074 - Developing Competence and Capability: mineral reporting in the mining industry

Abstract

The mining industry is undergoing rapid expansion in Australia. Each expansion project is based on the estimation of mineral deposits and the associated costs of recovery and distribution. The initial estimation process is critical to the investment decisions of each project and yet this scientific process is dependent on the capability and competence of individual estimators working in diverse, difficult and remote field operations. This paper is based upon a PhD study that is examining how estimator competence is regulated and constructed within the industry, and what frameworks might improve competence and performance within the industry. The paper reviews the current industry situation, details the perceptions of industry stakeholders and indicates the emerging issues from the study so far. While competence has become a key component of the Australian training system, it is diversely defined across industries. This study explores how the concept has been translated within the mining sector and indicates how that translation may be improved and developed in the future.

Introduction

VET developments in Australia over the last two decades are testimony to the efforts across industries and occupations to standardise and systemise both the meaning of competency and how competency can be developed. However, it is argued here that whilst these efforts are to be applauded, a universal understanding of competency is subject to the meanings and expectations derived within professions and within industries. By illustrating the meaning of competency and its development within a specific arena of the mining industry, this paper contributes to the discussion on competency development for professionals.

Before a more deliberate investigation of competency in the literature, a summary of the practice context of mineral reporting as a professional responsibility within the mining industry is presented. The research methodology is summarised and followed by a discussion of the research findings and implications regarding competency expectations of mineral reporting estimators. Along with an exploration of the contextual meaning of competency, this paper presents a model for the development of competency of mineral resource estimators. The paper closes with a discussion on the implications of this contribution for standardisation of definitions and competency development processes.

The JORC Context

The Joint Ore Reserves Committee (JORC) was established within the mining industry in the early 1970s in response to misrepresentation of mineral endowment to the Australian stock exchanges that caused the market boom-bust known as the "Poseidon Nickel Boom". Following a series of reports by JORC, in 1989 the Australian Stock Exchange (ASX) adopted the JORC Code into its listings rules. This code, and its subsequent updates, provides guidance and standardises the language used by defining terms and expectations for company directors, technical professionals and investors. The core is a principles-based code and does not prescribed what or how professionals apply techniques and use technology. Of particular relevance here is the principle of competence, which decrees that all publically

reported estimates of mineral endowment or potential extraction are based on the work of a 'Competent Person' defined within the JORC Code:

> *"Competence requires that the Public Report be based on work that is the responsibility of suitably qualified and experienced persons who are subject to an enforceable professional code of ethics." (JORC, 2004)*

To qualify as a Competent Person a geologist, engineer, metallurgist or other mining industry specialist must be a member of one of the prescribed professional organisations, have a minimum of five years relevant experience, and be confident to defend their estimate in the presence of his/her peers (Vaughan & Felderhof, 2005). Although there is an assumed degree of peer review control through the professional associations' Complaints and Ethics processes, these avenues cannot mandate on technical processes adopted by the Competent Persons. There is no formal system in place to accredit or regulate the ability of a Competent Person to perform in accordance with industry and investor expectations.

Literature Review

In contrast to the vague definition of competency offered in the JORC Code, competency frameworks are typically defined as dichotomous levels indicating functional achievement and are used for managing recruitment, training and promotion (Clardy, 2008; Daud, Ismail, & Omar, 2010; Ranade, Tamara, Castiblanco, & Serna, 2010). In this context competency is viewed as a list or set of achievable tasks: "First we identify an activity cycle that best fits the discipline, and then we list tasks associated with each phase of that cycle" (Ranade, et al., 2010, p. 32). More broadly, competency can be viewed as achievement on a continuum or within a range of requirements (Dreyfus, 2004; Dreyfus & Dreyfus, 1980) or as a level within a hierarchy of skills acquisition (Cheetham & Chivers, 2005). Unfortunately, competency may only be fully appreciated when incompetence is experienced: "Most of the time, we take their competence for granted. But when things go wrong, they can do so catastrophically" (Cheetham & Chivers, 2005, p. xix). For this reason, professional associations of all types "recognise the need for ethical behaviour by their members" (Cheetham & Chivers, 2005, p. 31). The sanctioning process within the JORC system recognises this need and relies heavily on the codes of ethics of the professional organisations to which the resource estimators belong.

