g., (i) *why is this paper submitted to CELDA 2012?* (ii) *what is the central argument of this paper?* Providing perspective of this kind can serve as a trigger for cognitive engagement and doing so – in the form of a well-constructed *abstract* – is an established academic convention. Roots of influence for this practice stretch back to the time of Aristotle, when *logos* was elaborated as well-formed argument within reason and, as such, one of three modes of persuasion – the others being *ethos* and *pathos*.

Thus, motivation for this paper emerges from consideration of future prospects for e-learning activities that probe the *why* dimension, or inquiry that involves *why* – asking, learning, understanding, knowing, reflecting upon, and explaining *why*. In order to develop an overarching narrative a number of interrelated topics are discussed: the evolution of e-learning; the role of questioning while learning; descriptive versus explanatory content; inquiry-based learning; scaffolding using information and communications technology (ICT); and, future prospects for ICT tools that support and promote *why*-questioning.

As a consequence of extensive academic literature on the subject it is assumed that *asking why* is an important foundation of inquiry and fundamental to the development of reasoning skills and learning. But, in direct contrast, sophisticated ICT tools that directly support this basic act of learning appear to be either undeveloped or, at best, in the very early stages of development. *Why is this so?* On the one hand, this paper suggests there are a number of very good reasons; on the other, it is focused on the implications of

developing better tools that support *asking why* and *understanding why* in the specific context of e-learning. It summarises relevant research with a view to informing the design of ICT tools that might stimulate deep learning and cognitive engagement. In supporting a clear rationale for the investigation the following real-world scenarios describe common, contemporary situations in e-learning involving concepts of *why*:

1.1 Scenario – University Student

Sarah is a university student majoring in international relations and history. She has opted to do much of her studies online because it provides her with the flexibility to take on some part-time work. The university has invested considerable funds into preparing appropriate content and assessment tasks for subjects offered in online mode; it has also implemented a standard single-platform policy and installed BlackBoard, a Learning Management System that helps structure learning content and contain interactions between staff and students. Sarah uses Google to search for additional resources for an essay on the conflict in the Middle East. While she finds numerous resources it is challenging for her to understand the causes of this conflict or what the appropriate actions might be for it to be resolved. The course resources seem well-structured but she is required to investigate sources beyond the prescribed texts. If she searches Google with '*why*' questions she feels very dissatisfied with the quality of the results. Likewise, when searching the library catalogue she is overwhelmed by the volume of resources and is not confident in making a judgement about *why* this conflict seems so deeply problematic because she finds so many plausible, yet contradictory, and politicized explanations. Even though she has access to a number of 'social software' applications that enable her to interact and share resources easily with others who might be investigating the same topic she feels like there is something lacking in the online tools available. She feels that she needs assistance in discerning fact from political rhetoric and some other way of navigating and evaluating the large amount of content on this topic. She wants to *understand* the key issues at the heart of the conflict.

1.2 Scenario – High School Teacher

Dave is an art teacher at a high school with two decades of experience. The school has a reputation for adopting ICT into the curriculum wherever possible; however, art has been the last subject to embrace ICT. This is partly due to the fact that Dave feels more comfortable using traditional media. The school is now urging him to make the shift. In moving his content into an electronic mode Dave discovers that he has to anticipate many of the questions that students typically ask when in the classroom ('*but why do we have to study Matisse, sir?*'; '*why is some abstract art seen as having great merit while some doesn't?*'; '*why are there different versions of what constitute primary colours?*'). Because of his experience he knows that the students need good answers to such questions so that they can be motivated to learn. He thinks that he may need to create a bank of such questions together with suitable answers but hesitates because he knows that when students ask questions a longer conversation often proceeds. He is unsure of the best way to make such information available so chooses just to make it explicit in the introductory text to each task described in the online version of his course. But he remains sceptical that anticipating such questions in a 'canned' way will be as motivating for the students as being able to respond in real-time. He would prefer to foreground student questioning and make it stimulating and interactive, rather than content that students read.

