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Cognitive and Logical Rationales for e-Learning Objects

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Motivation

The motivation for this discussion is to look at the cognitive and logical rationales of e-Learning objects, which reside in computer-based e-Learning artefacts. e-Learning objects, the system to which they belong, and the sequence of messages that form a discourse between the system and its environment are inseparable. Altogether, they formulate the "Universe of Discourse" (Wieringa, 2003, p. 14). When we talk about systems, we equally refer the discourse to e-Learning objects because they are the "workers" of the system. e-Learning is "a combination of content and instructional methods delivered by media elements such as words and graphics on a computer intended to build job-transferable knowledge and skills linked to individual learning goals or organizational performance" (Clark & Mayer, 2002, p. 311). The sciences of instruction, learning, and knowledge are intricate and the "e-" before "Learning" adds another dimension of complexity while paving new learning paths for e-Learning.

Keywords

e-Learning Objects, Cognitive Learning Theories, e-Learning Artefacts, Psychological Pedagogical Modelling, System Design, Subject Domain, e-Learning Object Theory, e-Learning Object Processes, e-Learning Object Methods, e-Learning Object Principles.

1. Introduction

e-Learning is a cross discipline artefact that spans e.g., philosophy, psychology, pedagogy, anthropology, artificial intelligence (e.g., Artificial Intelligence in Education (AIED)), and human computer interaction (HCI) (cf. Issroff & Scanalon, 2002). e-Learning artefacts should be more than just a technical solution; for example, a web-based e-Learning site (however sophisticated it may be) containing stylish multimedia assets, Java applets, and dynamic database bindings that engage users in multiple ways including prompting interaction at cognitive, behavioural, and physiological levels. e-Learning artefacts are probably compared most appropriately with information artefacts as known by the cognitive dimensions framework (cf. Green, 1996; Green & Petre, 1996) which describes the "system under investigation" as "something that has been built for the processing, storage and communication of information. Every information artefact provides one or more notations in which the information being manipulated is encoded … The environment used to manipulate the notation is equally important" (Blackwell, 2001; also, cf. Green & Benyon, 1996).

The user range interacting with e-Learning artefacts is large and multifaceted. Main actors are pedagogues, instructional designers, psychologists, and learners. Not only do actors have their individual expectations and assumptions towards an e-Learning artefact but also hold varying degrees of proficiency and professionalism (e.g., not every educator or psychologist is a professional pedagogue), motivation of learning (e.g., an adults student may have different techniques and motivations for learning than a student who has to memorise chemical formulas for an examination; an educator may not be elated to be taught by a computer system), education, environment, and alike. Ergo, anyone who engages in a learning process, using e-Learning artefacts becomes a participant in a versatile and complex learning paradigm.

When designing e-Learning artefacts, a non-expert may expect or assume a system's expert intelligence while an expert may wish to choose from available options or templates within the system, to adapt to, or even evolve further from behaviour (i.e., referring to knowledge representation, user behaviour, user action; cf. Dix et al., 1998). Similarly, a student may expect a virtual instructor to provide learning stimuli like an educator in the physical world. Accordingly, the attribution of action by learners prompts an immediate machine reaction (cf. Turkle, 1984). Indeed, if one were to design a schema to show all interactions and transactions of learning, then mapping these either a centralised e-Learning artefact or multiple e-Learning artefacts, it would be very easy to miss the cognitive and logical rationales used in tracing and exploring e-Learning objects and how these link to a higher e-Learning system. Although we are not exploring the technical aspects of e-Learning "system" interaction itself (cf. Muirhead & Juwah, 2004; Repenning et al., 1998), we are interested in the contextual causes by entities, actors, events, and requirements. Hence, expectations, assumptions, intended effects, underlying plans, situated actions (cf. Suchman, 1987), observable, and unobservable behaviour of ourselves and those of others must be known, distinguished, and formulated into explicit requirements to design e-Learning artefacts. However, depending on our epistemologies and research ontologies, observing processes is unnatural for us. Monitoring behavioural processes, initiated by cognitive (either conscious or unconscious) stimuli contain situated actions and reactions as shown in the following example: "… one shopper found an unusually high priced package of cheese in a bin. He suspected an error. To solve the problem, he searched through the bin for a package weighing the same amount and inferred from the discrepancy between the prices that one was in error. His comparison with other packages established which was the errant package. Had he not transferred the calculation to the environment, he would have had to divide weight into price, mentally, and compare the result with the price per pound printed on the label, a much more effortful and less reliable procedure" (Lave et al., 1984, p. 77). In Lave et al., 1984, the authors conclude on their example that the store setting and activities within the store "mutually create and change each other". Stimuli for such changes in our physical world are situations, or as Brown et al., 1989 argue: "Situations might be said to co-produce knowledge through activity. Learning and cognition, it is now possible to argue, are fundamentally situated".

e-Learning artefacts should not only deliver but also build job-transferable knowledge and skills in the learner so that e-Learning systems, in particular more than any others, ultimately accomplish human-like behaviour and reinforce us to interact with "the notion of a self-explanatory artefact … In this … sense the goal is that the artefact should not only be intelligible to the user as a tool, but that it should be intelligent – that is, able to understand the actions of the user, and to provide for the rationality of its own" (Suchman, 1987, p. 17). Consequently, e-Learning artefacts should be intelligent with clear-set learning goals i.e., "... the focus in thinking about distributed intelligence is not on intelligence as an abstract property or quantity residing in either minds, organizations or objects. In its primary sense here, intelligence is manifested in activity that connects means and ends through achievements" (Pea, 1993).

2. The Domain of e-Learning Artefacts

Bringing information and communication technologies (ICT's) into education has raised many issues, the least of which is how does the use of e-Learning artefacts improve or enhance both the learning process, motivation, help us build our knowledge base and increase our multiple intelligences (cf. Gardner, 1999). While studies of mutual intelligibility have been concerned with human action, we now have a technology available in e-Learning that has brought with it the idea rather than just using machines, we interact with them as well (cf. Suchman, 1987). Such interaction needs to investigate and separate the study of mutual intelligibility: The relation between observable behaviour and the processes not available to direct observation, that make behaviour meaningful (cf. Suchman, 1987). The expression "mutual" refers to and includes numerous actors and their disparate levels of interaction with e-Learning artefacts while processes of behaviour are essentially cognitive. The gain of interaction is the value of the perspective of one other and is a primary learning constituent in constructivist learning theories (cf. Jonassen, 1991), inducing mindfulness in learners (cf. Langer, 1990).

In view of most computer systems, however, we assume that a plan determines purposeful action (cf. Suchman, 1987) whereof "a plan is any hierarchical process in the organism that can control the order in which a sequence of operations to be performed" (Miller et al., 1960, p. 17). This rational notation also includes plans and goals, past actions, effects, their pre- and post-conditions, alternative and future actions.

The domain of generic systems, and how system thinking incorporates the use of e-Learning artefacts, has thus revealed the importance of psychological (i.e., cognitive) and social rationales which need to be firstly defined, then incorporated into any instructional design model that either uses or intends to use system thinking as a structure to build e-Learning artefacts. Cognitive, social, and even behavioural motives and intentions must be reflected in e-Learning systems more than in any other computer-based systems because learning is constantly evolving and changing, but also re-shaping how we interact on equally a psychological and pedagogical level. “An entity is a discrete identifiable part of the world” (Wieringa, 2003, p. 78) so that entities of e-Learning artefacts are primarily pedagogues and learners whose communication is subject to laws of psychology and pedagogy. Taken from here, we must precisely identify tasks and responsibilities of an e-Learning system and decompose them to analyse the functions, communication, and behaviour of e-Learning objects. Their authentic “... tasks and content analysis should focus less on identifying and prescribing a single, best sequence for learning and more on selecting tasks that are both meaningful and able to accommodate constructivistic applications” (Jonassen, 1991, pp. 29-30). However, it is important not to exclude cognitive and behavioural schools of thought and how they impact the design of and use of instructional technologies. There is no central answer as to how effectively to build or construct e-Learning artefacts, nonetheless, information can be dynamically inferred from its environment (cf. Suchman, 1987). The key to such information is the subject domain (as discussed in the subsequent section). Notably, such context-driven, evaluative information is meaningful although "… real-world criteria may be very objective. But they are real-world, and to the extent that they reflect real-world criteria, they are meaningful" (Jonassen, 1991, p. 30). Indeed, defining the “meaning” of what an e-Learning artefact is, to then apply its pedagogical context (e.g., cognitive; behavioural or social) is key to understanding and planning educational technology systems that are interrelated to “subject heavy domains” or “context specific” environments.