Beyond the ethics, the notion of competency infers a confidence with the techniques, technology and practice. However, evolutions in technology and techniques requires professionals to be engaged in continuous professional development to maintain high standards of competency (Dunlop, Barlow-Stewart, Butow, & Heinrich, 2011). One outcome of the deliberations of a working group at the November 2002 Competencies Conference (Future Directions in Education and Credentialing in Professional) was the consideration of how professional development could be linked to competency:

> *"A more sustained focus on professional development (PD) and professionalism may have implications for the credentialing and licensure of psychologists. As one example, regulatory boards might consider how PD might be approached more meaningfully and how professionalism might be assessed at initial licensing or at intervals throughout a psychologist's career. New strategies for monitoring*

> *"continuing competence" beyond traditional continued education (CE) might be developed."*(Elman, Illfelder-Kaye, & Robiner, 2005, p. 373).

Cheetham & Chivers (2005) go to great lengths to consolidate competency theories and to build a model of competence based on four core components: Knowledge/ Cognitive competence, Functional competence, Personal/ Behavioural competence and Values/ Ethics Competence. Their model, however, merely offers an alternative, albeit more complex, lists of skills or practice to achieve in accordance with varying emphases.

However, these singular dimensional task-list style definitions provide limited value when examining the notion of 'Competent Person' within the JORC Code where the expectations of competency are essentially experience and confidence based. Instead there is an additional dimension of embodied understanding implied that extends competency beyond the functional.

Dall'Alba & Jörgen (2006) present an interesting model of competency that extends the task/skill achievement with an additional dimension reflecting the level of embodied understanding of the task. D'alba & Jörgen's model provides an interesting opportunity to investigate and extend the notion of competency beyond the single dimensional task/achievement scale. The notion of embodied understanding is also reflected in Lave and Wegners' (1991) theory of Community of Practice. Here achievement is assessed within a community and depends on a broad framework of support from the expert community. The development of mastery through a community of experts allows the definition of competency to be embedded as an apprentice-style practice to reflect the quality of the skills developed as moderated by and within the community. Rather than specifying or listing requisite skills, the achievements are articulated through the acceptance by the community. The purpose of these communities of practice is to develop experts who have mastery over their skills to provide quality products from the community as a whole. Beyond this indirect requirement for quality, Lave and Wegners' (1991) note that "mastery of knowledge and skill requires newcomers to move towards full participation in the sociocultural practices of a community" (Lave & Wenger, 1991, p. 29) and that "learning is an integral and inseparable aspect of social practice" (Lave & Wenger, 1991, p. 31). Developing mastery in one's craft requires "(a)n extended period of legitimate (situated learning and) … provides leaners with opportunities to make the culture of practice theirs" (Lave & Wenger, 1991, p. 95). Learning a craft requires the learner or apprentice to situate themselves alongside experienced masters, to practice both the physical craft and participate in the social fabric of the community, thereby assimilating the business of the community well beyond the products of the community's labour.

The challenge in this research was to explore the mining industry community's understanding of competency for resource estimators and to articulate a framework for competency development that can be adopted to serve the needs of both individuals and the mining industry community. The current model for competency under the JORC Code is essentially based on entrance criteria. The three components required for competency are: (1) a minimum of five years' experience, (2) membership of a suitable professional organisation and (3) confidence to defend an estimate before one's peers. This approach extends competency to include a social dimension within which quality of practice is conveyed and moderated through industry norms. In this way, the JORC Code does express "legally well recognised and enforceable norms of competence, elsewhere expressed as conditions of an

expert's private and public utterances of opinion" (Carmichael, 2009, p. 4). In describing the legal liabilities of a Competent Person operating under the JORC Code, Livesley (2008) reinforces the legal interpretation of a Competent Person as an "expert" while Carmichael (2009, p. 3) emphasizes that "JORC's order of things compliments legally recognised notions of professional and expert obligation and responsibility". A notion of Competent Person as an expert is corroborated in ASX's 2012 listing rules that direct Competent Persons to have regard for Australian Securities and Investments Commission's (ASIC) Regulatory Guides detailing expectations of the content of experts' reports (JORC, 2012). "Competent Person" therefore implies a high level of expertise and professionalism than merely an ability to complete a set of tasks.

Beyond the JORC Code definition and limited guidelines offered within the JORC Code and practitioners' various practical interpretations of the JORC Code and guidelines (Examples can be found in Snowden, 2001; Stephenson & Miskelly, 2001; Stoker & Stephenson, 2001), no model of competency development has been articulated.