1.3 Scenario – Instructional Designer

Thor is an instructional designer for a publishing company that specialises in de-mystifying science. The publisher has already had commercial success in preparing online materials that mimic the successful television series in Australia during the 1960s, '*Why is it so?*' Thor has been asked to assist in developing innovative pathways to scientific content that will stimulate students to think and ask '*why*', to motivate their curiosity and that leads them into understanding scientific inquiry. He is not quite sure how to proceed and is suspicious of Q&A approaches because providing answers can often close down inquisitiveness; he knows that powerful search engines like Google can deliver responses to search queries but will also limit the student to searching, not *questioning*; he also aware that none of the natural language search engines he knows of seem to do a very good job with responding to *why* questions. How is he to proceed?

1.4 Scenario – Teacher Librarian

Lisa is a teacher-librarian. She has access to a range of repositories of high quality, digital learning content. Most of this content is described using Dublin Core metadata (i.e., information such as the author, title, keywords, and abstract) and some of it is described by IEEE Learning Object Metadata (i.e., information similar to Dublin Core metadata but also includes information about the educational level associated with the content and duration of the resource). Some resources also have metadata that describes associated learning objectives and competence level required in order to interact effectively with the resource. Lisa has found that many of the teachers she supports also want to know *why* a particular resource might be more suitable than another for a particular learning activity or goal. Lisa has found that rating systems and user-generated tags and 'folksonomies' are sometimes helpful in this regard but is frustrated that not all the repositories support such services. She wonders whether there might be a better approach.

2. E-LEARNING EVOLVES

2.1 Terminology and Scope

Theory and practice of any domain of human activity are constantly evolving and mutually informing. But while both philosophers and practitioners have discussed matters associated with *learning* for thousands of years, it is not yet two decades since the term *'e-learning'* entered mainstream discourse. It is therefore important to make explicit what is meant by this term as it has been appropriated by diverse communities of practice since it first appeared around 1998-99 (Cross, 2004; CIPD, 2008; Garrison and Anderson, 2003).

e-Learning can signify both a theoretical discourse and a range of activities that take place in many contexts – formal and informal, within educational institutions and workplace settings, or elsewhere '*any time any place*' as the saying goes. Adopters of the term include corporate training associations, professional associations, academic Web enthusiasts, government policy makers, software vendors, standards development organizations, and military organizations, just to name a few (Mason, 2005:320). There are distinctions according to context. For example, Bates identifies key differences between post-secondary education and corporate settings – the latter being more concerned with the broader context of knowledge management, the former focused on learning and research (Bates, 2004: 275). In an attempt to broaden philosophical perspective, Friesen puts the case for "re-thinking e-learning research" and argues for a "reconceptualization of e-learning as an inter- and cross-disciplinary endeavor" (Friesen, 2009:20). Conceptualizing in even broader terms, Cooper argues that its scope of activity is best understood as '*emergent'* and therefore subject to analyses that highlight perspectives on "complexity" (Cooper, 2010). Others prefer to use the related terminology *'online learning'* to frame the challenges of "integrating technology into classroom instruction" (Tomei and Morris, 2011). For the purposes of this paper, *e-learning* is defined as: *learning that is facilitated by engagement with ICT*.

2.2 Innovation and Practice

With the above definition in mind, a diversity of ICT development and innovation over the last few decades can meaningfully be described as *e-learning* systems, environments, or platforms. Examples of *structured, contained,* or *purpose-built* platforms include computer-based training systems, learning management systems, intelligent tutoring systems, e-portfolio systems, performance support systems, virtual worlds, gaming environments, e-books, and other related applications and services. Anyone with a young child who has access to an iPad will also know how engaging and educational a single app can be – whether it is explicitly educational or not. Examples of *unstructured* and *open* environments that can function as e-learning environments include use of mainstream search engines and social media. Benefits and deficiencies can be identified with all of these developments, as is documented in the extensive and growing discourse on e-learning – for example, the number of peer-reviewed journals worldwide dedicated to the subject is now in excess of 50 titles and the majority of these titles have emerged in the last five years. If related topics such as

Distance Education, e-Research, Technology in Society, Knowledge Creation, and Performance Support are included then there are hundreds of relevant journals.