3. The Subject Domain

The subject domain (also known as the Universe of Discourse as described by Wieringa, 2003) helps us to capture contextual actors, messages, responsibilities, and alike: “So the subject domain of the system is the part of the world that the messages received and sent by the system are about. To find out what the subject domain of a system is, ask what entities and events the messages sent and received by the system are about … to count as elements of the subject domain, these entities and events must be identifiable by the system” (Wieringa, 2003, p. 16). Wieringa, 2003 further specifies, that “The subject domain of a system not only consists of nature and previously installed systems … but also of people and their socially defined reality, including norms and meaning conventions” (Wieringa, 2000, p. 2). The collection of all possible symbolic interactions is called functionality and consists of three classes i.e., the information function, the control function, and the declarative function (cf. Wieringa, 2000). Its objects and components achieve functionality of a system. Therefore, when we refer to a system in the following discussion, we must bear in mind that it is the responsibility of its objects and components to realise the functionality.

We can now induce that the subject domain of intelligent e-Learning artefacts talks about delivering and constructing pedagogically and psychologically valid learning contents to learners. Therefore, messages (e.g., pedagogical, psychological, and alike) must be learner-centred (cf. Moreno & Mayer, 2000; Smulders, 2003; Coman, 2002) and not instructor-centred while learner-centeredness also includes autonomy and control (cf. Saba & Shearer, 1994). On the contrary, if we assumed that an intelligent e-Learning system should help and instruct educators to design pedagogically and psychologically valid e-Learning contents, the subject domain then talks about the construction of contents. In this case, messages are still learner-centred because the educator becomes a type of learner. Also, if both foci fell into place learning activities would truly be blended (cf. Orey, 2003). In either case, however, the subject domain of a system always talks about identifiable methods and events to construct, build, and deliver learning contents to learners but not about the actual learning contents itself. The exclusion of contents supports Moore, 1989’s argument of the three types of interaction (i.e., Learner-Content Interaction, Learner-Instructor Interaction, Learner-Learner Interaction) because the subject domain talks about how learners acquire intellectual facts and not about the contents of the intellectual facts.

The nature of a learner-centred interaction is something much greater than a simple transmission of information, navigating through learning contents (cf. Smulders, 2003), or “a mere process of passive reception and acquisition of knowledge” (Nunes & McPherson, 2003, p. 497; Giebler, 2000). We would therefore expect these types of events and messages of the subject domain to be of pedagogical nature to facilitate learning. Nevertheless, pedagogy is rather heuristic i.e., an objective experience of how to teach, and is henceforth primarily derived from situated actions. Pedagogy is argued to be ill-structured as Allert et al., 2002 argue, neglects research of theories in educational technology (cf. Issroff & Scanalon, 2002), and is thus not suitable for computer-based artefacts which are built on planned actions and intents contrary to situated experience. Situated actions in pedagogy become problematic when it comes to designing e-Learning artefacts so that this, in turn, exactly becomes one of our greatest challenges. According to Suchman, 1987, one of the propositions of the ethnomethodological view of purposeful action and shared understanding claims that plans are representations of situated actions. Rather than direct situated action, rationality anticipates action before the fact, and reconstructs it afterwards (cf. Suchman, 1987, p. 53; Mead, 1934). However, as of today, no such e-Learning architectures exist, which holistically de-construct this evolving paradigm. One attempt has been made by Reeves, 1996 who raises the issue of the forth paradigm which follows the Analytic-Empirical-Positivist-Quantitative paradigm, the Constructivist-Hermeneutic-Interpretivist-Qualitative paradigm, and the Critical Theory-Neomarxist-Postmodern-Praxis paradigm: That of an “Eclectic-Mixed Methods-Pragmatic Paradigm” (cf. McLoughlin, 1999; McLoughlin & Oliver, 2000; Phillips et al., 2000) which is specifically designed to solve educational technology problems. However, the literature on this forth paradigm is limited and there is great need of research on its theoretical and practical merits.

Contrary to the pedagogical predicament, theories originating from psychology (e.g., instructional processing theory, instructional-design theory; cf. Reigeluth, 1999) tell us how knowledge is represented, built, processed and alike in memory. Gagné et al., 1992 argue that instruction is "A deliberately arranged set of external events designed to support the learning process" (Gagné et al., 1992, p. 11). Instructional events are "… external, when deliberately planned and arranged constitute instruction" (Gagné, 1985, p. iv). Although there exists a myriad of psychological learning theories, models, and principles from cognitive and constructivist psychology, precise methodologies are needed specifically for e-Learning which allow objects of a system to execute identifiable events and messages. Moreover, such events and messages must be based on non-contradicting approaches as for example, an instructive versus a constructivist approach. Beyond, with a complex system in mind where for instance the artefact instructs an educator to construct a course and also delivers learning contents to a learner, learning processes cannot be fixed. Hence, our challenge as designers is to find both an optimal learning and teaching process, and identify how to support the interaction between them. To assume that a singular learning process will suffice may be a grave error in design.

Entities of the subject domain are reliant on the type of e-Learning system. We will find a broad modality (a term described by brandonhall.com, 2003) spectrum such as mobile learning, web-based learning, distance learning, and more. Geographical distance is less important than the interaction between the learner and the educator (cf. Moore, 1973; Moore, 1989; Coppola & Myre, 2002). As discussed earlier, the system could be the educator itself, which supports our argument that e-Learning artefacts must be intelligent as well as pedagogically and psychologically valid, more than most other systems. Presently, the most popular e-Learning systems deliver online packaged or instructor-led (i.e., system-led or man-led) courses and tutorials so that we infer that packaged courses or tutorials led by the system have more responsibilities than instructor-led ones. In either case, the subject domain talks about the nature and norms of an entire course structure, which is the composition of its individual components (e.g., module, lesson, assignment). The actual learning content that is outside the responsibility of the subject domain is the substance of the individual components. The term component used here is not to be confused with Merrill’s Component Display Theory (CDT) (cf. Merrill, 1983; Clark, 1999) although it is interesting to note how the CISCO, 2003 course structure applies Merrill’s components. Even though the subject domain talks about how to construct a course, no rational, pedagogical models exist that would tell us how course structures, lectures, or components are to be built validly. The term “lecture” hereto implies cognitive and constructivist learning processes and differentiates from a conventional, instructivist lecture as known from the physical world. At a lower level, we will find principles of instructional design (cf. Gagné et al., 1992) and cognitive learning principles (e.g., modality principle, contiguity principle; cf. Clark & Mayer, 2002; Clark & Harrelson, 2002; Moreno & Mayer, 2000). Despite their cognitive values instructing us of how to reduce the burden of working memory, these principles however, are nearly impossible for a system to put into practice. For example, these principles teach us that presenting visuals emphasising relevant and critical details is effective while arbitrarily adding visuals does not increase learning at all. Henceforth, a system will not be able to elaborate when a picture will be too many as also related to the cognitive load theory (cf. Sweller, 1988; Miller, 1956). Again, it is the educator or the instructional designer who holds responsible for the contents. Alternatively, what if the system were to help or instruct the educator or instructional designer? The issue is relevant because often, educators believe that fine-looking pictures make a lesson look attractive or give a relaxing ambience and do not know that learning is better when extraneous, content irrelevant materials are excluded (contiguity principle).

