

Situated Learning: A Workplace Experience

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Situated learning - a workplace experience¹

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INTRODUCTION

This article describes the procedures and findings of a study of workplace learning arrangements in a mining and secondary processing plant. The evaluation was conducted on-site between July and October 1993, and involved 15 employees of the plant as participants. The study examined the nature and outcomes of workplace learning arrangements, which comprise formal structured learning arrangements and informal learning arrangements experienced as part of everyday work practice. The article commences by outlining the basis for situated learning. The nature of the research method and sample is described next. Three types of formal findings are subsequently reported, through perceptions of the utility of different components of the learning arrangements, providing a comparative analysis among these arrangements and a basis to speculate how types of knowledge are likely to be generated within these arrangements. These findings are then discussed, along with concerns about the development of conceptual understanding through workplace learning and some observations about the role of personal values and epistemologies associated with engaging in learning arrangements.

SITUATED LEARNING

Situated learning has been defined as a learner executing tasks and solving problems in an environment which reveals the various intended uses of the knowledge (Brown, et. al. 1989). During the last decade there has been an unprecedented interest in situated learning within the educational research community. This interest appears to be the result of developments in theoretical understanding, which includes the acknowledgment of domain-specific knowledge' role in complex thinking, the social basis of learning and the role that activity plays in cognition. These factors are elaborated below.

A sustained research effort, over the last twenty years, within cognitive psychology has revealed the significance of domain-specific knowledge to expert performance (Glaser, 1989). A number of studies provided evidence that the presence of a comprehensive and well-structured knowledge base distinguished experts from novices. Views of instruction and learning, which emphasised the development of generally

¹. This article has been developed from the conference paper - *Situating learning in the workplace*, presented at the After Competence Conference in Brisbane, December 1993.

applicable forms of knowledge, are being challenged by this theoretical advance. With the acknowledgment of the role of domain-specific knowledge, has emerged a view that knowledge is embedded in the circumstances of its application (Brown, et al, 1989; Rogoff & Lave, 1984). This view does not deny transfer, but conceptualises transfer as being the product of higher order thinking which enables the abstraction of principles from specific instances and then applying those to novel situations (Stevenson, 1991). However, the emphasis domain-specific knowledge also suggests that expectations about the degree of transfer may need to be reconsidered. For example it is possible to ask, to what degree is it reasonable to expect transfer to occur, and under what conditions?

The second theoretical development, which is supportive of situated learning, emanates from the now almost common acceptance of learning being a social process (Goodnow 1990). Direct and indirect social guidance between the learner and more experienced others is seen as an essential and inevitable part of the learning process (Cazden, 1993, Goodnow, 1990, Rogoff, 1990 & in press; Scribner, 1985 & 1990; Vygotsky, 1978). The Vygotskian school emphasises the appropriation of knowledge as being through inter-personal, or inter-psychological processes, before becoming an intra-personal or intra-psychological attribute. Appropriation, in this article, is defined as the individualised process of constructing meaning from socially and contextually defined knowledge, using the individual's idiosyncratic structuring of knowledge and understanding. Or as Leontyev suggests, the learner "does not adapt itself to the world of human objects and phenomena around it, but makes it its own" (1981:422). This distinguishes appropriation from internalisation which seems to imply that externally developed knowledge is absorbed, unaltered, by the learner.

The social guidance which leads to the appropriation of knowledge is both proximal or distal. Proximal refers to the close guidance of another, for example parent working with child, expert with novice or tradesperson with apprentice. This form of guidance often involves joint problem-solving and the gradual withdrawal of the more experienced other as the learner becomes increasingly able to work without close guidance. Moreover there is also the more distant or distal forms of guidance. The tasks undertaken by learners are organised by others, part of which is the requirements for adequate performance. Even the most apparently solitary task is embedded in social practice (Scribner, 1990). The more distal social guidance is shaped by forms of social organisation, such as social influences, and the cultural practices which organise work activities, and its priorities and values, the nature of the physical setting and the institutional structures of the setting. For example it has been argued that formal learning institutions are not decontextualised, instead they possess a strong and pervasive set of cultural practices which are associated with the achievement of that institution (Billett, 1993b; Rogoff & Lave, 1984).

Interest in social practice leads to the third theoretical development, which is the notion of activities as key determinant in knowledge construction. Recent work in anthropological and cultural orientations of cognitive science have emphasised the nature of activity as being central to the organisation and, consequently, the development of knowledge. It is claimed that activity structures cognition (Rogoff & Lave, 1984). The activities that are undertaken are not separate from learning, but are an integral part of it, it is argued that situations co-produce knowledge through activity (Brown, et. al., 1989). Activities are developed socio-historically (Vygotsky, 1978) through a community of practice. A community of practice is a set of relations among persons, activity and world over time and in relation with other tangential and overlapping communities of practice (Lave & Wenger 1991:98). A culture of practice refers to the activities that comprise and distinguish a particular community of practice. The norms and practices are central to the conduct of, and participation in, vocational practice, and as such, need to be accounted for in learning arrangements.

