THE DESIGN OF EFFECTIVE ICT-SUPPORTED LEARNING ACTIVITIES: EXEMPLARY MODELS, CHANGING REQUIREMENTS, AND NEW POSSIBILITIES

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ABSTRACT

Despite the imperatives of policy and rhetoric about their integration in formal education, Information and Communication Technologies (ICTs) are often used as an "add-on" in many classrooms and in many lesson plans. Nevertheless, many teachers find that interesting and well-planned tasks, projects, and resources provide a key to harnessing the educational potential of digital resources, Internet communications and interactive multimedia to engage the interest, interaction, and knowledge construction of young learners. To the extent that such approaches go beyond and transform traditional "transmission" models of teaching and formal lesson planning, this paper investigates the changing requirements and new possibilities represented by the challenge of integrating ICTs in education in a way which at the same time connects more effectively with both the specific contents of the curriculum and the various stages and elements of the learning process. Case studies from teacher education foundation courses provide an exemplary focus of inquiry in order to better link relevant new theories or models of learning with practice, to build upon related learner-centered strategies for integrating ICT resources and tools, and to incorporate interdependent functions of learning as information access, communication, and applied interactions. As one possible strategy in this direction, the concept of an "ICT-supported learning activity" suggests the need for teachers to approach this increasing challenge more as "designers" of effective and integrated learning rather than mere "transmitters" of skills or information through an add-on use of ICTs .

> The Internet is an embarrassment of riches that is next to worthless without an educator to facilitate learning and integration in classrooms … what tends to be in shorter supply are specific learning activities that make use of this wealth. (March, 2001)

> How do we understand persistence, but also the reasons for transformation -- decays of old lines of work and the emergence of really new ones? For this, we need an as yet unknown nonexistent theory of the *structure and evolution of activities*. (Disessa, 2000, p. 78)

INTRODUCTION: THE CHALLENGE OF "DESIGNING" LEARNING FOR ICT INTEGRATION

In general, ICTs are often used as an "add-on" in the classroom, demonstrations of cutting-edge programs and possibilities often intimidate rather than encourage educators, and teachers often resent the naïve rhetoric of ICT integration typically associated with top-down policy imperatives (Cuban, 2001; Healy, 1998). The challenge for teachers to more effectively harness the educational implications and possibilities of ICT learning resources and tools is not simply a problem of finding sufficient time to develop appropriate computer skills or even think about potential applications. Relevant contexts or frameworks for practical integration which link to both the curriculum and the learning process are also needed, as are specific methods and models. Despite an often instinctive skepticism, many teachers have a

general awareness that the Internet offers a rich source of potential learning resources, that multimedia tools and design can make interesting, impressive, and interactive tools of learning, and that many of their colleagues are finding ways of harnessing the learning possibilities of ICTs in unique contexts. Even an ICT-resistant "traditional" teacher cannot deny that the World Wide Web (WWW) houses endless and ever-current information on all manner of topics, and that multimedia CD-ROMs are at the very least useful for skills-based tutorials or for making information links more attractive.

The inquiry represented by this paper began with an interest in developing transferable design principles for a teacher education context out of the many good ideas and examples of good practice available. This goal initially proved to be most elusive because of the difficulty of distinguishing between context-specific factors related to teaching and learning and any inherent principles of design that might be at work. Effective learning through an integrated use of ICTs often occurs despite, and not because of, the role of the teacher (Loveless, Devoogd, & Bohlin, 2001). Yet relevant designs for learning with ICTs can certainly enhance this possibility. An initial review suggested some inherent principles and strategies at work in effective examples and models of teaching with ICTs that emphasize an activity-based approach (e.g., Thomas & Knezek, 2002), hence the interest in alternative requirements needed to more effectively integrate ICTs in teaching and learning. This paper therefore investigates the idea that an emergent notion of "ICT-supported learning activity design" provides an antidote of sorts to an add-on use of ICT in education. This is insofar as the conventional generic structures of formal lesson-planning and syllabus design tend to reflect a view of learning as essentially a transmission of information or skills, as distinct from a dialogue between teacher and learner or an interaction between learners and the learning process (e.g., Laurillard, 2002)

One principle which suggested itself from the outset is that effective teachers tend to see ICT resources and tools as much more than an extension of "traditional" print resources, existing classroom practices, and "curriculum-as-content" transmission. The integration of ICTs in teaching and learning is more likely if the tools and resources of the Internet, multimedia, and related technologies are seen as being integrally connected with literacy learning in the wider sense of learning as a matter of accessing information, communicating, and applying knowledge (Kress, 2003; Lankshear & Snyder, 2000). In other words, to the extent that they represent new tools, media, and functions of learning in the digital age, ICTs complement, extend, and transform the role of language-across-the-curriculum in learning as the very basis of generic skills or competencies and applied knowledge as well as mere skill or content transmission. Thus, it might be argued that an across-the-curriculum approach does not just complement and extend a more skills-focused and specialized use of ICT in formal education, but is a key to ICT integration in teaching and learning (Richards, 1998; Roblyer & Edwards, 2000).

In addition to promoting the learning of generic skills and applied knowledge orientations instead of mere skill or content transmission, an across-the-curriculum approach is useful for recognizing and promoting the idea that to effectively integrate ICT in education teachers need to increasingly become designers rather than merely transmitters of learning (Kimber, 2003). Such an approach naturally also extends a "new literacies" perspective of how language and literacy learning as formal study is more effective and relevant in various ways if grounded in the functions and aspects of informal everyday discourses and interactions outside the classroom (Cope & Kalantzis, 2000). This is especially true in the digital age where young learners tend to be more confident and have greater familiarity with everyday (especially visual) literacy aspects and functions mediated by ICTs than older teachers and parents (Hird, 2000; Richards, 2000). The importance of every learner and teacher becoming designers of meaning through new ICT literacies has been well argued by Kress (1997), an influential critical literacy and language theorist. Kress's recent work has increasingly focused on how effective multimodal literacy learning needs to be grounded in (not merely imposed on) everyday practices and contexts. Kress's notion that *design* precedes yet is interdependent with *evaluation* in terms of the literacy (i.e., to the extent that

writing and reading are aspects of design and evaluation) as well as learning aspects of education in the digital age, suggests the need for new approaches to learning design also.

