THE EFFECTS OF DIGITAL STORY COMMUNICATION ON HEALTH LITERACY INDICATORS IN THE MINING INDUSTRY

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Abstract

The contemporary approach to health promotion that has arisen recognises the wide range of determinants that can influence health outcomes and their inherent complexity. These protective and risk factors are important foci that need to be considered when developing setting focussed evidence based strategies. The workplace has been identified as one such setting of priority due to the potential for sustainable impact on individual health status, return on investment for employers and flow on benefits at the population level. Despite this potential, many organisations do not prioritise the health of the workforce or implement ad hoc, unstructured, insufficiently planned and unsustainable programs.

In the mining industry context, safety has historically been an important focus for management and control due to risk associated with work tasks and the work environment. While health is an identifiable element within the domain of occupational health and safety, it typically concedes a lower profile and priority within mining and other industries. An integrated and evidence based approach to occupational health and safety can generate bidirectional influence leading to improvements in both elements. When considered this way, health and safety in an occupational setting are interrelated, mutually beneficial and equally important. Mining employees are required to undertake compulsory health and safety training when entering the workforce and regularly throughout their careers. A range of approaches to workplace health and safety training are currently implemented in the mining industry, to varying degrees of success. Of equal concern is the absence or high variability of evaluation methods applied to health and safety communication practices within the industry.

Health literacy has been identified as a potential outcome of health education, a significant antecedent of health promoting behaviour and a capacity building goal. Despite this potential, population level indices reveal a major proportion of the Australian adult population have inadequate health literacy, placing them at greater risk of compromised health status and burden on the health care system. In recognition of the association between health literacy and health education, and in the absence of any known applied empirical health literacy research in the mining

industry, it was included as an important focus within this action research project. Health literacy research has evolved during the past four decades from applied literacy skills in clinical environments, to an asset or strength based orientation across a range of settings. The definition and scope of health literacy has broadened during this time to include ecological orientations and a multidimensional model (Nutbeam, 2000) that is widely cited in the literature. Since the release of this model, there have been calls for the development of more comprehensive and appropriate methods of measurement and instruments. In the absence of a universally supported instrument measuring interactive and critical dimensions of health literacy, there was a need to develop a new instrument for this action research project.

This research project comprised three studies, with an overall goal to meet the aforementioned needs. The aim of the first study was to design and test the validity and reliability of a new instrument measuring interactive and critical health literacy indicators in the mining industry. The Health Communication Questionnaire (HCQ) was developed to support an evidence based evaluation of a narrative health education strategy implemented within study two. The study consisted of integrated stages including industry familiarisation, questionnaire development, readability assessment, implementation of validation procedures, questionnaire refinement, reliability testing and pilot testing. The HCQ captured demographic and industry specific information as well as health literacy data recorded via visual analogue scales.

Readability assessment included Flesch-Kincaid Grade Level (FKGL) testing, with the results falling within the target range. Two forms of validity testing were implemented during this study, including application of Substantive Validity Analysis (SVA) and Content Validity Index (CVI) techniques (Polit, Beck, & Owen, 2007; Anderson & Gerbing, 1991; Lynn, 1986). SVA testing involved participants (n=40) completing a randomised sorting task to evaluate the face validity of the instrument supporting the identification of potential HCQ item ambiguity. SVA results reflected a high level of agreement among participants about association with intended interactive health literacy (IHL) and critical health literacy (CHL) constructs. CVI testing involved nationally and internationally renowned health promotion and health literacy experts (n=3) critically reviewing HCQ items. Expert reviewers rated the relevance of each HCQ item with respect to the targeted health

literacy indicators. CVI analysis establishes the level of inter-rater agreement following independent reviews. Following questionnaire revision and item deletion, instrument CVI scores exceeded the minimum target values indicating that the HCQ is a valid representation of interactive and critical health literacy constructs.

Pilot testing and reliability assessment of the HCQ involved a test-retest procedure with a representative sample of mining industry personnel (n=46) under true work conditions. The correlation coefficient exceeded the target for newly developed instruments; however, this may not be an indication of intra-subject agreement, therefore a more rigorous interrogative methodology was necessary. Bland-Altman plots were generated for each of the health literacy associated HCQ items to evaluate intra-subject variability and instrument repeatability. Inspection of the Bland-Altman plots revealed a low level of bias for the instrument. In relative terms, this reflected greater precision than a thirteen point interval scale with one-third of all items offering a degree of precision greater than a sixty-one point interval scale. This level of sensitivity was a successful outcome demonstrating the reliability of the instrument when used within the target context. This outcome also justifies the use of VAS in the HCQ over dichotomous and interval scales. The research methods applied in this study supported objective and comprehensive evaluation of the questionnaire. They provided a strong evidence base for progressive instrument refinement and instilled confidence in HCQ application during the second study.

The aim of the second study was to evaluate engagement and impact of a digital story embedded communication strategy, and effects on interactive and critical health literacy indicators at underground metalliferous and open cut coal mines in Queensland. This action research study commenced with a period of digital storyteller recruitment and development. Digital story participants (n=6) included a combination of experienced mining industry workers and health specialists with nationally and internationally renowned expertise. Digital story filming was facilitated by interview guides which were tailored to suit each application. This is the first known comprehensive quantitative study exploring narrative health education engagement and impact on interactive and critical health literacy indicators within the Australian mining industry.

Following digital story development, two research sites were selected for a quasi-experimental parallel time series design including intervention and control

groups at each site. A large occupational health and safety climate survey data set derived from a diverse range of Australian mining operations (Parker & McLean, 2012) was consulted for the purpose of screening eighteen potential research sites. Two were selected via a systematic process of first round exclusion criteria and second round inclusion criteria. The intervention group (n=85) observed a multimodal health education presentation which included an embedded digital story. The control group (n=90) received the same health information communicated in a non-narrative manner, reflective of more common communication practices within the mining industry. Time series data collection occurred at baseline, impact and follow-up stages via the HCQ instrument developed and tested during study one. High response rates exceeding ninety percent at baseline and eighty-five percent at impact and follow-up assessment were achieved.

Preliminary data inspection and management included reverse scoring of negatively phrased HCQ items, calculation of sub-scale means and assessment against criteria for normality, homogeneity of variance and sphericity. Normality was evaluated via Levene's Test of Equality of Error Variances and visual inspection of boxplots, histograms and Q-Q plots. Other criterion based evaluation included Hartley's F_{max} Test for homogeneity of variance and Mauchly's Test of Sphericity. These results did not reveal any significant assumption violation, therefore adjustments were not required. Mean differences for the dependent variables at three time intervals were compared via repeated measures analysis of variance (ANOVA). Effect size comparisons were made using descriptive ANOVA data, and calculation of Cohen's *d* and Pearson correlation coefficient *r* values.