Data Collection and Assessment

A mixed methods approach was adopted to gather the mining industry community's and individuals' perceptions of competency. The study was prepared for external review and developed through both academic and industry feedback with the final proposal gaining University ethic clearance. Data collection included semi-structured interviews and online surveys. Members of JORC, industry experts and competent persons were interviewed to form a qualitative-based assessment of the inherent understandings and expectations of competency within the JORC context. These interviews were augmented with detailed contributions by practising and emerging competent persons through an online survey. The survey collected participants' self-perception of their competence, their approaches to twelve typical technical issues or circumstances they may encounter and the professional experiences contributing to their competence.

The responses from the 26 interviews were documented, transcribed and sent to each participant to for them to verify or edit their contributions. Prior to coding, the interview transcripts were read through and notes written. The interviews were then coded using NVivo10 in three phases: (1) open coding, (2) thematic coding and (3) conceptual coding.

The qualitative components of the 65 online survey responses were similarly coded. The responses to the twelve technical questions were assessed and converted to quantitative measures through a rubric documenting expected concepts. The resulting scores were assessed using a Rasch Analysis, which in turn identified the difficulty levels associated with each component of the technical assessment. This provided insight into the components of technical assessment that signify higher levels of competency in the interpretation and application of the JORC Code. Next the scores were compared against the self-assessments as well as the experience levels provided by the participants.

Participants' responses were grouped according to competency and experience levels. A comparative analysis provided insight into those work experiences that lead to elevated competency.

A model of resource estimation competency criteria as well as a framework for the development of this competency emerged.

Findings and Discussion

Several findings emerged from the research. This paper is focusing on those findings that impact upon how competency is constructed, developed and managed within the industry. The three most relevant to competency are discussed below.

Firstly, the current JORC Code criteria are insufficient to identify Competent Persons. A minimum of five years industry experience provides neither the experience levels nor the embodied understanding of the tasks at hand. More useful are the criteria that extend the passage of experience to include demonstration of applied technical skills along with proven literacy of the JORC Code. This analysis, therefore, supports a Dall'Alba & Jörgen (2006) style model that accommodates the two dimensions of competency: mastery of the task and a deep embodied understanding of the task. An additional dimension of business context is necessary to fully articulate the style of competency expected within the JORC Code environment.

Secondly, resource estimation competency development is embedded in the mining workplace. Workplace experiences in operations provide a breadth of experience that adds to the understanding of the mining business and hence the various contexts of the resource estimation process. These workplaces provide a community within which expectations are conveyed, developed and checked. Almost all participants noted the importance of the technical guidance provided to them throughout their careers. Particular attention was given to individuals who were patient and deliberate in their style. The impression given was that supervisors or mentors who, much like a master craftsmen proud of their skill, are willing to demonstrate the process, the reasons and the implications with care for both the individual and the ultimate product. Competency development thus is seen as more successful when framed within supportive apprentice style mentoring directly linked to the tasks and workplace responsibilities. This has implications for organisations with limited access to master craftsmen and, much like Lave and Wegner's (1991) Community of Practices, places the challenge firmly at the doorstep of the professional guilds purporting to uphold the technical standards of these professionals.

Thirdly, the professional networks that individuals develop through direct work experience persist beyond organisational boundaries since professionals within the mining industry are transient. This means individuals and members of their networks move between organisations and countries whilst maintaining the relationships. The support provided in these networks includes technical advice and career support. The endurance of these networks beyond professionals' organisational relationships begs the question of who is ultimately responsible for the quality of the competent persons. In Lave and Wegners' (1991) Community of Practice, responsibility for the development of competency rests with the master craftsmen. For example, the level of quality is communicated through master to apprentice. To some degree the JORC system provides an avenue to report professionals who contravene the professional bodies' codes of ethics or the JORC Code. However, these accusations can only be levelled at contraventions of principles or ethics. There is no avenue to challenge competent persons' claims of technical quality. The research, therefore, highlights a limitation of the JORC Code's sanction of the principle of competency.

These findings have implication for the way competency is perceived, valued and constructed within the industry. The next section explores the implications of these findings for the industry, the standards and training agendas.

Reframing Competency

The current JORC Code competency criteria rely on an expended time lag of experience. There is no accounting for the quality of that experience, nor for the level of practice experienced. Even membership of the professional guilds requires limited or no assessment of the ability of individuals to conduct estimates in accordance with the JORC Code. The criteria governing an individual's capability to act as competent person under the JORC Code is primarily contingent on the person's confidence to face their peers. However, self-assessment is weak when the assessor is ignorant of the wider context or of the technical implications of their work.