As will be discussed further, many of the new learner-centred concepts and models point in a similar direction but are often either practiced or theorised in a way which inadvertently reinforces teacher-centred or transmission approach assumptions. Practical concepts such as problem-based learning, collaborative learning, project work, authentic assessment, and inquiry-based activities all represent alternatives to the linear and hierarchical assumptions of formal lesson-planning and course design, yet tend to be seen in either opposition to or as an add-on to traditional educational design. To the extent that they provide exemplary foci for discussing the learner-centred implications of ICT tools and resources (Jonassen, Howland, Moore, & Marra, 2003), such approaches emphasize how effective learning should rather be understood as a process, cycle and/or set of stages proceeding from initial skill or information acquisition to more applied and reflective understanding, knowledge and even innovation .

Kolb's (1984) influential model of the learning process usefully lends itself to the practical requirements of ICT integration in terms of how it outlines a practice-reflection cycle proceeding as distinct stages of *concrete experience, observation, conceptual abstraction* and *testing*. Likewise, Sandholtz, Ringstaff, and Dwyer (2000) have developed a well-known model of instructional "evolution" as a traversal of five stages (*entry, adoption, adaptation, appropriation,* and *invention*). However such models or theories tend to view learning processes, cycles, or stages independently of context and often fail to recognize the discontinuities or "missing links" between learner doing and thinking, educational practice and theory, and ICT skills or information and applied understanding or innovation (e.g., Beard & Wilson, 2002). The hands-on requirements of ICT integration suggest how such models need to be more effectively grounded in the very situational contexts of practice, application, and various related notions of *activity* which every teacher needs to negotiate. The challenge of ICT integration also represents a good opportunity for productive change and interesting innovations.

THE CONTEXT AND DESIGN OF THE INQUIRY

Context

This paper represents an inquiry which proceeded for several years in teacher education ICT foundation courses taught in Singapore, and more recently Hong Kong, based on earlier interests and experiences of coordinating similar courses at Queensland University of Technology in Australia. It also developed as an implicit focus of two related projects undertaken in Singapore and Hong Kong: (a) the design and development of a model of activity-reflection e-portfolios as a learning and assessment strategy for ICT integration, and (b) a practical and conceptual investigation into a convergent model of ICT-supported learning environments (Richards, 2002, 2003). Whilst undertaken in different cultural contexts where language education and issues were significant, the most relevant context of the inquiry was a global one related to how new learner-centered practical models and theoretical projections offer the promise of a more effective approach to integrating ICTs in teaching and learning than still often dominant teacher-centered, transmission and rote learning approaches and practices.

The teaching modules which were the focus of the inquiry involved foundational ICT courses with common objectives for both across-the-curriculum classes and also language education classes from both primary and secondary level teacher education programs. While the specific purposes and contexts of ICT integration in teaching and learning varied somewhat in different classes, the inquiry addressed and responded to the challenge of the common main aim of foundational ICT teacher education modules, namely, to prepare future teachers to respond more effectively to the challenge of integrating ICTs in their pupils' learning and also in their own specific teaching contexts. In short, the specific inquiry represented by this paper is one of how might teachers be prepared and encouraged at practical, concrete, and "micro" as well as reflective levels of pedagogical design to integrate ICTs more effectively in their pupils'

learning and in their own teaching? In other words, how might we identify, represent, and make transferable the pedagogical principles of an alternative design strategy which seems to be implicit in both examples of good practices and influential practical design concepts such as project-based learning, problem-based learning, collaborative learning, authentic assessment, and so forth?

The challenge of ICT integration in education is intensified, and therefore exemplified, in contexts such as Singapore and Hong Kong. The Hong Kong Department of Education followed Singapore's example in developing an initial five-year plan in the late 1990s to increase access to computers and the Internet in school classrooms. Both Singapore and Hong Kong have ambitious and innovative policy projections which strongly link the challenge of ICT integration to new student-centered theories of learning as well as to strategies of educational reform relevant to an emerging global economy (Hong Kong Education Commission, 2002; Singapore MOE, 2002). However, despite increased access to ICTs, the schooling systems in both countries still remain largely dominated by an exam-driven curriculum and traditional teacher-centered methods of pedagogy (Pearson, 2001). Such contexts thus made it more difficult in some ways and easier in others to emphasize to students how the challenge of ICT integration exemplifies a larger challenge for teachers of the future to design contexts for more active and effective learning, that is, to go beyond related paradigms of teaching and formal education in both "traditional" and industrialized societies as primarily the transmission of information or skills in isolation or for its own sake.

The comparative context of the study thus emphasized that a generational gap between older teachers and younger students, who embrace a global "wired" culture at home, was as significant as the cross-cultural clash between traditional educational practices and the imperative of progressive new theories of learning (Richards, 2004). The challenge of ICT integration is as much at the centre of a conflict between old and new pedagogies as it is in terms of how educational values are alternately influenced by institutional imperatives for change and existing social contexts.

Design of Inquiry

The three case studies below also represent three stages of the action research inquiry outlined above, as well as examples of different approaches taken to prepare future teacher educators in terms of a pedagogical design approach which might more effectively facilitate integration of ICTs in teaching and learning and go beyond a mere add-on approach. Harris's (1995, cited in Grabe & Grabe, 1998) threefold typology of meaningful ICT learning activities (*information exchanges, interpersonal exchanges,* and *problem-solving projects*) provided a useful focus for linking different approaches to related concept of stages which increasingly emphasize more higher-order, applied, and innovative approaches to pedagogical design for ICT integration in learning. Such a model also seems to reflect how both pedagogical and technological perspectives involve three convergent principles of design and development: the organization or dissemination of *information,* the facility for *communication* (including modes of either presentation or publication which potentially go beyond the teacher as sole audience) and some aspect of user *interactivity* exemplified by the challenge of problem-solving, and also the participatory possibilities of role or game playing.

As performative action research, the inquiry represented stages of seeking to "change and improve" efforts to encourage participants to be more active designers of learning with ICTs (Richards, 2001). In other words, at each stage there was an ongoing action research cycle of *design, implementation,* and *evaluation* which linked up a focus on the generic structures of the models used with the larger interest or strategy in getting the student teacher cohorts involved to think more effectively about designing learning with ICT tools and media. Hence, this paper has further adapted a case study approach involving example artifacts by students from specific classes typifying the three different approaches and related stages trialled during the overall study. The names of students have been changed for reporting purposes.

The three studies described focus on how particular cohorts typically responded to the main approach taken at that stage. While the overall inquiry included cohorts of both primary and secondary student

teachers, the examples for the discussion below mainly reflect a "middle school" focus. Sample activity designs were selected for their typicality as an example focus and a practical reference-point for discussing here the specific models reflecting these three different approaches and stages. These studies are all relatively autonomous although somewhat overlapping as a progression. They also reflect a progressive and comparative refinement of approach as well inquiry in terms of distinct stages. For instance, the specific models (i.e., *webquests* and *microlessons*) and general focus (i.e., ICT integration as a strategy for mainly harnessing information resources) adopted and trialed at the first stage were still being used as exemplary models in their own right as well as a foundation for the second and third stages where the activity focus was more on ICT communications and interactivity.

