Queensland Magnesia Pty Ltd

Validation and Evaluation of Training Materials and Processes - July to October 1993

"you are not going to learn much if it runs smoothly"

QMAG worker

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1. EXECUTIVE SUMMARY

Introduction.

This executive summary describes the findings and presents recommendations from the evaluation of the skills extension program, at Queensland Magnesia Pty Ltd. Conducted on-site, between July and October 1993, the evaluation comprised an examination of the perceptions, experiences and responses of 15 QMAG employees, who participated in the validation trials of training arrangements, at five work areas at the Parkhurst and Kunwarara sites. The participants are described in more detail in the section entitled, Sample (3.1). The evaluation methodology comprised of both pre- and post assessment of the participants' attitudes, skills and understanding related to work activities at QMAG. During the validation, a series of three structured interviews were conducted, at either monthly, or three-weekly intervals. These interviews aimed to elicit, from the participants, information about their progress in the skills extension program, and, the relationship between the program and work activities. Of particular interest, to the evaluation was the effectiveness of learning guides, computer-based learning media, instructional videos and mentoring arrangements being trialled during the validation and evaluation phase. These aids to learning had been specifically developed by QMAG staff, and are characterised as the formal components of the skills extension program. The evaluation also sought to determine whether the participatory and consultative nature of work practice, at QMAG, contributed to an effective learning system. The brief, addressed in this project, has the following stated objective.

> *Evaluation and validation of the module learning materials, environment and delivery mode(s) as an integrated and effective learning system. (QMAG, 1993:5)*

The evaluation methodology used during the validation processes, which comprehensively sought to address this objective, is detailed in the section entitled, Procedures (3.2).

1.2 Findings and recommendations

This section summarises the findings of the evaluation, and proposes some recommendations for about possible future actions. Wherever possible, the findings described below are referenced to their source in Sections 4 and 5, or by a table which indicates the data. The organisation of this executive summary is as follows. Firstly, findings and recommendations relating to the formal learning components of the QMAG skills extension program, are presented. This is followed by findings concerning the contributions of the

informal aspects of workplace learning, which are an inherent part of the total learning experiences at QMAG. Some general recommendations, which will have direct influence on the training arrangements provide are then presented. To conclude this executive summary, some key recommendations are proposed.

Introduction

The learning arrangements experienced by the participants, at QMAG during the validation period, have been judged through a process of self-reporting and expert assessment, as being generative of the types of knowledge that should provide for complex work performance at QMAG. To maximise these outcomes, some general recommendations are proposed and should be considered when reading this report and its recommendations. Firstly, QMAG should view the entire range of learning experiences, as being part of the overall skills extension program. Essentially, this means an integration of the informal and formal learning experiences available at both Parkhurst and Kunwarara. Secondly, in considering this integration, it is important that the workplace learning experiences provide opportunities for the development of the conceptual understanding that is required for complex work performance. The evidence from the evaluation was that there were abundant opportunities to develop procedural knowledge - `how to do it' skills. However, there needs to be explicit attention to developing understanding about - `why things are done'. This may require explicit types of intervention, of the sort which are outlined in the text below. It should be added that these are not necessarily difficult or time - consuming, and can be easily integrated into everyday work practice. Thirdly, it is recommended that decisions about which elements of the skills development process should be the focus of further efforts and investment, should be made by considering the following findings and recommendations, which address both specific and general issues, associated with skill development at QMAG.

To commence with a specific focus, findings about learning guides, computer-based learning materials, mentoring and videos are described and summarised. In this description and summary reference is made to the generation of different types of knowledge. These types of knowledge are categorised as propositional knowledge - facts, assertions and propositions - *knowledge about* (Anderson, 1982), procedural knowledge - ability to secure goals - *knowledge how* (Anderson, 1982) and dispositional knowledge - values and attitudes.

1.2.1 Learning guides

The learning guides are valued as providing a knowledge base for novices, and a guide for workplace learning experiences. Evidence gathered from self-reports indicated that these guides are generative of specific procedural and propositional knowledge, and some higher order outcomes (see Tables 4, 8 & 9). However, learning guides are not frequently reported as being generative of more complex learning outcomes, (eg. problem-solving, predicting and minimising breakdowns, applying skills to new situations) (see Table 10). Nonetheless, there is evidence that they contribute to a foundation of

knowledge which is then built upon in other learning experiences, such as guidance by experts and practical experience, which provide a combination that is likely to be generative of more complex learning outcomes. The combination of this foundation, and practical experiences, is reported as co-producing deeper conceptual knowledge (Gott, 1989). The learning guides, if used effectively by the participants, have the potential to develop that base in an consistent and accessible form.

Consequently, it is recommended that the learning guides be used in a structured way, that integrates their use with workplace experience, and guidance from mentor or more experienced others - more experienced fellow workers. Such an integration might consist of the following process, for novices in a work area. The novices' induction would commence with a guided introduction to the work area to be learnt. This would need to include and emphasise reference to the processes involved, and the product of the work area. It seems important that learners understand both the processes and product of work area they are to learn, as this provides a basis for the learner to `make sense' of the things that they see and do, in the work area. The length of time of this induction should be as long as it is feasible to support such an induction, and as short as it is necessary for the novice to gain an appreciation of the procedures and product of the work area. Ideally, this induction should be undertaken, as much as is possible, as part of the shift activities. Although this may be seen as some initial `over-manning', its returns should be evident as this induction should allow effective use of the learning guides and aid the development of understandings which should benefit QMAG.

This guided induction would be followed by access to learning guides, to be used in conjunction with experience in the work area. Novices will require the workplace experience, to understand the learning guide, as much as later the learning guides will assist understanding work practice. This experience provides an authentic conceptual base for novices to construct their understanding of the work area, and the nature of skilled work within it.

The integration of the work experience, and learning guides might be best managed by use of the learning experiences contained in the module and/or a checklist of tasks required to be learnt in the work area. It is also acknowledged, and probably needs to be accepted, that learners are likely to use the guides in quite different ways. In the validation phase, some participants scanned the guides briefly, and stated that with the combinations of experiences they were having, this was an adequate use of the guides. Other learners, reported using the guides more thoroughly, and engaging in all the learning activities, consciously, and, with great fidelity. Still other learners, reported using the guides as a resource to dip into, as occasioned

by problems or situations in which they found their knowledge lacking. The importance is that the participants use the guides.

Some other, more specific, recommendations related to the learning guides.

A greater inclusion of text which address the `why' questions is recommended. Learners should be informed of the reasons "why", from - *"why it is important to check .... before starting up, to why it is necessary to consider x & y when planning to increase reduce feed/temperature etc.* An understanding of `why' , is important for developing understanding and to ensure that actions taken are appropriate. The severity of the incidents at both Chernobyl and Three Mile Island, have been attributed, in part, to a lack of understanding by operators of the processes they were controlling. Some participants, at QMAG, claimed that the learning guides described the work processes in an `idealistic' and simplified form, rather than processes with a range of variables which impact daily on the work area's performance. Consequently, a focus on `why' things are done, will assist with understandings about daily work practices and processes. It is this sort of understanding permits complex work performance, and the application of skills to new situations.

It is also recommended that the answers to questions in the learning guides **not** be presented on the following page. Even experienced participants reported cheating, particularly because the narrowness of a correct response meant that interpretations and understandings had to be both peculiar, and precise. It is suggested that answers are placed away from the area being examined, and that questions be included that encourage a broader, and deeper, response. Generally, questions that are so specific that there is only one pre-specifiable right answer are generative of very specific knowledge.

Central to the success of the learning guides is the literacy skills of the user. A learner who is struggling to comprehend the text, is unlikely to gain as much from these resources as a more literate learner. Whereas the more literate learner can read and monitor the text for inconsistencies in their interpretation, the less literate learner will lack this ability and their understandings are more likely to be based on an unquestioning understanding of their interpretation of the text.

1.2.2 Computer-based learning material

The computer-based learning (CBL) material provided learning experiences that were valued by the participants, because of the interaction between the media and the learner. It was reported that the CBL was stimulating, with learners being engaged in a highly active learning process. The interactive

components of this instructional media, questions to be responded to, and the visual appeal, were responsible for the active learning process. Active approaches to learning are valuable, as learning is itself a highly active process, with the learners constructing meaning from what they experience (von Glasersfeld, 1987).

Again, like the learning guides, the CBL process is reported as being generative of specific procedural and propositional knowledge, although to a lesser degree (see Tables 4,5,8 & 9). From an instructional design viewpoint, any effort to develop understanding, in the ways outlined above, for the learning guides would be appropriate, for the CBL. Similar issues arise with learners who are poor readers. However, the strong visual qualities of the CBL, probably provides a range of clues and support for the learner, which are less evident in the learning guides. While it is not suggested that the CBL is devoid of explaining the `why' questions, this again is a quality that should be maximised.

The narrow syntax required in the answering of items within the CBL, caused a high degree of annoyance and frustration, and restricts the responses to specific and potentially trivial knowledge types (see 4.2). These sorts of knowledge are useful for an initial understanding of facts, concepts and propositions. However, they are not the sort of outcomes that are generative of the important higher order skills that workers at QMAG are called upon, to use in addressing the more complex requirements of work activities.

1.2.3 Mentoring arrangements

Mentoring arrangements, within this report, include both the official mentors, appointed to the learners for the validation phase, and the defacto mentorship provided by other, and usually more expert workers, during the validation trials. The reason for combining these two forms of support is that learners reported frequently engaging in very purposeful mentoring arrangements, with either their official mentor or another worker on shift, who the learner acknowledged as having expertise in the work area (see section 4.4). Not all learners shared the shift with their official mentor. However, those who did share shifts reported this to be a positive situation. Moreover, those who did not share shifts with their formal mentors, reported frequently engaging in defacto mentoring arrangements, which were highly valued.

Mentoring arrangements, as defined above, were consistently reported as providing for the development of a range of knowledge types, and pressing learners into higher order activity, through joint problem solving as illustrated in Tables 4,6,8,9 and 10. It would seem that one of the great strengths of the QMAG

work environment is that guided learning is allowed to take place with great openness. This evaluation provides evidence that mentorship is now emerging as an ordinary component of work practice and shift collegiality. It is proposed that the quality of this mentorship is founded on two factors. Firstly, the openness of workplace arrangement as based on the QMAG work practice. Secondly, the small size of work team sizes, are themselves conducive of good interpersonal relations and responsibilities for novices. It has been recognised that communal activity of the type evident at QMAG provides the basis for interaction which avoids strict score-keeping (Clark, 1984). This type of activity is contrasted to one where exchanges require responses of a more tangible sort.

Significantly, this type of guided learning is being increasing reported, in research findings, as being conducive of complex learning outcomes (Lave & Wenger, 1991, Rogoff, 1991). These learning outcomes appear to be the result of the learner observing expert practice, being directly or indirectly guided to achieve the same standard of practice through a process of increasingly mature approximations of the task goal.

It is recommended that mentoring becomes a role to be undertaken on each shift, and that it become part of ordinary work practice. This will help achieve the desirable goal of a `learning culture' at QMAG, in which learning is accepted as being a normal requirement of work practice. To maximise the potential of the mentoring it may well be worth considering developing mentors' skills in modelling, coaching, guiding and fading (Collins, Brown & Newman, 1989; also see Billett 1993a). A key reason for this suggestion is founded on the previously mentioned concern for developing understanding, about work activities. To develop expert practice, this understanding may need to be made explicit by the mentors, given the nature of many of the tasks conducted at QMAG, include processes that are hidden, and the tacit or unconscious nature of much of expert work practice.