The PhD research has demonstrated the importance of at least three dimensions of competency:

1. Ability to perform requisite tasks,
2. An embodied understanding of those tasks, and
3. An appreciation for the context and implications of the product in the business or industry context.

This finding suggests a reframing of the notion of competency beyond Dall'Alba & Jörgen's (2006) two dimensional model of competency to a three dimensional model of competency (Figure 1).

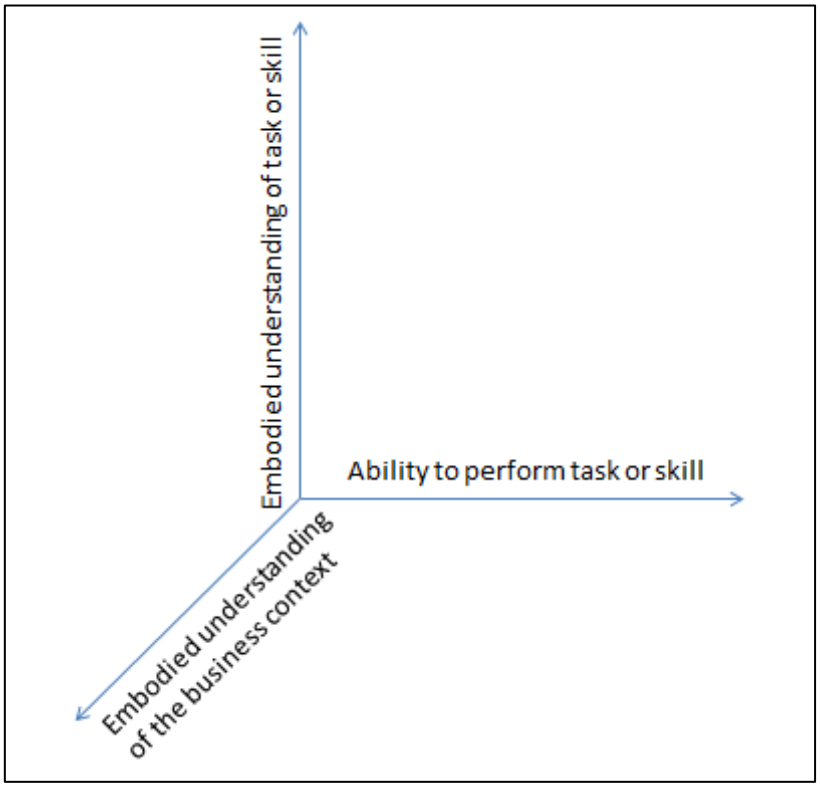

Figure 1 Three dimensions of competency

Competency Development Model

Five important aspects of competency development emerged from the research and were used to frame a competency development model to support the advancement of novices towards competent persons.

Three of the five competency development themes are discussed below:

1. **Entry requirements:** Competency development needs to account for the quality of novices entering a profession. Negative perceptions and attitudes towards problem solving can surface when practitioners have insufficient levels of capability on entry into competency development. Competency development programs should therefor endeavour to maintain high levels of entry requirements and/or confront lack of basic entry requirements through support programs.

2. **Workplace experiences:** The competency development model seeks to clarify the complex, but critical components of workplace experiences. Clearly, experiences relating to the specialisation are necessary to build competency in an area. However, this model proposes that specialisation on its own is insufficient and that the work experiences need to be put into context of the multi-disciplinary requirements, especially the opportunity to experience the business consequences of both mistakes and corrections. This also requires skills to navigate and communicate within the business and industry. In addition, a variety of contexts, demands and responsibilities contribute to both breadth and depth.

3. **Professional networks:** Professional networks form a critical component of competency development. Access to experts, either through formal or informal connections is vital to the development of professional expertise. More than transference of skills, professional networks provide opportunity to discuss concepts, potential consequences and leverage off a broader experience base. Professional networks include current and past colleagues, supervisors, internal and external specialist consultants as well as juniors who, through their questions, provide opportunity to develop and advance unrealised understanding and skills. The model of professional network is egocentric and enduring.