The first stage involved subjects taught at the Singapore National Institute of Education in the academic year 2000-2001. Likewise, stage 2 also corresponds to relevant subjects taught at the same institution in 2001-2002, and stage 3 similarly relates to a key focus taken in several subjects taught at the Hong Kong Institute of Education in 2002-2003. The main focus of the second stage was on the specific models of "Internet communication projects" and "multimedia project development" reflecting a general focus on ICT tools and media which encourage communication and collaboration in the process of knowledge construction. As will be discussed, the third stage trialed versions of a generic template conceived to encourage students to design and develop ICT-supported learning activities in interactive modes which might build on or even include aspects of both the specific models and approaches of the first two stages.

As a series of three stages, the studies represent both an interdependent progression of sorts on one hand, and a comparative progression of sorts on the other. Implicit to the kind of typology outlined by Harris and also the various models looked at is a sense that effective ICT supported learning activity models all reflect some aspect of information resourcing, communication (including publication or presentation), and learning interactivity. For instance, the seminal model of hypermedia learning projects outlined by Lehrer, Erickson, and Connell (1994) describes a general sequence where students (a) choose a topic or focus to research for information and resources, then (b) design a way of transforming this into a presentation or publication, and (c) finally refine this in terms of effects aimed at purposefully engaging an audience. Likewise, the comparative progression inherent in the study focused on how the models and approaches investigated all resisted being reduced to the constraints of formal lesson planning and linear/hierarchical syllabus design. Similarities and differences between these models suggested the outlines of alternative generic structures which could inform the design of an effective lesson plan or larger module, but not be reduced to this.

The models explored in the first two studies suggest the *anatomy* of an effective ICT-supported learning activity to the extent that they also seem to intrinsically "resist" merely linear and hierarchical approaches to educational design. This is might be better appreciated in terms of the kind of three-fold progression of knowledge inquiry and construction described in the methodology of dialogical hermeneutics; that is, an initial *naive* phase followed by a *critical,* or even procedural, phase and finally a *dialogical,* or applied phase. In this way our investigation sought to discern the design principles of how effectively designed "activity structures" involving ICT integration provide a context and focus for learning as a transformation in terms of bridging the gaps between learner doing and thinking, between practice and theory, and also between the literacy processes of design and evaluation.

Study #1: Webquests, Microlessons, and a "Learning Design" Focus on ICT Information Resources

Typical Learner Artifacts -- Class A, 2001

Hitendra's webquest

Because of the exam-driven curriculum (and despite official support for the introduction of project work), our Singapore students initially struggled to see the possibilities of webquests, and also found that many North American classroom examples did not translate well into a local learning context. However, many

soon become enthusiastic about developing webquests on their own Web sites and how this model would help motivate learners to search and use Internet information resources. Hitendra's webquest provides a context on one page and useful links on a related "resource pag"' to explore information about the regional Pilcher plant. At the end of the module there was a presentation sharing session which, with the approval of his peers, inspired Hitendra to collect and post the class webquests on a shared Web page resource.

Brian & Kai Ming's microlesson

The microlesson model usefully outlines the importance of designing learner-centred contexts. Although students in many other classes simply adapted their ideas to existing design templates, my class was encouraged to develop their own design schemes in a relevant way to the activity idea, and also use the often ignored multimedia functions of Powerpoint such as customized animation. Brian and Kai Ming's microlesson has a simple but effective design which links a wishful plan to save up for a mini disc player to a mathematical activity of interest calculation. They use a hypertext function well to get learners to explore different examples and scenarios, and an accompanying worksheet (not linked here). This microlesson could be undertaken by an individual learner or a small group.

In the initial year of the study when working at the Singapore National Institute of Education, the models used for getting students to design effective ICT-supported learning were *webquests* and the locally-developed *microlessons*. Typically the main focus of both these models is on providing contexts for students to collaboratively or individually engage with the use of ICT for information resourcing in either an actual classroom context or in distance education mode (McKenzie, 1999). Both are applicable to and provide many useful examples of across-the-curriculum applications.

Webquests are usually presented in Web page format and aim at getting students to use information resources from the World Wide Web in terms of either provided URLs or tasks in which students need to find their own links. For instance, Hitendra's webquest on tropical pitcher plants provides the context of mayoral intervention in a debate between town residents. The term *webquests* has become for many teachers almost a generic term for getting students to interact with information on the Internet. Indeed, it was originally conceived by Dodge (1997) as a general strategy for learning with Internet resources: "a webquest is an inquiry-oriented activity in which some or all of the information that learners interact with comes from resources on the Internet."

Microlessons, in contrast, are typically conceived as Powerpoint templates with one or two basic objectives for student-centred learning which may link to either Internet resources or some kind of worksheet (e.g., as a word processing or spreadsheet document) as exemplified by Brian and Kai Ming's microlesson. While webquests are typically posted online, microlessons may alternatively be saved to CD-ROM as multimedia learning activities. In theory, both models encourage independent and collaborative learner-centered inquiry as well as higher-order thinking. In practice, webquests mainly promote active engagement with information resources on the Internet, while microlessons encourage teachers to use Powerpoint as a multimedia activity format rather than just for standard presentations. Both models seemed to be -- and to a significant extent are -- useful templates for encouraging more active learning on one hand, and teacher designs for such learning on the other. However in practice both are often used to inadvertently reinforce the very inherent assumptions of the traditional lesson which their originators seemed to be challenging.

This was evidenced by the typical use of microlessons in the Singapore foundation teacher education courses where I was first introduced to the concept. Students were generally not required to design their own variations of the multimedia templates but simply to add their own content. Also, the expectation of having lesson objectives at the outset (like a normal lesson plan) also seemed to me to contradict perhaps the most powerful implication of this model: the facility for allowing student teachers to design

interesting and authentic contexts for engaging the learning process. Therefore the second semester we used this model students were required to design their own slide templates (especially in terms of customized animation and other multimedia functions) as well as a context of activity linked to one or more specific learning outcomes. As also exemplified by Brian and Kai Ming's microlesson, our students were expected to put their learning objectives at the end rather than the outset.

In these courses, webquests were found to be more useful for getting students away from the traditional lesson mindset for using ICT tools and resources, because they represented a more open-ended model. In other words, webquests provide typical examples and a basic design structure which is useful for promoting a design approach and also an appreciation of the power and possibilities of ICT-supported learning activities.