At last, the subject domain must therefore talk about logical operability within course structures, the binding between contents based on logical acquaintances and aggregations. These include knowledge mining, functional operability and computational algorithms, and many more to enable the system’s functionality.

4. Retrospection and Reinvigoration of e-Learning Systems and their Objects

Commonly known definitions of e-Learning objects clearly lack the significance of our previous discussion based on the norms and contextual nature of the systems in which e-Learning objects reside. Known definitions do not take intelligence and pedagogical and psychological validity into account, miss the responsibilities they have to fulfil, and disregard the complex interactions they must accomplish. For example, learning or e-Learning objects today are constructed from an instructivist view point (e.g., the Lego metaphor and its debate; cf. brandonhall.com, 2003; Littlejohn, 2003; Rehak & Mason, 2003), mix the physical learning with the digital "e-" learning world (cf. LTSC, 2002), are unclear about granularity (cf. Wiley, 2002), lifespan (cf. L'Allier, 1997), and nature (e.g., database entities; cf. Merrill, 1998).

However, the stringent requirements imposed by the subject domain can best be accomplished by an object-oriented (OO) approach. An OO paradigm offers better support for reuse, is qualified to incorporate instructional operations, and outweighs the capabilities of static database entities. Objects as known by the OO paradigm can be assigned responsibilities, change internal states, communicate by exchanging messages, react to external stimuli, cause effects, and respond to internal causes.

5. Conclusion

e-Learning artefacts, their objects, and the discourse they create in their environment express an e-Learning based Universe (of Discourse). While the domain of learning is already complex, the technological edge in e-Learning increases its intricacy. Yet, technology presents new dimensions in learning. e-Learning includes various disciplines which call for the need of an intensified communication and research when it comes to devising e-Learning artefacts. Their range of uses is versatile; individuals hold different expectations and assumptions towards systems, portraying various degrees of proficiency and professionalism including learning motivation, levels of education, and more. Human processes and interactions are intertwined and rely on underlying plans, situated actions, observable and unobservable behaviour. Humans learn and co-produce knowledge by these some of these processes and interactions. Similarly, e-Learning artefacts, which (in some cases are designed to build job-transferable knowledge and skills) are linked higher learning goals, which should be intelligent because they should be designed to understand human processes and interactions.

Traditionally, the learning domain has been a highly complicated, full of meaningful processes and interactions between an educator and a learner. With e-Learning artefacts, as researchers in the field we now not only find another intelligent actor in the picture, adding new degrees of interaction but also uncover a need to introduce new levels of processes and behaviour into systems that are essential to cognitive awareness, inducing mindfulness in learners. e-Learning artefacts are primarily built on planned action and are subject to the nature, norms, and laws of pedagogy and psychology. From this environment we can dynamically infer tasks and responsibilities for e-Learning artefacts. To comprehend the notion of the subject domain and identify (the part of the world that is relevant to a situational e-Learning artefact) we have chosen the metaphor that the system simply exchanges messages with its environment. This functional decomposition must result in identifiable entities, messages, and events to the system.

Pedagogical and psychological construction and delivery of contents rather than the actual content are major key issues. Thereupon, intelligent e-Learning artefacts must be entirely learner- rather than instructor-centred to the one, and prove pedagogical and psychological validity to the other.

Learner-centred interaction in e-Learning is about actively building knowledge in a learner's memory. This is a shift of paradigm from the conventional way of instruction. Conventionally, learners were assumed to be passive vessels ready to be filled with knowledge; however, this due to the introduction of educational technologies into learning environments, learners are not longer passive, and educators now have vessels (like instructional technologies) from which to communicate and share content with their students. Messages and events of the subject domain of an e-Learning artefact as well as in the context of related subject domains are therefore concerned with the delivery of content and active knowledge construction. The interactive and constructive process which deliver learning content embraces a multitude of facets and possible scenarios e.g., the roles, types, and levels of interactions between the system, the instructor, and the learner. Intuitively, we would assume that such delivery processes should primarily be of pedagogical nature but because pedagogy is mainly based on situated experience, it is not always suitable for e-Learning systems. On the contrary, psychological learning theories, models, and principles seem to give way to deliver learning content but they are still not sufficiently refined yet to be identified by a system. Also, these theories, models, and principles must all cohere within an artefact. Likewise, learning processes cannot be fixed and we are challenged to find optimal learning and teaching processes and to know the interaction between them. To assume that a singular learning process would suffice may be a huge error in design. Another particular area of messages and events of the subject domain relates to e.g., logical operability within course structures, knowledge mining, curricula, and computational algorithms.

De facto, presently known definitions of learning objects for e-Learning artefacts have not taken the diverse cognitive and logical rationales into account, which primarily come from the domain of learning (based on pedagogy and psychology). In more detail, the working with subject domains has helped us decompose entities, events, messages, laws, nature, norms, and alike leading to an OO approach which would be most suitable to satisfy these stringent requirements. Although the "e" before learning has brought forth new complexities of interaction, mutual intelligibility, situated action, planned action, pedagogical and psychological validity the "e" is maybe also about to bring forth a new shift of paradigm to conventional learning. We are challenged to re-evaluate how humans perceive computer-based e-Learning artefacts, design learner-centred e-Learning systems and their objects while being involved in e-Learning. As e-Learning stretches across many subject areas, there is a need to resolve semantic spaces between pedagogical and psychological learning theories, models, and principles to make them identifiable for computer-based systems, whilst constructing teaching models where the educator, the system, and the learner evolve together.

6. Questions for Discussion

6.1. Interdisciplinary issues to e-Learning artefacts:

a) Where are the intersections between different disciplines when it comes to system development of e-Learning artefacts?
b) What are the (functional and non-functional) commonalities of requirements for system development by the disciplines?

6.2. If a computer-based artefact must be intelligent and psychologically valid, then an e-Learning artefact and its objects must also hold true pedagogical validity:

a) Is pedagogical and psychological validity inseparable (cf. IMS Global Learning Consortium, 2004)?
b) What are the pedagogical and psychological requirements for an artefact to be pedagogically and psychologically valid?
c) What are the concise pedagogical and psychological learning theories, models, or principles to accomplish pedagogical and psychological validity for an e-Learning artefact? (Including semantic spaces between learning theories, models, and principles)

6.3. Degrees of pedagogical and psychological validity of e-Learning artefacts and their objects:

a) Which pedagogical and psychological validity is the artefact to accomplish in view of levels of interaction, authority, trust, and responsibility?

6.4. Meaningfulness of plan, action, and intent to build a packaged e-Learning course system:

a) Should pedagogical requirements for an artefact be expressed in terms of purposeful actions and plans, heuristics (situated actions) or both?
b) What models and theories formulate a structured approach considering situated actions?

6.5. The subject domain of packaged e-Learning course systems and inferred types of e-Learning objects:

a) What should be the responsibilities of a system delivering packaged e-Learning courses referring to our discussion regarding user and system roles, issues of interaction, relevance of contents, and alike? For example, conventional courses are different from the idea of concept maps (cf. Passmore, 1998; Novak &

Gowin, 1984; Novak, N/A; Cañas et al., N/A; Institute for Human and Machine Recognition, N/A; Mintzes et al., 1998) and so may be their fields of application.

b) What types of e-Learning objects, messages, events, and responsibilities can be inferred from the subject domain? For example, *Learning Community Objects* (cf. Van Assche, 2004).
c) What pedagogical and psychological learning theories, models, and principles exist to construct a full e-Learning lecture or course considering the threefold aspects of theories, models, and principles? For example, "Theories that emphasize the situated properties of human action and learning have been very influential on current understandings of these phenomena. Work on situated actions by Suchman, 1987 on situated learning and cognitive apprenticeship by (Lave & Wenger, 1991; Collins et al., 1991; Wenger, 1998; cf. Ghefaili, 2003) and have been extensively used in analyses of learning and interaction" (Tholander & Karlgren, 2002, p. 1).

7. Post-discussion Summary

Formal discussions were held in both the International Forum of Educational Technology & Society (IFETS), during May/June 2004 and the Instructional Technology Forum, in July 2004. The following post-discussion summary treats each forum separately.