It has been argued, then, that these theoretical advances underpin the current interest in situated learning. Such a view of learning has a range of implications for vocational education, as the very notion of vocational practice is consonant with a culture of practice. Indeed, much of the research undertaken to develop these positions was undertaken in vocational practice. Investigations into navigation, (Pellisier, 1990) abacus counters (Stigler, et. al, 1982), street vendors (Carragher, et. al., 1985), physicists (Chi, et. al., 1981), chess players (Chase & Simon, 1973), weavers (Rogoff & Gauvin, 1984), tailors (Lave, 1990) and mid-wives (Jordan, 1989) are examples of the vocational sources of findings used to develop this theoretical position. The nature of vocational activities also lends itself to an analysis of the situated nature of learning. Social relations of both a proximal and distal nature abound in vocational practice, as does expert performance, culturally-specific activities and knowledge. Consequently, the notion of situated learning is an area worthy of examination in the vocational context. The terms vocational is referred to broadly. The study below refers to a particular employment-related context, however the concept of vocation refers to all those situations which involve a culture of practice, for example social situations, parenting or community activity.

In the study reported below the opportunity is presented to compare skilled workers' perceptions of situated elements of learning that are embedded in work practice, with those that have been developed as part of a structured training programme - the learning guides, videos, computer-based learning media and mentors.

METHOD

This section describes and summarises the research methodology and commences by outlining the sample, which is followed by a description of procedures used in the investigation.

Sample

The participants comprised 15 full-time employees at the plant. The length of service and experience of the participants varied, both at the plant and within the specific work areas which participants were to learn about. The participant's work experience varied, from 2 days employment, to extended involvement which included employment during the construction and commissioning of the plant. The employees who participated in the research activity were all shift workers, rotating through a sequence of twelve-hour shifts, which usually comprises three consecutive day and two nights shifts. Occasionally, three consecutive night shifts were worked. The plant operates 24 hours a day, every day of the year. Program participants were interviewed either during work time, between shifts or sometimes on their days off. The sample comprised 14 males and 1 female. The sample was selected by the plant's management to provide a cross-section of workers from different work areas.

Five work areas were selected to be the subject of the investigation. In this article these areas are referred to as Fusion, Calcination, Minesite, Laboratory and Control Room. One experienced operator and novice workers in each work area were selected to participate. In this article, the former are referred to as experienced and the latter as novices. An additional role for the experienced participants was to trial the materials, and provide refinement and comment on the content of the learning guides. Not all of the participants had the equal access to the learning arrangements. The videos addressed only one work area (Fusion), and the computer-based instructional media was only developed for two areas (Fusion and Control Room). Three respondents also claimed they had been unable to participate fully in the program due to work commitments.

Procedures

Two types of research procedures were used. Firstly, there were those used to determine changes that occurred as a result of participation in the skills development program. The second set of procedures were those which sought to determine the effectiveness of the learning processes accessed during the program. This article focuses on the second type of procedures. The first set of procedures comprised a survey of the participants' previous method of acquiring skills and their perceived ideal method, an attitudinal survey, and concept maps. In addition to these procedures, during the post-test phase the participants responded to expert-derived problems, and an inventory of propositions designed to test tentative findings.

This article focuses is on data about the perceived efficacy of the learning arrangements, gathered during the training program. This comprised of structured interviews with each participant at monthly or three-weekly intervals. The interviews aimed to gather information about how the various learning arrangements contributed to the participants' ability to perform routine and complex work tasks. In

addition, the participants responded to a survey of how a range of attributes could be developed by the training system. The attributes, were determined in an earlier study (Billett, 1993a), as being those required for competent work at this particular plant.

Interviews

The interviews were used to determine participants' interaction with the structured learning arrangements at the plant - learning guides, mentors, videos and computer-based learning aids - and the unstructured learning that resulted from daily work practice. The learning guides are modularised text-based instructional media, which included text, diagrams, questions, and recommended learning activities. The computer-based learning media comprise a text and graphics-based approach, with an interactive question and answer interface. The videoed instructional media comprises moving images with narration. However, it is necessary to examine the contribution of these formal learning arrangements in conjunction with the other, informal, learning arrangements which workers experienced in the workplace. For this study it was speculated that perceptions about these experiences could be elicited and analysed under the categories of learning from *other workers, observing and listening, everyday work activities, direct instruction, and the work environment*. These categories were those reported in earlier workplace learning studies, and had provided a platform for workers to describe their informal workplace learning experiences (Billett, 1992 & 1993a).

As it was necessary to gather data on a number of occasions over the four-month period of the study, interviews were selected as a means to gather data about the way the aids to learning had contributed to learning throughout the period of the investigation. The nature of the work activities, and the need to gather data progressively over time, were such that strategies such as observation or participant observation were rejected as being inappropriate or impractical.

The validity of verbal data has been challenged, because it is based on self-reporting, rather than actual events or changes in behaviour (Ericsson & Simon, 1984:36). To improve validity of reporting, a critical incident approach was adopted, which induced the participants to ground their responses in actual events. The approach used was to request the participants recall and recount specific events and situations. It was expected that these learners would experience moments when they were able to achieve task goals for the first time, and be aware of it, that they would also face problems that were beyond their capability to resolve, and that they would also experience moments when they discovered that assumptions they had made or understandings they possessed, were not sufficient for problem situations in the workplace.