Discussion

Many educators still see the Internet as basically a reference or information resource. Dodge (1997) helped to promote and develop the idea of integrating Internet resources in terms of the teacher design of student-centered activities which mine the potential of the Internet to encourage more immediate, relevant, interactive, and authentic learning. His co-developer Tom March (1999) went on to develop a framework for Web-based learning activities which included *webquest* (alongside *topic hotlist, multimedia scrapbook, treasure hunt,* and *subject sampler*) as the one category which covered an integrated use of Internet resources. In contrast to conventional lesson planning designs, Dodge's model of a webquest incorporates the progressive structure of *introduction, task, Internet resources, process,* and *outcomes*. This is outlined in the online template he set up for teachers. Dodge also conceived it most typically as a collaborative activity where a group divides into different roles and perspectives for information searching in order to produce some kind of presentation report or publication outcome which addressed a particular topic or task in terms of focus questions.

However, some of the limitations of Dodge's model provided a focus for going beyond this as a design model. For a start, Dodge's initial definition of a webquest is somewhat of a catch-all and potentially covers all manner of uses of the Internet as an information resource for teaching and learning purposes. Even its use as a mere reference resource still involves some degree of inquiry where there is a need to search and evaluate quality information. Yet Dodge himself conceived webquests as a particular method which he developed into an example template with an associated assessment rubric. Thus the term *webquest* is often used interchangeably in confused fashion as alternately a *general approach* and a *particular method* associated with his personal authorization and online models. Put another way, should any classroom learning activity which makes use of Internet resources be referred to as webquests? If not (and clearly not), where do you draw the line and how do you distinguish an authentic webquest?

Although *webquests* were further defined by Dodge (1997) as "inquiry-orientated activities which include both specific or short-term and larger long-term projects," his examples have tended to be shorter activities. Dodge ended this his most definitive article about webquests with a plea for people to send him longer examples. It would seem that Dodge conceived his notion of webquests in the manner of a traditional self-contained lesson context and was thus confused about how this might be reconciled with a more general project-based learning approach. In short, the theoretical concept of webquests is ultimately a rather narrow and specific one, and is not able to contain extended and varied notions of learning activities which make use of Internet resources. As suggested by Dodge's own definition, the educational concept of project-based learning seemed to provide a more integrative context for not only different types and sizes of webquests, but also various types of ICT-supported learning activities.

Study #2: Project-Based Learning for Internet Communications and Multimedia Design

Typical Learner Artifacts -- Class B, 2002

Lena's monster exchange

The monster exchange model was conceived for younger learners. Yet as an imaginative writing exercise (which may be done either individually or in groups) also involving both a drawing with a graphics program and some form of Internet communication for interacting and sharing files, it soon captures the enthusiasm of learners of all ages – including student teachers. Normally the monster idea is exchanged and drawn by the other party. Here Lena also drew her own monster and then exchanged that back to other party for comparison with their drawing. This model thus provides a useful prototype and exemplar of the possibilities of Internet communication projects.

Mei's multimedia project

Many of the multimedia projects undertaken in our classes, especially those involving more advanced authoring or extensive use of audio-visual files, would involve so much computer memory that they would need to be submitted on CD-ROM rather than as a Web page. Mei's project was saved to a file which took up little memory (one reason for being selected here) but is simple and effective. As a language lesson it focuses on skills learning, but does so in relation to an interesting and well-conceived context. Many of the student multimedia projects focused on setting interesting contexts for introducing topics of information or skills learning. Others used the connection between introductory animations and related hypertextual link options (requiring learner choices) to encourage more interaction and higher-order learning.

We continued to use webquests and microlessons as useful templates for getting my students to design learning contexts with ICT tools and media. However we found that project-based learning was an even more useful framework to get these students to link the design of learning contexts for ICT integration with a range of associated issues and challenges -- especially those to do with reconciling the quantitative emphasis of much formal assessment and qualitative aspects of the learning process on one hand, and an applied, problem-solving focus with the acquisition of multiple skills and knowledges on the other. So to extend the focus and possibilities of designing learning for ICT integration two other specific design models were used *monster exchanges* as an introductory example of Internet communication projects, and *multimedia learning projects* as a design cycle developed around a particular topic or idea (Lehrer, Erickson, & Connell, 1994). The latter uses Internet communications directly as a pretext for writing, drawing, and other learning activities, whilst the former provides a convergent, developmental, and often collaborative focus for seeking and transforming information into modes of indirect communication as presentations or publications designed to engage particular audiences.

Monster exchanges exemplify the power of an interesting pretext for a range of ICT-supported learning activities within and between different classrooms, including international language exchanges. The basic idea of a monster exchange is that getting students to imagine in written and then also in graphic form their own unique monsters not only provides a powerful motivational focus for learning participation but also for interactive exchange in and between classrooms. A typical variation is students in two different classrooms send each other monster descriptions by e-mail to be drawn by the other as a focus for ongoing interactions. The originators of this particular model mainly conceived it terms of literacy learning, but other related models such as the Global Schoolhouse's "travel buddies" exemplify the power and across-the-curriculum possibilities of such exchanges and pretexts for learning. While we have used real-time chat programs such as ICQ as a means of conducting monster exchanges and organizing online dialogue (either with other classes running at the same time or groups within the same class), usually e-mail or even webforums are the ways in which students interact and send attached graphic or word files in their monster exchanges. Using this model we found that imaginative drawing and writing activities

provided a powerful focus and example for even older learners such as Lena to get excited about using Internet communications and graphical tools on one hand, and linking of design activities with the learning process on the other.

The development model of hypermedia proejcts seminally conceived by Lehrer, Erickson, and Connell (1994) -- also developed and refined by others -- provides a useful focus for both developing and converging the learning design models of webquests and microlessons. Such models provide a context for connecting multimedia effects and some form of curriculum content in a common design process. Multimedia learning projects are similar in many ways to commercial models of multimedia project development, but much smaller, more manageable, and more flexible. The key learning design principle involved here is that the trajectory between an initial idea and a developed project or outcome at the end not only provides a framework for the learning process but also a convergent focus for acquiring, refining, and reflecting on a variety of multimedia design processes and project development skills along the way. This may be represented and evaluated effectively as an activity-reflection learning e-portfolio or some similar way of grounding assessment in the learning process. Multimedia learning projects provide an especially useful focus for reflecting on the interactions between individual and collaborative or team efforts and visions in relation to a specific idea or topics. Electronic concept-mapping programs provide the means to get learners to design and develop their work through mindmaps, concept maps, hypermedia flowcharts, and storyboards. Mei conveived and developed her multimedia project in this way and presented the final product as part of an activity-reflection e-portfolio assignment.

