Workplace Learning: Metacognitive Strategies for Learning in the Knowledge Economy[1]

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The New Economy signals a significant growth in knowledge (Stiglitz, 1999) and economies are increasingly based on knowledge (OECD, 1996). The implications are that workplaces will become increasingly reliant upon workers who are learners and that schools will be expected to furnish students with appropriate preparation. The Canadian Advisory Council on Science and Technology (2000) argued, "experience with work programs [must be] core elements of elementary and secondary curricula" (p. 55).

In this paper, we propose general instructional approaches for workplace learning. Our approach derives from our research in co-operative (co-op) education, or work-based education as it is called in some jurisdictions. In our research, we have focused specifically on secondary

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co-op education programs. The purposes of these programs are quite different from the purposes of tertiary co-op programs in which work experiences are intimately connected with the flow of the overall curriculum, so that the work experience complements the entire program. Our studies of secondary co-op education reveal that students, parents, co-op teachers, and workplace supervisors hold different views about the purposes of secondary co-op education; but in general, the purposes centre around careers. Students, for example, might be trying out or exploring a career; workplace supervisors or employers might be interested in recruiting students to a career or even to a specific business (Hutchinson, Steiner-Bell, Munby, Chin, & Versnel, in press).

In many respects, secondary co-op education students can be viewed as novice learners in the workplace. Certainly, as our research has shown, the kinds of teaching and learning that these students have been accustomed to in their 12 or more years of schooling are very different from what they will experience in the workplace. As we have argued (Munby, Chin, & Hutchinson, in press), the action knowledge used in the workplace is qualitatively different from the knowledge used in school: school knowledge tends to be propositional (declarative) while workplace knowledge tends to be action knowledge (procedural). Indeed, propositional knowledge in the workplace is always directed ultimately at action, but this is not necessarily the case in school. Also, the curriculum of the workplace is organized differently: unlike the sequential nature of the school curriculum, the organization of workplace learning is centered on clusters of tasks that tend to be introduced early in the work placement. Further, the purposes of school are learning, but the purposes of the workplace are more about the production of goods and the delivery of services. We argue that these differences demand a different approach to workplace instruction, and one that is based on research on workplace learning.

The instructional approaches in this paper are drawn from the empirical work of the research group. The majority of our empirical work has consisted of case studies of co-op students in workplaces. The cases are ethnographic with detailed observations of students and interviews with students, workplace supervisors, and co-op teachers. We have also conducted focus group interviews with co-op students; and we conducted "multiple perspective studies" in which a co-op student, his or her parent, the workplace supervisor, and the co-op teacher are separately interviewed. Lastly, we have conducted observations and interviews in selected workplaces in order to document routines. All the empirical work of the group has been in workplaces that tend to be "science-rich." Prolonged observations have been made in a veterinary clinic, at a dental office, and on a hospital ward. And we have spent time in automotive repair shops, in a biological research lab, and in a medical testing lab. Our shorter observations on routines were in a multinational optical lens and frame organization, a large retail multinational department store, a national chain grocery store, and a garden centre. In all our studies, observational notes and interviews were transcribed and then coded using techniques of pattern and thematic analyses typical of qualitative research (McMillan & Schumacher, 2001). Audit trails were created and retained for all analytical work, and the entire research group of three academic staff and between four and six graduate students (M.Ed. and Ph.D.) critically appraised theoretical development.

The paper draws upon this considerable body of empirical work to advance strategies for three emphases in workplace learning. The first of these concerns metacognitive instruction and its relationship to routines, and the second concerns science in the workplace. The final section considers learning for students with exceptionalities, and here the theme is "participation is not enough."