1.2.4 Videos

The videos were accessed by only a few learners. The reported strengths of the videos were their ability to show the process of a series of operations, before learners actually experience them. This instructional media was reported as providing for the development of specific knowledge and understandings, by the few participants who had accessed it (see Table 8). In this sense they were adjudged to be useful. However, concerns were expressed about some of the content, including safety concerns, and the text exhorted learners to do things, without stating `why' they should be done (see slipping electrodes). The main strength, that was reported of the videos, was the opportunity for learners to preview the work area

and nature of work tasks, before actually experiencing them. This may be useful for work areas which are inaccessible. These issues are discussed below in general recommendations for the training system at QMAG.

1.2.5 Contributions from the informal elements of the skill development process at QMAG.

In addition to the formal elements of the skill development process at QMAG, the contributions from informal learning experiences were examined and findings reported upon. Already included in Section 1.2.3, above, Mentoring arrangements are the findings about the contributions provided directly by Other workers. In the next section the contributions to the participants' learning provided by Everyday work activities, Observing and listening, and Direct instruction, and the Work Environment, are reported.

1.2.6 Everyday Activities

Respondents reported that everyday work activities provide practice, which allowed work practice to become `second nature, and that these activities were contextualised by the requirements of work practice. This implies that the proceduralisation of the participants' knowledge and understanding was organised by the authentic requirements of work activities. For learning to occur it had to be legitimated by the evidence found in daily practice.

Everyday activities were reported as being useful for assisting with the problem situations as reported in Table 4. It was reported as being the fourth most important contributor in these critical situations after Other workers, the Work Environment, and, Observing and listening. Equally, everyday activities were reported as being facilitative in the development of a range of knowledge types, and was reported as being the second most frequently responded to element in the development of both procedural and dispositional knowledge items (see Tables 8 & 9).

In the reported development of higher order procedures (see Table 10) everyday activities again was the second most frequently reported item in being very useful, again, after Observing and listening. This data is highly supportive of authentic work activities as being conducive of a range of knowledge types and attributes that are essential for effective work practice at QMAG.

1.2.7 Observing and listening

Both novice and experienced participants acknowledged their perceptions of the value of `Observing and listening', as a means of acquiring and developing further their skills. It was suggested, by participants,

that this is an on-going and practical way that knowledge, and even highly specific information, can be communicated within the workforce. Respondents were able to detail in a range of ways when observing and listening had been useful. These experiences transcended formal workplace settings into the social milieu of the tea room.

Observing and listening was reported as being highly effective source of knowledge which could then be applied to problem situations to achieve desired results. It was the third most frequently reported aid to problem situations (see Table 4). However, it was very frequently reported as being a very useful way of acquiring all knowledge types, but particularly procedural and dispositional knowledge (see Tables 8 & 9).

This element of the skills extension program was reported most frequently for the development of procedural knowledge, being reported as a highly effective mode of learning in 15 of the 16 attributes which were categorised as being mainly procedural. Again, in Table 10, which reports participants' perceptions of the elements' ability to help secure higher order thinking, Observing and listening was the most frequently reported element in developing higher order knowledge.

1.2.8 Direct Instruction

The element of 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. 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' they might deliberately ignore what they were being told. Secondly, if direct instruction failed to provide reasons `why things had to be done', it was likely to press operators into activity, but without knowing why they were undertaking the activity.

Direct instruction was also reported as being very effective when respondents' perceptions to problem situations were canvassed (see Table 4). Equally, it was reported as developing a range of knowledge types, when the respondents indicated which elements would be effective in the development of a range of attributes required for effective work practice at QMAG (see Tables 8 & 9). Moreover, it was reported as being able to develop those attributes which, it was inferred, required higher order thinking skills (see Table 10).

1.2.9 Work environment

The contribution of the work environment was also reported by participants as being conducive of a range of knowledge types. The responses to this element, may not have always been consistent, as a number of respondents interpreted this element in different ways. It was intended to refer to the physical environment of the Parkhurst and Kunwarara sites. However, some participants indicated that they had responded to the nature of interpersonal relationships at Parkhurst. However, despite this limitation, data provides evidence of its general acceptance across the participants as being useful for the development of knowledge types (Tables 8, 9 & 10) and, also, in the resolution of problems (Table 4). When responding to problems, the Work environment was the second most frequently reported of all the elements, as being very useful (see Table 4), after Other workers. It was also reported as being perceived to be conducive of the development of a range of knowledge types, which included most frequently reported for dispositional knowledge. It was not highly rated in the development of higher order thinking, however (see Table 10).

1.3 GENERAL FINDINGS AND RECOMMENDATIONS

Effectiveness and maintaining the system in the future

1.3.1 Overall, there is considerable evidence that involvement in the skill extension program at QMAG had positive outcomes for the participants (see Table 15 & 16). Development was reported as being far greater for some learners than others, with some learners' development being described as almost spectacular, by expert mentors. Participants, and experts reporting on those respondents provided evidence that changes in attitudes, understandings and problem-solving, had occurred during the validation phase. There seems to be considerable evidence, from a number of sources, about which particular elements of the skill development processes were considered more effective than others. There is evidence, from a number of approaches, that suggest that the everyday workplace experiences of workers at QMAG, when organised and guided, allows the learner access to learning experiences such as observing and listening, undertaking tasks and seeing the results of those tasks.

1.3.2 Perhaps the most confounding issue, for the provision of the learning system at QMAG, is 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. Overall, some participants reported

being engaged far more actively in their approach to learning, than others. A group of learners 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 progress in a very useful way. Moreover, these learners also participated in the evaluation activities in a positive way that was able to effectively depict their development. 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). 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. Finally, some participants claim to have had difficulty accessing the learning experiences. However, overall there is a range of evidence which suggests that involvement was generally beneficial for most participants, but more for some, than others, 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 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, others would perceive it as an opportunity for their lack of skill and ability to be acknowledged, once more. 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.

1.3.3 Some form of incentive of either a tangible or intangible nature may be useful for gaining commitment from some of the reluctant learners. More subtle forms of involvement, and experiences of success, will probably be required for reluctant participants who are concerned about their ability to succeed.

1.3.4 From the responses, the notion of a learning system at QMAG is something which is worth pursuing. The strong evidence is that the environment at QMAG is very conducive for learning

of an on-going and broad nature to proceed. The evidence in this report emphasises the social learning processes at QMAG, and to a lesser degree, the explicit instructional media of learning guides, computer-based learning and videos. However, the informal learning processes will benefit from structuring and processes that assists with them being comprehensive and coherent.

The four elements of the skills extension program, the learning guides, computer-based learning, videos and mentors were differentiated by perceptions of their effectiveness. By far the most frequently reported element was the role of mentors, especially if this included the defacto mentorship that appeared to be provided to participants by `other workers'. The learning guides are reported as being the most strongly supported of the instructional media. A fewer number of participants had access to the CBL and videos. A range of support was advanced for the CBL media. However, the most frequent responses (modes) to these instructional media, from a number of instruments and procedures, indicated that they were not as valued, as other aids to learning. What this data indicated was that those who had used these aids, still reported other forms of learning as being able to develop similar outcomes, but more effectively.

1.3.5 One of the more difficult questions that needs to be addressed by QMAG is how the company's investment in training provisions can be managed in ways that maximise benefits to the company. In terms of the four deliberate (formal) arrangements that have been put in place by QMAG, learning guides, computer-based learning, mentors and videos the following might be considered. In reflecting upon the needs of an effective learning system capable of producing the sorts of skills and understandings required of QMAG, and the nature of the operations at Parkhurst and Kunwarara, the following priorities are proposed.

Given the need to integrate skill development processes and aids, with elements of work practice that are frequently changing, flexibility and maintenance of elements of the training system are, and will continue to be an important issue for QMAG. The closer the linkage between the learning aids and other documents the more frequently they will need to be modified.

1.3.6 In terms of effectiveness and cost effectiveness, the mentorship arrangements have the greatest potential as reported by participants below (see Tables 4,5,6,9 & 10). The mentorship arrangements are on-going, ubiquitous and provide access to a rich array of learning experiences and outcomes, such as guidance, observing and listening (see Section 4.4). Three aspects of the mentor's role are critical for the success of these arrangements. Firstly, the currency and depth of

their knowledge and understandings. Secondly, their ability to communicate with and provide activities and guidance for the learners. Thirdly, the ability of the mentor to probe and question participants to develop deeper understanding.

1.3.7 The learning guides provide the next level of effectiveness (see Table 4). They are restricted in the depth of understandings they develop (see Tables 4,5,9 & 10), but assist in providing a useful base of knowledge. (see Section 4.1) Given the need for the text, and information base of learning aids to be current and reflect the changing nature of work operations, it needs to be recognised that an on-going monitoring of resources will be required to keep the learning guides current and consistent, with work practice and documentation such as Work Instructions, Preventative Maintenance instructions, and any quality assurance requirements not addressed in the work instructions. The inherent danger is that if the learning guides are not perceived as being current, they might be dismissed as being irrelevant. There is need to consider, how best to maintain the currency of the learning materials, while maintaining a balance in terms of the need to incorporate the minutiae of ever-changing production requirements in the learning resources. The question is how can they be kept current and reliable, without being a punishingly heavy drain on resources. The answer may well be to make decisions about the degree that the guides need to address the minutiae of everyday production, against informing learners about the principles which make for effective work practice.

1.3.8 The computer-based learning material should also be considered in terms of usage against development and maintenance costs. It is generally acknowledged that this form of instructional media has an extensive developmental cost. However, this cost is usually justified in terms of the breadth of their use (eg. number of users), their flexibility of access, and a belief that once these systems are established they are self-managing. Decision-making, at QMAG, might be conceptualised in terms of whether the number of workers, who will access CBL, justifies the cost of maintaining and updating these systems.

Questions which might be pursued in these judgements might be: *Are there situations where the expenditure is more justified in certain areas than others? Are there particular areas where such expenditure is justified, eg. Deadburn Control Room, because of its computer interface?* It may be worth conducting a costing exercise on the development and maintenance of the CBL and considering the number of workers likely to access this media.

While the participants reported that the CBL was generative of certain knowledge types, the same material is available in the text of the learning guides, and the learning experiences available elsewhere are generative of the interactive qualities of CBL.

Other considerations might be how often the learners actually use the CBL media - is it once, twice or more often? Are they likely to want to use it as a reference source - is it accessible enough, to allow this type of use?

1.3.9 The main strength of the videos, was the opportunity for learners to preview the work area and nature of work tasks, before actually experiencing them (see Section 4.3) This may be useful for work areas which are inaccessible. However, the cost of producing the videos need to be balanced against the ease with which is possible to show the learner, more authentically, aspects of QMAG operation. It was suggested that they would only be used once, by each participant.

KEY RECOMMENDATIONS.

The following are some key recommendations that arise from the evaluation.

Recommendation #1

The learning system, at QMAG, be viewed as a combination of the both the planned and intended aids to learning, learning guides, CBL, videos and mentoring, and also the strong unplanned aids to learning, which are fostered by the participative and collaborative nature of work practice.