Correspondingly, during the interviews participants were asked, *Consider when you had a 'high moment' recently (when things went really well); What happened? Why were you able to be successful? How did*

you acquired this knowledge? They were also asked to recount problem situations - *Consider when you last had a problem to solve in the your work. How did you go about resolving that problem? What didn't you know? Who or what helped? Why was that helpful?* To complete the critical incidents they were asked about 'low moments' in their recent work practice, *Consider when you had a 'low moment' recently (when things didn't quite work out). What happened? What didn't you know? How could you have best acquired this knowledge?* Having recounted these events, the participants were asked to rate the contributions of the formal and informal elements of the training system to these situations, on a survey instrument. The responses to the critical incidents approach, and descriptions of the usefulness of elements of the learning arrangements were audio-taped and transcripts produced. An interview schedule sheet was used to display questions and capture ratings of the perceived effectiveness of the elements of the learning system, and also data about linkage between these elements. The quantitative data was entered onto a table which is presented below (see Table 1). Transcripts extracts from the qualitative data are used to make judgements about aspects of the learning arrangements.

The critical incident items were asked during each of the interviews, although by the final interviews many of the participants had difficulty recalling new events. During the interviews, the participants were also asked to provide a specific example of how each of the learning arrangements had contributed to their learning. Much of this data is presented below.

Attributes inventory

As part of the third interview, participants were presented with an inventory of attributes required by skilled workers at the plant. This inventory had been generated in an earlier study (Billett, 1993a). By the time of the interview, participants had experienced a range of learning experiences, and were aware of different approaches to skill acquisition. Consequently, it was rationalised that the participants' experiences with different learning components would provide responses grounded in the learners' actual experiences. The attributes in the inventory had been developed by approximately forty workers at this plant, six months previously, in their response to a survey about what it meant to be a skilled worker at that plant. These attributes were categorised into propositional knowledge - facts, assertions and propositions - *knowledge about* (Anderson, 1982), procedural knowledge - ability to secure goals - *knowledge how* (Anderson, 1982) and dispositional knowledge (Prawat, 1989) - values and attitudes. During this interview participants were asked to rate the usefulness of the formal and informal learning experiences, in the development of those attributes. These were ranked from 'very useful' to 'not useful' using a numerical scale between 5 and 1, respectively. This data was analysed and frequencies of responses recorded (see Table 2).

FINDINGS

As a means of reporting the data, responses to perceptions of the efficacy of the various components of the learning system are first described, using qualitative data, and then discussed. Next, a quantitative analysis of the responses to the formal and informal learning experiences during the critical incidents approach is presented. Following this is an analysis of the perceptions of how a range of attributes reported required for work at the plant could best be developed.

Learning Guides

How they were used

The learning guides were used in different ways by participants. Although a range of structured activities, was included in the guides, respondents did not report using these. Most respondents reported reading the resources through. However, the most frequent statements were linked to their use as an adjunct to other learning experiences, notably everyday work activities. The guides were described, by the participants, as providing reinforcement to what was experienced in the workplace, as a back-up to practical activities, providing a source of reference to students, and a base for backtracking. The following extracts from interview transcripts are illustrative of these findings.

I've always found it easier to learn things by doing them practically. And then the manuals reinforce what you learn through - - if you read the manual, and it says something and you do something else - do it some other way, you either challenge it or you say "That's the way I should be doing it". (novice)

I reckon that you're better off just using them as a back up to the practical doing of it. You read it initially, to get an idea of what and where you are, and then after that use it as a back up to what you're doing. (novice)

When we started, we didn't have to worry about that (terminology) too much. And also if you have a manual that you can follow, it's easier to learn that way. Because you can sit there and watch someone do their job, but if you have a book where you can sort of read and that while you're doing the work, and he's doing it exactly the same as in there, it's easy. (novice)

Well, there's things in there that, If you're not too sure, and you think it's right -- or you think it's wrong, you go back to that book and check up on that. (experienced)

I wouldn't be using them now. I've gone through them three or four times. And I sort of got them down pat. I do back track and just make sure about something. But I think I've got that down pat now. (novice)

From these examples it is evident how the learning guides are being used, and also the need to integrate their use with work place activities. An initial reading, of these resources, was reported as providing background information, but as the learner experienced situations of uncertainty in the workplace, the guides, reportedly, became a resource to be accessed in order to clarify meaning and remove uncertainty.

Computer-based Learning (CBL)

The CBL material was valued by participants because of its stimulating and interactive nature. It was perceived as being more interesting and active than reading learning guides. The graphics presented a source of interest to participants and the interactive nature of the CBL was reported as being engaging. Respondents also claimed that when compared with learning guides, the CBL provided greater depth of understanding.

.... it's like a new thing, so you just, you learn a lot more because it's different. It's not just plain old reading. It's more interesting. (novice)

I think they'd get a lot more understanding out of that than what they would by the learning guide. (experienced)

It's good.. like when I went through those startup and shutdowns on that. It gives you how to shut it down. Which is good. But it's like a learning guide, because it doesn't tell you - it can't tell you - the time intervals. It will basically set it out for you, the steps to do, but it doesn't tell you, how to do it.. It's a step beyond the learning guide. (novice)

Well, it gives you a more in depth learning. It explained what the calcination process does. Were the notes didn't give you much background. Were this went into it in more depth. (novice)

However, tightness of the syntax caused concern, frustration and, occasionally, anger among participants.