Discussion

A project-based learning (PBL) approach usefully goes beyond the notion of webquests because it represents a general integrative approach which can include as well be exemplified by, but not reduced to, specific learning activities, methods, and outcomes. A project may also include the collaborative emphasis of webquests, but ultimately encourages personal motivation for and ownership of the learning process. Any teacher who has used project-based learning strategies well should be able to attest to the power of a project topic (especially if negotiated) to capture a student's energies and enthusiasm for exploring knowledge. As an aspect and model of problem-based learning, *project-based learning* with the Web represents an exemplary focus and framework for the integration of ICT in education in terms of being a general approach which also embraces various types of Web-based learning activities or teaching methods.

As a transformational focus for learning multimedia skills and knowledges in a doable, applied context, multimedia learning projects contrast with workshop models which either focus on skill acquisition without much effective connection to the design of learning process, or rather tease with the distant promise of advanced cutting-edge possibilities which the average teacher has little hope of attaining. Multimedia learning projects may be further developed as learning contexts in themselves in terms of how hypermedia may be approached as either an animated sequence or as a set of multimedia links. Commercial programs are usually some sort of mix involving an opening animated context followed by the options of hypermedia links. For example, the Winnie-the-Pooh literacy skills programs sets the main character in a forest and children then need to decide which path to take from there to engage in learning activities. The typical design for teacher multimedia learning projects typically involves an animated sequence which introduces a topic or process of learning linked to a menu of further topics or processes. However, many of the more effective multimedia projects tend to be more mixed with ongoing animation linking with interactive options for engaging learners in the negotiation of choices or selections (Mayer, 2001).

As the *Challenge 2000 Multimedia Project* (1999) outlines, "project-based learning is a model for classroom activity that shifts away from the classroom practices of short, isolated, teacher-centered lessons and instead emphasizes learning activities that are long-term, interdisciplinary, student-centered,

and integrated with real world issues and practices." As a context for discussing the integration of Internet resources in teaching and learning, PBL also goes beyond the webquest model in terms of emphasizing that problem-based and inquiry-based contexts for transforming *information* are ultimately part of a larger *communication* framework of learning, interaction, and presentation -- instead of vice versa -- by those who focus on the Internet as a gigantic database rather than primarily as a telecommunications media. While the student webquest report is typically produced for the teacher alone, influential models of Internet PBL emphasize the sharing and even wider publication or presentation of activity outcomes and products.

As a communication tool, the Internet extends the process of learning in terms of a range of "telecomputing activity structures" (Grabe & Grabe, 1998, p. 44). Particular types of activities ranging from *key pals* or *electronic mentoring* through to *tele-fieldtrips* and *social action projects* may be adapted to and extend the specific contents of different subjects. Whether or not a particular project makes use of e-mail, webforums or even chat and other conferencing Internet functions or programs, influential organizations such as the *Global Schoolhouse*-- which has pioneered telecollaboration projects since 1984 -- use the World Wide Web itself as a communication medium to advertise projects, to link classrooms across the world, and to develop online educational communities. Various communication options from e-mail lists through to Internet chat provide contexts of interaction on these sites for teachers to discuss possible projects and for students to undertake projects (e.g., Lerman, 1998). Likewise, within a communication framework of collaborative projects, student Web sites provide a focus for reporting and interaction as well as developing information resources -- as exemplified by the International Schools Cyberfairs organized by the Global Schoolhouse.

Although Internet communication projects typically involve more simple pretexts for learning and social interaction than the other models looked at, examples such as Monster Exchange and Travel Buddies illustrate how even simple pretexts can provide the focus for more varied and developed modes of ICT-supported learning activity. Project-based learning might productively be considered as one useful sub-category of problem-based learning in terms of not only designing a specific focus and context for student projects but in terms of getting students themselves to also (a) identify project constraints and feasibility; and (b), to plan and apply a "design" approach. Sternberg's (1997) "six A's of designing projects" provides a useful overview of relevant criteria for an effective PBL context: *authenticity, academic rigor, applied learning, active exploration, adult/effective guidance,* and *assessment practices.*

At this stage of the inquiry some of the convergent principles (or "anatomy") of an effective ICT-supported learning activity are clearer and more explicit. In particular, it is the function of learning activity "pretexts" to engage learner interest, participation, and their very process of learning and focus this in the direction of some kind of applied learning, explicit knowledge, and effective outcomes. This initial transformatory connection is a crucial not just accidental or add-on function of learning activity design. Such a learning design structure is significantly different to that associated with formal lesson planning although the latter may be used to develop the former. *The whole more effectively informs the parts in a progression of learning focus from implicit to explicit knowledge,* both in terms of individual lessons and larger modules. As indicated, for instance, by Blue N'Web's typology of ICT resources and learning designs, a specific learning *task* (i.e., a narrow conception of a learning activity) may organize the plan for up to several classroom lessons. In contrast, a *project* is an educational focus which is able to provide an organizing framework across and beyond a series of lessons and many quite distinct even if related activities (March, 2001).

Study #3: Interactive Learning with ICT and the Quest for Generic Alternatives to the Traditional Lesson Plan

Typical Learning Artifact -- Class C 2003

Kristina's ICT-supported "'learning activity" idea template

Section B is actually the activity template and generic structure (which was conceived out of the first two stages of inquiry) for generating and developing a range of ICT-supported learning ideas. In effect this represents an initial draft or stage which can be further developed in terms of various models or modes. Section A is a warming-up task where students are asked to come up with three innovative ideas for transforming a typically boring lesson plan objective into a much more interesting context. Kristina's responses are more typical than exemplary. A bit mixed in quality, her activity design nevertheless indicated some innovative context ideas and she started to develop this quite well as an activity sequence. Her idea could be adapted and refined in different ways.

In this third phase, we continued to use earlier models both as useful examples in their own right and also as ways of getting our students teachers to think about designing effective learning with ICTs. However in this phase we generated a template which would try to exemplify some of the structural resemblances of these other models to the extent that this was quite different to the traditional lesson plan. The use of this learning activity "generic structure" either in its own right as a design strategy or as a complement to the use of various models (such as webquests, multimedia projects, and various kinds of problem-based or inquiry-based learning using ICTs) might still be applied to formal lesson planning and module or subject design -- but not vice versa. Feedback from both student evaluation surveys and learning activity assignments indicated that this template was useful in getting student teachers away from merely replicating particular models or specific examples and to think about and apply the generic learning activity functions of (a) providing effective and interesting contexts for engaging learners and (b) linking this to organizing learning objectives ranging from skill and information acquisition to various higher-order understandings, syntheses, and applications.