Metacognition and Teaching about Routines

Our argument in this section of the paper is that workplace learning can be enhanced by introducing co-op students to ideas about routines and to the questions that learners can ask about the routines in which they are engaged (Munby, Versnel, Hutchinson, Chin, & Berg, 2002). By focusing on the concept of routines, we develop an instructional theory that capitalizes upon the strength of metacognition in learning and in performance. We begin by noting two difficulties with current approaches to workplace knowledge. First, there are descriptive studies of communities of practice and the socialization of novice and inefficient workers (e.g., Wenger, 1998) that describe the role of interaction in workplace learning; but it is not clear how these interactions can be used to promote learning. Second, there are suggestions that there are generalizable workplace skills that can prepare high school students for workplace entry (e.g., Conference Board of Canada, 1992). Yet there is little evidence about how such skills directly foster workplace learning.

Workplace Learning and Metacognition

The research on workplace learning suggests the need to recognize the contextual nature of work. Our approach to understanding workplace learning is cognitive and assumes that the efficacy of a learning arrangement can be determined by its ability to offer the learner access to knowledge that forms the basis for complex activity.

Recent research on learning has emphasized metacognition. Metacognition refers to higher order thinking that involves knowledge of one's cognitive functioning and active control over one's cognitive processes while engaged in a learning task. Research over the past two

decades has shown that metacognitive skills can be taught and are critical to the development and use of strategies by inefficient learners (e.g., novices, students with learning disabilities) (Borkowski & Muthukrishna, 1992; Clark & Wittrock, 2000). These learners benefit from having others make implicit processing explicit to them (Davidson & Sternberg, 1998).

The immediate challenge is to apply ideas about metacognition to workplace learning. Part of this is achieved by the relatively simple step of conceptualizing the workplace as a learning environment. The greater part of the challenge is determining what might function as an appropriate domain or framework. Below, we explore the concept of routines to show that it presents an ideal conceptual framework for considering metacognition in workplace learning.

Routines in the Workplace

Our approach is to ask what is common across varied contexts of work. When we do this, we cannot escape the idea that routines are central to workplaces. Although routines are manifested quite differently, they are nonetheless routines. Given the obvious success in schools of metacognitive strategy instruction (e.g., Swanson, 2001; Swanson & Sachse-Lee, 2000) it seems reasonable to explore the concept of routine to see if it has promise for offering a pedagogical framework for learning in the workplace. We pursue this argument first by reviewing some of the research on workplace routines.

Our studies of students in the workplace suggest that workplace learning centres on clusters of tasks that can be understood as routines (Pentland, 1995). Studies show that routines are central to work. Gersick and Hackman (1990) claim "habitual routines exist when a group repeatedly exhibits a functionally similar pattern of behaviour in a given stimulus situation without explicitly selecting it over alternative ways of behaving" (p. 69). Literature suggests that routines assist novice employees and, by association, co-op education students in a number of

ways (Dosi, Nelson, & Winter, 2000; Louis & Sutton, 1991). The frequent repetition of routines leads to mastery and acceptance as a legitimate peripheral participant in the community of practice (Lave & Wenger, 1991). Routines reduce uncertainty and improve confidence. Novice employees and co-op education students are frequently overwhelmed by the stimuli in a new environment and routines assist in reducing the cognitive engagement needed to complete tasks (Steiner Bell, Chin, Munby, & Hutchinson, 2002).

A Metacognitive Theory of Routines for Workplace Instruction

Three central ideas underpin our theory of the metacognitive functions of routines: (a) that work can be conceptualized as routines; (b) that the concept of routines can be taught; and (c) that the metacognitive functions of routines give structure to learning in the workplace. Our observational research shows that routines can be small or large, and that work tends to comprise routines set within routines. The term "routine" invokes something dull and changeless, and this is not a productive way to think of the workplace because routines in work can be interrupted and can change in response to external or internal conditions.

The first step in an instructional theory about routines is to recognize the power of teaching students that they can understand their activities in a workplace in terms of routines. Added power comes from understanding that routines have generalizable properties. For example, the following are characteristics or functions of routines:

Something initiates them,

they proceed until some definable point is reached,

and then they repeat.

When we teach students to identify these functions, we engage in metacognitive instruction. This instruction invites students to identify the routine(s) for which they have responsibility.