I don't like some of the remarks. I think some of the remarks are a bit caustic. its treating you personally saying it's doing this and doing that and some of the remarks are really cutting. (novice)

Particularly when you put something down something like tank and the (expletive) answer is tank and you get a really caustic remark - you feel like punching the bastard. Because you know you're right, you know. (novice)

I kept thinking that question wasn't precise enough. What plane do you have up, or something like that. When you ask someone how to place a starter bar, well I automatically thought that they were trying to get technical. (novice)

... the only trouble I did have with it, was, I answered the correct answer, as far as I was concerned, but the computer said no, you're wrong. And that was a bit disturbing. You can't get back to the question. As soon as you answer the question, you go on to the next question. And you say, hold on, I was right. So you switch off and you go right back and you find that your answer was right. But so, what happened was, it didn't have enough variations for a novice like myself to accept an answer. One example, it was, what number hearths are the fire hearths on the multi-hearth furnace. And the answer, and the thing in the instructions, the answer is 5 to 16. Well, I put down 5 to 16 and I was called wrong. Because what I should have put down, was 5 space 16. What I was putting down was 5 dash 16. So it called me wrong. I put 5 to 16. and it called me wrong. I put 5, you know, and all this. I never thought about using space. Not up with computers. And it was very frustrating. When you know you're putting the correct answers in and it kept saying you're wrong. You end up pulling your hair out, in the middle of the night. Bloody hell. (novice)

In terms of learning outcomes, the concern is that the questions and answers are so tightly pre-specified that only comparatively trivial learning outcomes, such as factual or basic propositional knowledge can be assessed. The constraints of the instructional media means that the most complex types of knowledge to be generated are very specific and low level propositional knowledge. It was, however, seen as being visually appealing, and interactive.

It's really well done ... it probably sticks in my mind because there's good graphics. (novice)

Videos

The videos were only used by three participants. The responses were mixed. One respondent thought they were pretty amateurish, another suggested they were well done.

I was a bit off on the videos. They're very amateurish. There are some things in there that are bad work practices. Just shouldn't be done. (novice)

They're well done. Teaches you a lot of things. If you didn't know nothing about it, it would certainly teach you. (novice)

The videos were intended to be used as part of a learning process, organised through the learning guides. However, the interviews indicate that they were used, as and when it became convenient to access them. Moreover, it was indicated that participants would only use the videos once. In responding to the question "Would you ever use the videos again?" a respondent replied:

Yeah. Like if they were different videos on something that I didn't know about. I'd go back to using them. But if they're the same ones - I do it all day.

Mentors / Other workers

In this section the formal provision of Mentors and the contribution of informal mentors have been joined together, as all participants using either their nominated expert mentor or other workers, who they perceived could assist them. "Mentors" and "other workers" were valued by participants. They were able to tell, explain, and make explicit things that were not immediately observable. In these ways they were able to provide useful contributions to the participants' understanding of work tasks.

...no you can't see it. It's all covered. I said, I don't know and he told me. - making explicit what is not observable (experienced)

They always come down and explain it to you. - addressing the level of the learner's development (experienced)

The qualities required of mentors were reported as being approachability, with an ability to explain fully without being too technical, patient and willing to repeat explanations. Moreover, good mentors provided opportunities for learners, and, then monitored their progress or worked with them.

...the main thing is just having to work with someone you can approach. (novice)

Explains everything fully. Not too technically. Not afraid to go over something a few times. (experienced)

A good mentor is someone who's willing to go over and over it until you've got it. I know I find it hard to learn things first up. If I'm shown a couple of times, I'm on the train. Plenty of patience, a mentor's got to have. (experienced)

Because he pointed me in the direction of it and let me loose with it. And working with him, we sorted it all out. (novice)

I find it very hard to grab things straight up. It takes me a couple of times to work it out and then I'm right. If someone just tells me, boom that's how you do it, and walks away, I just tend to scratch my head. (novice)

Mentors were also regarded as being able to assist in developing attitudes towards work practice that are conducive of effective work performance. The question "How does a mentor teach a novice about doing high quality, consistent work?" was asked of a participant. The following reply illustrated an approach to modelling, coaching and exemplifying an approach to work practice.

Probably making the person aware how important the accurate and precise work is. And actually giving example of the work that they've done previously that shows, maybe of grab samples, how different results you can get from them. Actually work backwards through mistakes that actually happen. And show, instil, I don't know how you'd say it. Instil that work ethic that the whole plant can produce what it wants, but unless the work is accurately done here, it's a waste of time, and they may as well not produce anything. (novice)

"Other workers", were prized for the direct and indirect support they provided. As is detailed below in Tables 1 and 2, the overall qualities of guidance were strongly supported.

I'm proficient with what I do down there and I mean I haven't learned that from the books, I've learned that from my mentors. (novice)

Well I wouldn't have done anything at all without them. I wouldn't have got to the point where I'm at now, because I'm fairly confident, not an expert, but I'd describe myself as confident. And I wouldn't have got to that stage without, not only Steve, but particularly Steve. On the shift, I'd say they were mentors as well. They were all experienced and I was a babe in the woods. (novice)

I don't... well you learn off one person. You know, there's other people other ways, that may be better than your way. (novice)

Of particular interest was the degree of access to sources of expertise, that was reported by a number of participants.

I've used just about everybody as a mentor, I suppose. But they've been really good. (novice)

These qualitative findings from the formal aspects of the skills extension provide perceptions of their value by workers who have utilised as they conduct their daily work practice.