As e-learning develops into an established academic field it brings with it a discourse that refines its core concepts and terms while ICT innovations and trends evolve. It is also likely that certain trends and biases will be revealed along the way. For instance, evidence suggests that much of the first generation of practice associated with e-learning has been very focused on the delivery and access to *purpose-built learning content*, not so much with *learning activities* or the *cognitive processes* associated with learning (Dalziel, 2003; Alonso, *et al.*, 2005; LETSI, 2008; ADL, 2009). This first generation of learning content has also been constrained by metadata that is *descriptive* in function – in other words, metadata that describes the content in terms of semantics that have roots in *who*, *what*, *when*, and *where*.

It is also the case that the educational potential of existing, emerging and future developments in ICT is now commonly discussed in many diverse settings (daily newspapers, school curriculum support materials, political party policy documents, workplace human resource departments, standards-setting bodies, academic literature, and in higher education strategic planning). The *'Digital Education Revolution'* policy of the Australian Governments during 2007-2012 is a prominent example of a public policy response. Such public policy has been commonplace since the invention of the World Wide Web, although prior to this, the transformative potential of educational technology was recognised at various other historical moments (such as with the inventions of radio, television, personal computers, interactive and game-based digital media). There are therefore multiple perspectives that help explain the history and viable developmental paths of e-learning into the future. The Australian *School of the Air*, which began in 1951 and continues today in servicing the needs of remote communities in Australia, represents an example of an older communications technology that is still used effectively for educational purposes. This is significant because it suggests that the viability of a technology is not necessarily made redundant by new technologies.

2.3 Historical and Social Narratives

Broader historical perspective provides further context. Not only has evolution of the World Wide Web taken place within a short period of time accompanied by rapid innovation, it has been *transformative*, representing a global revolution in the production, distribution, and access to information and communications (Castells, 1996; Benkler, 2006; Gleick, 2011) and can be seen as having enormous impact upon teaching and learning.

A number of commentators have consequently introduced narratives on the evolution of the Web in terms of its impact upon learning. Taylor (2001), for instance, began visioning "fifth generation distance education" around 2001-2002 as an "intelligent flexible learning model" – it was student-centric in conception but impacted significantly the organizational structures and readiness for institutions concerned. In 2005, Siemens proposed a new learning theory called "connectivism", motivated principally by the impact of the proliferation of networked ICT applications and the limitations of dominant learning theories (behaviourism, cognitivism, and constructivism) to explain and support the scope of interactions a learner. The distinguishing characteristic of Siemens' theory is the prominent role of networks in creating connections between disparate learning sources and events (Siemens, 2005). Siemens' work resonates with the extensive sociological work of Castells (1996, 2001) in outlining the "rise of the network society" and in the work of Benkler on the social production of intellectual capital (Benkler, 2006).

More recently, there has been popular usage of the terminology 'Web 2.0' typically to describe networking capabilities that leverage social media providing individuals with enormous scope for publishing content and social interaction. Adoption of such terminology has also led to characterisations of "Learning 2.0" being learning that is facilitated by Web 2.0 social media applications (Brown and Adler, 2008) and related commentary about the "post-LMS era" (Mott, 2010). The utility of such characterisations is yet to be determined; however, in terms of the evolution of e-learning, they can be somewhat misleading because they mask, or do not always explicitly acknowledge, the capabilities that already existed in early phases of development – such as in Computer Based Training (CBT), Computer Assisted Learning (CAL), Computer Managed Learning (CML), Computer Mediated Communication (CMC), and Computer Supported Collaborative Learning (CSCL). The important observation here is that there are numerous technologies that have shaped what e-learning is today. Secondly, and most importantly for this investigation, none of the innovations mentioned hitherto have explicitly explored how *why*-questioning during learning might be explored, supported or scaffolded.