In the following summaries, the author excludes his own comments which are archived and available electronically.

7.1 Post-discussion Summary held at the International Forum of Educational Technology & Society

The first question looks at interdisciplinary issues involved in developing e-Learning artefacts in view of commonalities of requirements with reference to user profiles, and systems thinking.

Taken from her experience, **Beatrice Traub-Werner** has observed that one tends to assume that those learners participating in a program share commonalities, the same cultural perceptions, the same kind of educational profiles, and alike. However, when it comes to recognizing user profiles, challenges arise, the assumption of prior knowledge, and the variety of socio-ethno-cultural backgrounds. These factors and others, become important contributing influences occurring at the predevelopment stage of e-Learning artefacts. Beatrice Traub-Werner has concluded that that no 'uniformity' of user profiles exists since individual instructors are clear about the intended delivery and outcomes.

Frances Bell believes that the situated aspects of learning could be explored better if we regarded learning as taking place within a human activity system. In this respect, Frances Bell believes that, rather than focusing on 'hard system' thinking, Peter Checkland's soft systems methodology (SSM) is appropriate in developing e-Learning artefacts (cf. Checkland, 1988; Checkland & Holwell, 1998; Checkland, 1999).

The second question has tried to explore the meanings and extent of psychological and pedagogical validity in e-Learning systems. The discussion, however, has continued on requirements analysis and elicitation by including differences between categories of e-Learning artefacts and the LO (Learning Object[s])/SCO (Shareable Content Objects) paradigm. While these discussion threads have addressed equally the third and fifth questions they have clearly revealed the complex and entwined degrees of e-Learning.

Hao-Chuan Wang has drawn our attention to the differences between the concepts of ITS (Intelligent Tutoring Systems) and LMS (Learning Management Systems) which are due to the practitioners and problem domain of the respective systems. However, he believes in the convergence of both (cf. Brusilovsky, 2003). ITS and AHS (Adaptive Hypermedia Systems) as addressed by Brusilovsky, 2001, Brusilovsky, 1996, and de Bra et al., 1999 typically focus on user modelling liasing to user interaction on the basis of HCI (Human-Computer Interaction) while LMS are based on the paradigm of LO and management concerns (cf. Wang & Li, 2004). However, LMS and AHS/ITS are not mutually exclusive ideas. Each attempts to address different facets of the incorporation of computers into education. If we want to compare their differences, we should then look at their backgrounds and functionalities. Both, management and interaction are parts of the requirements e-Learning artefacts need to provide. This encompasses the delivery of pedagogy, instruction, tutoring, and learning and therefore, both types of systems have their own validity of existence. This perspective excludes the question of superiority or inferiority of either system while, however, we may consider merging both systems.

Nevertheless, the notion of LO/SCO causes obstacles when it comes to interpreting ITS or identifying the corresponding parts of ITS equivalent to LO. Doing so partially addresses the subject matter of the type of e-Learning paradigm existing in ITS. Many ITS systems for example, ANDES (cf. VanLehn, 2002), which tutors students interactively to solve homework problems of Newtonian Physics, facilitate learner problem solving. The system uses Bayesian networks (cf. Stern & Woolf, 2000; Horvitz et al., 1998; Stern et al., 1999) to organise pieces of domain knowledge and steps of problem solving i.e., a fine-grained domain model. Furthermore, it makes use of probabilistic reasoning to identify students' buggy actions and attempt to direct students towards the right solution of a particular physics problem. The domain model consists of nodes and steps which, if we relate these to the LO paradigm, will let us wonder which ones should be an LO. In consequence, we may query about the level of granularity leading us to conclude that an individual physics problem within ANDES itself may be regarded as an LO. Yet, the consequence of such inference will agitate the types of methods of how to mark-up metadata of this type of LO and of how to resolve the dynamic nature of interaction at run time because learning activities and experiences are dynamic and not easily to be packaged and reused as conventional static materials. The consequence of inferring the individual parts to an ANDES physics problem are LO confuses the issue of metadata mark-up. This confusion could weaken the functionality of each LO when student-learning requirements trigger a required response. LO/SCO, by their nature ,are illiterate and static. This static nature makes their use in ITS difficult because these systems are designed for specific domains and purposes.

Another example taken up by Hao-Chuan Wang refers to STEVE (cf. Rickel & Johnson, 1998) which is an ITS with pedagogical humanoids in a virtual reality environment (in memorial of Prof. Rickel, N/A).

Both examples detect various flavours of the ITS field.

Hao-Chuan Wang further discusses pedagogical and psychological validity based on the LO/SCO paradigm by which he argues another impediment of this very paradigm. In the same manner computer algorithms, which are usually described in pseudo-code rather than actual programming syntax, the validity of which is judged by both its implementation and through mathematical analysis. Hao-Chuan Wang argues that it would not be reasonable to validate the pedagogical and psychological content if it were packaged in LO or used in systems that were built on the notion of LO. He believes that the quality of learning material could have two meanings:

1) learning material residing in LO, and
2) educational evaluation criteria such as achievements, and attitudes.

In this respect, tracing the chain of development of instructional design methods is directly related to the quality of the learning content. In addition, it is also suggested that we ought to consider implementing these methods in computer systems.

In the context of this discourse, Hao-Chuan Wang reminds us of the debate on the effectiveness of different media on learning (cf. Materi, 2001). While Clark, 1994 claimed that 'media will never influence learning', Kozma, 1991 has indicated that 'media and method are inseparable'. He therefore places emphasises on the importance of experimental evaluation allowing us to prove pedagogical and psychological validity by deploying standard scientific methods. ITS are real and not a dream of Artificial Intelligence (AI) for they have significantly shown effects to improve learners' achievements based on adequate experimental proofs (cf. Koedinger et al., 1997).

In his discussion, Hao-Chuan Wang has intentionally used the term 'computers in education' instead of e-Learning. To him, the main objectives of what the subject domain of today's e-Learning tries to attempt is inconclusive and thus unclear. Should it be better learning achievement, economical benefits, or both? The role of computers in education is therefore less ambiguous. Computers can be used as active tutors, as simple simulation, a tool for collaboration, or discussion tools as an active part of classroom-based learning activities. The objective is plain and straightforward i.e., to achieve successful learning as discussed by Lajoie & Derry, 1993. In his eyes, this very ambiguity about the objectives of e-Learning itself is becoming more and more an issue in related fields like LO, ITS, AEH (Adaptive Educational Hypermedia), Educational Technology, Educational Media, and more. In Conclusion, Hao-Chuan Wang thinks educational professionals and non-professionals seem to regard the elements of e-Learning as found in ITS and AHS to be mere learning extensions of SCORM as described by The Learning Systems Architecture Lab (LSAL), 2003.

Other Resources provided by Hao-Chuan Wang: Eklund & De Bra, 1995; TU/e, N/A; elm, 2003.

Mitchell Weisburgh believes that LMS serve as information containers, record user navigation, monitor courses taken, and skills acquired. In contrast ITS are believed to be more integral with courses and are more capable of deeper analysis for better skill adaptation while having the ability to offer alternatives. Mitchell Weisburgh has developed a system that stores courses, tracks individuals, diagnoses skills, and prescribes actions and remediation (cf. CollegePilot, 2004). He also addresses the influence of system design onto the outcome of the course itself which is ultimately perceived by users (cf. Weisburgh, 2003).

Mitchell Weisburgh does not think it is possible to come up with a generalised way to use an LO to build a course then have that course flexible enough to meet the needs of a large body of students. The course author expends much effort becoming familiar with LO and not much in metadata development is found fitting the course. Yet, he would use existing LO to supplement future primary material he may develop. Building a course out of existing LO is not practical for him.

