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SUPPORTING VOCATIONAL EDUCATION THROUGH NEW LEARNING TECHNOLOGIES

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In preparing citizens of the knowledge society and in building new kinds of capacities, vocational (and other) education must address issues such as being able to act in a network society, developing collective intelligence, and fostering collaborative work (Cornu, 2005). In terms of accessing and processing information and developing procedural as well as other forms of knowledge, new learning technologies are ideally positioned to provide appropriate support. However, the term 'appropriate' is not unproblematic, and an activity theory approach could help to align the various kinds of applications with their intended outcomes. From another perspective, research on informal learning in the workplace could inform the design and development of mediating technologies in formal education, even though there are different contexts and goals in the different activity systems. This paper will synthesise research on the needs of a knowledge society, new learning technologies as mediating artefacts, and informal workplace learning.

Vocational Learning

In the Call for Papers for this conference, vocational learning is described as 'an openness to developing understanding and gaining meaning from experiences which have personal or professional significance across the lifespan.' John Stevenson (2003) notes that:

> Meaning can be co-constructed with others, constructed in relation to artefacts and technologies in the setting, constructed in relation to other known ways of reading the problems and its situation (e.g. theories) and so on. (p. 20)

While theoretical principles may be propositionally known and meaningfully related to personal experience, Stevenson notes that they may also be tacit. The work of Michael Eraut further develops these ideas.

In contrast to an individual perspective on knowledge and learning, Eraut (2004) asserts that a social perspective draws attention to the "social construction of knowledge and of contexts for learning, and to the wide range of cultural practices and products that provide knowledge resources for learning" (p. 263). He asserts that skills can be considered as both a form of cultural knowledge (i.e., non-codified work-based knowledge) and a form of personal knowledge (codified knowledge enabling thinking, interaction, and performance, and non-codified everyday knowledge of people and situations).

Eraut (2004, p. 265) presents a typology which he notes might be used as a heuristic to remind people of possible aspects of their own informal contextualised learning. However,

I believe that it might also be considered by designers and developers of formal vocational education programs in order to make stronger connections with work and life beyond the classroom or other site of instruction. It includes:

1. Task Performance: the speed and fluency, complexity of tasks and problems, range of skills required, communication with a wide range of people, collaborative work.
2. Role Performance: prioritisation, range of responsibility, supporting other people's learning, leadership, delegation, handling ethical issues, coping with unexpected problems, crisis management.
3. Awareness and Understanding: of other people; colleagues, customers, managers, etc.; contexts and situations; one's own organisation; problems and risks; priorities and strategic issues, value issues.
4. Academic Knowledge and Skills: use of evidence and argument, accessing formal knowledge, research-based practice, theoretical thinking, knowing what you might need to know, using knowledge resources (human, paper-based, electronic), learning how to use a relevant theory (in a range of practical situations).
5. Personal Development: self evaluation, self management, building and sustaining relationships, disposition to attend to other perspectives, disposition to consult and work with others, disposition to learn and improve one's practice, accessing relevant knowledge and expertise, ability to learn from experience.
6. Decision Making and Problem Solving: when to seek expert help, dealing with complexity, group decision making, problem analysis, generating, formulating, and evaluating options, managing the process within an appropriate timescale, decision making under pressurised conditions.
7. Teamwork: collaborative work, facilitating social relations, joint planning and problem solving, ability to engage in and promote mutual learning.
8. Judgement: quality of performance, output and outcomes, priorities, value issues, levels of risk.

This is a complex list of research-based characteristics of learning in the workplace. It clearly also relates to personal development beyond the needs of the workplace, in family and community participation. How might some or all of these characteristics be nurtured through the development of vocational programs 'delivered' or supported by new learning technologies?

The sub-themes of this conference have been listed (with selected supplementary questions) as: transitions (re-engaging disaffected learners; allowing for culturally inclusive practices), interrelationships (how might learning technologies mediate learning across different communities?), partnerships (engaging students in collaborative learning), and sustainable futures (how to engage learners in considering their attitudes and values towards sustainable futures?). It could be argued that these sub-themes of vocational learning are relevant to the so-called 'knowledge society'. However, this term is by no means unproblematic.