Recommendation #2

The learning arrangements need to focus on developing participants' understanding of `why' they are doing things, and a deeper appreciation about what they are doing.

Recommendation #3

That guidance be provided by mentorship as a universal quality of work practice, and that guidance support autonomous learning activities through the qualities of indirect and direct guidance, tolerance and the provision of adequate practice.

Recommendation #4

That some form of enticement or reward be considered, for both sponsors and participants, to increase commitment to participation in the program.

Recommendation #5

To assist with maintaining the system it is necessary to consider the best way to retain currency of the materials, without excessive resource commitment.

Recommendation #6

It may be appropriate to use a checklist of activities, required skills, or the learning exercises from the learning guides to assist with novices engaging in, and learning the full range of activities in the work area.

2. INTRODUCTION

This report describes the procedures and findings of the evaluation of the skills extension program at Queensland Magnesia Pty Ltd. The evaluation of the training arrangements was conducted on-site between July and October 1993, and involved 15 QMAG employees who participated in trials of training arrangements at five work areas at the Parkhurst and Kunwarara sites. In addition, the evaluation included significant contributions from five mentors, responsible for creating much of the modularised text-based material. The participants' characteristics are described in more detail in the section entitled Sample (3.1). The evaluation methodology comprised pre-assessment, and summative evaluation of the participants' attitudes, skills and understandings. Between the pre-assessment and summative evaluation phases three structured interview were conducted, at monthly or three weekly intervals. These interviews aimed to elicit information, from participants, about their progress in the learning arrangements and the relationship between these arrangements and their work practice. Of particular importance, to the evaluation, was the efficacy of the learning guides, computer-based learning media, instructional videos and mentoring arrangements being trialled during the validation and evaluation phase. These aids to learning had been developed by QMAG staff and are characterised as the formal components of the skills extension program. In addition, the evaluation specifically sought to determine whether the participatory and consultative nature of work practice at QMAG contributed to an effective learning system. The brief which was addressed in this project is as follows:

> *Evaluation and validation of the module learning materials, environment and delivery mode(s) as an integrated and effective learning system. (QMAG, 1993:5)*

The procedures used in the evaluation and validation processes which sought to address this objective are detailed in the section entitled Procedures (3.2).

As specific learning interventions, the learning guides, mentors, videos and computer-based learning aids are part of the overall activities that learners participate in at QMAG, it is necessary to consider these in conjunction with the other learning activities. In addition, the links between the aims of the QMAG award, which stress participation and consultation, and a learning process which demands an active and autonomous role for the learner needs to be acknowledged, as being a key consideration for human resource development and management practices at QMAG.

3. METHODOLOGY

This section describes and summarises the approach taken in the evaluation. It commences by outlining the sample, followed by procedures used in the evaluation.

3.1 Sample

The sample consisted of 15 participants who are all full-time employees of QMAG. The length of service and experience, of the participants varied, both at QMAG and also within the specific work areas which were targeted for the validation phase. The work experience varied, from 2 days employment with QMAG, through to involvement which included employment during the construction and commissioning of the plant (see Table 2). The workers who participated in the validation exercise were all engaged on rotating twelve-hour shifts, which usually comprises three consecutive day and two nights shifts. Occasionally, three consecutive night shifts were worked. It is intended to keep the plant working 24 hours a day, every day of the year. Program participants were interviewed during work time, between shifts or sometimes on their days off.

Five work areas were selected to be the subject of the validation and evaluation. The basis for this selection included the preparedness of the learning guides. One experienced person and other workers, who were novices in the particular work area, were selected from each work area. In this study, the former are referred to as experienced and the latter as novices. The role of the experienced participants was to trial the materials, and provided refinement of a technical nature of the content of the learning modules. However, there were two types of novices. Firstly, there were those that were new to the organisation and the work area. Secondly, other novices were experienced operators, but were new to the work area they were learning about. The breakdown by work areas is detailed in Table 1. The sample comprised 14 males and 1 female. The sample was selected by QMAG to provide a cross-section of workers from different areas for the validation and evaluation.

Table 1 Participants by work area

Work area	Novices	Experienced	Total
Electrofusion	2	2 experienced - trialing	4
Calcination	1	1 trialing in an area outside current duties	2
PCS/BSG	3	1 experienced - trialing	4
Deadburn C.R.	1	1 experienced - trialing	2
Preconcentration	2	1 experienced - trialing	3

Total	9	6	15

The participants' preference for learning arrangements was elicited in an initial survey. This survey reported a strong preference for workplace learning (see Table 3). However, this support was qualified by some of participants who expressed concerns about the ability of workplace learning procedures to develop understanding (see section 4.02). Not all of the participants had the equal access to the learning arrangements. The videos addressed only one work area (Electro-fusion), and the computer-based instructional media was only developed for two areas (Electro-fusion and Deadburn Control Room). Three respondents claimed they had been unable to participate fully in the program due to work commitments.

As has been discussed above, one of the significant findings from this study was the range of levels of involvement indicated by participants. This range of involvement ranged from highly pro-active involvement to virtual disinterest. Given the key role of responsibility for learning to be placed with the participant, this finding is quite significant to the skills extension program at QMAG.

3.2 Procedures

A range of evaluation procedures was used. These procedures can be categorised firstly, as those which were designed to determine changes that occurred as a result of participation in the skills extension program, and, secondly, those that sought to determine the effectiveness of the learning processes accessed as part of the program. The first category, which could be described as pre and post-testing, comprised of 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. During the validation phase of the skills extension program, the participants took part in three structured interviews which sought to determine the effectiveness of the training system. In addition, the participants responded to a survey of how a range of attributes could be developed by the training system. The attributes, were reported in an earlier study (Billett, 1993), as being those required for competent work at QMAG. An overview of the evaluation procedure is illustrated in Figure 1 - overleaf.

Figure 1
Evaluation overview - Queensland Magnesia (Operations) Pty Ltd

Phase	**Briefing & Setup** **24/25 June**	**Progressive Evaluation** **i) 22-23 July** **ii) 19-20 August** **iii) 16-17 September ***	**Summative Evaluation** **7 & 8 October**
Activities	**During this phase:** **n Individual Briefing and backgrounding** **n Attitudinal survey** **n Concept maps** **n Mentor consultations**	**During these phases:** **n Structured Interviews** **. critical incidents** **. problem situations** **. survey of aids to learning** **n Inventory of skills required by means of acquisition**	**During this phase:** **n Attitudinal survey** **n Concept maps** **n Expert-derived problems** **n Responses tp propositions about learning at QMAG**

As a means of describing these procedures the following approach has been adopted. The initial survey concerning the participants' initial and preferred modes of skill acquisition is described first. This is followed by a description of an approach used in the structured interviews and attribute inventory, which were used to elicit data about the efficacy of the formal and informal skill development processes at QMAG. Next, the attitudinal surveys which were conducted during the briefing and the summative phases are described. Following this is a description of the concept maps, also used during the briefing and summative phases. Finally, the use of the expert-derived problems is outlined.

3.2.1 Individual Briefing and backgrounding

Briefings were conducted with each of the participants in the set-up phase. The briefing involved explanations about the validation and evaluation process, and its aims. In addition, some initial responses was gathered about the participants' familiarity with the skills to be learnt. This process was also used to inform the participants about confidentiality and determine information about prior experience with, and preferred mode of learning vocational skills. The participants were asked to respond to the following questions.

. *How long have you worked at QMAG?*

. *How long have you worked in the ....area? (the work area the participant will be learning about) (see Table 2)*

. *Which method have you acquired your work skills in the past?*

Integrated college and work, like apprenticeship, or College first, then on-the-job, or On-the-job (see Table 3)

. *What was useful about that approach?*

. *What wasn't useful about that approach?*

. *When wasn't this method useful?*

. *What do you believe is the ideal way of acquiring skills and why? (see section 4.02)*

This data was gathered using a survey instrument, onto which the participants wrote their responses.

3.2.2 Interviews

A series of three structured interviews were conducted at monthly or three-weekly intervals (see Figure 1). The interviews were used to determine perceptions of the effectiveness of the learning arrangements. As mentioned above the formal elements comprised the learning guides, computer-based learning materials, videoed instructional media, and mentoring arrangements. The contribution of informal elements of the learning system were also investigated. These elements were direct instruction, everyday work activities (just doing it), observation and listening, other workers, and the workplace setting itself. In addition, the contributions of the Action Thinking seminars, with which many of the participants had been involved with were also recorded.

Interviews were selected as a data-gathering strategy, given the nature of work activities at QMAG, and the highly interactive process of workplace communications. As it was important to gather information over a period of time, interviews were used to gather information about progress and experience with the aids to learning on three occasions. The nature of the work activities and the need to gather data over time, were such that strategies such as observation or participant observation were rejected. However, as the validity of self-reporting is often questioned, approaches were used which attempted to ground the responses to particular events and situations, rather than provide opinions. It has been claimed that verbal data can be founded on opinion, rather

than actual events or changes in behaviour (Ericsson & Simon, 1984). A critical incident approach was adopted to increase the validity of reporting. The participants were encouraged to ground their responses in actual events. This approach involved getting the participants to recall and consider `high moments', `problem-situations' and `low moments'. Having recounted these events, the participants were asked to rate the effectiveness of the contributions of elements of the training system to these situations (see Attachment #3). This approach is illustrated below. The responses to the critical incidents approach and descriptions of the usefulness of the learning system were audio-taped and transcripts were produced. An interview schedule 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 participants were asked to respond to each of the three sets of questions below.

n *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?

Consider when you last had a problem to solve in the work associated with .....

How did you go about resolving that problem? What didn't you know? Who or what helped? Why was that helpful?

n 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?

During the interviews, the participants were also asked to provide a specific example of how each of the elements of the learning system had contributed to their learning (see Section 4).

3.2.3 Attributes inventory

As part of the third interview, participants were presented with an inventory of attributes of skilled workers that had been generated in an earlier study (Billett, 1993). By this time in the validation phase, the participants had experienced a range of learning experiences, and were aware of different approaches to skill acquisition. Consequently, the use of this inventory was deemed timely, and again, likely to provide responses grounded in the learners' actual experiences. The attributes in the inventory had been developed by approximately forty workers at QMAG some 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 - values and attitudes. In this evaluation participants were asked to rate the usefulness of the elements of the learning system, 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 and the global data compared (see Tables 9 & 10).

3.2.4 Attitudinal survey

A survey was used at the briefing and in the summative phase of the evaluation to determine the respondents' attitudes towards the work area they were to learn, and the conditions of their employment at QMAG. (see attachment #2). The participants were asked to indicate on Likert scales their responses to the

following questions and then provide justification of their responses.

1. How much of the jargon used in the .....area do you currently understand?

The responses for this item were (eg. *None - Very Little - Most of it - All of it*)

How did you learn what this jargon means? (see Table 11)

2. How strongly do you identify with being a skilled ..... ?

The responses for this item were *(Strongly - Some identity - Not much - Not at all)*

Why is that? (see Table 12)

3. Do workers in this area do something that is different or special?

The responses for this item were *(Not different or special - Some specific differences -Special and distinct - Quite different*)

How has your opinion been formed?