Repeated measures ANOVA and effect sizes demonstrated greater engagement with the digital story based intervention strategy. This was evidenced by small versus large effect sizes between baseline and impact for the control and intervention groups respectively. Additionally, the digital story health education strategy yielded a reasonable degree of sustainable engagement through demonstration of a medium effect size two months post impact assessment. There was no statistically significant evidence of maintenance within the control group which returned to near baseline level at the follow-up assessment stage. Greater impact on health literacy indicators was also evident for the digital story intervention group. Small to large effect sizes were evident within the digital story intervention group for the three interactive

health literacy indicators: *responding to health information provided by others* (1-RHI); *discussing health at work, home or with friend*s (2-DH); and *seeking health information* (3-SHI). This contrasted greatly with the predominantly non-significant effect sizes for the control group. No significant effect sizes were observed within the control and intervention groups for the two critical health literacy indicators: *achieving control over personal health* (4-ACP); and *helping others improve or maintain health* (5-HO).

The aim of the third study was to investigate the lived experience of mining industry employees who shared their health related story with colleagues via a digital communication strategy. This was facilitated by capturing the perceptions, beliefs and observations of self-selecting digital storytellers (n=3) during semi-structured interviews. Each participant was interviewed twice, prior to and following implementation of the digital stories within the mining industry with an interval period of six months. This qualitative study included descriptive case study (DCS) analysis of digital storytelling as a health education strategy within the Australian mining industry.

Exploratory recursive analysis and iterative coding of interview transcripts established three emergent themes. These themes incorporated a range of foci including; interactive communication, schema, motivation, critical reflection, self-evaluation, exerting control, supportive environments, empowerment and strengthening capacity. Observed effects of digital storytelling on others included impact on four of the five health literacy indicators developed for this project, as well as value based affective learning outcomes. Personal reflection exhibited evidence of impact on all five health literacy indicators and a higher order affective learning outcome of characterisation among the digital storytellers. This study also captured cognitive dissonance experienced by a digital storyteller and counter-argument from a digital story viewer. The latter ultimately generated constructive dialogue between co-workers engaged in rigorous discussion. These outcomes reflect the personal challenge and vulnerability that can come with authentic discussion of health and the potential power of narrative communication for deeper level engagement and thinking.

This thesis documents a cross-disciplinary mixed methods action research project that included a narrative health education strategy implemented as digital

stories within the mining industry. Digital stories enable effective, efficient, widespread and consistent communication of health-related information. As such, this project has delivered unique applications, outcomes and insights that are of benefit to a range of fields and settings. The development of a new health literacy measurement instrument subjected to robust validity and reliability testing supported unique data collection within the mining industry. This strong foundation enabled the novel evaluation of highly specialised digital stories developed with utility in the mining setting and their impact as a health education strategy. Evidence garnered from this research emphasises the impact and sustainable outcomes associated with the implemented strategy. This research has challenged current communication and health education methods implemented within the mining industry. It provides justification for the adoption of critical evaluation methods for health communication and the merging of health expertise coupled with workforce narratives delivered as quality assured digital stories. Additionally, this project has presented unique insights into digital stories for the mining industry from the storyteller perspective. These qualitative insights should be considered as valuable evidence informing digital storyteller recruitment in workplace settings and comprehensive evaluation strategies.

The validated health literacy instrument, digital story application, narrative communication insights and research methodologies support informed planning, future practice, evidence based evaluation of health communication and ongoing research within the mining industry. This project has produced outcomes that should be of interest within the fields of occupational health and safety, health promotion and health education.

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List of Abbreviations

ATSI	Aboriginal or Torres Strait Islander identification
ANOVA	Analysis of variance
AQF	Australian Qualifications Framework
CD	Cognitive dissonance
CHL	Critical health literacy
CI	Confidence interval
CVD	Cardiovascular disease
CVI	Content Validity Index
DCS	Descriptive case study
ES	Effect size
FHL	Functional health literacy
FIFO	Fly-in fly-out
FKGL	Flesch-Kincaid Grade Level
fMRI	Functional magnetic resonance imaging
HCQ	Health Communication Questionnaire
HPW	Health promoting workplace
HSET	Health, Safety, Environment and Training
HWM	Healthy Workplace Model
I-CVI	Item-level Content Validity Index
IHBI	Institute of Health and Biomedical Innovation
IHL	Interactive health literacy
LoA	Limits of agreement
MCA	Minerals Council of Australia
NHPA	National health priority area
OHS	Occupational health and safety
PDF	Portable Document Format
QR code	Quick response code
QUT	Queensland University of Technology
ROI	Return on investment
S-CVI	Scale-level Content Validity Index
S-CVI/Ave	Scale-level Content Validity Index averaging method

S-CVI/UA	Scale-level Content Validity Index universal agreement method
SD	Standard deviation
SE	Standard error
SVA	Substantive Validity Analysis
TRCM	Triadic Reciprocal Causation Model
US	United States
USB	Universal serial bus
VAS	Visual analogue scale
WHO	World Health Organization
WUN	Worldwide Universities Network
1-RHI	Health literacy indicator 1 / HCQ sub-scale 1: *Responding to health information provided by others*
2-DH	Health literacy indicator 2 / HCQ sub-scale 2: *Discussing health at work, home or with friends*
3-SHI	Health literacy indicator 3 / HCQ sub-scale 3: *Seeking health information*
4-ACP	Health literacy indicator 4 / HCQ sub-scale 4: *Achieving control over personal health*
5-HO	Health literacy indicator 5 / HCQ sub-scale 5: *Helping others improve or maintain health*

List of Definitions

Determinants of health:

"The range of personal, social, economic and environmental factors which determine the health status of individuals or populations (World Health Organization, 1998, p.6)."

Health education:

"Health education comprises consciously constructed opportunities for learning involving some form of communication designed to improve health literacy, including improving knowledge, and developing life skills which are conducive to individual and community health (WHO, 1998, p.4)."

Health indicator:

"A health indicator is a characteristic of an individual, population, or environment which is subject to measurement (directly or indirectly) and can be used to describe one or more aspects of the health of an individual or population (WHO, 1998, p.9)."

Health literacy:

"Health literacy represents the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health (WHO, 1998, p.10)."

Health promotion:

"Health promotion is the process of enabling people to increase control over, and to improve their health (WHO, 2009, p.1)."

Narrative communication:

"Narrative communication is an emerging form of persuasive communication used in health education that solicits actual stories or narratives from the target population to motivate behaviour change in others." (Houston, et al., 2011, p.687).

Organisational climate:

"Organizational climate may be defined as the shared perceptions of and the meaning attached to the policies, practices, and procedures employees experience and the behaviours they observe getting rewarded and that are supported and expected (Schneider, Ehrhart, & Macey, 2013, p.361)."

Organisational culture:

"Organizational culture may be defined as the shared basic assumptions, values, and beliefs that characterise a setting (Schneider, Ehrhart, & Macey, 2013, p.361)."