The Knowledge Society

Nowotny, Scott, and Gibbons (2001) identify both the *Knowledge Society* and the *Risk Society* as over-simplified conceptualisations of societal change. The former approach they describe as scientific-technical-economic, with a heavy emphasis on production; the latter is described as more sociocultural. They see the first as too linear, cool, and deterministic; the latter as too fluid, allusive, even regressive. Consistent with their concept of Mode-2

knowledge production, accounts of the Knowledge Society suggest phenomena such as an increase in ‘knowledge’ workers and proliferation of sites of ‘knowledge’ production:

> many, perhaps most, organizations in the Knowledge Society have to become learning organizations, in order to develop their human and intellectual capital, and have also to become increasingly dependent on the ‘knowledge’ system to operate efficiently — or at all. (p. 15)

However, they question some of these assumptions, noting that the growth has actually been in ‘data’ workers rather than ‘knowledge’ workers, for example. Nevertheless, this first approach prevails in the education-related policies internationally. Interestingly, Nowotny et al. see society as ‘talking back’ to science, arguing that changes in society make communications in both directions more likely and more necessary. How can vocational education support learners at all levels to be in a position to ‘talk back’ not only to science, but also to engage in critical dialogue with other technologies of power in and beyond the workplace?

Bernard Cornu (2005), a member of the French National Commission for UNESCO and mathematics professor, adopts both a scientific-technical-economic approach as well as a humanitarian one. In contrast to the traditional focus on the development of individual intelligence and individual capabilities, he observes that in a knowledge society collective intelligence is needed for the development of communication and networks. This, Cornu notes reflexively, can be developed by ICTs and networks, via exchange and cooperation; through virtual communities for example. Accordingly, Cornu notes that the goals of capacity building in knowledge societies require profound changes to traditional notions of education. He suggests that education should incorporate the collective dimension into learning and teaching; students should practise collaborative work and develop their communication and information processing skills in order to function in the new physical and virtual spaces of the knowledge society. He continues that networks enhance the possibilities for participation by citizens in social life, and that “citizenship addresses ethical issues that must be taken into account in education” (p. 32), reminding us that “knowledge societies are for human beings, not for technology” (p. 32). Cornu’s observations reflect the importance of the conference sub-themes of interrelationships and partnerships in education, and suggest that including ethical dimensions in relation to civic participation could support the development of sustainable futures.

Discussing networked learning in the workplace, Mikko Ruohonen (2005) notes that many organisations still rely on technology-driven knowledge creation rather than seeing it as a work-driven process, involving contextual development — as indicated by Eraut. (In a similar vein, many post-compulsory education institutions are promoting a technology-driven rather than a technology-supported approach to education, which is essentially a human activity — see Burbules & Callister, 1999.)
Drawing on the work of Wenger (1998) to focus on the formation and change of working communities, Ruohonen notes that “contextual knowledge involves interactions, conversations, actions and interventions” (p. 181), recognising that people need acquire not only explicit knowledge, but also encultured knowledge. However, he also observes that many formal electronic workplace instructional programs are “transmissive, viewing learning as passive, and focusing on individual learning, rather than as interactive and engaging” (p. 182), as required for the promotion of higher order learning in both formal education and the workplace. This observation resonates very strongly with the

experiences of many of my undergraduate adult learning and development students, currently employed as workplace trainers and educators, who are obliged to follow transmissive pedagogies in their program design and/or delivery work. These approaches do nothing to re-engage disaffected learners, who may have no option but to complete the required training, and who may come to feel even more alienated under such coercion, particularly when they judge that their own personal learning needs with respect to both content and pedagogy have not been taken into account. It is also unlikely that such technical-rational approaches allow for culturally inclusive practices or gender differences, for example.

Ruohonen (2005) warns that:

> The use of ICT enables and even dominates cognitive processes, such as intranet and other communication media and furthermore operational processes, such as enterprise and logistics systems. However, knowledge creation also demands social and reflective processes in order to foster social innovations. (p. 185)

It is apparent that Ruohonen's approach to formal workplace education recognises the importance of a sociocultural approach rather than a techno-rational approach. Also in line with Eraut's (2004) work on informal learning in the workplace and Cornu's (2005) suggestions for capacity building, I believe such an approach could contribute to supporting citizen-workers to address the rapidly changing to society in an era of globalisation.

An important question then becomes: If ICT is used as a means of delivery, and/or focus of instruction, as a tool for understanding or an object to be mastered, is there a framework which may be used to guide instructional developers? I now turn to an activity theoretical approach focusing on new learning technologies.