4. How strongly do you identify with the goals of the Q Mag award - participation and collaboration?

The responses for this item were *(Not at all - A bit - Quite a lot - Very strongly)*

What has caused you to hold this opinion? (see Table 13)

5. How realistic are the goals of the Q Mag award - participation and collaboration.

The responses for this item were *(Totally Unrealistic - Ambitious - Achievable - Realistic)*

Why is this? (see Table 14)

The responses were used to make judgements about initial understanding and association with the area of work. In addition perceptions about how the participants identified with the industrial agreement they were employed under, and the likelihood of its aims being realised. The initial responses were shown again to the participants in the summative phase, they were asked if their opinions had changed on any of these matters. If changes had occurred they were asked to indicate why that change had occurred. The responses to the questions were marked either on the original survey instrument or a fresh instrument which was attached to the original.

3.2.5 Concept maps

One of the key distinctions between expert individuals and novices is the degree and quality of the organisation and structuring of their knowledge (Glaser,

1984). Experts have information which is highly organised and structured, which allows for ready and accurate recall (Ericsson & Simon, 1984). Expert knowledge, in a domain, is organised hierarchically with key concepts being tightly structured. As novices move toward greater levels of expertise it would be expected that their knowledge would become more organised and structured. There also exists a view that as the novice begins to structure and organise knowledge it is likely to be structured in not dissimilar ways to those of the experts in the same work area. This structuring is due to the influence of guided learning of a proximal nature. To determine the degree and nature of conceptual knowledge and understanding, at the beginning and completion of the validation phase, concept maps were used (Novak, 1990). Concept maps can be used to determine how individuals represent and organise their knowledge. In the QMAG project key concepts, were identified in the learning guides. The concepts were ratified by the content experts, as being important concepts for the particular work area. The concepts were presented to the participants, on adhesive labels. Having been shown an example of a concept map, from the unrelated task of driving a car, the participants were asked to organise the concepts in away which represented a hierarchical organisation of the work in their area. They were encouraged to either add any other concepts that were not included, or discard any of the concepts which they thought were not important or did not understand. The participants created their maps on a large sheet paper, provided for them. The participants were also encouraged to make linkages between concepts and indicate the nature of any relationship between the concepts. This is used to indicate the linkages, which experts enjoy.

Participants created a concept map during both the briefing and the summative phases. In both instances care was taken, to provide the same instructions and labels to the participants. In addition to the learners, the on-site experts or mentors were also asked to develop maps in both phases, to act as a control group to determine whether by repeating the concept map exercise, scoring would be improved. The concept maps were assessed in two ways. Firstly a count of all the connections of each map was conducted. Secondly, the on-site experts were provided with anonymous maps and were asked to rate the organisation and correctness of linkages, using a scale which emphasised organisation and linkages. It would be expected that at the completion of the training process, the learners would have a more complex organisation of concepts associated with that work area. The two methods of assessing the concept maps aimed to provide a useful basis of comparison, which would also aid validity. Given the five different work areas, the different levels of complexity, and the use of five

mentors, the ability to make reliable comparisons across work areas is limited.

3.2.5 Expert-derived problems

Problem-solving, within a domain, is something which is undertaken far more effectively and speedily by experts than novices. Consequently, problem situations can be a useful assessment strategy to make comparisons between the thinking processes of novices and experts. The expert mentors were asked to generate a selection of problems from their work areas. From this selection, three problems per work area were selected. In the summative phase, these problems were presented to the participants, who were was asked to respond to the problems. The solutions to the problems were audio-taped and converted into transcripts. These transcripts were used, by the expert mentors, to make judgements about the quality of the responses. The expert mentors were given anonymous responses to the tasks and asked to rate them on a scale provided. The judgement process was aided by an assessment sheet, containing a Likert scale, which addressed the comprehensiveness of the responses to the problem. A separate scale was provided for each problem, but the criteria remained the same across the problems. The criteria was as follows.

Best possible response, no better options - good response, other options could have been considered - good response, but obvious alternatives not considered - OK response, but not very effective. (see Table 16)

3.3 Organisation of findings and basis for analysis

The specific findings are contained in the next section with some more general outcomes in the following section. The basis for analysing the knowledge types could be considered in the following terms.

Conceptual (propositional) - concept maps pre-test vs post-test

Procedural - skilled tasks - ability to respond to problem situations (during learning and post-test)

Dispositional - pre-test vs post-test attitudinal

4. FINDINGS

4.01 Participants' prior experience

The participants' experience, in the work area to be learnt, was elicited to gain insights about how the amount of prior experience may effect participation in the skills development process. The responses show that some of the novices had extensive experience in the work area, although it was reported that they did not necessarily participate in the actual work activities to be learnt. The nature of the participants' experiences is indicated in Table 2.

Table 2.
Experience in work area to be learnt
compared by participant type

Participants	Years.Months	Weeks.Days
Experienced workers	1.5, 1.8, 2.0, 1.10, 2.0, 1.10	
Novice workers	2.0, 2.0, 1.0	8.0, 12.0, 0.3, 1.0, 6.0, 4.0

The three novice participants, who had either one or two year's experience, all worked within one area of the Parkhurst plant. One of these novices had actively been involved in the work activities to be learnt, whereas the other two had been assigned duties separate from those to be learnt. Of the experienced participants, one was trialing the learning materials in an area, that was different from current duties. Whereas, experienced participants had over a year's experience, a number of the novices were recently employed, two of these workers had less than a week's experience, and were novices both to the organisation and the work area.

4.02 Previous and preferred modes of skill acquisition

The initial survey also elicited data about previous and preferred approaches to the learning vocational skills. Responses indicated means of skill acquisition, experienced by the participants, and also what they perceived ideal way to acquire the sorts of skills required for their work. The findings of the survey are stated in Table 3. and emphasise a preference for learning on-the-job. The respondents also reported the valuing of engaging in activities and working with others to acquire knowledge. Although the frequency of On-the-job and Integrated modes of learning remained constant between the acquired and `ideal', there was a exchanges of preferences between these two modes. While generally valuing the on-the-job mode of learning, a number of participants stressed a need to develop an understanding or knowing the `why' of activities. Some of these respondents suggested that some form of structure for workplace learning should exist, and others suggested that theory should be included work place learning experience (see Table 2). 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)

The ideal way of acquiring skills is to combine the overall background understanding then learn the practical aspects. (experienced participant)

... 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 were tasks are hidden from the learner.

Table 3
Sample's means of acquiring skills
and preference for the `ideal' approach

Modes of skill acquisition	Method of acquisition	Ideal mode
On-the-job learning	9	9 * **
Integrated	5	5
Formal Pre-employment	1	
Self-directed		1

* - On-the-job - with theory (2)
* - On-the Job - with structure (1)

In the next section, the participants' perceptions of the utility of elements of the learning system being trialled at QMAG are described. As indicated above, structured interviews, which pressed the respondents into providing evidence of utility, were used to gather this data. The participants were interviewed three times during the validation exercise about the effectiveness of elements of the learning system, that they experienced. They were pressed into supporting their

contentions, about the value of the aids, by providing examples of their effectiveness.

4.1 LEARNING GUIDES

How they were used

The learning guides were used in quite different ways by participants. Although there was a range of structured activities, in the guides, respondents did not report using these. Most respondents reported reading the resources through. However, the most frequent statements about their use related to them being used not in their own right, but as an adjunct to other learning experiences, notably everyday work activities. The guides were described 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 illustrate these points.

> *I've always found it easier to learn things by doing them practically. And then the manuals reinforce what you learn through -- you know, 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, yeah, 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)

> *Exactly like a reference.* (novice)

> *When we started, we didn't have to worry about that (terminology) too much. We just .... you know. 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)

A Reference source - That would be it. But it's a bit hard to define that. (experienced)

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. Sort of thing, you know. 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 the importance of integrating them with work place activities. The initial reading was reported as providing background information, but as the learner experienced situations of uncertainty in the workplace, the guides became a resource to be accessed in order to clarify meaning and remove uncertainty.

Responses about useability were varied from requests for more detail, to comments about them being clearly written - *good plain Australian language.*, Contrasting these were claims about the guides being *`very long winded'* and repetitive. The need for the guides to accurately reflect work practice and work instructions was emphasised by some participants, particularly those from the laboratory.

A lot of stuff is different to the actual work instruction book. That we call the bible in the lab. ... they don't seem to correspond. As soon as it's

updated, like the bible in there, as soon as it's updated, they'll have to come and do this one immediately. They'll have to be... there'll be no room for errors. (novice)

Overall, the guides were valued for providing `background' knowledge, and a platform for understanding. There were requests for the content to be more focussed on critical factors of operation not just a description of how the plant operated. The variety of forms of usage and the integration with workplace activities seem to characterise their use in the validation phase.

4.2 COMPUTER-BASED LEARNING (CBL)

The CBL material was valued because of its stimulating and interactive nature. It was seen as being more interesting and active than reading learning guides. The graphics presented a source of interest to the participant and the interactive nature of the CBL appeared to have engaged the learners. Respondents also claimed that when compared with learning guides, the CBL provided greater depth of understanding.

like, that I've actually done learning off a computer, so, it's like a new thing, you know, so you just, you learn a lot more because it's different. It's ah, 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 <u>can't</u> tell you - the time intervals. What ah, just that sort of thing. It's, like, it will basically set it out for you, the steps to do, but it doesn't, um, tell you, you know, how to do it.... you know.... like it.... It's a step beyond the learning guide. (novice)

Well, it give 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 users.

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. You know. 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, ah, what number hearths are the fire hearths on the multi-hearth furnace. Right. 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. Didn't know. And it was very frustrating. When you know you're putting the correct answers in and it kept saying you're wrong. You know. You end up pulling your hair out, in the middle of the night. Bloody hell. (novice)

Of concern, in terms of learning outcomes, is that the questions and answers are so tightly pre-specified that only comparatively trivial learning outcomes, such as factual information, can be assessed. This does not detract from the overall appeal of the interactive nature of the CBL material, but may limit its effectiveness as an assessment tool for learning outcomes, other than specific facts and simple propositions.

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

Problems of access were mentioned by a number of participants and mentors, often in informal discussions. It was suggested that the location of the CBL materials might be a key determinant in the frequency of its use. It was claimed that when it was taken into the Deadburn control room, one night shift, it was widely used by workers.

4.3 VIDEOS

The videos were not widely used. 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 reports, 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.

The inference is that while videos are visually stimulating they may not develop knowledge that is different from what could be achieved through observation.

4.4 MENTORS / OTHER WORKERS

"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 was reported as being approachable, 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. So.... 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. In response to the question "How does a mentor teach a novice about doing high quality, consistency work? 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 this is detailed below, 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.

4.5 CONTRIBUTIONS OF INFORMAL ASPECTS OF THE LEARNING SYSTEM

In addition, to the formal elements of the skills extension program there are also informal aspects. The key qualities of these elements is their ubiquity (hence access), and their on-going nature. Operators are emersed 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, Collins & Duguid, 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 situation, of 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.

4.5.1 EVERYDAY ACTIVITIES

Respondents reported that everyday work activities provided practice, which allowed their work activities to become `second nature'. 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 components of 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 idea of work activities becoming `second nature' appears to be significant. As individuals develop their ability to undertake tasks, these tasks become compiled and automated which allows for smooth performance (Anderson, 1982). This compilation reduces the demands of the working memory, which can be used to respond to new information or stimuli. This automation reduces the cognitive load (Sweller, 1990), freeing the mental processes to manage other problem areas. However, 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, you know, to keep up, to maintain the reputation of the lab, you

have to consistently put out accurate results. (novice)

This last example indicates the way that the values associated with work practices can be learnt by a novice, by engaging 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.