Settings for health:

"The place or social context in which people engage in daily activities in which environmental, organizational and personal factors interact to affect health and wellbeing (WHO, 1998, p.19)."

Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

QUT Verified Signature

Signature:

Hugh A. Shannon

Date: 19 May 2017

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project and thesis. I dedicate this thesis to my daughter Evelyn, who was born during the latter stages of my candidature. I hope she will value her future education, be inquisitive about the world around her and enjoy lifelong learning.

Chapter 1: Introduction

Storytelling is a form of communication that has permeated the ages and has been used to capture and share the human condition. Narrative communication allows us to understand and learn from the lived experiences of others (Bentley, 2007). Effective storytelling can be entertaining, informative, transformative and even therapeutic. This thesis will document a mixed methods action research project that included a narrative health education strategy implemented as digital stories within the mining industry. It will also evaluate the effects of the communication strategy on interactive and critical health literacy indicators, and include a qualitative account of the experiences, perceptions and observations of the storytellers.

This chapter will outline the background, context, purpose, significance, research scope and provide definitions of fundamental terminology and concepts. It will conclude with an overview of the structure and content of the remaining thesis chapters.

1.1 BACKGROUND

Historically, occupational health and safety (OHS) has primarily presented as action to create a safer work environment for employees. Of great importance, however, is the association between health and safety in occupational settings. A bidirectional relationship reflects the potential for safety improvements to positively impact on the health of the workforce. Likewise, the reverse can also be true, as the health of the workforce can also influence safety outcomes. Despite the potential, there is a clear delineation evident between health and safety in many settings and a need for greater integration (Winder, 2009). This research project was established on the principle that health and safety in an occupational setting are interrelated, mutually beneficial and equally important.

The collective health status of employees in workplace settings impacts upon industry in terms of productivity and economic expenditure. A reduction in workplace injury, illness and enabling positive health-related behaviours and

attitudes has the potential to enhance productivity, decrease financial outlay due to poor health or injury, and most importantly enhance the health status and quality of life for employees (Bilski & Wierzejska, 2008). The social, physical, demographic and cultural characteristics of a group must be carefully examined in order to facilitate appropriate health promotion intervention (Jirojwong & Liamputtong, 2009). Opportunities exist for the establishment of sustainable health promotion actions by enabling positive health behaviours and building social capital (WHO, 1998). Well designed interventions can have a positive and lasting effect. The potential of education as a powerful tool for social mobilisation has been lost in some cases through health promotion intervention that is "…done 'on' or 'to' people, rather than 'by' or 'with' people" (Nutbeam, 2000, p.265). There is therefore a need in occupational settings for innovative health promotion models that fulfil an enabling role. This research project drew on the stories of workers from within the industry, utilising their experience as a form of social capital.

The Australian Institute of Health and Welfare (2013) have identified nine national health priority areas (NHPA) that have been targeted by the Australian Government due to the associated burden of illness and injury. Cardiovascular health was one of the initial NHPA established and it was the theme of the first digital story developed as part of this health communication research project. Cardiovascular disease (CVD) is a term encompassing conditions and diseases of the heart and blood vessels (Australian Institute of Health and Welfare, 2012). Two prominent types of CVD are coronary heart disease and cerebrovascular disease. Coronary heart disease can manifest as two major clinical forms including acute myocardial infarction commonly referred to as a heart attack, and angina, a chronic condition presenting as chest pain (Australian Institute of Health and Welfare, 2012). Despite a downwards trend in Australian coronary heart disease mortality rates for both genders since the 1970s, it remains the leading cause of mortality in Australia (Australian Bureau of Statistics, 2013). Cerebrovascular disease, the second major form of CVD can present as acute incidents including ischaemic stroke due to arterial blockage or haemorrhagic stroke due to arterial rupture (Senes, 2006). Modifiable risk factors for CVD that were targeted through the communication strategy applied within this research project included smoking, hypertension, high levels of low density lipoproteins and triglycerides in the blood, unhealthy dietary choices, sedentary

lifestyle, depression and social isolation (National Heart Foundation of Australia, 2012). The mining industry worker who shared his story as part of this aspect of the research project experienced an acute myocardial infarction at a relatively young age. He described the incident, impact on family, health behaviour, rehabilitation, lifestyle changes and his current attitude towards his life and health. This story served as the focal point for implementing and testing a narrative communication method during study two of this research project. Two other health stories shared by mining industry workers were also captured. These additional stories, told by one male and one female worker included their discussion of prostate and breast cancer diagnosis and the importance of cancer screening and early detection. These foci are associated with cancer control, another foundation NHPA established by the Australian Government (Australian Institute of Health and Welfare, 2013). Coronary heart disease, cerebrovascular disease, lung cancer, prostate cancer and breast cancer are among the leading causes of mortality in Australia (Australian Institute of Health and Welfare, 2012). They are therefore important foci for the digital stories developed for this investigation. The experiences and perceptions of all three storytellers were captured and analysed during study three.

Occupational health promotion has evolved significantly over the past four decades with a ‘settings approach’ to health promotion introduced during the 1990s (Bilski & Wierzejska, 2008). The workplace has been identified as one of the most important settings where health promotion can occur due to the potential for efficiencies, success and sustainability (Egger, Spark, & Donovan, 2013; Bilski & Wierzejska, 2008). Despite this potential, many occupational organisations and particularly those in more challenging settings develop inappropriately planned, unstructured or unsustainable programs that are insufficiently evaluated (Egger, Spark, & Donovan, 2013). The major impetus for this research project was a perceived need and desire to establish a rigorous method for evaluating the impact of workplace health education and an opportunity for implementation within the mining industry, a challenging setting for conducting applied research.

1.2 CONTEXT

Mining has a long history associated with a wide range of operations and processes related to the extraction of minerals in solid, liquid or gaseous states (Australian Bureau of Statistics, 2012; Donoghue, 2004). It is also a diverse industry, drawing workers from a range of disciplines and sub-disciplines (Donoghue, 2004). The mining industry impacts significantly on the Australian economy, engaging a large workforce and providing the third greatest contribution to gross domestic product (Australian Bureau of Statistics, 2015).

Mining carries health and safety risks which need to be controlled and are potentially greater than many other occupations due to the nature of the work and the environment in which it is occurring. Hazards can be broadly classified as being physical, chemical, biological, environmental, ergonomic or psychosocial (Donoghue, 2004). Since the late 1980s, there have been significant safety improvements observed in the Australian mining industry. Influential factors on this observed historical change include the adoption of risk assessment and safety management techniques as standard procedures (Joy, 2004). The Minerals Council of Australia (MCA), an industry association representing companies responsible for eighty-five percent of mining production in Australia decided in 1996 that safety and health would become their top priority (Minerals Council of Australia, 2013a; Minerals Council of Australia, 2013b). Despite an acknowledgement of the importance of both foci, the bidirectional relationship is often undervalued or not recognised. Therefore occupational safety should be complemented by proactive and integrated health promotion.