2.4 Into the Future

With the foundations of e-learning now well-established there is enormous scope for new developments that may enrich learning experiences through supporting deeper *inquiry* and cognitive engagement via environments that stimulate reflective practice and the development of *understanding* while learning online. A number of likely future trajectories can be discerned from the current context – for example, the broad uptake of social media provides stimulus for the use of diverse collaborative environments at scales unprecedented. Other developments will emerge as a consequence of ubiquitous broadband connectivity, innovations in natural language search technologies, access to open content, the proliferation of mobile technologies, work integrated learning programs, and intelligent tutoring systems. Will IT develop further as an "intelligent technology" or an "interruption technology" (Carr, 2010)? No doubt, unexpected innovations will also impact the evolutionary story.

This paper, however, is concerned with *one* of the frontiers that beckon further development – *ICT that supports deep learning instigated by questioning, reflective practice, and promotes cognitive engagement.*

3. COGNITIVE ENGAGEMENT

3.1 Ubiquitous Distraction?

There can be little doubt that the Internet has spawned a proliferation of ICT tools useful for learning. But the story of the impact of such relentless innovation is not an intrinsically positive one. It is also accompanied by a growing discourse arguing that extended use of the Internet can also have detrimental effects on cognition and behaviour (Clark, 2002; Bannister and Remenyi, 2009; Carr, 2010; Aguirre, 2011; Chalupa, 2011). Evidence shows there is definitely an impact upon *cognitive load* (Verhoeven, 2009; Kleinberg, 2011), a topic that instructional designers have been concerned with for decades (Sweller, 1994). For example, for reasons that being online can be very distracting with the effect of weakening cognitive focus, the term "interruption technology" has been a catch-phrase in contemporary popular commentary on the Internet:

> the single most mind-altering technology that has ever come into general use … when we go online, we enter an environment that promotes cursory reading, hurried and distracted thinking, and superficial learning … The Net's cacophony of stimuli short-circuits both conscious and unconscious thought, preventing our minds from thinking either deeply or creatively. (Carr, 2010)

Of course, similar commentary and research has existed for decades about extended exposure to television and virtual gaming environments. Thus, the discourse is not all negative – for example, research shows that while extended Internet use can cause some loss of short-term memory there is also a gain in that "The Internet has become a primary form of external or transactive memory, where information is stored collectively outside ourselves" (Sparrow, et al., 2011).

There is truth in both arguments – so in terms of the nature of cognitive engagement while learning online, evidence that drives this debate will be important for researchers to track.

3.2 The Search Paradigm

The enormous market success of the Google search engine can be seen as paradigm-shaping in the way that much learning online and scholarship is now initiated – via *search*. Its functionality has also delivered routine information retrieval and discovery into the mainstream. Of course, not all searches using Google are concerned with learning and most are better classified as *information-seeking* and Google's effectiveness has also impacted corporate workflows, the socialization of information (Brown and Duguid, 2000), Government-based services, and the expectations of citizens of the developed world. As Google (the company) has developed its own services, such as *Gmail* and *Google Docs* and *Drive*, the flagship search engine can be seen as the core piece of technical architecture – *search* being the key operator on, and organizing technology for, *content*. Again, however, Carr notes a downside:

> Google … shapes our relationship with the content that it serves up so efficiently and in such profusion. The intellectual technologies it has pioneered promote the speedy, superficial skimming of information

> and discourage any deep, prolonged engagement with a single argument, idea, or narrative. "Our goal," says Irene Au, "is to get users in and out really quickly. All our design decisions are based on that strategy." (Carr, 2010:156)