New Learning Technologies in Support of Vocational Learning

Kari Kuutti (1996), drawing on the activity theory work of Leont'ev, identifies three hierarchical levels of description and analysis: operation, action, and activity, which are oriented towards conditions, goals, and motives, respectively. Applying these analytically to new learning technologies, she sees the relationship between activities and potential support from information technology as (a) automating and substituting human operations, (b) serving as a tool in manipulative and transformative actions, and (c) helping in actions directed towards sense making. In a table which categorises each of the three levels — operation, action, and activity — against the six vertices of Engeström's (1987, 2001) triangular model — artefacts, object, subject, rules, community, and division of labour — Kuutti gives examples of the kinds of support offered by new learning technologies in education.

Under the *Operations* sub-heading, Kuutti includes automating routines, triggering predetermined responses, embedding and imposing a certain set of rules. This approach to learning relates most closely to the individualistic drill-and-practice type of educational resource, and assumes either that learning for understanding has already taken place and that skills maintenance is needed, or else that rote learning is sufficient. If there is a community, it is implicit in that several people may be working on parallel tasks and/or the instructor may be distant in time or space: human interaction is possible but not necessary.

Under the *Actions* sub-heading, Kuutti includes supporting of transformative and manipulative actions, making tools and procedures visible and comprehensible, making an object manipulable, supporting sense-making actions within an activity, making the set of rules visible and comprehensible, supporting communicative actions, making the network of actors visible, and making the work organisation visible and comprehensible. Here, there is a dual focus on sense-making actions intended to foster an understanding of the content of the procedures as well as of the tools themselves. In other words, the learner comes to understand how the software or other electronic tool (e.g., calculator) may be used, as well as gaining a deeper understanding of the process/es that are intended to be understood (often via multiple representations) and manipulated by the learner. The community (other learners and/or instructor) as well as the organisation become visible and comprehensible, and communications by electronic and other means are supported. This approach may be compared to a learner-centred classroom where the focus is on meaning making and all are encouraged to participate in this process. Nevertheless, the intended outcomes (or goals) and rules (instructional and behavioural) are clearly set — usually by the teacher, perhaps as a representative of the state education authorities and also the discipline or industry/trade.

At the level of *activity*, the focus is on creative, innovative, and transformative learning. In Kuutti's model the tools are now utilised to enable the automation of a new routine or the construction of a new tool. The object of learning is enabled to become a common object, shared between learners. The learner is supported in learning and reflection with respect to the whole object and activity, and the negotiation of new rules is enabled. Also enabled are the formation of new communities and the reorganisation of the division of labour. Communication may be enhanced by genuine collaboration via projects, local and global, and supported by multimedia conferencing (e.g., Bellamy, 1996; Olivero, John, & Sutherland, 2004). The activity level of support could be focused on what Engeström (1987, 2001) terms *expansive learning*—which allows for creativity and interaction arising from tensions and contradictions within and between activity systems. Expansive learning would emanate from conversations, analyses, and genuinely open research; and by all stakeholders, collaboratively reflecting on alternative shared models of planning and implementation.

In Kuutti's model there is a dual focus on the object of learning as well as the tools and procedures themselves. According to Luc Trouche (2004), following Vérillon and Rabardel, *instrumental genesis*, where a tool or an artefact becomes an instrument takes place when a person appropriates it and integrates it into his/her activities. The construction of this instrument "is a complex process, *needing time*, and linked to the artifact characteristics (its *potentialities* and its *constraints*) and to the subject's activity, his/her knowledge and former method of working" (pp. 285-286). Following Piaget, he notes that implicit knowledge of the learner is contained in the schemes, theorems-in-action, which have three main functions: *pragmatic* (allowing the agent to do something), *heuristic* (allowing the agent to anticipate and plan actions) and *epistemic* function (allowing the agent to understand what he is doing). Also following the work of Vérillon, George Head and John Dakers (2005) note that instrumented actions can be of a pragmatic, epistemic or semiotic nature, or even a mixture of these: "As a matter of fact, instrumented activity whether material or semiotic, usually comprises both pragmatic and epistemic phases" (Vérillon 2000, quoted in Head & Dakers, 2005, p. 34). Discussing technology classrooms, they suggest that activities within a community of learners could be conducive to nurturing Vérillon's trio of aspects of instrumented activity.