Jean-Marc Dubois has emphasised that education is a particular way of communication and that communication is more important in learning than information. Therefore, when it comes to LO, Jean-Marc Dubois has stated that LO need recipes, i.e. a description of their composition. He has related this description to the use of metadata. Metadata is required to talk of LO and LO repositories while, in his opinion, (a set of) asset(s) without metadata should not be called LO but should at best be regarded as a piece of information. LO, therefore, can only be considered as objects if there is data describing them and more particularly if there were pedagogical information concerning their usage. He believes that 'the smaller the object, the bigger the metadata' while two dependent granular assets will need to be described by their metadata.

ITS, a kind of Computer Based training tools, are able to react to the learners on the interface. Any entity doing training, even with classical face-to-face sessions, can use LMS, which is regarded as a learning tool helping us manage training. In addition, the idea of putting ITS capabilities into LMS is a way of introducing rules that are more complex. Jean-Marc Dubois thinks most of the trouble is that some presume that e-Learning has effects on learning while as of yet there is no conclusive evidence.

In **Michael Verhaart**'s perspective, LO have different degrees of granularity and consist of

- A metadata file containing a description of the object itself,
- A set of files making up the course content –with pedagogy, and
- A set of resources, which you term the database entities or assets.

Engin Koc argues that learning and teaching (pedagogy) cannot be separated and raises issues in relation to flexibility and routes of communication. In his view, a major obstacle relates to LO residing in LMS.

The third question relating to the degrees of pedagogical and psychological validity has expanded the discussion by a debate on pedagogical, psychological, philosophical, instructional, and educational aspects. These discussions have paved the way for the fourth and fifth questions.

When it comes to emotional factors in learning, **Alfred Bork** believes that learners should always enjoy learning (cf. Bork & Gunnarsdottir, 2001). Stimuli that Alfred Bork indicated were:

- Everyone should succeed.
- The language of instruction should be always friendly.
- Exams should be invisible to the student.
- Learning should be an active process.
- Learning should be individualised.
- Learning should take place in groups.
- Knowledge should be discovered.

In response, **Michael Butler** believes that a hierarchically based learning content within a system should be time constrained to attain mastery.

David Piper feels there are many facets to learning and to personal perception within a particular context. He has argued that some people might view learning as a memorisation process, others view learning as a practical applicability of things remembered, others believe learning should be measurable, while the neurological perspective considers learning as a connection of and creation of neural pathways. Another observation considers motivational backgrounds towards learning linking to varying social backgrounds, for example, finding better jobs or making better contributions to society. Moreover, motivational stimuli in the brain might relate to the need of survival, which humans may not necessarily perceive consciously. In agreement with Jensen, 2000 and other cognitive scientists, David Piper believes that the primary function of the brain is survival. Both views towards learning outlined earlier i.e., training for professions in the world of 'abstract' and skills for the ‘concrete’ share the fundamental concept of providing a means for employment, which in turn, provides a source of income to survive. We could therefore make the assertion that the brain only ‘learns’ what is needed to ensure survival. However, there are two counter effects to the previous assumption:

- If we accept remembering as a type of learning the brain will remember things that we do not always recognise. The reticulate activating system (RAS) filters information and only calls the brain’s ‘attention’ to those environmental factors that can threaten our survival. The brain remembers everything but also acts on perceived threats to survival.
- Empirical evidence shows multiple examples that contradict the assumption. For example, there are people who thrive on trivia and play games where trivia knowledge is keen. As a second example, David Piper has provided an example by reminding us of how easily we memorise advertising slogans that – in most cases - have no relevance to survival, at all.

David Piper, therefore, claims that we should not consider learning processes in isolation. A successful i.e., valid and predictable learning theory needs to be developed that considers motivational facets, the neural processes in a human’s brain, individual learning styles, didactic teaching styles, and environmental contexts.

In David Piper’s eyes, a learning theory has a number of responsibilities:

- To convince the learner’s brain that what is being offered as the ‘knowledge domain’ would be worth knowing. This could be accomplished by convincing the brain that the domain would have impact on the learner’s survival. In addition, such conviction would make the brain more teachable;
- To convince the learner’s brain that what is being offered as the ‘knowledge domain’ would be worth knowing. This could be accomplished by convincing the brain that the domain would have impact on the learner’s survival. In addition, such conviction would make the brain more teachable;
- To take advantage of both short-term and long-term memory;
- To consider learner’s learning styles;
- To take into account the teaching style in a formal setting; and
- To take into account the construction of the learning context and environment.

David Piper also believes that philosophy, psychology and education cannot be totally separated. The crux of e-Learning is in discussing, choosing, and justifying the underlying theories and processes used.

Alex Heinze has taken our view to epistemological and ontological perspectives. Alex Heinze does not feel at ease with the view of the soft science background claiming there would be no right answer available. While relating to Laurillard, 2002 where the author claims that constructivism and instructional design are limited to application, Alex Heinze has addressed difficulties such as different learning styles, different lecturing styles, motivations, and alike. Alex Heinze believes that we should consider the conversational model whose main feature is the flexibility of dialogue. More specifically, with reference to Laurillard, 2002, Chapter 4 on ‘Generating a teaching strategy’, Alex Heinze points out an argument that Instructional Design Theory is logically based, not empirically based, therefore unable to build teaching on a knowledge of students and concludes that phenomenography is the more fitting approach.

Ania Lian argues that theories are to be explored in relation to how they enable us to achieve our goals. According to her, everything about learning is abstract so constructing systems according to some learning theory should not be undertaken.

No direct responses have made concerning the fourth question while discussions have explored further on the LO paradigm and built a broad spectrum of facets with regard to pedagogy, pedagogical ad psychological learning theories, models, processes, and principles as addressed by the fifth question.

On the basis of the work by Reigeluth & Frick, 1999, **Goknur Kaplan Akilli** contends that the choice of a learning theory is determined by preferences such as effectiveness, efficiency, and appeal. Coupled with these aspects, he added aspects on usability of a system. According to him, these facets must be added whenever it would come to evaluating learning theories (cf. Nielsen, 1994).

Michael Weisburgh has argued that without a learning theory, we will never get the metadata about LO right; nor would we get online ‘courses’ right. In his argument, he has suggested that we might look at the layered theories of knowledge and skills.

David Piper believes that Instructional Design models (ID) are static but due to a number of factors, we will need a fluid model much like a Lego metaphor.

Based on his exhaustive academic experience in science, **Alfred Bork** has argued that ‘the hallmark of a successful theory is its predictive value’ while predictability itself must prove validity. He has related learning and his experience to ‘quantum relationships with consciousness and the human brain’. Alfred Bork has therefore drawn our attention to the issue of what a successful learning theory ought to predict.

Lorraine Fisher has argued that the discussion on learning theories, models, processes, and principles needs to include the domain of philosophy. More specifically, she relates her argument concerning the philosophical basis of choosing technology in curriculum to the development of an Instructional Design (ID) model. Once this choice is made, Lorraine describes an ordered procedure; choice of an appropriate theory, designing a model, applying the model.When this process is complete, principles and practices will emerge.

One obstacle to starting with the philosophical base, according to her, is concern with time constraints or resources to ‘contemplate epistemological underpinnings of an approach’.

In conclusion, Lorraine Fisher has extended predictability of a successful theory with the need to assign a metric or measurement to theories.

According to Richard Dillman, the goals of e-Learning artefacts should focus on intelligent learner interaction. Therefore, e-Learning artefacts should be able to understand the action of the user, and provide for the rationality of its own. For Richard Dillman who is working between scientists and engineers over the creation of intelligent computer programs, the potential development, control, and explanation of AI is more pragmatic and appreciated.

He also argues that a theory could be seen as an ‘expression of an attempt to understand’ which gives rise to human curiosity trying to reason how ‘an individual mind changes during a particular exercise’. Nevertheless, according to him, we are unable to describe the state of any one particular brain so no complete learning theory can yet emerge. Therefore, Richard Dillman deduces that the discussion should not focus on learning theories but should be related to two engineering assumptions:

1) Treating a large number of individuals in the same manner as one individual is treated,
2) The possibility to design simulated learning environments, which would substitute for teachers.