The template used by Kristina includes a "warming up" activity as introduction to the exercise of conceiving, developing, and outlining an ICT-supported learning activity idea -- along the lines suggested in Figure 1. In the activity of this initial section, which is modeled in class, students are challenged to transform boring curriculum learning objectives into exciting pretexts or foci for interaction. In this way they should become ready to choose and develop one idea with promise.

1.	CONCEIVE OF AN AUTHENTIC OR IMAGINARY SITUATION/CONTEXT/PROBLEM.
2.	WHAT WILL LEARNERS NEED TO DO AS THE PURPOSE OF INITIAL INTERACTION (solve a problem, address some issue or challenge, etc.)?
3.	HOW WILL THIS PROVIDE A PRETEXT FOR SPECIFIC LEARNING OUTCOMES IN A CHOSEN SUBJECT AND RE: MAIN LEARNING OBJECTIVE?
4.	PROVIDE AN OVERVIEW OF KEY STAGES OR STEPS OF ACTIVITY.
5.	WHAT IS THE MAIN ICT-SUPPORTED LEARNING FOCUS AND WHAT ADDITIONAL RESOURCES NEEDED FOR THIS ACTIVITY?

Figure 1. Design aide for developing an ICT-spported learning activity

In terms of the structure indicated in Figure 1, an effective learning activity design will involve two transformations as the foundation for learning as an effective connection between learning activity and reflection or doing and thinking. Firstly, the authentic or imaginary context for an activity must somehow lead into an activity involving curriculum learning through some kind of use of ICTs for information resourcing, communication, or interactive engagement. Although ICTs may be used for a combination of purposes (e.g., initial access to digital information resources as the basis for a multimedia presentation or

web publication), one mode should be primary. Kristina's nascent activity describes the imaginary context of leaners being asked to help an alien stranded on Earth get back to his own planet. This pretext for interaction is then linked with a curriculum learning activity focus on identifying distinct words in relation to supermarket items. The second transformation should represent a stage of applied learning which realizes an organizing learning objective which has been implicit from the beginning but emerges directly out of the curriculum focus of the learning activity. Kristina's lesson involves English as second language learning. Although her plan has yet to be developed in detail yet, there is indication that a communicative or conversational framework is being provided for learning new words in a second language context.

Whilst the curriculum focus of the learning activity is central, the initial context idea is crucial as both a stage and in terms of indirectly engaging learners in the learning process generally, and their own learning process in particular. In other words, designs for interactivity are a key to the learning process itself as a productive transformation of information and/or skills into actual knowledge (Salmon, 2002). The generic structure of an ICT-supported learning activity outlined in the template is also consistent with the kind of dialogical model of learning with ICTs advocated, for instance, by Laurillard (2002). This model, often associated with the Socratic model of teaching through questions which engage and challenge the learner, views the learning process as kind of a "conversation" between learner and teacher, other learners, and even the curriculum mediated as much by "technologies" of communication as language itself (Light & Cox, 2001). Thus, relevant focus questions are another way of setting up interesting and effective pretexts for engaged learning -- contexts to critically explore or developmentally engage with topics or issues, and to encourage active learning as a process of transforming knowledge in terms of understandings, applications and transferable principles.

The common stages and dialogical trajectory of effectively designed learning are depicted in Figure 2 in terms of effectively linking both content and process, and also leaner thinking and doing. In contrast to the linear and hierarchical assumptions of the traditional lesson, the two related transformations of learning outlined above are framed here in terms of the three phases of a dialogical methodology: *naïve, critical,* and *applied* modes of the learning process corresponding to *introductory, explanatory/procedural,* and *synthesizing* stages of knowledge construction. The diagram attempts to depict how the generic structure of an ICT-supported learning activity represents an activity-reflection cycle grounded in contexts of both *individual performance* and *social knowledge* (Richards, 2003). It can be visualized as either a threefold process or as open-ended design spiral. A naïve phase initially engages learner interaction and understanding as a basis for achieving a subsequent phase of "disciplined" performance, adequate explanation, or critical reflection. In turn, a dialogical phase represents the potentially innovative transformations implied by any effective grounding of reflective knowledge and the learning process generally in concrete contexts of application and interaction. Such a design strategy is as applicable to larger contexts of curriculum design as it is to specific activity design or lesson planning.

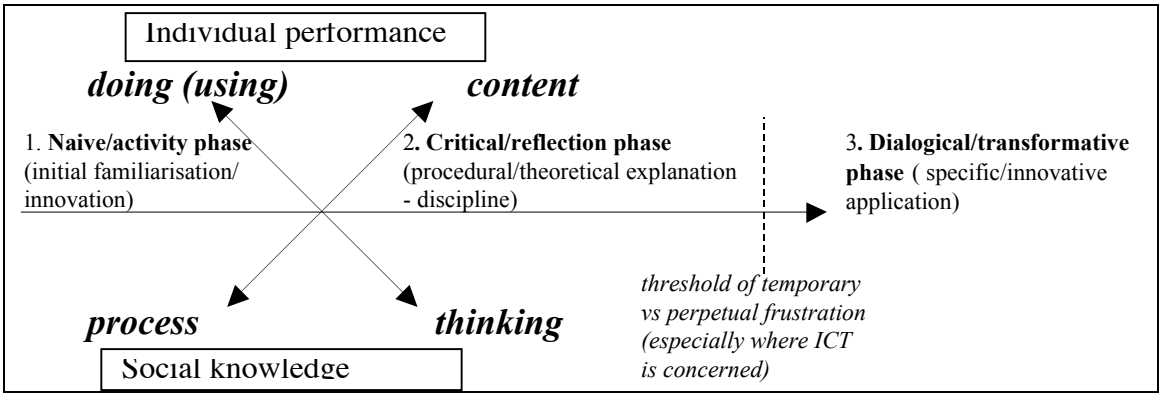

Figure 2. ICT integration and learning as an activity-reflection cycle (adapted from Richards, 2004)

The process of learning to use ICT tools and programs effectively and with confidence, especially across different contexts of application, can be most frustrating and often is not achieved without adequate support. In this way the hands-on requirements of ICT integration exemplifies the inherent dilemmas of the learning process generally. Thus, relevant and appropriate designs for learning are needed which provide contexts or frameworks for bridging the missing links between learner doing and thinking (and also content and process) so that confidence, application, and even innovation begin to be achieved. Practical ICT skills and even related new learning concepts are often taught in somewhat of a vacuum. ICT-supported learning activities provide an applied focus for learning which extends from a primary focus on ICT skills and knowledge acquisition through to ICT integration in various modes of and subjects of across-the-curriculum learning. In other words, it is an approach which suggests that technical competence in using ICT tools and programs can actually be enhanced when linked to either (a) applications which also encourage the design process at the same time or (b) any key or convergent learning objectives, even if this focused on the content of different subject or disciplinary areas of knowledge.