Miners are required to undertake compulsory health and safety training when entering the workforce and regularly throughout their careers. A range of approaches to workplace health and safety training are currently used in the mining industry, to varying degrees of success. Of equal concern is the absence or high variability of evaluation methods applied to health and safety communication practices within the industry (Cullen, 2008; Parker, Hubinger, & Worringham, 2004; Somerville & Abrahamsson, 2003). Effective workplace health education has the potential to impact upon both the health and safety of mining industry employees by positively influencing knowledge, attitudes and behaviours. A scoping study conducted by Parker, Hubinger, & Worringham, (2004), identified the types of health education

programs delivered within twenty-two New South Wales and Queensland coal mines, representing a sample size of nine and thirteen mine sites respectively. The health education topics, in order from most to least prevalent were; drugs, auditory health, alcohol, lifting, injury prevention, smoking, fatigue, driving, hydration, stress, strength training, aerobic fitness and non-work related injuries. The most significant methods for evaluating the effectiveness of programs in these areas included monitoring injury records and employee satisfaction. The same report emphasised high variability of efficacy and program sustainability (Parker, Hubinger, & Worringham, 2004). It is evident that durable and quality controlled communication strategies are necessary. Evaluation of health education methods, modes and impact is essential for establishing evidence based practice and supporting proactive and sustainable occupational health promotion in the future.

This research was conducted at three sites operated by the mining division of a large Australian contract services company. Two of the sites were open cut mining operations supplying thermal coal used for domestic power stations and hard coking coal for overseas export (Queensland Government, Department of Natural Resources and Mines, 2012). The third site was an underground metalliferous mining operation which supplied gold for processing at a mill located nearby. A total of 10 site visits were conducted during this project. They included two initial industry familiarisation trips, followed by two for the first study and six to complete the requirements of the second study.

1.3 PURPOSE AND PROJECT OVERVIEW

The first World Health Organization (WHO) International Conference on Health Promotion held in Ottawa 1986 was a landmark event in preventive health. The Ottawa Charter for Health Promotion presented at this conference described health as a "resource for everyday life" (WHO, 2009, p.1). This action research project was developed in accordance with this view and a need for health to be integrated with safety in occupational settings.

The mining industry is a challenging setting for conducting health promotion and research activity due to the diversity of the workforce, remote location of operations, demanding work roster schedules and worker fatigue. Limited time and

pressures associated with meeting site production targets are also potential constraints when implementing research projects. The strategic use of health communication opportunities and delivery of authentic, meaningful and relevant learning experiences has the capacity to facilitate desirable health and safety outcomes in these settings. Mining is a production driven industry, therefore research activity that directly involves a mining workforce must be carefully designed and managed. As such, comprehensive and efficient data collection methods were developed and utilised for this research project. Proactive communication with site management and key personnel was undertaken prior to visits to explain the planned activities, express their purpose and foster support. This mixed methods action research project was developed as three studies to test the effectiveness of a narrative health education strategy applied within the Australian mining industry. A summary of the project aims and research questions is presented in Table 1.1.

Table 1.1. Project studies, aims and research questions

Study 1	**Evaluating a new health literacy measurement instrument**
Aim	To design and test the validity and reliability of a new instrument measuring interactive and critical health literacy indicators in the mining industry.
Research questions	Are the questionnaire items a valid representation of interactive and critical health literacy constructs? Is the questionnaire reliable and capable of yielding consistent results with a representative sample of mining industry employees under true work conditions?
Study 2	**Digital stories as a strategy for health education**
Aim	To evaluate engagement and impact of a digital story embedded communication strategy, and effects on interactive and critical health literacy indicators in the mining industry.
Research questions	Can a digital story health education strategy facilitate greater engagement and perceived impact than a non-narrative comparable method, and if so, is the effect maintained with time? Can health education via a digital story generate positive effects on interactive and critical health literacy indicators in the mining industry?

Study 3	Digital storytellers and their narratives
Aim	To investigate the lived experience of mining industry employees who shared their health related story with colleagues via a digital communication strategy.
Research question	What are the experiences, perceptions and beliefs of storytellers, prior to, and following digital story implementation within open cut and underground mine sites?

The first study focussed on the development, validation and reliability testing of a new instrument for measuring interactive and critical health literacy indicators. Suitability was assessed by testing it with a representative sample of employees under true work conditions. Questionnaire development was preceded by mining industry engagement and site visits to facilitate an understanding of the context. This was followed by four questionnaire evaluation stages including a Flesch-Kincaid Grade Level (FKGL) test procedure, expert review and Content Validity Index (CVI), construct matching tasks and Substantive Validity Analysis (SVA), and reliability testing via a test-retest procedure. There was no identified evidence of existing empirical health literacy data in the Australian mining industry and population level data suggests that health literacy is a significant issue. Nearly sixty percent of the Australian adult population exhibit a low level of health literacy and there is a need for clear, audience appropriate and focussed health communication (Australian Commission on Safety and Quality in Health Care, 2014).

The second study included baseline, impact and follow-up assessment of digital stories as a narrative communication medium for health education in the mining industry. The instrument developed and validated during study one was used for this purpose. Due to the variability that could be evident between mine sites, a quasi-experimental parallel time series research design with intervention and control groups at each site was implemented. Quasi-experimental or longitudinal study designs are generally the most suitable options for quantitative occupational health research in the field, as it usually is not possible to conduct a randomised control trial in these contexts (Nutbeam & Bauman, 2006; Goldenhar & Schulte, 1996). Digital

stories and other health education resources were prepared in readiness for the delivery stage of study two. The digital stories developed included mining industry workers telling their own health related story, with embedded contextual information and credible health experts providing key health messages. They were filmed and edited by a video production company, and sequenced to provide a congruent story.

The third study involved qualitative descriptive case study (DCS) analysis to develop an understanding of the perceptions and experiences of individuals in context (Tobin, 2012). It offers narrative insights into the thoughts, expectations and reactions of three mining industry workers, prior to and following delivery of their digital stories to the workforce. Study three included a post filming interview with the story tellers and a follow-up interview six months later. It was concurrently implemented with the resource preparation and data collection stages of study two. The three studies conducted in this research project are complementary and interrelated. The flow chart presented as Figure 1.1 demonstrates the relationships between the studies, precursory activity and relative time frames.