One of the issues regarding such environments, however, needs to look at the possible discrepancy between knowledge acquired by (a) learner(s) versus the intended knowledge taught by the teaching body. Although the issue of controlled learning is not new, Richard Dillman has posited that simulated learning environments will need to focus on the efficiency of teaching merged with the learning media i.e., the materials alone should suffice to teach.

Richard Dillman thereof addresses two areas of interest, the cultural aspect (delivery by electronic media) and the commercial aspect (dissemination of information on a CD is inexpensive).

Although Richard Dillman has programmed instructional modules for over 30 years, the only benefit, Richard Dilman addresses, is the convenience of presenting and teaching information electronically. He therefore concludes that simulated learning environments should help spend less time on simple, repetitive tasks so that he could spend more time encouraging students to think and communicate critically (cf. Dillmann, N/A-a; Dillmann, N/A-b).

With reference to ‘The Society of Mind’ by Minsky, 1988, **Ania Lian** believes that learning can be seen relationally which means that it is an ‘on-going’ process. She emphasises that one constructs relationships in order to have a greater sense of control. Therefore, in her eyes, a learning theory is not much more than a semiotic model.

On the issue of ‘Do e-Learning platforms truly dictate the pedagogy?’, Ania Lian has used WebCT since 1995 and never has it happened that a platform has dictated anything to her. She believes that making the platforms capable of being used intelligently instead of needing a learning theory and interacting with fellow educators (for example, sociologists, semioticians, and more) is what it means for the platforms to adjust to intelligent uses. On this basis all the functions of learning theories and descriptions of types of knowledge can be subsumed in platforms which do not seek to teach but are flexible to facilitate intelligent manipulation of information. It is suggested that we should start at one of the easier levels and develop a good theory and methodology for teaching at that level and then expand from there.

Ania Lian also believes that the need for learning theories should not be based on human curiosity but on intentional education to transmit knowledge. Teaching one as teaching many would be questionable. The complex issues involved in e-Learning requiring pedagogy and other critical perspectives may give ground to consider other, alternative goals instead of using sophisticated tools.

However, **Mike Zenanko** has argued there will not be any ‘model of thinking about a thing as prescribed in some learning theory’. He has based his argument on Eisner, N/A.

Alex Heneveld who is also researching in the field of learning styles and learning theories has provided us with the following references: Alkhalifa & AlDallal, 2002; Albalooshi & Alkhalifa, 2002; Alkhalifa & Albalooshi, 2003.

Lorraine Fisher and her colleagues have undertaken an informal and unstructured survey in which they found that academic staff based their choice of a ‘Model’ on cognitive needs of the student, university or organisational policies and curriculum design epistemologies. Based on the fact that present research revisited this field, the research question looked at well cited models in the educational literature such as Chickering & Ehrmann, 1996, Chickering & Gamson, 1987, and Kruse, 2004.

Lorraine Fisher has indicated that the author in Laurillard, 2002 addresses valuable research questions and that Laurillard, 2002 is highly appropriate with particular research approaches in mind. She believes that one could claim that a best practice ID model is that which satisfies the learning outcome such as cognitive, behavioural, and alike. In her opinion, a good and practical model is one that can be replicated and re-tested.

With this regard, Lorraine Fisher has provided us with the following, additional references: Ryder, 2003; UCCS, 2002; Ayersman, 2003; PennState, N/A; University of Florida, N/A; Barba, 1997; Lee & Lee, N/A; Grasha, N/A; DoIT, 2003; University of Missouri, 1997; Clark, 2000; Ryder, 2004a.

Referring to numerous postings, Lorraine Fisher has concluded that all theory could well be a representation and collocation of beliefs and experiences (conscious and unconscious) that are metamorphosed into a ‘concept’ when applied to research would be either ‘defined, defended or dismissed’ by academic peers. By removing the constraints of theory, ID becomes a process, which can be ‘defined, defended or dismissed’ and follows the rules of philosophy, which are then ‘defined, defended or dismissed’ (creating theory) and lead to ‘Lego’ components to create a model, which can be embedded as part of a research processes, then applied in practice.

7.2 Post-discussion Summary held at the Instructional Technology Forum

Terri Buckner has raised the lack of clarity concerning the use of definitions/language as well as issues of confusion between learning theories, theories of social interaction, instructional theories, and programming processes.

Terri Buckner claims that the term e-Learning seems to have been adopted for everything these days. Based on Terri Buckner’s background in higher education, e-Learning means anything from hybrid courses i.e., face-to-face and online, to revenue generating courses outside the academic credit model. With regard to the discussion paper, Terri Buckner has been wondering if the use of the term e-Learning could be narrowed to specify a digital environment.

As for mixing theories, Terri Buckner refers to Suchman, 1987’s theories which are associated with socially constructed interactions. The use of such theory in conjunction with the design of self-contained instructional objects offered via a digital environment has seemed like a suitable fit except that Terri Buckner does not see there is a role for instructors or other students in the definition of the paper of an e-Learning artefact.

With regard to an artefact, Terri Buckner thinks of it from an assessment perspective as of an object e.g., a written paper, discussion, graphic, formula, and video that represents an attempt to meet a particular goal. Furthermore, Terri Buckner also perceives an artefact as the outcome of what students produce, not what a programmer/instructor would design.

From this point of view, Terri Buckner has addressed the need to differentiate between and provide definitions for both an artefact and an object. Based on the literature, Terri Buckner has thus argued that an object is something a student acts upon while the output of this interaction yields an artefact. In this sense, Terri Buckner thinks that an LO is built around AI technology. Hereto, Terri Buckner has questioned if a social constructivist theory applies to AI and if a learner's interaction with a database can be considered a social interaction.

In Terri Buckner's opinion, it will be difficult to replace a content expert with a digital artefact even if we used AI because content matters because the interaction between pedagogy, learning theories, and content is claimed to be the basis for a dynamic learning environment. Learning theories as well as sociocultural theories are broad generalisations of how people might be expected to behave under certain conditions. Pedagogy consists of theories of instruction which Terri Buckner considers as generalisations and theories are always generalisations. Generalisations propose generalised guidelines for developing materials/resources/environments in which learning is possible.

A further concern addressed by Terri Buckner is related to the discussion of excluding content from a computer-based e-Learning system. Should content be generic where the benefit of a generic view would be adaptivity? Therefore, Terri Bucker has questioned how realistic adaptivity is and has been wondering about suggestions and guidelines for how all instruction, regardless of the content, should be developed. Terri Buckner therefore believes that Rowley, 1997's work on AI says that content does play a role but perhaps not at the level of granularity that we generally use (the instructor expert). For additional exploration, Terri Buckner has recommended further investigation of the concept of electronic support systems.

Divina Casim has reported that the term e-Learning in Korea encompasses all types of learning using electronic devices either with analogue or digital content and the hybrid of face-to-face or c-learning and online learning stands for blended learning.

Bruce Jones has also addressed the need to define the meaning of an artefact but has decided to arbitrarily accept the term artefact as a product of education and the 'object/pathway' leading to education. Bruce Jones has been querying if an artefact could be understood as a learning artefact utilised many times to build the same or different learning experiences.

For a further basis of understanding the meaning of the term artefact, Bruce Jones has referred to "a man-made object taken as a whole" (TheFreeDictionary.com, 2004) under a contextual umbrella (cf. Brown, 1995), and that "The point that mass stupidity and self-adsorption is a deliberate educational artefact needs to be hammered in" (FreeRepublic, 2004). Bruce Jones claims that the confusion about artefacts when used in an educational sense is real and obstructing. Most of us have heard the word in our studies and have used the word in our writing but there appears to be a contextual, cultural, and professional education disparity about the meaning. Bruce Jones welcomes the term artefact as the product of a course of study used to enhance or assist in future study because 'we stand on the shoulders of those who went before' which means that we learn through the use of educational artefacts of earlier study.