Discussion

The three stages of the inquiry represented in this paper have linked the challenge to get teachers to be more active and effective designers of learning with the tools and media of ICTs with a response to how formal lesson syllabus planning seems to involve an inherent tendency for add-on uses of ICTs in teaching and learning. In a way, the dialogical methodology and related constructivist learning approach that underlies the generic structure and alternative model of an ICT-supported learning activity represents a turning-on-its-head of the formal lesson plan format and associated assumptions about educational design and even the learning process.

The need for a better exemplary model or strategy for designing ICT-supported learning is given weight by a closer examination of the assumptions and limitations of two currently influential approaches or general theoretical perspectives -- *instructional design* and *social constructivist learning theory.* Both approaches represent a range of diverse interests and methods but also general assumptions about learning design. Also despite ostensibly opposing the linear and hierarchical tendencies of traditional formal education, it may be argued that both approaches are often used to reinforce such tendencies, likewise, oppositional views of the relation between pedagogy and technology.

Gagne's (1987) theory exemplifies this tendency in instructional design. Taking specific and typically lower-order learning outcomes or tasks as its reference point, this theory proceeds retrospectively in linear fashion to describe the required "learning hierarchy" of skills and processes. Gagne's associated theory of "instructional events" then proceeds in terms of the typical linear and hierarchical assumptions of formal lesson planning: *gaining attention, lesson objectives, recall of prior learning, presentation, guidance, learner performance, reinforcement, retrieval,* and *generalization.* Adaptations of instructional design as "instructional technology" thus tend to view the educational use use of ICTs (and any technology media) in terms of their add-on facility to this process. Gagne's collaborator David Merrill developed this approach further to outline a model of reusable ICT "learning objects" and metadata which barely recognize the role of teaching or learning performance in context.

Different versions of instructional design theory make use of constructivist learning theory as they do cognitivist and behaviourist models. However, social constructivist learning theory can be regarded as distinct for present purposes insofar as it represents an influential approach to how learning with ICTs lends itself to collaborative activities and the concept of bonded learning communities and "rich" learning environments (e.g., Barab, Kling, & Gray, 2004). Such an approach is most notably associated with the theoretical work of David Jonassen which has long explored the learner-centred and "cognitive tool" implications of ICTs. For instance, Jonassen's (2000) adaptation of cultural-historical activity theory tends to be more interested in the concept of activity as a systemic use or context of cognitive tools rather than

specific and transferable designs for grounded hands-on use of ICTs as a form of media literacy. Such theories have a tendency to discuss in vague abstraction how ICT tools and media lend themselves to learning community development, collaborative interactions, and knowledge building, rather than specific and transferable ideas applicable by the average teacher. Thus, for instance, Scardamalia & Bereiter's (1994) well-known CSILE (Computer-Supported Intentional Learning Environments) model of knowledge building is really not so much about ICT integration in education as such, but functions of learning linked to one particular program which many teachers find difficult to use in average classrooms.

In sum, both models make useful gestures about how ICT might not only be integrated in learning but enhance the learning process. However, it may be argued that both models retain implicit linear, hierarchical, and oppositional assumptions about learning which represent tendencies for an add-on use of ICT in education and fail to most effectively overcome missing links between practice and theory and learner doing and thinking. Just as the cultural-historical model of activity theory derived from the work of Vygotsky and others represents a more systemic and abstract model of the technology-learning process connection, so too there are related instructional design models (e.g., concepts such as intelligent learning or tutoring systems, often associated with knowledge management principles) which see learning primarily in terms of networked information systems. The message from this short discussion of two particularly influential approaches is that the discussion about the challenge of ICT integration in terms of teacher designs for learning has largely remained at macro levels of theory as well as policy and rhetoric. The many good ideas and useful concepts associated with these general approaches might be even more relevant if related to a more bottom-up perspective on how effective practice presumes some kind of design strategy grounded in performance or dialogue.

Thus, in contrast to the more abstract cultural-historical notion of ICT-supported learning activity, the approach taken here focuses at the outset on simple practical design models which any teacher can soon begin to customize and apply ICT both as discrete tools and as a general media interface (i.e., both as physical and cognitive extensions of human activity) in relation to his/her own specific contexts of practice. In this way any teacher can soon become an innovative designer of learning contexts which encourage not only ICT integration in learning and the learner-centred implications of ICT generally, but also the learning process in relation to any specific pedagogical objectives or strategies. Such a bottom-up perspective is able to appreciate in practice how specific or situational contexts of individual performance both ground and open up for potential transformation any implicit or explicit (i.e., designed) structure of social knowledge -- and thus ultimately the kinds of cultural-historical structures or relevant macro objectives emphasized by activity theory and related models.

The effective design of an ICT-supported learning activity as some kind of doing-thinking or activity-reflection transformation relates to, complements and reinforces the kind of dialogical approach to learning outlined in Laurillard's (2002) conversational framework for the effective use of learning technologies -- the designed contexts of either actual or virtual learner interactions with (a) teachers, (b) other learners, and (c) mediated knowledge itself. The importance placed on *designed pretexts* recognizes the need for grounding learning in context, and the greater efficacy-- at least where ICT integration is concerned -- with emergent and developmental rather than arbitrary or fixed and imposed learning objectives and processes. As new modes of literacy and learning, the models, which provide a practical design focus for the inquiry, have exemplified alternative ways, structures, and strategies for harnessing, in formal contexts of education, the great interest and seemingly natural confidence that the young have for the kind of new digital media worlds and cultures similarly outlined, for instance, by the critical pedagogist Peter McLaren and the new media critic Douglas Rushkoff. Figure 3 provides a comparative breakdown of how the kind of generic activity design investigated represents an alternative generic structure to a top-down formal lesson plan format.

If the "generic activity design" structure were imagined visually, then it might be represented as three stages or even two interpenetrating spirals informing (a) an overall link, connection, or transformation

between doing and thinking as well as skills or information and higher-order learning; and (b) the two specific links or transformation indicated earlier which engender effective participation and then potential achievement or realization of key or convergent learning objectives. Instead of designs for showing' being a mere add-on to telling, the link between designed or virtual and actual contexts is recognized as crucial for an emergent and developing learning process along the lines of the dialogical framework outlined above.