CONTRIBUTIONS OF SITUATED ASPECTS OF THE LEARNING SYSTEM

In addition to the structured learning arrangements informal learning processes were also accessed by the participants. Key qualities of these processes are their ubiquity, and their on-going nature. The operators are immersed in situations in which authentic problems have to be solved, where the solution as well as the cause of the problems are to be found in the work environment (Brown, et. al. 1989), where observable actions of other workers and the plant itself is tangible, and where workers engage with others in discussions about problems and their solutions. This direct access to everyday work activities provides problems, problem solutions, and indirect forms of guidance. In addition, it places the learner in a situation to access more direct forms of guidance from expert others. The sections below report participants' perceptions of contributions to learning from everyday work activities - observing and listening, direct instruction, and the workplace environment. The contributions to learning provided by other workers have been reported above under mentors.

Everyday Activities

Respondents reported that everyday work activities provided practice, which allowed their work activities to become 'second nature', which is interpreted as being the process of proceduralisation. Learning activities were contextualised by the requirements of the work. In addition, participants reported that this way of learning was useful for making explicit the standards and values associated with work practice.

If you're not understanding what's going on, it can be very hard, because you don't understand how to fix the problem. (experienced)

...once you seem to know the area, you don't really seem to think about your work activities very much. You just sort of do it. You always trying, and you probably don't realise that you did something. I just flows on. Automatic. (experienced)

The more you do it just becomes second nature. (novice)

Practice is important so you can go from being competent to being expert. (novice)

This reporting of work activities becoming 'second nature' is noteworthy. As individuals develop their ability to undertake tasks, they become compiled and automated for smooth performance (Anderson, 1982). This compilation reduces the demands of the working memory, which can be used to focus on new information or stimuli. Automation reduces cognitive load (Sweller, 1990), freeing the mental processes to manage other problem areas. Moreover, this compilation and automation does not lead to mindless

execution of tasks, regardless of situation. Instead, the executive role of cognitive structures, monitor and manage the deployment of compiled processes, according to the demands of the activity (Stevenson, 1991).

The authenticity of actual practice was raised by a number of participants as being of important to the development of skills and understanding.

Well, if you weren't here you wouldn't be learning would you. (novice)

It's the only way you can get the pressure of grinding right. And get the knowledge of when everything's right. After a while, with the grinding, you can just tell by the way your moulds slide on the pads whether it's ground enough. It's the only way you can get to learn this job. You can understand the job from the books but, work activities would be one of the only way you can learn it. It's all hands on. (novice)

Being in the lab helps you get a good sense of how, the priority of things, they have to accurate. Everything has to be done to the letter. And it has to be done correctly and everyone has to do the same. Inconsistencies are problems and to keep up, to maintain the reputation of the lab, you have to consistently put out accurate results. (novice)

The last example illustrates the way values associated with work practices can be appropriated by a novice, through engagement in a culture of practice within the workplace. The repeated and explicit nature of external reinforcement, which coincides with the what novices experience, should provide a strong base for the development and maintenance of the dispositional knowledge. This type of knowledge becomes the moderating factor that determines the quality and nature of daily work practice. Ultimately, it is up to the individual whether they do a good or a shoddy job.

Observing and Listening

The participants reported, "observing and listening" as partially providing a basis for workers to move from 'knowing about' something to 'knowing how' it can be skilfully undertaken. It was suggested that this on-going form of learning is essential for the communication of information which could not be practically communicated in other ways.

You have to always be listening to what's going on, without detracting from the concentration on your work. Because there's always different things going on that aren't - can't be communicated, there's so many memos as it is. That different things have to be communicated by word of mouth. (novice)

It was reported that learning from more 'experienced others' did not always involve being directly guided, but through more indirect forms of guidance, such as observing and listening. Respondents were able to detail situations in which they were able to learn indirectly in this way.

Well, we've got some tradesmen that've been around for a long time. They are very skilled group of people. Watching and learning from them is good. (novice)

When Steve's talking to any of the other guys, I sort of listen in. I normally draw something on the board. That's got to do with the multi hearth. I just look and listen to whatever is going around. You know, just look and listen. (novice)

I'm always listening to the two way. And I'm always listening to, ah, what's going on. And, ah, what they're doing to solve the problem, and have a listen and then I go over and ask the bloke what was going on. You know, I say what were you doing over there. Were you having trouble. And he'll tell me. And I might pick something up that way. (novice)

*.....in the control room. There's lots of talk going on. About different things that are happening. **Is that useful?** Yeah. If you know what they're talking about. If you don't know. I just wait till they finish talking and then ask them what was this and what was that. (novice)*

...you watch how other people do the job and you learn from that. Or they might have a different approach to you or a different perspective on a certain problem. (novice)

It was also reported that learning through listening and observing, **was not restricted to novices**. Experienced respondents suggested that they developed further their skills by observing and listening.

You can never quit learning anything, so your always, looking for different methods of doing things, listening to what other guys are saying, and picking up new trends and methods of doing things. (experienced)

Where techniques are involved. With, ah, doing various tasks. Particularly, where the technique can vary from person to person. Observing that sort of situation and evaluating that, as long as you do evaluate it. (experienced)

Moreover, the informal nature of the learning from others was illustrated by the communication with other workers in non-work situations. This suggests learning processes which are not forced, but become a normal part of the discussions between workers, even during breaks from work.