4.5.2 OBSERVING/LISTENING

The participants reported, "observing and listening" as partially providing a basis for workers to move from `knowing how' something to `knowing about' 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. From the calcination side. We're both on channel 4. 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. Do you find that useful. Just following what everyone, what other people are doing.

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 the 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. So there's always observing and listening.* (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 a key 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. That sort of thing. You just listen to what's going on.*

Consequently, the respondents have been able to report some of the important ways in which listening and observing is contributing to their knowledge and understanding.

4.5.3 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' they might deliberately ignore 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 know, you might change it but, you know, like if ..... 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 operators not knowing something or not being able to know something can be 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)

4.6 CONTRIBUTIONS OF ACTION THINKING SEMINARS

In a separate, but parallel exercise, some participants in the validation were also participating in an Action Thinking program. This section reports on participants' perceptions of the utility of this program's application to workplace activities.

I really enjoyed that. I've done those before. But this one was really excellent. Because you get projects at the end. And the project at the end makes you keep using it. I'm running behind schedule with the project. (novice)

A lot of action thinking is simple common sense. You do it but you don't categorise it as being action thinking. The average person just runs that though experience. You know. Most people, people who go out and do things. The average successful person, they do it subconsciously. (novice)

Before I did that course, I'd think about things differently. I'd just get on the one track. I'd think that this is, I was really narrow, I'd made my mind up before I'd about why someone had said that. I'd made my mind up why they did it that way. I had my own view and I sort of thought there could be this but, I'd sort of turn it to my way, the way I thought it should be. (novice)

One outcome of participation in the Action Thinking seminars was that differences in individuals' approach to engaging in this type of learning arrangements became evident. A number of respondents reported, or had reported for them, dispositions towards such approaches to learning.

> *Actually, I don't apply it as much as I should do... I think it's a bit alien to me at this stage. I'm a bit old. Too set in my ways, perhaps.* (experienced)

> *There's a certain sort of bloke, who won't get any information from those seminars.*

What are the characteristics of those sorts of blokes?

> *He is totally convinced that he's got his lot in life. That he won't improve any more. He's quite happy with the way he's going and he's at a level of competency in what he does, whatever he does, and he's totally disinterested in doing anything else. And there's quite a few of them. And they get nothing out of these seminars, whatsoever. Unless something like a bolt of lightening strikes them between the eyes during it. And they get spark of interest.* (experienced)

Some respondents suggested that a greater degree of guidance is required to suit their approach to learning.

> *But there was one thing that I was disappointed about. It was called the lateral action thinking process. It was all about lateral thinking. And I found it, and when we first, the first morning session was about thinking, and I found it terribly interesting and it was hardly mentioned at the next three days. And I was very disappointed about that. And now I forget how to do it... just about. I thought there should have been much more emphasis on it.* (experienced)

4.7 GLOBAL FINDINGS

In the sections above, perceptions of utility of elements of QMAG skills extension program have been described. They have provided information about how each of those elements contributes to learning and how they might be organised to maximise their potential. In this section, data from two separate procedures is used to provide some global and comparative findings about the efficacy of the elements. 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. Secondly, in the last set of structured interviews the participants responded to an inventory of attributes of skilled work at QMAG, which had been generated in a previous study. In both situations, the participants were asked to rate the utility of the elements of the learning system at QMAG.

4.7.1 Perceived utility of learning aids during critical incidents

During the structured interviews, participants were asked to recall three types of incidents; when things went well, when they had a problem to resolve, and when they had a low moment. This was undertaken to improve the validity of the self-reporting. Having described these incidents, and what had been of particular assistance to them, and what had not, the participants were asked to rate the effectiveness of the learning aids in providing for their success, helping them resolve problems, and lacking in the situation where things did not go well. Table 4 provides a frequency of how each aid to learning was perceived to be useful in response to problem situations. This table displays the frequency of responses. Modes indicate the most common or frequent response.

The findings in Table 4 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 aids 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 reduced

the claims of invalidity through different frequency of reporting.

What these findings report 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 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, it should be acknowledged that data was collected while respondents were recalling recent events, consequently that data was gathered by self-reporting with a much higher validity than the provision of opinions.

Table 4
Frequency of utility of aids of learning
when problem-solving

Aid to learning		**5**[1]	**4**	**3**	**2**	**1**[1]
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
F	Everyday activities	21[2]	8	11	5	3
G	Observing & listening	30[2]	10	3	5	
H	Other workers	22[2]	7	17	3	2
I	Work environment	11[3]	11[3]	10	4	3
J	Action Thinking seminar	6	7	10[2]	4	1

notes

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

In Tables 5, 6 and 7 there are other forms of comparison. The responses to this data has been ordered by the three categories of learning experiences which participants have had the opportunity to engage in; instructional media-based, indirect and direct guidance in workplace and the activities they engaged within.

In Table 5, 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 perceptions about instructional media, now need to be compared to the other clusters of learning aids.

Table 5
Reported utility of instructional media
in solving workplace problems

Learning aid	**5**[1]	**4**	**3**	**2**	**1**[1]
A.Learning guides	6[3]	1	3	1	6[3]
B.Computer-based learning		1			4[2]
C.Video				1	2[2]

notes

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

Table 6 reports the data of learning aids which are characterised as providing guidance. This data is contrasted with the responses to instructional media (Table 5), with modal frequencies for all forms of guidance being perceived to be very useful.

Table 6

Reported utility of direct and indirect guidance[4]
in solving workplace problems

Learning aid	**5[1]**	**4**	**3**	**2**	**1[1]**
D. Mentors	15[2]	7	8	1	2
E. Instruction	17[2]	9	9	3	3
G. Observing and listening	30[2]	10	3	5	
H. Other workers	22[2]	7	17	3	2

notes

1. Rating from 5 to 1 = very useful through to not useful
2. mode
3. bimodal
4. Direct and indirect proximal interpersonal guidance (mentoring, instructing, observing and listening, and other workers)

Table 6 indicates that perceptions of the value of direct and indirect interpersonal guidance was highly valued. The frequencies are very high and modes consistent across this category of learning aids. This table reports the perceptions of workers, which state that achieve goals and solve problems in the workplace, mentoring, instruction, other workers and observing and listening are very useful.

Table 7 reports the perceived contributions of activities and the physical context of QMAG to learning.

Table 7
Reported utility of activities and physical context
in solving workplace problems

Learning aid	**5**[1]	**4**	**3**	**2**	**1**[1]
F. Everyday activities	21[2]	8	11	5	3
I. Workplace environment	11[3]	11[3]	10	4	3

Table 7 also suggests that participants valued the contribution of work activities and the workplace in resolving problems and achieving goals. The modal frequency was very useful for Everyday activities, and for the Workplace environment it was bi-model between 4 and 5, which also indicates a perception of utility.

4.7.2 Perceived utility of aids to learning across work attributes.

As part of the last structured interview, participants rated the utility of elements of the learning system against a list of work attributes. These attributes had been generated in an earlier study and had previously been organised into attributes that largely reflected propositional, procedural and dispositional knowledge. The findings reflected a similar pattern to those found in Tables 4-5-6-7. In Table 8 the frequency of aids to learning which were valued by the participants is reported. By isolating the responses weighted either 4 or 5 it is possible to infer which were most valued. By far the most frequently reported learning aid was *Observing and listening* with 15 times being reported as the mode. *Other workers* was reported the second most frequently with 5 modes, followed by *Everyday activities* with 3, the *Workplace* with 2, and *Mentors* and *Instruction* with 1 apiece. Table 8 (overleaf) provides substantial evidence of how the participants' perceive the contribution of the learning aids to tasks reported to be important for successful work practice at QMAG.

Table 8.
Accumulation of aggregated responses to effectiveness of learning aids against work attributes

Top number indicates frequency of responses indicating 4 or 5. Lower number indicates frequency of responses indicating 3 or 2

Attributes	learning guides	computer -based	video	mentor	instruction	everyday activity	observe & listen	other workers	work place	Action Thinking	Other (please specify)
facts about your work	8 7	3 5	2 1	12	11 1	10 2	11 2	7 5	8 4	2 2	
understanding about work	4 3	5 2	2 2	9 2	10 2	12 2	13	8 5	10 2	2 2	
competence in routine tasks	1 5	1 2	1 4	6 3	9 3	12 1	8 2	7 2	9 2	 1	
competence in applying skills to new situations	4 6	1 1	 1	7 2	5 5	8 5	12 2	10 1	6 3	6 2	
minimising breakdowns	4 5	 1		5 3	8 3	11 2	11	8 3	6 2	6 1	
planning of routine tasks	1 7		 1	4 5	10 3	13 1	9 1	5 5	6 4	4 2	

Attributes	learning guides	computer -based	video	mentor	instruction	everyday activity	observe & listen	other workers	work place	Action Thinking	Other (please specify)
planning of complex tasks	52	1	1	53	73	76	91	91	52	62	
communication in work teams	13		2	37	64	73	131	101	54	62	
communication with managers	1			11	31	42	63	41	61	44	
predicting & minimising problems	36			72	72	92	14	74	74	71	
routine problem solving	25	1	1	64	64	82	101	65	63	63	
problem-solving with complex tasks	3			91	82	54	101	92	54	81	
multi-skilled	3	1	1	6	10	9	9	8	7	3	

Attributes	learning guides	computer -based	video	mentor	instruction	everyday activity	observe & listen	other workers	work place	Action Thinking	Other (please specify)
within routine tasks	5	2	1	1				1	1	2	
multi-skilled across different work areas	8 3	3 1	1 2	10 1	10 2	9 2	11 1	12 1	8 2	3 4	
keep up with technology	7 2	5	4 1	7 1	10 4	4 4	11	8 3	5 3	1 6	
interpersonal skills	1 2			6 1	3 4	13 2	14 1	9 2	4 4	7 3	
consultation	1 1	1		4 1	5 2	5 2	6	6 1	3 3	2 3	
analysis & thinking skills	2 4	1		4 2	2 2	7 1	12 1	3 6	5 4	6 2	
dedication to work tasks	4			4 3	6 4	8 2	6 4	10 1	9 2	4 2	

Attributes	learning guides	computer -based	video	mentor	instruction	everyday activity	observe & listen	other workers	work place	Action Thinking	Other (please specify)
interest	1 2	2 1	 1		7 3	6 2	6 2	7 3	10	3 1	
job satisfaction	1 3	 1	 1	2 5	4 4	11	7 2	11 1	10	2 3	
working without supervision on routine tasks	4 3	2 1	2 1	4	5 2	12 1	9 1	4 5	4 4	2 4	
working without supervision on complex tasks	3 1		1	3 1	6 2	9 2	10	5 5	7	5	
team work	2 1		1	4	4 2	8	11	10 2	8 1	3 3	
consistency	3 2			3	7 3	10 1	7 3	8 1	7 1	3 1	

To analyse this data in another way the long list of attributes has been categorised into attributes that are strongly identifiable with either propositional, procedural or dispositional knowledge. Table 9 provides a view of the data which illustrates how the learning aids are perceived as producing the different types of knowledge. All instances of a learning aid scoring 7 or more `very useful' responses in indicated in this table. As the computer-based learning materials and the videos failed to score in this table they have been omitted.