Formal lesson plan format	**Generic activity design**
• key learning objective/ outcomes explicitly outlined from outset (also tendency for confusion of implicit and explicit objectives) • linear and often 'closed' or fixed sequence of topics or procedures • hierarchical and oppositional view of relation between thinking and doing, theory/content and practice/examples • introduction and conclusions gesture towards learners prior and developing knowledge	• initial activity context and focus encourages and frames convergent modes of participation and learning – implicit links between learner involvement and key learning objective/s • more open-ended, transformational relation between (a) initial activity context and specific 'curriculum' context and (b) content and key learning objective/s • spiral structure underlies learning design connections between doing and thinking, practice and theory/content • introduction and conclusion frame the learning process as an activity-reflection cycle and as dialogical stages (naive/critical/applied)

Figure 3. A contrast between formal lesson-planning and learning activity design

The concept of an ICT-supported learning activity has some initial resemblance to the task-based pedagogy (and larger communicative) model in language education (e.g., Nunan, 1993). In the communicative language classroom, tasks serve the purpose of making sure that the learner's "attention is focused on meaning rather than linguistic structure" (Nunan, 1989, p. 10), that is, it is an initial and key requirement that learning activities engage interaction and understanding. Tasks thus provide pretexts for grounding various aspects of language study (grammar and vocabulary as well as conversation) in some everyday context of application or topic of interest. The term *activity* has been used here to refer to both a process and a generic structure which encompasses pretexts, tasks and specific *activities*. In both senses activities inform a larger convergent focus and design for learning in time. In this way, activity as a generic organising structure of learning complements an associated notion that effective learning often proceeds as an activity-reflection cycle grounded in context, and is a process by which learners both individually and collaboratively transform skills or information into applied knowledge.

The later work of Paul Ricoeur (e.g., 1994) has powerfully argued how the discursive and textual applications of language in context not only mediate but transform the connection between interpretative processes of thought and reflection and the world of human action; and, also, how the mind-body dualism in western and modern thought is transformed in practice as a dialogical interplay of understanding and explanation, innovation and structure, and individual performance and social knowledge. Activity in context as both individual performance and social process opens up structures of knowledge and thus learning to processes of innovation as well as habituation or discipline. Just as Hannah Arendt (1958) identified intrinsically meaningful action rather than labor or work as the key to her famous study of the human condition, other thinkers such as Huizanga have proposed that *play* is the characteristic human activity which precedes and transforms *work.* Not only does the generic structure of a learning activity represents a design framework for linking learner doing and thinking, but also play and work in ways we will need to understand better if we are to harness the extra-curricular ICT literacies of younger learners (e.g., Gee, 2003).

An important related aspect of pedagogical design for ICT integration which will be investigated further beyond the scope of this particular paper is the link between learning activity design and visual interface design as convergent aspects of the growing importance of interaction design principles. Educational interaction design has much to learn from the cultural and commercial contexts of how various popular and visual aspects of interaction with ICTs such as digital gaming represent transformations of old media as well as new possibilities, requirements, and innovations (Bolter & Grusin, 2000; Johnson, 1997; Murray, 1997; Manovich, 2001). A key to linking interface design with educational content and structures of learning thus lies in the convergent functions of visual metaphors and narrative structures for encouraging interactivity in a dialogical and applied fashion. Digital games in particular exemplify the importance and possibilities of designing engaging and structured participation or interaction which hook in, engage, and direct the attention of users through functions of virtual navigation and goal-directed interaction of some kind (Aldrich, 2003; Prensky, 2000). In contrast to the commercial purposes and various entertainment genres of many popular games -- especially open source games which exemplify the process of collaborative learning communities -- effective educational multimedia designs for learning face the additional challenge of needing to extend interaction design principles to include educational content or specific learning objectives.

As Norman (2002) has argued, any effective design process needs to be understood as an interactive communication with "users" in terms of functionality and flexibility as well as form. ICTs need to be integrated in teaching and learning to the extent that they represent a new or extended mode literacy in the digital age, and effective designs for ICT-supported learning need to be grounded in activity as both process and structure. As Kress (2003) has recognized, the design possibilities and literacy implications of multimodal learning with ICTs tools and media represent a convergent focus for language and technology in general, and verbal and non-verbal modes of interaction in particular. This is consistent with how any teacher who attempts to effectively integrate ICT in his/her teaching and the learning of their pupils or students is a curriculum as well as learning designer of sorts. The generic structure of an ICT-supported learning activity represents one strategy in this direction which many teachers are already finding useful in the guise of various models and practices, and which may be refined further to encourage even more effective designs for learning.

CONCLUSION

To more effectively harness the exciting educational implications and learner-centred possibilities of ICTs, teachers need (a) new design strategies for teaching and learning which promote the applied integration of ICTs, and (b) to avoid the kind of add-on tendencies associated with still dominant assumptions about formal lesson planning and syllabus design on one hand, and are often inadvertent in the use of top-down models such as instructional design and social constructivism learning theory. This inquiry has investigated how the exemplary use of practical design models (a) provide a useful focus in teacher education for encouraging teachers to become more active and innovative "designers" of ICT-supported learning in the digital age, and (b) indicate the generic structure or anatomy of an effective ICT-supported learning activity. Practical activity-based learning with ICTs that provides pretexts for more effective curriculum learning and reflective practice exemplify a dialogical approach to educational design. Such an approach to educational design goes beyond (rather than merely oppose) the linear, hierarchical and transmission assumptions still dominating formal education in a way which is able to ground critical and applied thinking in transferable contexts of practice and knowledge. The dialogical stages of *naïve, critical,* and *applied* learning represent a framework for not only linking educational content and process and also learner thinking and doing, but the very transformations which exemplify an ICT literacy transition from mere competency to applied understanding, knowledge and innovation.

The alternate challenges of integrating the Internet and related ICTs in education on one hand, and encouraging innovation and applied thinking in students on the other, are helping us to appreciate that the

new 'literacy and learning' skills of the electronic age revolve around the complementary organizing concepts of *design* and *evaluation,* and also *learner doing and thinking*. This paper has argued that there is a similar need to reconstruct the role of the teacher as a designer and evaluator of learning activities, contexts, and environments in a way which more effectively links the learning process to the curriculum, especially when using the Internet or ICT generally. In short, teachers need to consider overall design elements when outlining or setting up specific assignment contexts, criteria, and outcomes which exemplify effective ICT-supported learning. The emergent notion of an effective ICT-supported learning activity provides a useful focus for encouraging teachers to approach the challenge of ICT integration in education more as designers of interesting and applied learning rather than mere transmitters of skills or information through an add-on use of ICTs in teaching and learning.

ABOUT THE AUTHOR

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