Importantly, instruction about these metacognitive functions is generalizable to all routines because it is about the *concept* of a routine and not about particular routines that students encounter in the workplace. So metacognitive instruction can enhance students' understanding of the work that they are meant to perform, and students would be invited to answer questions like the following as they begin at a work site:

What is the routine? What initiates the routine?

How do I know when the routine is complete?

This instructional theory accommodates students who need more context for understanding the routines they perform because it acknowledges that work consists of connected routines. Thus students could be asked to identify the larger routine to which their routine contributes.

Our conceptualization of routines in the workplace embraces the commonplace that routines can fail. Sometimes they do not work: they get off track, a component is omitted, or the initiation is incomplete. It is important that students learn to identify and then to respond appropriately when things go awry. The concept of routines, then, invites students to attend in general terms to what goes wrong, to identify specific failures within their own routines and then to learn within their workplaces how to respond. Basic metacognitive questions for students to learn to ask themselves might be: "If the routine does not work, is it because there is a problem in the initiation?" and "If the routine does not work, is there a problem in my performance that allowed the routine to get off track?"

The theory of the metacognitive functions of routines also accommodates the changeable nature of routines. The kind of metacognitive instruction here takes the student to a different level because it invites attention to how routines can be improved. Students could be introduced to questions like, "Can the routine be made more efficient? Can the routine be combined with

another routine into a single routine?" Importantly, these and the above questions come from thinking about the *concept* of routine and not from particular routines. These questions, which together suggest instruction, are independent of particular workplaces. The general applicability of the questions is a clear strength of instruction that can be built on the metacognitive functions of routines.

Discussion and Implications

Our theory of the metacognitive functions of routines for workplace instruction is consistent with our findings about the curriculum of the workplace: "working knowledge" is the mastery of routines, and routines represent the organization of this knowledge (Munby et al., in press). Our theory of routines suggests that what is general lies at the level of performance of routines rather than skills themselves, because routines have properties that are generally applicable.

The theory shows why workplace knowledge is not just procedural but is at root tacit or opaque (Billett, 1995). Routines are similar to patterns in that they are not self-evident. One almost needs to be looking for regularity in order to observe it. Certainly, the behaviours of workers do not readily reveal the underlying routine that these behaviours are enacting. Billett's (2001) work has shown that the use of guided strategies embedded in everyday work activities has enhanced the development of knowledge needed for successful workplace performance. Our theory also sits well with the idea of legitimate peripheral participation (Lave & Wenger, 1991). Novices can begin to learn a complex routine by participating in one small subroutine, because participation provides a vantage point for observing and understanding the events that initiate, sustain, and terminate the larger routine.

Although this metacognitive theory of routines is untested, we may make tentative suggestions about its implications for those involved in school-to-work programs. For example, co-op education teachers could use the classroom portion of their courses to explain the nature of routines. Equally, workplace supervisors might find it helpful for students to have the overall routines and the subroutines in a workplace identified for them early in their placement, and possibly before they begin to learn tasks. We believe that these approaches can contribute to making the tacit aspects of the routines in the workplace explicit.

Revealing the Science in the Workplace

Some of our case study data showed the extent to which co-op education students recognized the science found in science-rich workplaces such as a medical laboratory, a veterinary clinic, and a dental office. Generally, the co-op students were able to assume successfully many of the duties associated with the role of a laboratory technician, veterinary technician, and dental assistant, but they saw few relationships between workplace science and school science. As a result of this, we have developed a theoretical framework aimed at understanding the form and function of workplace science, and how it is different from school science. When this is combined with ideas about cognitive engagement in the workplace, we derive a theoretical framework that suggests the kinds of instructional interventions that can enhance students' understandings of the form and function of workplace science, and its relationship to school science (Chin, Munby, Hutchinson, Taylor, & Clark, 2002).