Table 9
Frequency of 7> when learning aids are reported as being most useful in developing different knowledge types [1]

Learning Aids	**Propositional Knowledge[2]**	**Procedural Knowledge[3]**	**Dispositional Knowledge [4]**
Learning guides	1	3	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
Action Thinking	0	3	0

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 analysis again reinforces the perceived potency of contributions of *"Everyday Activities", "Observing and Listening" and "Other workers"*, in the development of a range of knowledge types.

4.7.3 Reported development of higher order procedural knowledge

In another analysis of the same data, perceptions about the development of higher order cognitive thinking is examined. Seven of the attributes which have a strong relationship to higher order cognitive activity were identified. These were analysed in the same way to determine which learning aids were perceived to generative of more complex forms of knowledge. 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 value of QMAG employees developing these attributes is their significance in responding to the challenges that are evident in work practice at both Parkhurst and Kunawarara, where workers have a high degree of autonomy and need to be able to problem-solve and achieve high levels of plant operation.

Table 10
Frequency of 7> when learning aids are reported as developing higher order procedural knowledge types

Learning Aids	Higher Order Procedural Knowledge
Learning guides	1
Mentors	4
Instruction	5
Everyday Activities	6
Observing & Listening	7
Other workers	6
Workplace	2
Action Thinking	2

The importance of generating this type of knowledge is that it allows for the individual to apply their knowledge in new situations. 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. This data reinforces the pattern evident in previous studies and affirms the perceived role of *Observing and Listening, Everyday Activities, Other workers and Instruction* in being generative of these knowledge types.

4.8 PRE AND POST-TESTS OF ATTITUDES, CONCEPTUAL AND PROCEDURAL DEVELOPMENT

The previous set of findings have reported the perceived value of the learning processes during the validation phase. In the next section, the findings of interventions which were intended to determine the degree and nature of the participants' development are reported. These findings report changes in the

participants' attitudes towards aspects of the work area they are learning, and also to the conditions under which they are employed - the QMAG award.

4.8.1 Attitudes and values about work type and the QMAG award

It was conjectured that the degree with which an individual was able to understand language used in the work area would provide an indication of how effectively they are participating in the culture of work practice. The participants reported, before, and on completion of the validation phase, how much of the language or jargon used in that particular work area they understood. Table 11 illustrates the responses to the two interviews, with clear levels of improvement being reported.

Table 11
Understanding of workplace jargon reported before and after validation

	All the jargon	**Most of jargon**	**Very little jargon understood**	**None**
Before validation	4	9	2	
On completion of validation	9	6		

In the initial interview the 4 respondents that reported knowing *All the jargon*, were categorised as being experienced in the work area. They reported that they had acquired these understandings in the following ways:

- hands on
- learnt by participating in work practices
- through people you work with and time
- acquired in previous job listening to ex-miner

Those respondents that reported *Most of jargon understood* comprised three experienced operators and six novices. They reported having acquired their understandings in the following ways:

- original training by furnace manufacture's reps and here from commissioning stage gave me a good grounding
- hearsay

- asked what it meant.
- on-the-job training/listening; thinking about what people say/tell me; going through the work screens at my own pace after I have been told something or shown something
- learnt from instructors in the area, reading published articles
- by time on the job
- on the job training
- asking, listening to text used, assumptions
- from working with people who started off the plant

Two novices reported *Very little of the jargon understood*, who stated that:

- I have not yet learnt
- I am attempting to track down the meanings of the jargon by communicating with the operators

In the interviews at the end 9 participants reported understanding *All the jargon*. They comprised 5 experienced operators and 4 novices. Of the 6 participants that reported understanding most of the jargon 5 were novices and 1 was an experienced operator. The greatest movement was evident in the novices, with one reporting a move from *Very little* to *All of it*. When reporting how they had acquired the understanding during the validation the following was reported:

- by finding out what things are and what they do;
- day to day work experience;
- working with mentor and other workers, and operating things myself;
- training yourself;
- learning guides and cbl helped;
- being aware that there is more to learn;
- experience, more time, more listening and being around people when they use it (jargon);
- pandering to people, listening to what they are saying.

4.8.2 - Identification with work area

The respondents were also asked how strongly they identified with being a skilled worker in the area they had ben assigned to learn. At the completion of the validation phase only two novices reported having *Some identity* with all of the rest of the participants reporting strong identity with that work area.

Table 12
Pre and post-test of
identification with work area

	Strongly	**Some identity**	**Not much**	**Not at all**
Before validation	9	4	1	1
On completion of validation	13	2		

At the commencement of the validation 9 participants claimed to *Strongly identify* with the area of work, with 6 of these being experienced and other 3 being novices. They gave their reasons as follows:

- because I do and know my job well;
- being placed in a situation which calls for application of skills is an on-going thing;
- I like to be able to achieve at the highest possible standard, this means I must be skilled;
- having been involved in the commissioning and on-going production development;
- its what I do best;
- the area of BSG/PCS was developed to the required standard during the time I have spent in the area;
- because I like the job;
- one operator runs the shift;
- happy to be here, likes sunshine mining, lucky to have a job, good money, good people to work with, separate from Parkhurst;

Four respondents, all novices, reported *Some identity* with this area of skilled work at the commencement of the validation. They stated their reasons for this as follows:

- still learning;
- I would like to learn another area to help with my progress in the company;
- I still have a lot to learn, although I would be able to handle most situations in that area. I feel it is an extremely important area as it requires constant; attention as things can go wrong suddenly. The area is very sensitive;
- have to, will be part of necessary skills needed to be useful part of shift in lab.

One experienced operator stated not having much with the area of work because they - only called on to

apply the skills on odd occasions.

One novice reported that they *did not identify at all* with the area of working stating that they had - only two days experience.

On completion of the validation phase there had been movement in respondents' perceptions of how they identified with the work area. In addition, respondents suggested some reasons for that closer identification with the work area:

- been there longer, feeling confident, not scared and worrying about mistakes;
- understanding what's involved, understanding the section;
- judging myself against experts in the area, until I can achieve at the same level;
- direct involvement in the work, doing it on a daily basis, and
- more confident, more familiar, checking myself no major disasters

4.8.3 Identity with QMAG award

Respondents were asked to state at both the commencement, and the conclusion of the validation phase, how they identified with the award and its commitment to participation and consultation. This was undertaken to determine attitudes towards the overall goals of the award and the participants' role within it.

Table 13
Pre and post-test of
identification with QMAG award

	Very Strongly	Quite a bit	A bit	Not at all
Before validation	5	7	1	0
On completion of validation	8	6	1	

In the initial interviews 5 participants reported *Very strong identification with the QMAG award*, these being 2 experienced and 3 novices. The reasons they proposed for this identity are as follows:

- directs my future career;
- I find the general working conditions to be very innovative and stimulating. I have no hesitation

in expressing my opinion. management, supervisors listen and act if suggestions are relevant;
- never been so well off in my life;
- I haven't had a lot to do with it. Not much exposure to the subject. But I feel it has many good points;
- it gives me self-satisfaction and a sense of pride that I have done my personal best towards the main objectives of QMAG;

Seven participants reported *Quite a lot of identification with the QMAG award* in the initial interviews, these comprised four experts and three novices. Their reasons are as stated below:

- I feel it is unlikely to achieve a goal without participation;
- I believe in multi-skilling, to an extent as to increase involvement in your work. As long as it doesn't jeopardise other people's jobs;
- the QMAG award is progressive, allowing all levels with QMAG to work together for one goal;
- it is necessary to keep employees and company from becoming stagnant;
- a totally different approach to what I have been used to; and my initial reaction is one of enthusiasm;
- can make decisions; will be listened to; what you have said actually happens - its being done;

One novice and one expert stated they *Identify a bit with the award.* There reasons are as follows:

- personal;
- I admit to a lack of good working knowledge of the award

On completion of the validation phase the strong identification with the QMAG award had grown, with 8 operators (5 novices and 3 experienced) stating their very strong support. One novice reported identifying with the award *a bit*, and three novices and three experienced operators indicated quite a lot. The reasons they provided for this change is stated as follows.

The respondents were asked if they thought the goals of the QMAG award were realistic and achievable. This was to determine how realistic and personally committed they were to QMAG's goals. Table 14 reports the findings.

Table 14
Pre and post-test of views
about achieving goals of QMAG award

	Totally Unrealistic	**Ambitious**	**Achievable**	**Realistic**
Before validation	0	2	7	4
On completion of validation		2	8	4

Four participants, all novices, stated that the goals *are realistic*. The reasons they proposed for their judgement are as follows:

- the only way that a project of this size can succeed in the current world economic climate is to be totally efficient and provide an outstandingly consistent product. To do this it is necessary for all employees to participate and perform to the best of their abilities. People do not perform if they feel they do not belong. This applies equally to workers and management.

- its the way the industry is going; having worked in private industry for the last two years you have to have other skills to hold down a job.

- operators and QMAG are in the business of making money. I will do what ever I can for the company.

- the feeling of being a part of the team at Kunwarara and the ready acceptance that has been afforded me by the crew

Seven participants, four experienced operators and three novices, stated that the *Goals are achievable.* The reasons for their judgements are as follows:

- I see it as something that can be achieved
- given time and conditions I feel any goal is achievable
- because of the amount of support given to the employees, like additional training not just the minimal amount to get by, the better trained the workers the more effective the company
- if everybody does their part towards helping others and not just themselves
- QMAG has shown the strong desire to work together at all levels to benefit the company

- no one wants to regress - young company - potential - action thinking seminar

One novice and one experienced operator stated that the *Goals are ambitious*. They suggested that:

- compared to where I worked here it is to good to be true.
- top idea but isolation means lots of training; never had a job with so much training

On completion of the validation phase there was little difference in whether the participants' perceived the goals of the QMAG award were achievable. What was interesting was that one experienced operator expressed concerns about commitment and made a more pessimistic forecast.

4.8.4 Conceptual development

The participants, and also expert mentors, generated concept maps (Novak, 1990) at the commencement, and on completion, of the validation phase. The expert mentors were asked to complete the maps for two reasons. Firstly, they would provide a basis to make some judgements about the effective organisation of concepts associated with the work areas. Secondly, they provided a comparative basis to determine if the repetition of the task, after a three-month period increased scores. The concept maps were scored in two ways. Firstly, a count of the connections made in the concept maps was recorded. It is argued that because experts have knowledge which is highly connected and indexed that the number of linkages would provide one indication of the organisation of knowledge. The second way the maps were scored was to have the expert mentors make judgements about the nature and correctness of the maps.

It was speculated that there should be development in conceptual knowledge as a result of involvement in the skill development program. A limitation is advanced. In the post-testing a small number of the participants did not appear to give the same amount of effort to the exercise as they did in the creation of the first map. This lack of engagement in the task could be accounted for in a number of ways. Firstly, one participant appeared to be suffering from the effects of night shift. Secondly, one participant was experiencing some personal problems which he spoke about at some length, during the interview. Thirdly, the participants had been subjected to a range of different instruments and approaches to gathering data over the three month period and may have become quite blasé about the task. However, when participants had engaged in the task in a purposeful way, the results were quite interesting and provided some substantial evidence of development. When scoring concept maps, some of the expert mentors expressed surprise at the degree of development, particularly when it was revealed to them, after

their judgements, that the maps represented pre and post-tests. One expert described the development by one novice as being incredible.