At smoko talking about things. I reckon that's when you learn a lot. Just listening to the blokes. Like you can't big note yourself. You just listen to what's going on.

Direct Instruction

Direct instruction was valued by the participants when it provided information that they did not know, and were unlikely to learn, without it being made explicit. For instance, production processes that were hidden from the novice needed to be made visible or accessible. Explanations of an explicit nature, can be very useful in this process. However, it was reported that the quality of direct instruction was important, for two reasons. Firstly, if the operator thought they were being 'talked down to' it affects their approach to what they were being told. Secondly, if direct instruction failed to provide reasons 'why things had to be done',

it was likely to press the operator into activity, but without knowing why they were undertaking the activity.

With the proviso that it isn't so direct and so straight lined that the person being instructed doesn't feel that he's being railroaded and, that there's no other way of doing things and not taking his thinking away. But I think, considering that this particular operation is a little different from anything else, or most things else around the place, direct actual instruction on what's actually happening is good value. (novice)

*...direct instruction, when you're learning, it can be a bad thing. Because you get told to do something, but you don't know **why** you did it. **I think that you should be told why you're doing it.** You don't have someone come in and say, 'change this.' You might change it but, ... or someone comes in and says 'change it', you change it, but you just got to say, 'why do you want it changed'. Ah, so that direct instruction - unless you know exactly why they want it done - it can be a bad thing. (novice)*

you've got to be careful, how you do it. Otherwise the guy's just going to think - Oh, I don't care. I'm not going to give my input. This is what he wants done. I just going to do it. (novice)

The issue of workers not knowing something or not being able to know something was reported as being addressed by direct instruction.

There was a steel bar - it was just worn out. Now I was told about that. But I didn't see it so I didn't fix it. Now if they wouldn't of told me, I wouldn't of seen it, and I wouldn't a fixed it. (experienced)

...when the place is operating and during start-up or shut-down. That's about the times that it's most helpful to you because you can actually see, or somebody is actually showing you, while the place is in operation - you can actually see what they mean. It's a lot better than any written text at all. (novice)

SOME COMPARATIVE FINDINGS

In the sections above, perceptions of utility of elements of learning arrangements have been reported. This data has provided some information about how each of those elements contributes to learning and how they might be organised to maximise their potential. In this next section, data from two separate procedures is used to provide some global and comparative findings about the efficacy of the learning arrangements. Both procedures gathered quantitative data, and used approaches that sought to validate self-reporting. The first data reports some quantitative findings emanating from the critical incidents approach, used in the structured interviews. In the second procedure, the participants responded to an inventory of attributes of skilled work at the plant, which had been generated in a previous study (Billett, 1993a). In both situations, the participants were asked to rate the effectiveness of the elements of the learning arrangements.

Perceived utility of learning aids during critical incidents

The findings in Table 1 reveal that the informal elements of the learning system were most valued for their ability to assist operators be successful with tasks and resolve problems. This finding is supported in two ways by the data. Firstly, the frequency with which the elements were reported as being 'very useful' indicates a strong preference for particular elements of the learning system. However, as not all elements were accessed by all participants, it is necessary to seek modes within each set of responses to different learning aids. The modal responses report the most frequent response within a category, which provides an analysis of those elements not frequently reported.

What is reported is that mentors, direct instruction, everyday activities, other workers, observing and listening were consistently perceived to be of great utility for the resolution of problems and securing of goals in the workplace. These finding have some limitations. Firstly, they are self-reports. Secondly, not all participants were able to recall all three types of situations. Thirdly, it is difficult to actually ascribe a learning outcome accurately to a mode of learning. However, despite these limitations, some strong trends emerged from this data.

The responses in Table 1 have been ordered by the three categories of learning experiences; instructional media-based, indirect and direct guidance in workplace and the activities they engaged within, the latter two reflect key components of situated approaches to learning.

Table 1
Frequency of utility of aids to learning
during critical incidents

Aid to learning		5¹	4	3	2	1¹
A.	Learning guides	6 ³	1	3	1	6 ³
B	Computer-based learning		1			4 ²
C	Video				1	2 ²
D	Mentors	15 ²	7	8	1	2
E	Direct instruction	17 ²	9	9	3	3
G	Observing & listening	30 ²	10	3	5	
H	Other workers	22 ²	7	17	3	2
F	Everyday activities	21 ²	8	11	5	3
I	Work environment	11 ³	11 ³	10	4	3

Notes

1. Rating from 5 to 1 = very useful through to not useful
2. mode
3. bimodal

In the first category, which deals with instructional media, the mode, or most common responses, for CBL and videos are 'not useful'. The responses to learning guides produced a bi-modal response between 'very useful' and 'not useful'. These responses to the perceived efficacy of the instructional media, provide a different pattern than those to be found in the categories of learning experiences concerned with direct guidance and those concerned with actual workplace activities.

This data concerning the contribution of guidance has been grouped together to gain insights into how the participants' perceived elements of the learning system which provided direct or proximal forms of guidance. This data is contrasted with the responses to instructional media with modal frequencies for all forms of guidance being perceived to be 'very useful'. Table 1 indicates that perceptions of the value of direct interpersonal guidance was highly valued, by the participants in terms of achieving goals, and solving problems and its absence when participants were unable to resolve problems. The frequencies are consistent across this category of learning aids with them modes and the overall pattern of responses indicating that guidance of others is perceived to be very useful.