Versions of Science and Cognitive Engagement

To match our instructional interests, we find it useful to distinguish three versions of science on three dimensions: purpose, accountability, and substance. The first version is *bench*

science—the theoretical and experimental work that generates the laws, theories, and principles that constitute the substance of science. The purpose of bench science is to develop new scientific information, and the accountability of bench science lies in its attention to the validity of the information it generates. Our next version of science is *school science*, whose purpose is scientific literacy. The accountability of school science lies in assessment; and the substance of school science is constructions of scientific information, laws, theories, and principles that meet its purpose. Our third version of science is *workplace science*. In an earlier discussion about the curriculum differences between classroom learning and workplace learning, we showed how the purposes were different because the settings were different. Even though a veterinary clinic is a co-op placement, its primary purpose is the health and well being of its patients and not the learning of the students, which is the primary purpose of the classroom (Munby et al., in press). So the purpose of workplace science is to support the goals of the workplace, and the accountability lies in ensuring that the science invoked is current and is used appropriately. The substance of workplace science is constructions of scientific information, etc. that meet the workplace's purpose.

These distinctions help to show how science learning in the formal context of schools is different from the science found in the informal context of a science-rich workplace. Hughes, Moore, and Bailey (1999) and Hennessy (1993) concluded that understanding the connection between the knowledge gained in an academic setting and the knowledge needed to solve real-world problems is critical. Our distinctions show why a student who is participating successfully in a science-rich workplace does not necessarily see a direct relationship between workplace science and school science: a direct relationship does not exist. In the case of the veterinary clinic, the form (i.e., breadth and depth) of the "substance" is dictated primarily by the purpose

of the workplace—namely, patient health and recovery. That is, the scope of the necessary "substance" of science is exclusively limited by the purpose of the particular context.

Our approach to workplace learning leans on the idea of situated cognitive engagement—the components of a social theory of learning that Wenger (1998) called practice and meaning. The quality of cognitive engagement is initially dependent on the quality of access the co-op student has to opportunities for learning within the workplace setting. This improved access is more likely to occur when the student adopts a progression of self-regulated forms of activity, apprenticeship, and appropriation (Hung, 1999). This access is also dependent upon the willingness of the workplace to create such opportunities for co-participation (Billett, 2001). Increased access to learning opportunities increases the potential breadth of cognitive engagement, but does little to enhance the depth of that cognitive engagement. Deeper learning occurs when the student utilizes a reflective stance to better understand his or her role within the community of practice, and to better understand the reasons behind his or her particular duties. In this way, the student is encouraged to synthesize the knowledge underlying the actions. Thus, in addition to access, we contend that cognitive engagement is comprised of two more parts: procedural knowledge (knowing how) and declarative knowledge (knowing that). These can be seen as similar to practice and meaning. Learning at the workplace is enhanced when students can carry out specific actions and when they also understand the knowledge underlying those actions. We believe that workplace science becomes apparent at the level of declarative knowledge, and the co-op student needs to understand the form and function of the workplace science before he or she can see its relationship to school science. Thus, we see the importance of creating instructional strategies so that co-op students can increase their access to learning, can perform proper practices, and can understand the knowledge underlying those actions.

A Framework for Identifying Areas of Instruction

The meshing of our understanding of the different versions of science with our understanding of cognitive engagement (with its access, procedural, and declarative components) results in the creation of a theoretical framework that allows us to understand workplace learning from an instructional perspective. In this way, it provides researchers with possibilities for designing instruction that can enhance the quality of students' co-op experiences, and of the students' understanding of the relationships between school science and workplace science.

Our in-depth case studies clearly revealed that as the semester progressed, the co-op students in the dental and veterinary clinics took on the roles of dental and veterinary technicians respectively. Even so, interviews with the co-op students suggested that they saw little relationship between the science-rich workplace and the science they learn at school. Our understanding of school science and workplace science led us to believe that we could identify instructional implications for bridging the science found in school and in the workplace within three specific areas of the framework.