> Practice, as negotiated between teacher and pupil, entails an element of pragmatism; experience as it is challenged and justified, has an epistemic quality; and identity — since it is created and maintained through communication with others in a particular context — is semiotic in its development. A community of learners, therefore, might be an appropriate learning context in which to foster Vérillon's conditions for technology education and which provides a naturally occurring context for the social construction of learning. (p. 37)

They suggest that project based pedagogies allow collaborative work; activities where design and realisation is visible and concrete enables challenge to ideas over time; working together towards a single collective goal encourages debate and recognition of individual skills. However, it is important to realise that these pedagogies can also applied to learning mediated by new learning technologies for students on- and off-campus, and are related particularly to Kuutti's (1996) action and activity levels.

It is important to realise that the use of technological artefacts as both tools and objects of vocational education is neither simple nor transparent. Educational designers and developers of programs offered via distal modes, could benefit from a more nuanced understanding of the opportunities and constraints offered by new learning technologies as outlined here.

Discussion

The literature reviewed above stresses the importance in knowledge societies of collaborative work and the development of communication and information processing skills. These are no less important in vocational education than in any other sector; in fact they reflect much recent workplace research. They also apply to subject areas such as mathematics/statistics and numeracy, traditionally viewed as individualistic and even competitive. Formal educational programs, whether delivered in institutions or in workplaces, need to move away from transmissive paradigms which view learning as passive. This is crucial in workplaces, where enculturation is an important facet. Above all, I believe that it is essential that workers and citizens be able to adopt a critical approach to situations in which they find themselves and to have the ability to enter into meaningful dialogue on issues affecting themselves, other people, or the environment at large.

The richness of Eraut's (2004) eight contextualised learning characteristics (listed above) as possible goals of vocational education resonates with the activity-level of support from new learning technologies identified by Kuutti (1996) and Engeström's (1987, 2001) conception of expansive learning. However, developing high quality instructional materials, particularly for technology-mediated education, is far from simple and likely to require extensive resourcing of time and money — not for the sake of a technology-driven approach featuring expensive 'gadgets', but for the sake of employing a collaborative team of experienced educators, designers and technicians who understand the curricular and pedagogical issues at stake (see, e.g., Hedberg, 2004).

Although this expansive learning focus has much in common with the exhortations — by business and industry leaders and politicians, as well as the research literature including that reviewed above — for vocational education to address the needs of the knowledge society, it represents a significant departure from my own experience of vocational education in Australia, whether face-to-face or online. However, activity-level work

clearly needs to be supported by knowledge and skills developed by the learner. Hence, there is a need for the operation- and action-levels of support to be judiciously and thoughtfully integrated into any learning experience. My own observations of Australian vocational mathematics and statistics online offerings over recent years suggest that there is little beyond the operation-level. And while numeracy training packages have the potential to integrate all three levels, this possibility is seldom realised, due in part to the focus on assessment of outcomes rather than process and breadth and depth of (non-existent) curricula. The situation is exacerbated by the systemic neglect or ignorance of the needs of numeracy practitioners or others who take on this role in addition to other responsibilities such as literacy teaching or workplace commitments. In fact, any attempts to educate learners through technology and for technology rely on a level of sophistication in the program design and delivery. This is because, as noted above, learning to use artefacts or tools, such as electronic technologies, as instruments is not straightforward, and cannot be taken for granted in learners.

Conclusion

It is widely, although not universally, accepted that we are living in a 'knowledge society' — one in which more privileged groups are connected by ICTs at work and in life generally, reducing distances of time and space. In this paper I have sought to demonstrate possible considerations for vocational educators in these relatively advantaged parts of the globe in their preparation of students as citizens and as workers. In particular, I have specifically addressed the support that is increasingly likely to be provided via technology-mediated design and delivery, as well as new learning technologies as tools for understanding and objects of learning. I have also tried to extend external horizons of program designers by synthesising research on informal workplace learning, activity theory, and the knowledge society. Above all, I have sought to stress that the goals of vocational education should extend well beyond the narrowly focused and instrumental, perceived needs of the workplace.

Federico Mayor (2004) notes that universities and other higher education — and here I include vocational education and training institutes as well as private providers — must reform themselves. He stresses that the knowledge economy depends on these institutions preparing citizens as economic and social actors, as people able to adopt an international and ethical perspective, together with others, aware of their own rights and responsibilities. He concludes:

> We strive for a knowledge-based economy not only because of its benefits for trade and productivity, but also because of its ethical principles and its better distribution of goods — including knowledge. The educational system for world citizenship must be one of global vision, and of global responsibility. (p. 494)

I see no reason why these principles cannot apply to vocational education, whether institutionalised in the academy or in the workplace, formal or informal. And I see increased possibilities for their achievement through appropriate and care-full use of new learning technologies.

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