In regard to an 'intelligent e-Learning artefact', Bruce Jones has asked the discussion list to consider if an 'intelligent e-Learning artefact' should be regarded as an AI LO that is able to recognise progress and respond with appropriate remediation, or if it should be considered as a constructivist data base of non-related entities that are brought together as the learner interacts with the lesson to formulate new knowledge.

In response to question 6.1 Bruce Jones agrees with Terri Buckner on the need to differentiate between a system and an artefact while he thinks the answer to the question 6.1 should be a verbal description of a VIN diagram.

The whole process, as Bruce Jones sees it, is shaped like a triangle, going from broad and general statements to very narrow and specific content presentation. In the case that this is an acceptable model for a 'system', all learning entities should have a common set of foundational artefacts or knowledge objects both establishing and being defined by, the curriculum. As specific knowledge content becomes a requirement the field of study narrows to specific content i.e., artefact, LO, and its appropriate delivery.

Bruce Jones does neither thinks social constructivist theory applies to AI nor is a learner's interaction with a database social interaction. Interaction relates to "Communication between people" (cf. Webster-dictionary, 2003), social is "Inclined to seek out or enjoy the company of others; sociable" (cf. Dictionary.com, 2004) while, however, interaction is "Mutual or reciprocal action or influence" (cf. Webster-dictionary, 2003). On such basis of argumentation, Bruce Jones claims that if we step back from the mechanistic view point of a database as a collection of data points of bits and bytes and consider it to be an entity with a learning or social disorder i.e.:

- non-communicative unless queried directly which means that it will not volunteer knowledge unless asked specifically;

- giving answers based on a data embedded into a relational schemata and what it knows without constructive associations which indicates that it cannot associate non-content specific data nor make an intuitive connection; and
- ‘single-minded’ which means it can only query databases of specific content one at a time;

Then, ‘social’ takes on a radically different and more simplistic meaning. To him, ‘social’ then becomes a ‘content limited association’ that is ‘bounded by literal translation of input and output’, which could be considered as a working definition of human-database ‘social interaction’. So, LO respectively artefacts query single or multiple databases based on limited input to return content specific information which the learner can use to build knowledge i.e., much alike a search engine that then allows the learner to contribute new data to both personal and publicly shared databases. According to him, this could be said to be socially interactive.

In response to question 6.2, Bruce Jones believes that pedagogical and psychological validity is inseparable (cf. question 6.2 a)) and that the answer to question 6.2 c) is sociocultural theory (cf. Ryder, 2004b).

Further to the discussion on knowledge architecture, Bruce Jones refers to Quinn, 2004’s Knowledge System Architecture. Beyond Lorraine Fisher’s issue regarding ‘fear of technology’, Bruce Jones has drawn our attention to accuracy of present work of industry leaders by having pointed us to Microsoft, 2004’s project on “Windows Automotive”.

Further to the assertion about the social nature of interaction, **Terri Anderson** concludes that interaction can also be used to describe learner-content ‘mutual action’. Contrary to older conceptions of content, LO or databases being mechanistic or unchanging, Terri Anderson reminds us of games and simulations where the learner and the content are both changing in response to other entity’s action. These interactions may not be described as social because the term ‘social’ can depend upon the definition one uses. Therefore, social constructivist theory does apply to AI.

In response to Bruce Jones’ criteria on entities of a database, Terry Anderson believes that these are not characteristic of such active LO as results of the work of Kurzweil, 2004 are still pending.

Kurt Rowley has welcomed the anthropological-philosophical viewpoint and suggests that the type of e-Learning object and e-Learning artefact discussed in the paper could be identified as an ‘intelligent LO’. Kurt Rowley agrees with the idea that the definition of a LO or as quoted ‘any artefact of e-Learning’, should be expanded to allow it to be more intelligent in the sense of AI to reflect more of what is known about teaching and learning. That is a difficult but important goal in the AIED field because we are only in the beginning, and to tie everything together and create intelligence would require an agreed-upon ‘unified theory’ that presently does not exist, and may be some advances in distributed forms of AI.

With this respect, Kurt Rowley proposed a related idea several years ago, which, at that time, was regarded as futuristic. Nevertheless, Kurt Rowley now sees this as a vision that can orient our thinking but may not be achieved for some time (cf. Rowley, 1997).

Furthermore, Kurt Rowley believes that there are many answers on how to effectively build and construct e-Learning environments, and thus the LO, or 'artefacts'. However, this knowledge is distributed in the broader education research community. According to him, there are countless studies that provide some useful information about implementing the many paradigms of learning and teaching. He therefore refers to research in areas of computer science, human factors, management, educational research, secondary education, educational computing, and others that

- review a learning theory and/or teaching approach,
- build a teaching technology,
- test that technology;
- present the results, and
- draw conclusions about how to effectively build and construct 'e-Learning' environments.

As designers, however, Kurt Rowley argues that we should be mining this kind of research, and helping the greater e-Learning community to follow effective design processes as they build e-Learning courseware that is based on all learning and teaching strategies that are known to be effective. Our contribution can be to help them apply a systems discipline as the work through the complex and non-linear, opportunistic process of design.

With regard to the sociocultural aspects of the discussion paper, **CLFLM** has addressed the need to include and discuss very relevant literature on artefacts such as Postholm, Pettersson, Flem, Gudmundsdottir et al., 2002 and Postholm, Pettersson, Flem, & Gudmundsdottir, 2002. Sociocultural theory (or theories), though by no means very new, has recently received quite a lot of attention inside/outside academia (cf. John-Steiner & Mahn, 1996).

Under the discussion criteria of understanding the meaning of artefacts, CLFLM has referred us to reflect on Viseu, 2000b's paper while arguing that one might also encourage educational/instructional practitioners' to think critically when designing/developing new technologies for educational/instructional purposes (cf. Viseu, 2000a).

In consequence, CLFLM observes that there might not be anything inherently wrong in theories or technologies themselves, but instead of following, chasing or even being entangled with theoretical or technological trends, educational practitioners might need to always remind themselves of our main aim or mission, i.e., to try to improve or enhance both teaching and learning for the benefits of both teachers and learners. Otherwise, we might run the risk of 'putting the cart before the horse'. Therefore, no matter what theory/theories to be adopted/adapted, learning technologies should be considered as the means by which we try to fulfil our general aim i.e., to improve teaching and learning. If this aim is clear to us as educational/instructional practitioners, any theories or technologies might somehow be of secondary importance (cf. Wilson, 1997).

Stephen Downes has raised issues of emotional factors in learning like e.g., anger, which, though computationally not identifiable, is nonetheless real. To Stephen Downes, learning is a lot more like anger than it is like the post that carried it. While the post may be computationally identifiable, the learning is not, and it is arguably a reductionist fallacy to suppose that it is.

According to him, the language of 'LO' or 'artefacts' and of 'constructing' or 'building' knowledge is misleading because we would not talk of 'building' anger in another person, nor of an 'anger delivery system', yet the very purpose of online communications is to engender anger or for example, love, happiness, or learning. And when we think of it that way, we realize, that just as there is no clearly identifiable, universal, definable, or concrete way of producing anger (or love, or happiness) in a person, the same also is true of learning. An irreducible element of learning is the prior mental state of the person. This makes learning impossible to define computationally but not impossible to do with computers.

As an example, Stephen Downes suggests us to consider the sort of enquiry method a photocopier uses to teach its human operators. In her discussion of the failure of such 'computer-based teaching', Suchman, 2000 argues that at least part of the failure is due to the fact that "the machine had access only to a very small subset of the observable actions of its users" (Suchman, 2000, p. 3). Viewed in this way, the problem becomes one of giving the machine access to a wider range of stimuli, so that it is better able to understand the context in which the learning is taking place i.e., the situation in which the situated cognition is occurring. The machine, as an artefact conveying (but not containing) the designer's knowledge of how the machine functions, must be designed in such a way as to be able to read, and react to, the situation in which learning occurs.

Stephen Downes argues that the sort of concept, then, that we are looking at is a sort of AI for the design of autonomous LO. One way of doing this - the method that failed in Suchman, 1987's account, is to give the users a set of rules to follow. He claims, this is essentially the approach taken by IMS Global Learning Consortium, 2004.