The final category in Table 1 reports the perceived contributions of activities and the physical context of the plant to learning. These two items were grouped to gain insights into the perceived value of the contributions of the distal guidance of the culture of practice and the physical context. It is reported that participants valued the contribution of work activities and the workplace in resolving problems and achieving goals. The modal frequency for Everyday activities was 'very useful', with the Workplace environment being rated between 4 and 5, which also indicates a high perception of utility in resolving workplace problems.

Perceived utility of aids to learning across work attributes.

During the last structured interview, participants rated the utility of elements of the learning system against a list of attributes, which were stated as being necessary for effective work performance at the plant. These attributes had been generated in an earlier study (Billett, 1993a). The attributes were aggregated into categories of either propositional, procedural and dispositional knowledge. The knowledge category which most effectively reflected the attribute was used to aggregate the responses, as illustrated in Table 2. In the table all instances of a learning aid scoring 7 or more 'very useful' responses in indicated in this table. The findings in this table reflected a similar pattern to those found in Table 1.

Table 2
Frequency of 7> when learning aids are reported
as being 'very useful' in developing
different knowledge types¹

Learning Aids	Propositional Knowledge²	Procedural Knowledge³	Dispositional Knowledge⁴
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Learning guides	1	3	0
Computer-based learning	0	0	0
Video	0	0	0
Mentors	2	5	0
Instruction	2	7	2
Everyday Activities	2	13	5
Observing & Listening	2	15	5
Other workers	2	11	5
Workplace	2	3	6

notes

1. Frequency of item scoring 4 or 5
2. Maximum possible for Propositional knowledge = 2
3. Maximum possible for Procedural knowledge = 16
4. Maximum possible for Dispositional Knowledge = 7

This data supports the perceived potency of contributions of "Everyday Activities", "Observing and Listening" and "Other workers", in the development of a range of knowledge types.

Reported development of higher order procedural knowledge

In a separate analysis of the same data, those work attributes which were identified as requiring higher order procedural knowledge were identified. This analysis was undertaken to determine which of the learning arrangements were perceived as being most likely to generate higher order cognitive structures. Seven of the attributes which have a strong relationship to higher order cognitive activity were identified. The attributes identified, and responses examined are; *competence in applying skills to new situations, minimising breakdowns, planning of complex tasks, predicting and minimising problems, problem-solving with complex tasks, multi-skilled across different work areas, and analysis and thinking skills*. The importance of workers developing these attributes is their significance in responding to the complex challenges that are evident in work practice at both the plant and the minesite. As workers have a high degree of autonomy with decision-making they need to be able to problem-solve and achieve high levels of plant operation.

Table 3
Frequency of 7> when learning aids are reported as developing higher order procedural knowledge

Learning Aids	Higher Order Procedural Knowledge
Learning guides	1

Computer-based learning	0
Videos	0
Mentors	4
Instruction	5
Everyday Activities	6
Observing & Listening	7
Other workers	6
Workplace	2

One important facet of generating this higher order procedural knowledge is in its facilitative role in the application of knowledge to new situations (Stevenson, 1991). This is of key concern to a work situation that is dealing with the new and complex situations that have been frequently alluded to by participants in the validation process. The data presented in Table 3 reinforces the pattern evident previously and affirms the perceived role of *Observing and Listening, Everyday Activities, Other workers and Instruction* in being generative of these knowledge types.

The strong support for "Observing and listening" perhaps indicates perceptions of the very engaging and active nature of situated learning in the workplace. Within the formal learning setting (schools, TAFE colleges, training rooms), observing and listening are equated with passive learning and low level outcomes (Stevenson & McKavanagh, 1991). However, within the context of learning in the workplace context it is perceived as being highly active and generative of higher order outcomes.²

In the next section two issues of great relevance to workplace learning are discussed. The first relates to concerns about the ability of informal learning situations to develop conceptual understanding about vocational activities. The second issue concerns dispositions associated with engaging in learning activities.

Concerns about understanding

In an initial survey those participants who had had previous experience of learning in workplaces were asked to disclose its shortcomings. These participants emphasised a need for workplace learning to develop an understanding about the activities they were engaged in. Some of these respondents suggested

². I would like to acknowledge the discussion with Dr. Leonie Jennings, who alerted me to this distinction.

that some form of structure for workplace learning should exist, and others suggested that theory should be included work place learning experience. The following statements are expressions of this concern, as reported by some participants.

"You are probably shown the quickest way to do the job, but not the correct way. They show you the shortcuts.not knowing why your doing what you've been told to do ie. changing? a diverter, why are you diverting material and where to? (novice)

... didn't understand what the job was all about - I just done a job. (novice)

... not broad-based learning; skills targeted to job at hand only. (OTJ was not useful when attempting to deal with unusual situations. (novice)

.. (not effective) did not provide an overall understanding of material ie. subject matter and technical problems with matters, characteristics, contaminations, etc. (novice)

The concerns reported above are common to workplace learning processes and indicate the respondents' perceptions of the need for these types of learning experiences to explicitly address conceptual (propositional) knowledge, which helps develop understanding. These concerns suggest that a totally informal learning process may lack the development of understanding, particularly in situations where tasks are hidden from the learner. It would seem from the data above that workplaces provide rich opportunities to generate procedural knowledge. However, the reporting of propositional knowledge in the attributes surveys, may have failed to elicit deep understandings. The less obvious qualities of deep understanding may not have been recounted in the learning process. The concern is that the tacit understandings, enjoyed by more skilled workers, may need to be made deliberately explicit in situated learning situations. There is evidence from cross-cultural studies that although much learning is undertaken as part of everyday activities, explicit instruction is part of situated learning. For example, Pelissier (1991) reports that learning navigation in Palawat includes direct instruction, with substitute artefacts, such as stones and shells, being used to represent star patterns. Consequently, explicit use of explanation, diagrams or stories may be required to develop understandings in learning situated in a culture of practice.