Table 15
Qualities of concept maps, prior to and on completion of validation phase.

Participant	Status[1]	Work Area	Comparison of linkages[2]		Mentors' Appraisal[3] pre to post- test
15	exp	Pre-con	22	**+2**	**2 -> 3**
14	nov	Pre-con	21	**+9**	**3 -> 3.5**
13	nov	Pre-con	26	-4	3 -> 2
12	nov	BSG/PCS	33		
11	nov	BSG/PCS	18	**+26**	**2 -> 3**
10	nov	BSG/PCS	41	-2	2 -> 2
9	exp	BSG/PCS	37	**+1**	**3 -> 3.5**
8	exp	Deadburn Control	34	**+3**	**3 -> 3**
7	nov	Deadburn Control	31	**+7**	**2 -> 3.5**
6	exp	Calcination	24	**+4**	3 -> 2
5	nov	Calcination	24	**+8**	**2 -> 3**
4	nov	Fusion	25	**+18**	3.5 -> 3.5
3	nov	Fusion	28	**+4**	3 -> 3
2	exp	Fusion	32	**+6**	
1	exp	Fusion	27	-3	**2 -> 2.5**
Mentor		BSG/PCS	46	-6	
Mentor		Fusion	41	-4	
Mentor		Calcination	16	**+6**	
Mentor		Deadburn Control	39	no second	
Mentor		Pre-con	27	**+5**	

Notes

1. Participant status
2. No of links created between concept labels

3. Response to a likert scale - minimum 0 to maximum 4
0 indicates no response, 1 = no clear hierarchy of concepts, 2 = some organisation, a number of concepts ill-placed, 3 = well developed, some concepts ill-placed, and 4 = very well developed expert standard.

The data reported in Table 15 indicates that when comparing the number of linkages between the concepts in the pre-test situation and post-test situation that 11 participants improved their score, 3 had a lower number of linkages and 1 respondent is not reported. The expert mentors were asked to repeat the concept map at the same time as the participants, to act as a control group. The concern was that by simply repeating the exercise, the number of linkages would be upheld. However, this was not evident in the control group.

The mentor's appraisal of the pre-and post-tests, indicated that the organisation and hierarchy of the concepts had improved between the pre-test and post-test for 7 participants, remained the same for 4 participants, had declined for 2 participants, and 2 participants were not reported on.

All of the participants, except one, who were appraised by their mentors as having improved in their organisation of concepts, also had improved in the number of connections made in the concept maps. Of the participants 12 had improved in one or the other of the concept map assessment process. One novice participant scored lower in both counts, one novice remained the same in organisation and had reduced linkages, and one participant could not be reported on.

A qualitative observation is that participants, characterised as being highly active were generally those that performed better on both counts. This data infers that for the majority of the participants, their understanding of the conceptual nature of their work practice had improved, in some cases quite markedly.

4.8.5 Expert-derived problems

Table 16 reports the findings of the participants' response to the expert-derived problems. The expert mentors generated a series of questions, and these were given to the participants to respond in the fifth and final interview. The expert mentors were presented with anonymous transcripts of problem solutions, to grade using a Likert scale that was provided.

Table 16
Comparison of participants' scores

to expert-derived problems.

Participant	Status[1]	Work Area	Expert's appraisal of responses to problem.[2]		
			1	2	3
15	exp	Pre-con	2	3.5	4
14	nov	Pre-con	3	4	4
13	nov	Pre-con	2	4	1
12	nov	BSG/PCS	4	2	3
11	nov	BSG/PCS	3.5	1.5	3
10	nov	BSG/PCS	4	1.5	3
9	exp	BSG/PCS	4	3.5	4
8	exp	Deadburn Control	1	0	1
7	nov	Deadburn Control	1	1	1
6	exp	Calcination	4	3	4
5	nov	Calcination	4	3	3
4	nov	Fusion	2	2	1
3	nov	Fusion	2	2	1
2	exp	Fusion			
1	exp	Fusion	2	2	2

Notes

1. Participant status - experienced or novice
2. Expert mentors rating of responses to problems - 0 minimum to maximum 4. 0 indicates no response, 1 = OK response, but not very effective, 2 = good response but obvious alternatives not considered, 3 = good response, other options could have been considered, and 4 = best possible responses, no better option.

In reporting the data from the expert-derived problems it is important to note that it is only possible to undertake an analysis within each work areas, as the participants were responding to different problems, set and assessed by different mentors. A useful comparison is to see how the novices compared with the experienced workers in the work areas. This might indicate whether the performance of the novices is getting closer to the more experienced workers.

The data presented in Table 16 indicates that in all areas, except Pre-con the experienced worker performed better than the novices workers. However, there was not a lot of difference between many of the novices and the experienced workers. What could be inferred from this Table is that the novices are getting close to the levels of procedural understanding as their more experienced counterparts. It is also inferred that this ability is a product of the learning arrangements at QMAG, given the specific nature of the tasks and the problems that were set.

5. GENERAL FINDINGS AND RECOMMENDATIONS

This section summarises the findings of the evaluation, and proposes some recommendations for about possible future actions. **This information is also found in the executive summary at the beginning of the report.** Wherever possible, the findings described below are referenced to their source in Section 4 and 5. The organisation of this summary is as follows.

Firstly, findings and recommendations relating to the formal learning components of the QMAG skills extension program, are presented. This is followed by findings concerning the contributions of the informal aspects of workplace learning, which are an inherent part of the total learning experiences at QMAG. Some general recommendations, which will have direct influence on the training arrangements provide a conclusion to this executive summary.

Introduction

The learning arrangements experienced by the participants, at QMAG during the validation period, have been described by the participants, through a process of self-reporting and expert assessment, as being generative of the types of knowledge that should provide for complex work performance at QMAG. To maximise these outcomes, some general recommendations are proposed. Firstly, QMAG view the entire range of learning experiences, as being part of the overall skills extension program. Essentially, this means an integration of the informal and formal learning experiences available at both Parkhurst and Kunwarara. Secondly, in considering this integration, it is important that the workplace learning experiences, provide opportunities for the development of conceptual understandings that are required for complex work performance. The evidence from the evaluation was that there were abundant opportunities to develop procedural knowledge - `how to do it' skills. However, there needs to be explicit attention to developing understanding about - `why things are done'. This may require explicit types of intervention, of the sort which are outlined in the text below. Thirdly, it is recommended that decisions about which elements of the skills development process should be the focus of further efforts and investment, should be made by considering the following findings and recommendations, which address both specific and general issues, associated with skill development at QMAG.

To commence with a specific focus, findings about learning guides, computer-based learning materials, mentoring and videos are described and summarised. In this description and summary reference is made to the generation of different types of knowledge. These types of knowledge are categorised as propositional knowledge - facts, assertions and propositions - *knowledge about* (Anderson, 1982),

procedural knowledge - ability to secure goals - *knowledge how* (Anderson, 1982) and dispositional knowledge - values and attitudes.

1.2.1 Learning guides

The learning guides are valued as providing a knowledge base for novices, and a guide for workplace learning experiences. Evidence gathered from self-reports indicated that these guides are generative of specific procedural and propositional knowledge, and some higher order outcomes (see Tables 4, 8 & 9). However, learning guides are not frequently reported as being generative of more complex learning outcomes, (eg. problem-solving, predicting and minimising breakdowns, applying skills to new situations) (see Table 10). Nonetheless, they contribute to a foundation of knowledge which is then built upon in other learning experiences, such as guidance by experts and practical experience, which provide a combination that is likely to be generative of more complex learning outcomes. The combination of this foundation, and practical experiences, is reported as co-producing deeper conceptual knowledge (Gott, 1989). The learning guides, if used effectively by the participants, have the potential to develop that base in an consistent and accessible form.

Consequently, it is recommended that the learning guides be used in a structured way, that integrates their use with workplace experience, and guidance from mentor or more experienced others - more experienced fellow workers. Such an integration might consist of the following process, for a novice in a work area. The novice's induction would commence with a guided introduction to the work area to be learnt. This would need to include and emphasise reference to the processes involved, and the product of the work area. It seems important that a learner is able to understand both the processes and product of area they are to learn, as this provides a basis for the learner to `make sense' of the things that they see and do, in the work area. The length of time of this induction should be as long as it is feasible to support such a visit, and as short as it is necessary for the novice to gain an appreciation of the procedures and product of the work area. Ideally, this should be undertaken as part of the shift activities. Although this may be seen as a costly exercise, its returns should be evident in as this induction should allow effective use of the learning guides and aid the development of understandings which should benefit QMAG.

This guided visit would be followed by access to learning guides, to be used in conjunction with experience in the work area. Novices will require the workplace experience, to understand the learning

guide, as much as later the learning guides will assist understanding work practice. This experience provides an authentic conceptual base for novices to construct their understanding of the work area, and the nature of skilled work within it.

The integration of the work experience, and learning guides might be best managed by use of the learning experiences contained in the module and/or a checklist of tasks required to be learnt in the work area. It is also acknowledged, and needs to be accepted, that learners are likely to use the guides in quite different ways. In the validation phase, some participants scanned the guides briefly, and stated that with the combinations of experiences they were having, this was an adequate use of the guides. Other learners, reported using the guides more thoroughly, and engaging in all the learning activities, consciously, and, with great fidelity. Still other learners, reported using the guides as a resource to dip into, as occasioned by problems or situations in which they found their knowledge lacking.

Some other more specific recommendations related to the learning guides are as follows.

A greater inclusion of text which address the `why' questions is recommended. Learners should be informed the reasons why, from - *"why it is important to check .... before starting up, to why it is necessary to consider x & y when planning to increase reduce feed/temperature etc.* An understanding of `why' things happen is important for developing understanding and to ensure that actions taken are appropriate. The severity of the incidents at both Chernobyl and Three Mile Island, have been attributed, in part, to a lack of understanding by operators of the processes they were controlling. Some participants, at QMAG, claimed that the learning guides described the work processes in an `idealistic' and simplified form, rather than processes with a range of variables which impact daily on the work area's performance. Consequently, a focus on why things are done, will assist with understandings about daily work practices and processes. This understanding permits complex work performance.

It is also recommended that the answers to questions in the learning guides **not** be presented on the following page. Even experienced participants reported cheating, particularly because the narrowness of a correct response meant that interpretations and understandings had to be both peculiar, and precise. It is suggested that answers are placed away from the area being examined, and that questions be included that encourage a broader, and deeper, response. Generally, questions that are so specific that there is only one pre-specifiable right answer are generative of very specific knowledge.

Central to the success of the learning guides is the literacy skills of the user. A learner who is struggling to comprehend the text, is unlikely to gain as much from these resources as a more literate learner. Whereas the more literate learner can read and monitor the text for inconsistencies in their interpretation of the text, the less literate learner will lack this ability and their understandings are more likely to be based on an unquestioning understanding of their interpretation of the text.

1.2.2 Computer-based learning material

The computer-based learning (CBL) material provided learning experiences that were valued by the participants, because of the interaction between the media and the learner. It was reported that the CBL was stimulating, with learners being engaged in a highly active learning process. The interactive components of this instructional media, questions to be responded to, and the visual appeal, were responsible for the active learning process. Active approaches to learning are valuable, as learning is itself a highly active process, with the learners constructing meaning from what they experience (von Glasersfeld, 1987).