First, instructional strategies can be developed for co-op students, co-op teachers, and workplace supervisors that overtly attend to the issue of co-participation so they can maximize their access to opportunities for learning. For example, students can be taught about the importance of asking questions of the workplace personnel about what they need to learn in the workplace. Second, instructional strategies for co-op students and workplace supervisors can be developed to help students understand the metacognitive functions of routines (practices) and to identify and understand the declarative knowledge (meaning) that is imbedded within typical workplace routines and within the "machinery" of the workplace. For example, workplace personnel can receive instruction on how to "think aloud" when performing tasks or making

decisions so that the co-op students can see the reasoning behind actions. This will enhance the co-op students' access to the declarative knowledge in the workplace. Third, instructional strategies for co-op students, workplace supervisors, and co-op teachers can be developed to help students recognize the differences in form and function between workplace science and school science. For example, students could receive instruction that emphasizes how they can see they are being successful within the accountability of the workplace. They need to be encouraged to understand the science behind their procedural knowledge, and to recognize that the scope of the workplace science underlying those procedures is limited solely to the purpose of the workplace in question.

Our case studies of science-rich workplaces highlight the distinct form that science takes in the workplace, and the functions that science serves in meeting the central purposes of the workplace. If we want high school co-op education students to understand better the relationship between school science and workplace science, science teachers and workplace supervisors need to help co-op students recognize and understand the situated form and function of workplace science, and this can only occur when the access, procedural, and declarative components of cognitive engagement are present.

Focusing on Equity in Co-op Education

In this section, we focus on issues of equity in co-op education. Canadians with disabilities already face barriers to education and employment (Human Resources Development Canada, 1998). While in theory knowledge societies offer unprecedented access to self-transformation, critics argue that in practice they appear to be "highly susceptible to recreating and reinforcing systemic social inequalities" (Chisholm, 1999). Changes are needed in equity

policies and educational programs to ensure that those with special needs contribute to the knowledge economy (Peters, 2001). A recent policy document in Ontario states that co-op education should be available to all students, including students with special needs (Ontario Ministry of Education, 2000). "The employer and supervisor must be made aware of the student's area of exceptionality and special learning needs. If at all possible, this should be done well before the placement begins" (p. 34). Many of our studies have produced suggestions for enhancing the accessibility of co-op education (e.g., Hutchinson et al., 1999; Hutchinson et al., 2001). However, a study we completed recently focused on the experiences of two adolescents with special needs and sharpened our understanding of the growing challenges in a knowledge society (Versnel, Hutchinson, Munby, Chin, & Chapman, 2002). Here we provide a brief summary of two cases that highlight the role of factors like routines, which we have already discussed as important to the workplace learning of all co-op students, and factors like communication which are critical to informing workplace supervisors about special needs. We then make recommendations for co-op instruction and workplace supervision that meet the needs of exceptional youth.

The Cases of Jerry and Laurie

Jerry and Laurie were placed in garages that employed advanced technologies for diagnosing and repairing automobiles. Two researchers met with them during the fourth week that they were in their workplaces. We then conducted observations of the students at work, talked with them when they were between tasks, and conducted formal interviews with the workplace supervisors.

Jerry had a speech impairment and, according to his teacher, a history of difficulties with reading and writing. In the initial meeting with the two researchers, Jerry described how 12 technicians worked at the garage, but he had not been assigned to any one of them for supervision. He said he was "always circulating, helping everyone, all around." Jerry was observed on six occasions. He was increasingly absent from the placement, and when questioned, he responded that no one had told him that he had to be at the workplace every day.

Laurie's teacher described her as experiencing difficulties with listening, reading, and writing. She had completed two successful terms in co-op placements at a garage in a government agency before dropping out of school. Laurie said she had returned to school "because I need more credits. I want to go to college, and am applying to take a mechanic's course." She said she had been assigned responsibilities for "oil changes, brakes, and tire changes," and Sam, one of three mechanics, was her guide. One of the researchers observed Laurie wandering aimlessly in the garage for more than 30 minutes and growing increasingly frustrated. She explained later that she could not find the necessary tools and was uncertain how to replace a rod in an axle. In this 30 minutes, Laurie quietly asked for help twice; finally two mechanics brought the tools and helped her to finish. Two weeks later, Laurie stopped attending her co-op placement following an altercation with Sam.