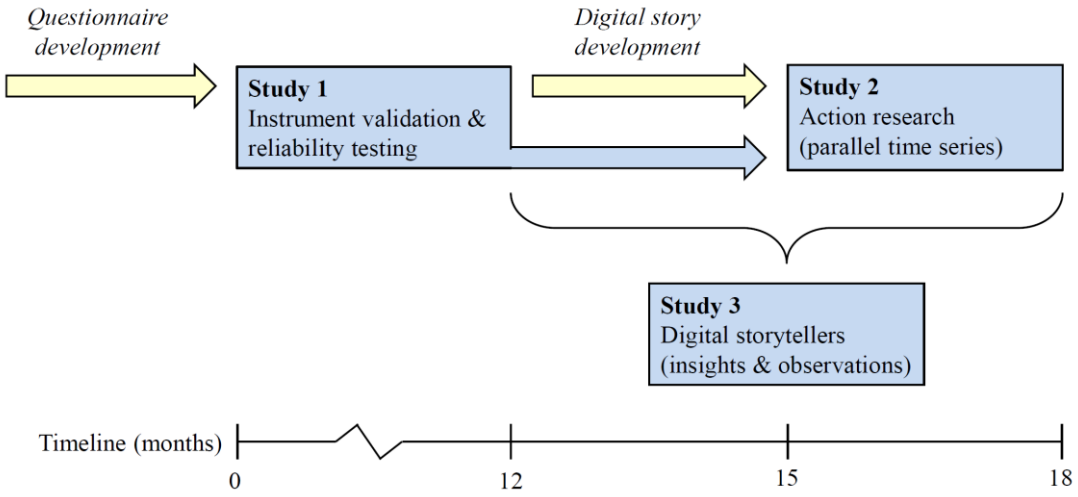

Figure 1.1. Project flow chart

1.4 DEFINITIONS, SIGNIFICANCE AND SCOPE

The OCHP published by the WHO during 1986 continues to be widely used as a framework for preventive health action. The OCHP defines health promotion as "…the process of enabling people to increase control over and to improve their health" (WHO, 2009, p.1). Health promotion is a broad concept encompassing a wide range of strategies and actions including health education. Health education is defined by the WHO (1998, p.4) as "…consciously constructed opportunities for learning, involving some form of communication designed to improve health literacy, including improving knowledge, and developing life skills which are conducive to individual and community health." A narrative health communication strategy incorporating the use of prepared digital stories was a core component of the health education delivered during study two. In order to fully understand and appreciate health education, it is necessary to define health literacy as it is an outcome focused concept referred to in the definition of health education.

The concept of health literacy has evolved significantly during the past four decades since it was first used by Simonds (1974). Despite this evolution, a range of definitions and interpretations still remain and will be discussed in detail within chapter two. For the purposes of establishing a broad conceptual understanding, the following WHO definition will be used as it is widely recognised. Health literacy is defined as "...the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health" (WHO, 1998, p. 10). Health literacy is considered a significant antecedent of health promoting behaviour (Frisch, Camerini, & Diviani, 2011). This research project was based upon Nutbeam's (2000) model of health literacy comprising three dimensions: functional, interactive and critical. This model and definition have been widely cited and applied.

During the past decade, the need for validated measurement instruments that reflect a comprehensive view of health literacy has been expressed by researchers in the field of health promotion. This need has been conveyed in response to efforts to clearly define the scope of the term and the corresponding inception of it as a core concept within a contemporary approach to health promotion. The aforementioned model, definition and evolution of the concept will be discussed in detail within the literature review. This research project included the development, validation,

reliability testing and application of a new instrument for measuring interactive and critical health literacy indicators in a workplace setting. There is no known evidence of empirical research evaluating interactive and critical health literacy within the Australian mining industry.

Health education is also concerned with fostering the confidence or self-efficacy to use knowledge and skills to improve or maintain health (WHO, 1998). Higher risk occupations tend to exhibit organisational cultures that are strongly embedded in their work practices, due to the associated dangers of the job and workers are more likely to resist changes suggested by people outside the organisational culture (Van Maanen & Barley, 1984). This research project attempted to proactively use organisational culture to facilitate the communication of health information through the delivery of worker oriented digital stories. The rationale for this approach is that a narrative communication strategy driven by worker derived stories can establish a sense of familiarity, which could promote organisational culture as an enabling factor rather than a potential barrier. Narrative methods involving the telling or writing of one's experiences and integrated cognitive, socio-cultural and affective learning help to develop shared understandings (Cozolino & Sprokay, 2006). Stories can be powerful forces for the construction of ideologies, especially when they involve a range of stakeholders (Mattingly, 2008). The use of stories as a communication tool is not new. The fact that this practice has been common to many cultures around the world over long periods of time bears testament to the strength of this approach. Digital stories serve as a new interpretation of an old process and a form of narrative expression. Sylvester & Greenidge (2009) describe digital stories as multimedia presentations which can include embedded text, video, still images and narrative soundtracks.

A coordinated future focus for health literacy research and projects at the global level was instigated at the 2012 Worldwide Universities Network (WUN) Global Public Health Conference (Worldwide Universities Network, 2014). During this conference, the WUN Health Literacy Network held their inaugural meeting to discuss five themes for future progress. One of the chosen themes was 'health literacy in the age of digital communication' (Worldwide Universities Network, 2014). Digital storytelling was chosen as the means of communication for this research project three years prior to this event, culminating with implementation of

the strategy in the same year. To date, there is no known empirical action research evaluating the impact of digital story based communication methods on health literacy in the mining industry.

There are different forms of action research that reflect characteristics common to the work of action research pioneers during the 1940s and 1950s. The onset of action research methodology is generally credited to the work of social psychologist Kurt Lewin (1946), who proposed three goals for action research including knowledge advancement, situational improvement and development of behavioural science research methodology. Since the 1940s, action research has been applied extensively in educational settings and workplace contexts during periods of reform and as a means to support professional learning (Scott, Clarkson, & McDonough, 2012). Lewin (1946) originally described action research as a cyclical process of planning, acting, observing and reflecting. This basic action research model is still used today, along with variations evident including reordered and cumulative cycles (Reierson, Hvidsten, Wighus, & Brungot, 2013; Costello, 2011). One such variation is Norton's (2009) action research cycle which commences with an observation stage. This variation enables a thorough understanding of the people, environment and culture necessary for facilitation of health promotion by an external agent.

A new action research model was also developed for this project (Figure 1.2), incorporating a fifth stage involving direct feedback to personnel at participating sites, and a feed-forward communication mechanism with other stakeholders, supporting future evidence based practice.

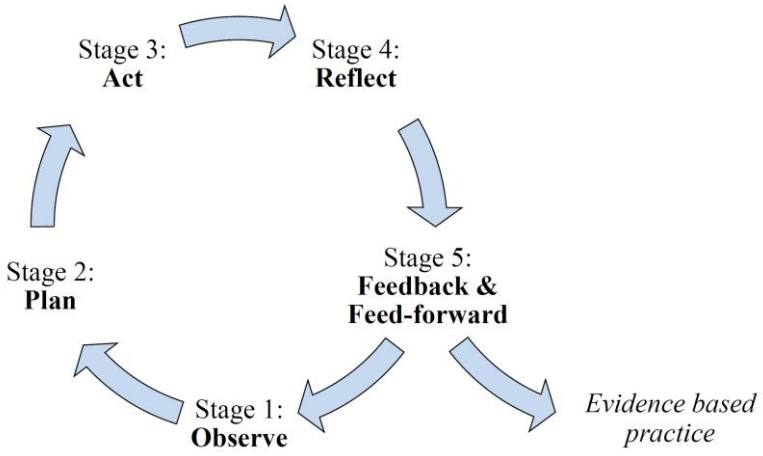

Figure 1.2. Five stage action research model developed for this research project (adapted from Norton, 2009)

The developed model acknowledges evaluation and dissemination which are fundamentally important for effective action research and health promotion in workplace settings (Sommer, 2009; McQueen & Anderson, 2001; Springett & Dugdill, 1999). The five stage action research model served as a guiding framework for the design, implementation and reporting activity associated with this project.