Again, like the learning guides, the CBL process is reported as being generative of specific procedural and propositional knowledge, although to a lesser degree (see Tables 4,5,8 & 9). From an instructional design viewpoint, any effort to develop understanding, in the ways outlined above, for the learning guides would be appropriate, for the CBL. Similar issues arise with learners who are poor readers. However, the strong visual qualities of the CBL, probably provides a range of clues and support for the learner, which are less evident in the learning guides. While it is not suggested that the CBL is devoid of explaining the `why' questions, this again is a quality that should be maximised.

The narrow syntax required in the answering of items within the CBL, caused a high degree of annoyance and frustration, and restricts the responses to specific and potentially trivial knowledge types (see 4.2). These sorts of knowledge are useful for an initial understanding of facts, concepts and propositions. However, they are not the sort of outcomes that are generative of the important higher order skills that workers at QMAG are called upon, to use in addressing the requirements of work activities.

1.2.3 Mentoring arrangements

Mentoring arrangements, within this report, include both the official mentors, appointed to the learners for the validation phase, and the defacto mentorship provided by other, and usually more expert workers, during the validation trials. The reason for combining these two forms of support is that learners

reported frequently engaging in very purposeful mentoring arrangements, with either their official mentor or another worker on shift, who the learner acknowledged as having expertise in the work area (see section 4.4). Not all learners shared the shift with their official mentor. However, those who did share shifts reported this to be a positive situation. Moreover, those who did not share shifts with their formal mentors, reported frequently engaging in defacto mentoring arrangements, which were highly valued.

Mentoring arrangements, as defined above, were consistently reported as providing for the development of a range of knowledge types, and pressing learners into higher order activity, through joint problem solving as illustrated in Tables 4,6,8,9 and 10. It would seem that one of the great strengths of the QMAG work environment is that guided learning is allowed to take place with great openness. This evaluation provides evidence that mentorship is now emerging as an ordinary component of work practice and shift collegiality. It is postulated that this mentorship is founded on two factors. Firstly, the openness of workplace arrangement as based on the QMAG work practice. Secondly, the small size of work team sizes, are themselves conducive of good interpersonal relations and responsibilities for novices. It has been recognised that communal activity of the type evident at QMAG provides the basis for interaction which avoids strict score-keeping (Clark, 1984). This type of activity is contrasted to one where exchanges require responses of a more tangible sort.

Significantly, this types of guided learning is being increasing reported, in research findings, as being conducive of complex learning outcomes (Lave & Wenger, 1991, Rogoff, 1991). These learning outcomes appear to be the result of the learner observing expert practice, being directly or indirectly guided to achieve the same standard of practice through a process of increasingly mature approximations of the task goal.

It is recommended that mentoring becomes a role to be undertaken on each shift, and that it become part of ordinary work practice. This will help achieve the desirable goal of a `learning culture' at QMAG, in which learning is accepted as being a normal requirement of work practice. To maximise the potential of the mentoring it may well be worth considering developing mentors' skills in modelling, coaching, guiding and fading (Collins, Brown & Newman, 1989 also see Billett 1993). A key reason for this suggestion is founded on the previously mentioned concern for developing understanding, about work activities. To develop expert practice, this understanding may need to be made explicit by the mentors, given the nature of many of the tasks conducted at QMAG, include processes that are hidden, and the tacit or unconscious nature of much of expert work practice.

1.2.4 Videos

The videos were accessed by only a few learners. The reported strengths of the videos were their ability to show the process of a series of operations, before learners actually experience them. This instructional media was reported as providing for the development of specific knowledge and understandings, by the few participants who had accessed it (see Table 8). In this sense they were adjudged to be useful. However, concerns were expressed about some of the content, including safety concerns, and the text exhorted learners to do things, without stating `why' they should be done (see slipping electrodes). The main strength, that was reported of the videos, was the opportunity for learners to preview the work area and nature of work tasks, before actually experiencing them. This may be useful for work areas which are inaccessible. These issues are discussed below in general recommendations for the training system at QMAG.

1.2.5 Contributions from the informal elements of the skill development process at QMAG.

In addition to the formal elements of the skill development process at QMAG, the contributions from informal learning experiences were examined and findings reported upon. Already included in Section 1.2.3, above, Mentoring arrangements are the findings about the contributions provided directly by Other workers. In the next section the contributions to the participants' learning provided by Everyday work activities, Observing and listening, and Direct instruction, and the Work Environment, are reported.

1.2.6 Everyday Activities

Respondents reported that everyday work activities provide practice, which allowed work activities to become `second nature, and that these activities were contextualised by the requirements of work practice. This implies that the proceduralisation of the participants' knowledge and understanding was organised by the authentic requirements of work activities. For learning to occur it had to be legitimated by the evidence found in daily practice.

Everyday activities were reported as being useful for assisting with the problem situations as reported in Table 4. It was reported as being the fourth most important contributor in these critical situations after Other workers, the Work Environment, and, Observing and listening. Equally, everyday activities were reported as being facilitative in the development of a range of knowledge types, and was reported as being the second most frequently responded to element in the development of both procedural and dispositional knowledge items (see Tables 8 & 9).

In the reported development of higher order procedures (see Table 10) everyday activities again was the second most frequently reported item in being very useful, again, after Observing and listening. This data is highly supportive of authentic work activities as being conducive of a range of knowledge types and attributes that are essential for effective work practice at QMAG.

1.2.7 Observing and listening

Both novice and experienced participants acknowledged their perceptions of the value of Observing and listening, as a means of acquiring and developing further their skills. It was suggested that this is an on-going and practical way that knowledge, and even highly specific information, can be communicated within the workforce. Respondents were able to detail in a range of ways when observing and listening had been useful. These experiences transcended formal workplace settings into the social milieu of the tea room.

Observing and listening was reported as being highly effective source of knowledge which could then be applied to problem situations to achieve desired results. It was the third most frequently reported aid to problem situations (see Table 4). However, it was very frequently reported as being a very useful way of acquiring all knowledge types, particularly procedural and dispositional knowledge (see Tables 8 & 9).
It was the element of the skills extension program reported most frequently for the development of procedural knowledge, being reported as a highly effective mode of learning in 15 of the 16 attributes which were categorised as being mainly procedural. Again, in Table 10, which reports the participants' perceptions of the elements' ability to help secure higher order thinking, Observing and listening was the most frequently reported element in developing higher order knowledge.

1.2.8 Direct Instruction

The element of 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. 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' they might deliberately ignore what they were being told. Secondly, if direct instruction failed to provide reasons `why things had to be done', it was likely to press operators into activity, but without knowing why they were undertaking the activity.

Direct instruction was also reported as being very effective when respondents' perceptions to problem

situations were canvassed (see Table 4). Equally, it was reported as developing a range of knowledge types, when the respondents indicated which elements would be effective in the development of a range of attributes required for effective work practice at QMAG (see Tables 8 & 9). Moreover, it was reported as being able to develop those attributes which, it was inferred, required higher order thinking skills (see Table 10).

1.2.9 Work environment

The contribution to the work environment was also seen as being conducive of a range of knowledge types. The responses to this element, may not have always been consistent, as a number of respondents interpreted this element in different ways. It was intended to refer to the physical environment of the Parkhurst and Kunwarara sites. However, some participants indicated that they had responded to the nature of interpersonal relationships at Parkhurst. However, despite this limitation, data provides evidence of its general acceptance across the participants as being useful for the development of knowledge types (Tables 8, 9 & 10) and, also, in the resolution of problems (Table 4). When responding to problems, the Work environment was the second most frequently reported of all the elements, as being very useful (see Table 4), after Other workers. It was also reported as being perceived to be conducive of the development of a range of knowledge types, which included most frequently reported for dispositional knowledge. It was not highly rated in the development of higher order thinking, however (see Table 10).

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Attachment One

Queensland Magnesia

Skills Development Program
Briefing Survey

Name	Work Area	Interview
		Briefing

How long have you worked at QMAG?

How long have work worked in the .....area?

Q.1 *By which method have you acquired your work skills in the past?*

Integrated college and work, like apprenticeship [ ]
College first, then on-the-job [ ]
On-the-job [ ]

Q.2 *What was useful about that approach?*

Q.3 *What wasn't useful about that approach?*

Q.4 *When wasn't this method useful?*

Q.5 *What do you believe is the ideal way of acquiring skills and why?*

Attachment Two - Attitudinal Survey
Queensland Magnesia

Skills Development Program
Survey # 1

Name	Work Area	Interview
		1 2 3 4 5

Q.1 How much of the jargon used in the .....area do you currently understand?

None	Very Little	Most of it	All of it

How did you learn what this jargon means?

Q.2 How strongly do you identify with being a skilled ..... ?

Strongly	Some identity	Not much	Not at all

Why is that?

Q.3 Do workers in this area do something that is different or special?

Not different or special	Some specific differences	Special and distinct	Quite different

How has your opinion been formed?

Q.4 How strongly do you identify with the goals of the Q Mag award - participation and collaboration?

Not at all	A bit	Quite a lot	Very strongly

What has caused you to hold this opinion?

Q.5 How realistic are the goals of the Q Mag award - participation and collaboration.

Totally Unrealistic	Ambitious	Achievable	Realistic

Why is this?

Attachment Three
Queensland Magnesia

Skills Development Program
Schedule # 2

Name	Work Area	Interview
		1 2 3 4

Q.1 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?

Rate the usefulness of the following list of learning aids from 1-5 (1 is not useful - 5 is highly useful) Indicate N.A if not applicable

modules[ ] computer based texts[ ] videos[ ]
mentors[ ] direct instruction[ ] everyday work activities[ ]
observing & listening[ ] other workers[ ] the work environment [ ]
Action Thinking process [ ] others (please name).....[ ]

Q.2 Consider when you last had a problem to solve in the work associated with .....

How did you go about resolving that problem?

What didn't you know?

Who or what helped?

Why was that helpful?

Rate the usefulness of the following list of learning aids when resolving this problem; from 1-5 (1 is not useful - 5 is highly useful) Indicate N.A if not applicable

manuals[ ] computer based texts[ ] videos[ ]
mentors[ ] direct instruction[ ] everyday work activities[ ]
observing & listening[ ] other workers[ ] the work environment [ ]
Action Thinking process [ ] other (please name).....[ ]

Q.3 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?

Rate which of the following list of learning aids you would have liked to gain greater access to, from 1-5 (1 no more - 5 much more) Indicate N.A if not applicable

manuals[ ] computer based texts[ ] videos[ ]
mentors[ ] direct instruction[ ] everyday work activities[ ]
observing & listening[ ] other workers[ ] the work environment [ ]
Action Thinking process [ ] others (please name).....[ ]

Q.4 Of the aids to learning below could you provide a specific example of how each has been important in your learning to date. (if you have not accessed or cannot recall contributions from these just skip)

A) manuals B) computer based learning C) videos
D) mentors E) direct instruction F) everyday work activities (just doing it)

G) observing & listening H) other workers I) the workplace
J) Action Thinking process K) other factors (please name)

Q.5 Many of the aids to learning will have been used in conjunction to one another. Using the phrases stated below, indicate those aids that have been worked together. You might like to draw a line around them or lines between them.

manuals computer based texts videos

mentors direct instruction everyday work activities (just doing it)

observation and listening other workers the setting itself

Action Thinking process