Four Themes: Expectations, Routines, Communication, Preparing the Stakeholders

Using standard qualitative methods to analyze detailed observations and transcripts of interviews, we generated four themes that captured the problematic experiences of these youths in co-op education: expectations and mismatches, routines, communication, and preparing the stakeholders.

In Laurie's case, the teacher created expectations when she praised her mechanical abilities in previous co-op placements while relating nothing about Laurie's difficulties in school. The workplace supervisor formed unrealistic expectations that "Laurie was an entry-level position." In Jerry's case, the workplace supervisor expected initiative and independence, which Jerry did not deliver, while Jerry expected that behaviours he engaged in at school, like frequent absences, would be acceptable in the workplace.

Jerry might have benefited from having routines demonstrated and explained. As it was, he understood little of what the mechanics were doing and of how he could help. Laurie had mastered simple routines, but observation showed she was expected to and unable to execute complex and unfamiliar routines.

The students demonstrated weak communication in the workplace—Jerry was absent from his co-op placement frequently without notifying the supervisor, and Laurie was unwilling to ask questions even when she could not perform her assigned tasks. The supervisors were rarely seen to communicate workplace knowledge to the co-op students and appeared reluctant to communicate their dissatisfaction to the school, while the school failed to communicate the students' special needs to the workplace supervisors.

Both workplace supervisors made suggestions for preparing co-op students. They especially wished to see students asking questions, showing initiative, and acting independently. The supervisors were not prepared with the information they needed to help Jerry and Laurie succeed. Brenda said that with such information, she "would have done everything differently."

Implications for Instruction for Exceptional Learners

Workplace learning is different from school learning. It is informal, embedded in the routines of the workplace, and implicit. The natural curriculum of the workplace is not designed around the needs of the novice. Our four related themes of expectations, routines, communication, and preparation demonstrate that workplace learning can be particularly challenging for exceptional learners.

We believe that workplaces that see themselves as communities of practice can do much to consciously initiate novices to their shared knowledge by making what is known explicit (Wenger, 1998). The most effective mentors are those who consciously guide their protégés (Darwin, 2000). Guidance is usually needed on three levels: (a) organization of learners' experience, (b) close guidance in the development of routines and understanding associated with work practice, and (c) the development of self-regulated learning and the transfer of working knowledge to new tasks and workplaces (Billett, 1995, 2001). When aspects of work are not intrinsically interesting to youth, we can enhance their motivation by increasing their feelings of: relatedness to their co-workers; competence (by ensuring they experience some success); and autonomy (by giving them some choice) (Ryan & Deci, 2000). For these strategies to succeed, employers must be aware of the strengths and needs of exceptional co-op students. These two workplaces received no relevant information and made none of the accommodations that Canadian employers are expected to provide for people with disabilities (HRDC, 1998). It is urgent that we "move from the goal of access for as many students as possible to success for as many as possible" (Gouvernement du Québec, Ministère de L'Éducation, 1999), as we embrace the challenges of a knowledge society.

Closing Comments: From Participation to Engagement

In this paper, we have drawn on our empirical work in the area of secondary co-op education to advance strategies for workplace learning with three emphases. The first of these concerns instruction that focuses on the metacognitive functions of routines for novice workers, the second concerns instruction about science in the workplace, and the final section considers workplace instruction for students with exceptionalities. In each of these three related emphases, participation in not enough. The strategies we recommend provide guidance at three levels: organizing learners' experience, guiding the development of routines and the understanding of routines, and facilitating the development of self-regulated learning and use of knowledge to respond to changing tasks and workplaces. The knowledge economy demands that we recognize the differences between school learning and workplace learning and that we scaffold adolescents' experiences so that they are cognitively engaged with the workplace.

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