Personal dispositions of learners

A confounding issue for the learning embedded in the processing plant was the differences in how participants engaged or were able to engage in learning activities. This difference seems to be accounted for in a number of ways. Some participants were novices, and it would be reasonable to expect initial rapid development. Some participants reported being engaged far more actively in their approach to learning, than others. A group of participants emerged, who could be characterised as being highly active learners. This group appear to have made the most of the situation and maximised their involvement in the validation phase, appear to have made substantial progress. It would seem reasonable to infer that those participants that set out to be active, developed greater understanding and more finely-honed procedures,

than those who took a passive role in the learning arrangements (Stevenson & McKavanagh, 1991). However, it is inferred, from some participants' comments on the learning processes and aids, that they did not welcome, enjoy or value the array of learning opportunities that were being made available, to them. These participants indicated a reluctance to be involved, which was reflected in their reported low levels of development.

During the total of five interviews with the participants, it became evident that participation was differentiated across the sample, with personal and motivational factors playing a key role. The motivation, or reluctance, to be involved in the learning arrangements are usually attributed to personal values and dispositions (Dweck & Leggett, 1988). The decision to be active may be linked to notions of beliefs about benefits, which are likely to be differentiated among individuals. Individuals' perceptions about their ability to be successful may also be a determining factor. Whereas some individuals would see the opportunity to be involved in the skills extension program as an opportunity to learn and excel, it appeared that others perceived the opportunity as a threat. Perhaps they felt their lack of skill and ability was to be acknowledged, once more, and avoided participation? Individuals cannot be made to learn, they have to want to be engaged actively in the process for anything, other than very superficial outcomes, to be achieved.

This concern about dispositions is most forcefully argued by Goodnow (1990) who suggests that the willingness of learners to participate in learning processes needs to be considered in both learning theory and instructional practice. She argues that the notion of appropriation is problematic, rather than being benign, with the learner determining the degree and nature of involvement in the learning process. Although personal dispositions have been acknowledged in learning theory (Prawat, 1990) they are not adequately accounted for in cognitive psychology. Yet, given the notion of learning that is conceptualised in the definition of appropriation, provided above, is a matter of individuals constructing meaning rather than simply internalising externally generated knowledge (Rogoff, in print), personal dispositions need to be considered more adequately.

CONCLUSION

There is evidence from the grounded perceptions of the participants in the study that the embedded nature of learning activities is supported for the development of a range of knowledge types and problem-solving strategies. Those aids to learning which were not embedded in a culture of practice, were not as valued. One of these, learning guides, was requested to be given context through workplace experiences. This embedded learning is explained as providing representations, arising out of activities that cannot be easily replaced by the descriptions provided through disembedded instructional processes (Brown, et. al. 1989:36). When the learning is without appropriate context and is based on description, the whole nature of the interaction changes and understanding becomes more complex.

This study has provided findings which are supportive of situated learning. When describing the utility of instructional media designed for the specific purposes of the plant, participants emphasised the need for this material to be integrated with everyday working activities. The direct guidance provided by expert mentors and other workers, either through direct instruction or through a process of observing and listening were strongly supported as a means by which learners could come to understand in a direct and purposeful way. Equally, the indirect guidance afforded by everyday activities and the physical context were supported. When participants were asked to rate the efficacy of the elements of the learning system in two different ways, consistent outcomes were reported. The consistency resided in the support provided to aspects of learning situated in a culture of practice. This data emphasises that when learning was disembedded from authentic activities and social relations it was perceived to be markedly less effective.

The significance of personal dispositions or personal epistemologies was another outcome of this research, albeit unintended. The concerns which Goodnow (1990) has stated about personal dispositions determining whether a problem is worth solving, were evident in the interviews with participants over the four-month period. These dispositions appeared to be sometimes culturally determined, but it is inferred, were more often based on individuals' belief about personal efficacy with learning. Further work is required to explore this important aspect of learning, which is central to concepts of learning in which the individual has the role of making the knowledge "its own". In addition, the deepening of conceptual understanding still remains a concern, unless explicit interventions of guides and mentors are able to develop the level of understanding required for complex work activity.

To conclude the data gathered in this study suggests that learning arrangements which are situated in a setting of a culture of practice, is not, by itself, a sufficient quality for the optimum appropriation of skills and knowledge. Rather, for situated learning to be effective it needs to be embedded in the authentic activities and social relations which comprise cultural practice. This does not exclude instructional interludes to deepen an understanding of vocational activities, but suggests that learning activities which fail to access and engage in a culture of practice are less likely to be generative of effective learning outcomes.

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