This project is cross-disciplinary in nature and offers a range of original and novel contributions to the OHS and health promotion fields, and more specifically, the mining industry. These include the development and validation of a new instrument for assessing interactive and critical health literacy indicators, and deeper understanding of the impact of digital story based health education methods applied within mining industry settings. Furthermore, they include case study exploration of the experiences, perceptions, beliefs and observations of miners as digital storytellers.

1.5 THESIS OUTLINE

The remaining chapters of this thesis will include the following foci. Chapter two presents a thematically structured literature review including critical analysis of research associated with the underlying conceptual frameworks and theoretical constructs of this research project. It will justify the purpose of this research and provide a foundation for discussing the method and results. Chapters three, four and five focus on the three studies completed. They will describe the quantitative and qualitative research methods, provide a rationale, outline participant involvement and include a detailed description and discussion of the data generated. Chapter six summarises key outcomes, conclusions, strengths, significance, limitations and potential ongoing research.

Chapter 2: Literature review

A range of electronic databases including MEDLINE, PubMed, CINAHL, ERIC and PsycINFO were systematically searched using exclusion criteria and a combination of phrase, truncation, nesting, proximity and Boolean operators. Due to the multidisciplinary nature of this research project, the literature review is presented as five thematic topics including health literacy, health literacy measurement, workplace health promotion, narrative health education and digital story health communication. It also provides conceptual links to the applied methodology discussed within chapters' three to five and concludes with a summary of the underlying theoretical frameworks for the research project.

2.1 HEALTH LITERACY

At the global level, health literacy has appeared in the literature after it was first used during the 1970s by Simonds (1974). Since then, there has been increasing coverage within the literature, including academic discussion about what the term represents and how it should be evaluated (Paasche-Orlow, Wilson, & McCormack, 2010; Berkman, Davis, & McCormack, 2010). As previously mentioned within chapter one, health literacy is an important antecedent of health promoting behaviour (Frisch, Camerini, & Diviani, 2011). A range of consequences have been associated with limited health literacy including poorer health status, greater use of medical services, lower adherence to medical advice and lower use of preventive health services (Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011; Wagner, Steptoe, Wolf, & Wardle, 2009; Marks, 2009; Kickbusch & Maag, 2008; Lee, Arozullah, & Cho, 2004). These personal and community impacts translate into greater burden of illness, increased strain on the health care system and greater economic expenditure (Australian Commission on Safety and Quality in Health Care, 2014; Frisch, Camerini, & Diviani, 2011).

Health literacy is a significant health determinant which has evolved during the last four decades to reflect two major orientations. These include a risk factor approach to applied literacy skills in clinical settings and a more recent asset or

strength based orientation reflecting the contemporary approach to health promotion (Smith, Nutbeam, & McCaffrey, 2013; Pleasant & Kuruvilla, 2008). The dual orientations will be individually discussed in this section, to highlight the conceptual evolution of health literacy. This will then support a rationale for an integrated focus on a multidimensional approach to health literacy as included within this research project.

Literacy skills applied in clinical health care settings

During the 1970s and 1980s, a focus on the applied literacy skills of patients in clinical settings and practitioner-patient interactions led to the progressive acceptance and use of the term health literacy (Kickbusch & Maag, 2008). Given the clinical context where it was applied, much of the early health literacy research emerged from medicine and nursing journals (Speros, 2005). The applied literacy skills that were typically focussed on included reading and understanding printed health education materials and consent forms, and comprehending verbal information provided by health professionals (Kickbusch & Maag, 2008; Kickbusch, 2001). This clinical orientation emerged within the US (Pleasant & Kuruvilla, 2008) and was driven by concern about the poor literacy skills exhibited by patients in the health care system (Kickbusch, 2001). Clinical health literacy interpretation is still the predominant orientation evident in the US. Other terms reported in the literature reflecting the same orientation include patient counselling, patient education, medical literacy, patient health literacy and clinical health literacy (Peerson & Saunders, 2009; Pleasant & Kuruvilla, 2008; Ishikawa & Yano, 2008).

An early study in this area assessed the level of comprehension among US cancer patients during the informed consent process (Morrow, 1980). The findings highlighted that the forms were very complex and required tertiary education level reading ability, resulting in a significant proportion of patients being unable to comprehend the information and provide informed consent. A similar study by Baker & Taub (1983) investigated the suitability of informed consent forms for research participation in clinical settings. The consent forms were retrospectively analysed from the period 1975 to 1982 using the Flesch readability scale. During this period, tighter controls for recruitment and gaining consent for research participants were being introduced. The authors identified the need to conduct research to evaluate

how information is interpreted in a health care setting through direct measures of comprehension. Both studies reflected the typical interpretation of health literacy during the 1970s and early 1980s, as a functional characteristic associated with information communicated in health care settings. They advanced understanding of direct communication in clinical settings and patient comprehension, but did not provide insights into actions and behaviours of patients beyond the clinical setting.

Health status is influenced by a range of determinants which can exist as risk or protective factors (Australian Institute of Health and Welfare, 2012). Educational attainment is recognised as a significant social determinant of health and there is strong evidence at the population level globally to confirm this (Keleher & MacDougall, 2009; Marmot, 2005). Although at an individual level, educational attainment may be an inconsistent indicator which does not always translate as a protective factor (Berkman, Davis, & McCormack, 2010). The latter can be seen among individuals who experience difficulty understanding, using and sourcing health information, despite having a high level of education and more advanced literacy skills (Kickbusch & Maag, 2008). Likewise, individuals who comprehend health information and can acknowledge personal risk factors, may still choose to engage in behaviours that compromise personal health, despite knowing the risks. In consideration of this, a more holistic view of health education and communication warrants looking beyond information transmission and reception, to include translational outcomes and the inherent cognitive and ecological factors. The emergence of the contemporary approach to health promotion has afforded a new interpretation and orientation for health literacy.