Development of competency is essentially embedded within a community comprising multiple and varied masters. However, competency is not independent of the individuals' contribution to and engagement with the development of their craft. The basic entry requirements are necessary to establish a baseline for further learning. The quality of the engagements with workplace experiences govern the acceptance and attainment of practice quality whilst access to master craftsmen through professional networks provides opportunity to access greater breadth and depth of experiences as well as opportunity for review and reflection.

Conclusions

This study of competence development of estimators in the resources industry has gathered data from practitioners to investigate how competency is conceptualised within the industry, how competency is developed and what patterns of development appear to have the greatest impact. This paper has focused on how competency is conceptualised and developed within the industry. The study makes a contribution to knowledge both in terms of pragmatic advice for the industry and also in terms of exploring how the competence is conceptualised. This paper highlights that the notion of competency is not universal. When applied to estimation and reporting of mineral endowment, competency refers to a level of mastery of skill, an embodied understanding of the tasks and an appreciation for the context within which the product of the labour will be used. Whilst some competency models could contribute to the measurement of competency, ultimately the notion of competency needs to be defined within the industry context. This requires an exploration of the embodied understanding of the notion coupled with measurement systems that can be validated as representing the professional guild's expectations.

Acknowledgments:

The authors would like to acknowledge the research participants who gave their time freely. Without their generosity this research would not have been possible.

References

Carmichael, H. (2009). Not Rumsfeld on JORC. Retrieved 31/7/2012, from http://www.ampla.org/lib/pdf/events/Vic/Not%20Rumsfeld%20on%20JORC%20Seminar%20paper%20-%20H%20Carmichael.pdf

Cheetham, G., & Chivers, G. (2005). *Professions, Competency and Informal Learning*. Cheltenham, UK: Edward Elgar Publishing Limited.

Clardy, A. (2008). Human Resource Development and the Resource-Based Model of Core-Competencies: Methods for diagnosis and Assessment. *Human Resource Development Review*, *7*(4), 20.

Dall'Alba, G., & Jörgen, S. (2006). Unveiling Professional Development: A Critical Review of Stage Models. *Review of Educational Research, 76*(3), 383-412.

Daud, R., Ismail, M., & Omar, Z. (2010). Exploring Competencies. *Professional Safety, 55*(10), 39-47.

Dreyfus, S. E. (2004). The Five-Stage Model of Adult Skill Acquisition. *Bulletin of Science, Technology & Society, 24*(3), 177-181.

Dreyfus, S. E., & Dreyfus, H. L. (1980). *A Five-Stage Model of the Mental Activities Involved in Directed Skill Acquisition.* . Washington, DC: Storming Media.

Dunlop, K. L., Barlow-Stewart, K., Butow, P., & Heinrich, P. (2011). A Model of Professional Development for Practicing Genetic Counselors: Adaptation of Communication Skills Training in Oncology. *Journal of Genetic Counseling, 20*(3), 217-230.

Elman, N. S., Illfelder-Kaye, J., & Robiner, W. N. (2005). Professional Development: Training for Professionalism as a Foundation for Competent Practice in Psychology. *Professional Psychology: Research and Practice, 36*(4), 367-375.

JORC. (2012). The Austaliasian Code for Reporting of Mineral Resoruces and Ore Reserves. from http://www.jorc.org/jorc_code.asp

Lave, J., & Wenger, E. (1991). *Situated Learning - Legitimate Peripheral Participation*. Cambridge: Cambridge University Press.

Livesly, K. (2008). Liability of Competent Persons for JORC Reports. *The AusIMM Bulletin*, 7.

Ranade, S., Tamara, C., Castiblanco, E., & Serna, A. (2010). MAPPING competencies. *Mechanical Engineering, 132*(2), 30.

Snowden, D. V. (2001). *Practical Interpretation of Mineral Resource and Ore Reserve Classification Guidelines*. Paper presented at the Mineral Resource and Ore Reserve Estimation - The AusIMM Guide to Good Practice.

Stephenson, P. R., & Miskelly, N. (2001). Reporting Standards and the JORC Code. *The AusIMM Guide to Good Practice*, 621-630.

Stoker, P. T., & Stephenson, P. R. (2001). *Classification and Reporting.* Paper presented at the Mineral Resource and Ore Reserve Estimation - The AusIMM Guide to Good Practice, Melbourne.

Vaughan, W. S., & Felderhof, S. (2005). International mineral resource and mineral reserve classification and reporting systems*. *CIM Bulletin, 98*(1086), 132.