Instead, then, of a list processing approach to the sort of AI such a machine would require, we turn to the architecture suggested by an events based processor. On this model, different scripts, different routines, are brought into play depending on the nature of the learner and the circumstances in which the learning is taking place. If Learning Design is like a play, in which the student actors follow a script, then this model is like a game, in which the learners are participants, seeking a means to accomplish an objective, with the photocopier responding appropriately and helpfully. Suchman, 2000 argues that "I often found myself in the position of being able to 'see' the difficulties that people were encountering, which suggested in turn ideas of how they might be helped. If I were in the room beside them, in other words, I could see how I might have intervened" (Suchman, 2000, p. 3).

This second sort of task is no less immense, even if we could give the photocopier full access to the entire situation in which the learning is taking place (and indeed, for each new bit about the situation, the complexity of the instructional system would increase exponentially). He argues that it would take a million dollar computer system to provide instructions on how to use a five thousand dollar photocopier. This is why he thinks, people ‘drop their jaws’ at the idea that such a thing could be done, and why to some the request for a greater and more precise specification of the learning outcomes, pedagogical model, and other computational structures, seems only to increase the impossibility of the task, not to clarify it.

These considerations have led Stephen Downes to conclude that the learning process cannot be in the LO. If the LO is an artefact, that which acts as a carrier or representation of the knowledge of the original designer of the photocopier (or, at least, someone who knows how to use it), it cannot by itself accomplish this task. The LO cannot do what Suchman, 2000 says is so easy for her, to observe what they are doing wrong and offer suggestions. The LO is what is presented when questions of situation - both in the environment and specific to the learner - have ‘already’ been resolved. The LO - a map - may be a representation of the domain, but will only partially reliably guide the learner. To Stephen Downes the question is not, “could a LO ever determine an appropriate response?” because a LO is not the sort of thing that determines responses. The only equivalent question, in his opinion, from the standpoint of computers, is to ask, “could a computer network ever provide an appropriate response?” or more specifically, “could the internet ever provide the appropriate response?” Stephen Downes thinks that the answer to this question is “yes” - yet argues that it is “yes” conditionally; that is, it depends on our having a correct understanding of the internet. The appropriate understanding of the internet, in his view, is to picture it as a vast communications system. To stimulate learning, a communication must have its origin in - and therefore the capacity to cause - an emotional response which means that we want to know a person’s thought, not a data structure.

Therefore, Stephen Downes believes that it is not a question of putting the pedagogy into the system, which means it is not a question of creating exactly the right sentence. Rather, to him, it is a matter of giving a channel through which to flow. It is a question of making the right connection between one person and another person, and of determining how these people can exchange information in the right way. Stephen Downes believes that if we get the ‘communication’ right, the learning will take care of itself.

Clark Quinn has argued that many of the installations of the standard LMS (e.g. WebCT, newly IPO'd Blackboard) are being used by faculty who have received little pedagogical preparation, and have insufficient support. The typical path, it appears, is that such faculty first put their lecture notes up, and over successive semesters, they start taking advantage of other features.

As with regard to LO and critical view points (cf. IEEE Technical Committee on Learning Technology, 2004) towards their present perceptions, Clark Quinn has provided us with a reference discussing smart objects (cf. Quinn, 2000).

With regard to the discussion on AI, the role, the interaction and social perception of an intelligent, psychologically and pedagogically valid e-Learning system, **Lorraine Fisher** has argued that the fear of using computers and computer anxiety is still very real and cannot be ignored in educational technology.

With regard to a question by author enquiring about formal and mathematical/algebraic/logical work on the understanding of the relation attributes of the DCMI (cf. DCMI, 2003b; DCMI, 2003a) which are relevant to the commonly known LO paradigm, **Andrew Deacon** quotes that he has also been confused as to why LO were not drawing on richer abstract models as generalised in Object Modelling. In answer to a question from the author, Andrew Deacon states that he has also been confused as to why LO were not drawing on richer abstract models as generalised in Object Modelling. These models are represented by the attributes of DCMI (cf. DCMI, 2003b; DCMI, 2003a) as they relate to Mathematic and other logical systems. Hao-Chuan Wang and the author provided citations by Daniel Rehak at CMU (cf. Learning Systems Architecture Lab, 2004) in support of their stance. One of the points made there is that LO were developed for vendors and publishers, not educators, learners or anyone else. The implication seems to be that more or different tools enforcing relations and adding intelligent behaviours are needed (they may import and export LO). There are other interests too, such as supporting developers and assessment/feedback workflows that will need their own special relationships. Andrew Deacon’s understanding of the research in business workflows is that non-trivial actual workflows are so complex to model that no simple formalism exists which can be efficiently and unambiguously implemented. Statecharts are an example of a balance between power of expression and simplicity of execution (note by the author: Statecharts contain state reaction, state hierarchy, and parallelism as outline by Wieringa, 2003). Therefore, in practice there are many representations and methodologies - a plethora of tools and many expensive consultants. In the education field, there may well be things that can be exploited to keep everything much simpler.

Andrew Deacon has been investigating how frameworks such as sakaiproject.org, 2004 and other portal technologies will make it easier to execute dependencies - by making more events accessible than, in a generic web environment. One of the examples cited was the ability to ask a survey or quiz question when some or other resource had viewed to the end. As Stephen Downes noted, we cannot hope to build-in everything to behave intelligently, but we do need more information about what students are doing. This is important so we can provide the guidance we would have provided if we had been teaching them individually. Such mechanisms are not unique to the needs of education, thus we should benefit from work (and failures) elsewhere.

8. For future Discussions

Further exploration on the first question could look at the distinctions between conventional systems development and soft systems methodology of e-Learning artefacts. Also, as clearly addressed by the discussions, there is a need to research on the differentiations between an artefact, intelligent artefacts, a system, LO, and intelligent LO. Further research will be needed to specify the degrees of influence of sociocultural theory, philosophy, epistemology, and anthropology affecting the behaviour, construction, and cognition of artefacts, systems, and (intelligent) LO. Further development, based on the situated facets of e-Learning artefacts and the outcome of systems development methodologies need to be contrasted in view of requirements analysis and elicitation. Practical realisation would therefore need to investigate on the ‘pedagogical and psychological ideal situations’ and contrast these with the today’s technological possibilities. Hence, future discussion will be needed to encourage intensified discussions among multiple research disciplines such as computer science, psychology, AI, and pedagogy.

As with regard to the second and third questions, we could well explore further the distinctions and needs of different levels of pedagogical and psychological validity and their implications e.g., at the level of LO, at the object, artefact, and system level as well as at the system level by distinguishing various categories. Further study will be needed to compare artefacts and systems by exploring constructivist, behaviourist, and cognitive facets of databases and intelligent/adaptive systems under the light of AI. Nor have we discussed the meaning and essence of ‘pedagogical and psychological validity’. Expanding on the arguments of Hao-Chuan Wang, how do we relate ‘pedagogical and psychological validity’ to e-Learning systems or computers in education? What should their objectives be? Pedagogical and psychological validity may also represent other perspectives such as a user perspective i.e., exploring the question of how to incorporate emotional factors in learning into an e-Learning artefact and how an e-Learning system could stimulate learning?

Neither the fourth or fifth questions have not been explored. These questions leave further space for discussion and research into technical realisation of purposeful actions and plans and how their relationships with learning theories. An interesting extension in research would certainly need to build distinctive classes of learning theories to discuss their applicability in both the technical and psychological domains.

Last but not least, both discussions have been extremely rich and reveal many future research opportunities. In particular, the author would like to thank the participants for the vivid participation and valuable observations and for the many, “… insightful inquiries and analysis help[ing] us to focus on tomorrow by what we see today” (Bruce Jones) as “… our [instructional designers and technologists] main aim or mission is to try to improve or enhance both teaching and learning for the benefits of both teachers and learners” (CFLM).

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