A contemporary health promotion orientation

A significant event in the development of a contemporary approach to health promotion was the inception of the Ottawa Charter for Health Promotion (WHO, 1986). This charter, presented at the First International Conference on Health Promotion in Canada, provided a framework for understanding health issues in different contexts and for the development of interventions around the strategies and action areas proposed (Davies & Macdowall, 2006). The charter emphasised three prerequisites for improving health status: enabling, mediation and advocacy. The enabling prerequisite is primarily concerned with allowing individuals to take control

of their own health through accessing information, developing skills and utilising opportunities within a supportive environment (Kickbusch, 2002; WHO, 1986). These desired attributes, outcomes and ecological perspective were inherent within an expanded view of health literacy that emerged following maturation of health promotion theory and practice.

The field of health promotion has grown significantly as more attention has been given to a preventive focus and the potential benefits that can arise for individuals, communities and whole populations. Adopting a forward thinking perspective requires an understanding of why health problems arise and the development of proactive and context specific initiatives. In order to gain a complete understanding of health issues, it is necessary to consider the determinants of health and their positive or negative impact on health status. Theories of behaviour change, including the theory of planned behaviour and social cognitive theory emerged during the 1980s (Ajzen & Fishbein, 1980; Bandura, 1986). A significant body of empirical research on the determinants of health followed during the 1990s. This led to a stronger evidence base for more comprehensive investigation of health issues and a greater proportion of theory informed interventions (Keleher & Murphy, 2006). According to Ajzen and Fishbein's theory of planned behaviour (1980), intentions are a function of behavioural beliefs or attitude, normative beliefs or perceptions of social support, and control beliefs or perceived ability (Cottrell, Girvan, & McKenzie, 2009; Ajzen, 1991). Successful theory based interventions during this time, attempted to promote positive health behaviour through the development of personal skills and recognition of the social context in which people are based.

As the evidence base for health promotion intervention grew, the WHO acknowledged the effectiveness and importance of a settings based approach in the Jakarta Declaration on Leading Health Promotion into the 21st Century (WHO, 1997). This declaration, presented at the Fourth International Conference on Health Promotion also emphasised that participation and empowerment depend on access to health education and information (WHO, 1997). The Jakarta Declaration also expressed future priorities for the new millennium, including promoting social responsibility for health, increasing community capacity and empowering the individual (WHO, 1997). The listed priorities also featured prominently in a more comprehensive view of health literacy that emerged from the late 1990s.

In response to the contemporary view of health that had arisen, the WHO defined health literacy as "…the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health" (WHO, 1998, p.10). This interpretation of health literacy was more comprehensive than the functional literacy based orientation previously discussed within this literature review. It emphasised constructs associated with autonomy, implied behavioural responses and offered a more universal application as it was not bound to a particular setting. As a postscript to this definition, the WHO articulated that health literacy is essential for empowering individuals and groups by improving access to health information and strengthening the capacity of individuals to effectively apply this information (WHO, 1998).

Although health literacy retained a focus on the individual, progressive conceptual evolution led to necessary broadening of the term to include ecological perspectives such as culture and social capital (Berkman, Davis, & McCormack, 2010). As the concept expanded, variation in meaning and interpretation of health literacy was evident across different contexts (Sykes, Wills, Rowlands, & Popple, 2013; Baker, 2006). Two years after release of the WHO definition of health literacy, there were calls for ongoing discussion across a range of fields and contexts about how to define and measure health literacy (Nutbeam & Kickbusch, 2000). During the same year, Nutbeam (2000) published a conceptual paper detailing a framework for a more comprehensive multidimensional model of health literacy. This model identified and distinguished three dimensions including, functional health literacy (FHL), interactive health literacy (IHL) and critical health literacy (CHL). According to this model, FHL, IHL and CHL exist along a continuum of increasing autonomy and empowerment (Nutbeam, 2008). A summary of the orientation and inherent constructs of each dimension within the continuum is presented in Figure 2.1.

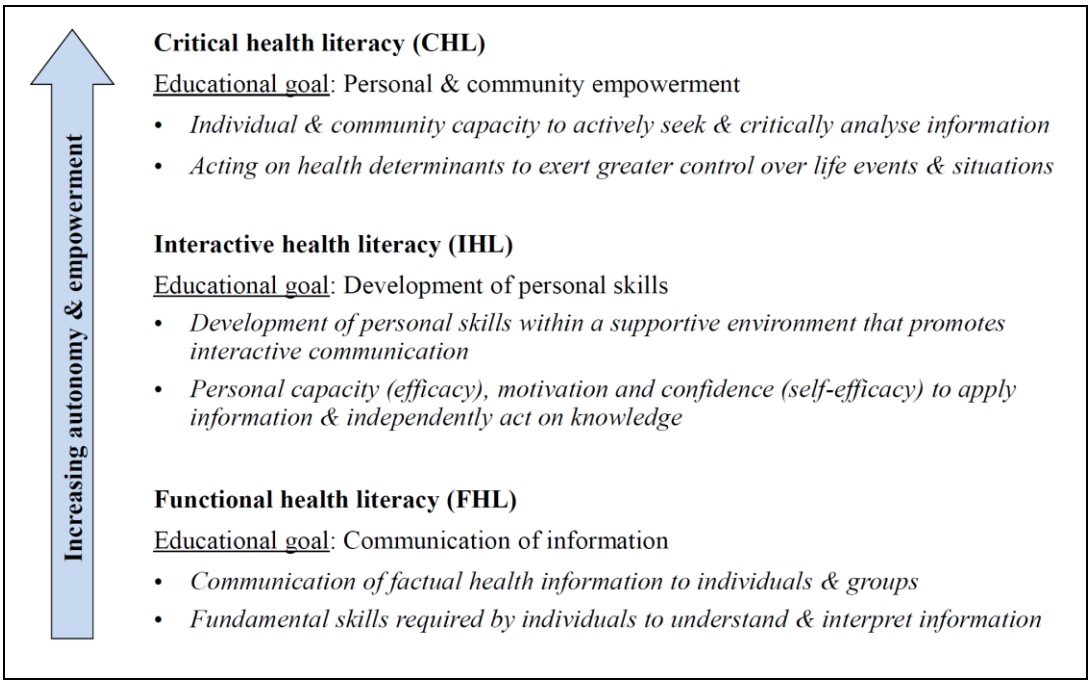

Figure 2.1. A summary of Nutbeam's multidimensional model of health literacy (adapted from Nutbeam, 2000)

The FHL dimension of health literacy reflects the skills and attributes of the clinical orientation previously discussed. The greatest conceptual evolution of health literacy came with the inclusion of IHL and CHL. These dimensions integrated additional foci including culture, motivation, confidence, critical analytical skills, empowerment and responsiveness (Nutbeam, 2008). Nutbeam's (2000) multidimensional model of health literacy also opened up the scope to alternative settings that are encountered in everyday life and looked beyond the individual. In doing so, it elaborated on the WHO (1998) definition of health literacy. This model collectively represented a comprehensive ecological approach to conceptualising and promoting health literacy.