The immediate counterpoint to this argument is that innovations in ICT are far richer than the Google suite of services. But, there is a further issue with the 'Google paradigm' relevant here: its search engine is calibrated with a design bias that privileges the *aboutness* of content – in other words, it is focused on parsing *information* as *data*. Its internal indexes are all built on data that is *factual* and *measurable*; and searches are typically instigated by keywords and phrases, *not questions* constructed in natural language. Thus, interactions with Google can be seen as being constrained by "factoid" information (Verberne, 2010), or what Mason describes as the "primitives of information-retrieval" – facets of information that are readily associated with questions of *who, what, when,* and *where* (Mason, 2008). While Google uses sophisticated algorithms involving various weightings associated with "backlinks" this still functions as factoid information. Even with value-added services to Google search, such as ManagedQ, results to queries are organized into sets associated with people (*who*), things (*what*), and places (*where*). This underlying constraint has the effect of 'information begetting information' and interrupts prolonged inquiry or direct pathways into the discovery of content that is *explanatory* in nature (Mason, 2008; 2011a). This does not mean that explanatory content is not retrieved, just that it is not easily or directly discovered. In particular, queries that are conceived with '*why'* in mind are not parsed well by Google because of the semantic ambiguity and linguistic versatility of the term *why* (Evered, 2005; Verberne, 2010; Mason, 2008). This has significant repercussions for the design of ICT systems aimed at supporting learning.

3.3 Dimensions of *Why* –Related Research

Why distinguishes itself from other 'primitive' questions (*who, what, when, where,* and *how*), in that it often requires a plausible *explanation* or rationale as an adequate response – in other words, reasoning as well as information (Verberne, 2010:10). Thus, *why*-questioning has the potential to initiate a shift from information processing to engagement of other cognitive functions, such as inquiry, analysis, problem-solving, and reflection. As Walton has noted, *why* is a key initiator of dialogue (Walton, 2004).

For researchers pursuing question-generation techniques in intelligent tutoring, *why* questions are seen to belong to a "deep/complex" category of all possible question types (Graesser, et al., 2007). Evered (2005) provides an analysis in which the 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, 2005:201). Thus, in identifying opportunities for ICT-enabled scaffolding that might support inquiry and reflection, access to and production of *explanatory* content, as distinct from *descriptive* content, is of prime concern here.

It is also interesting, however, that while *why* can be shown to have wide linguistic versatility (Mason, 2011a:93) it is not regarded as a "semantic prime" by linguists developing Natural Semantic Metalanguage (research that is focused on identifying concepts with irreducible semantics), primarily *because* this versatility is not free from ambiguity (Goddard and Wierzbicka, 2007).

Thus, in probing the linguistic dimensions of *why*, at least five key activities relevant to e-learning can be identified – asking, learning, knowing, understanding, and explaining *why*. The literature on educational psychology tells us that *asking why* is an important foundation of inquiry and fundamental to the development of reasoning skills and learning (Dewey, 1966; Piaget, 1966; Schank and Cleary, 1995; Bruce and Casey, 2012). Processes of *learning, knowing,* and *understanding why* build upon inquiry and all involve reflective practice (Schön, 1987:72). After learning something, *explaining why* can reveal a person's understanding (or lack of it). Thus the motivating question for this investigation: what ICT scaffolding – as application, services, or interventions – might support inquiry instigated by *why*-questioning?

3.4 Tools for Scaffolding and Reflective Practice

Investigations into ICT tools that explicitly aim to support *why*-questioning reveals a number of search technologies based upon natural language processing and computational linguistics, although findings to date demonstrate that much research is yet to be done (Ferrucci, et al., 2010; Verberne, 2010). Research is also proceeding in the fields of information science (metadata schemas and question-answer techniques) and

question-generation for intelligent tutoring (Kunze, 2001; Mason, 2008; Rus and Graesser, 2008). Of immediate relevance, however, is the application of wikis and e-portfolio systems to support reflective practice that is consistent with the goals of inquiry-based learning. Evidence is mounting that both approaches – one via the route of enlisting open, social engagement in content production (wikis); the other, individually-controlled reflective journalism that is discretionally shared – develop reflective practice and therefore prolonged cognitive engagement (Loo, 2012; Mason 2011b). A challenge, then, that is specific to the focus of this investigation is how scaffolding interventions might leverage these platforms.

4. CONCLUSION

Investigations into *why*-questioning reveal there are significant repercussions for the design, development, and utilization of ICT systems aimed at supporting learning. In particular, accommodating multiple dimensions of *why* – asking, learning, knowing, understanding, and explaining – point to a frontier that will focus on the pivotal role of *explanatory* content and prolonged cognitive engagement through reflective practice.

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