The decade following delivery of the multidimensional model of health literacy included rigorous debate about the different orientations of health literacy, broadening applications and the emergence of new methods of measurement. The latter will be discussed in section 2.2 of this literature review. A focussed literature search strategy was implemented for this period, to gain an understanding of health literacy orientation, proportional coverage and whether there was evidence of associations with the targeted industry and planned communication mode for this

project. A total of six forced phrase searches were conducted and exclusion criteria limited the search results to full text and peer-reviewed articles published in the English language. The first four searches involved the corresponding forced phrases; health literacy (HL), functional health literacy (FHL), interactive health literacy (IHL) and critical health literacy (CHL) to ascertain the depth of coverage. Two further searches involved HL in combination with derivatives of truncated digital story (DS) and the mining industry as a targeted setting. A graphical summary of the identified publications per search focus for the targeted period is presented in Figure 2.2.

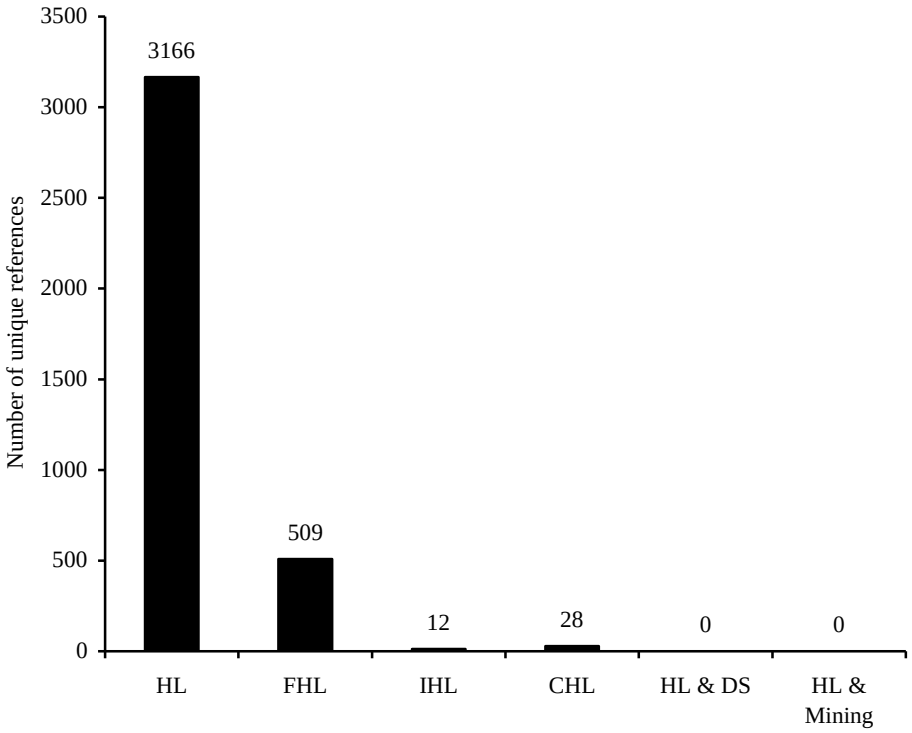

Figure 2.2. Database search results (January 2000 to January 2010)

Despite the importance of IHL and CHL as previously acknowledged, there was relatively limited coverage of these health literacy dimensions as shown within Figure 2.2. In contrast, there were significantly more publications identifying FHL from Nutbeam's (2000) multidimensional model and the broader term health literacy that has an origin dating back to the 1970s (Peerson & Saunders, 2009). The greater proportion of the combined forty IHL and CHL publications were released during the latter half of this period, and represented the next cycle of emergent health literacy discussion papers and research.

The majority of the literature associated with IHL and CHL focussed on specific populations. Examples include low-income mothers and empowerment through interaction with health professionals (Porr, Drummond, & Richter, 2006); critical skill development in formal education settings and community health centres (Mogford, Gould, & Devoght, 2011); decision making among groups with differing levels of educational attainment and FHL (Smith, Dixon, Trevena, Nutbeam, & McCaffery, 2009); and shared decision making associated with use of a bowel cancer screening aid (Smith, Nutbeam, & McCaffrey, 2013). Most of the applied methods evident within the literature have been quantitative; however, qualitative exploration of variations in educational attainment and FHL yielded interesting results. Comparisons between a tertiary educated group and community sample with lower educational attainment, revealed that the latter group were less likely to actively engage in decision making processes with health professionals and were more likely to rely on friends and family when seeking health information (Smith, Dixon, Trevena, Nutbeam, & McCaffery, 2009).

More recent research has shown significant insights into health literacy from a settings perspective and with investigation of the relationships between FHL, IHL and CHL. For example, findings from a series of qualitative and quantitative studies into the use of cancer screening aides, indicated that application of health literacy skills during decision making was a non-linear process (Smith, Nutbeam, & McCaffery, 2013). Participants showing evidence of all dimensions of Nutbeam's (2000) model, were able to oscillate between FHL, IHL and CHL skill application, as they engaged in different stages of the decision making process. This observation reflected the view held by some researchers that health literacy is dynamic and responsive to circumstances, experience and the context (Berkman, Davis, & McCormack, 2010; Zarcadoolas, Pleasant, & Greer, 2005). Research examining the content and context specificity of health literacy responses, highlighted the necessity for setting focussed approaches to health education and communication (Smith, Nutbeam, & McCaffery, 2013).

Improved health literacy has been identified as a potential outcome of health education and communication strategies tailored to suit the context, recognising the culture and environment in which they are delivered (Nutbeam, Harris, & Wise, 2010). Improved health literacy can then act as antecedent for modified health

behaviours and improved health outcomes. In the early stages of the contemporary health promotion focussed orientation to health literacy, Kickbusch (2001) suggested that technology could be an important enabling factor for better learning opportunities, engagement and health literacy development.

In acknowledgement of this need for contextualised health education initiatives and potential of narrative communication, the final two literature searches identified within Figure 2.2 were conducted to examine this suggestion. Health literacy, in combination with technology facilitated digital storytelling, or the mining industry context was also considered in this review. Search strategies included health literacy as a forced phrase, Boolean operators, nesting and truncation of key terms including digital story, stories or storytelling for the communication method and mining or mine for the context. As previously stated, these searches did not reveal any published research literature investigating health literacy within the mining industry or linking health literacy with the application of digital stories.

As indicated in the preceding section of this review, much of the early and ongoing clinically focussed health literacy research has adopted a risk based perspective, examining the impact of low literacy skills on patient understanding and outcomes. In contrast, the contemporary health promotion orientation that has emerged, provides an opportunity for an asset or strengths-based perspective of health literacy which emphasises capacity building and supports empowerment (Nutbeam, 2008; WHO, 2005b). Despite this advancement, there is a need for further research within the field of health literacy that goes beyond conceptualisation, focussing on the development of more sophisticated and comprehensive methods of measurement and instruments (Smith, Nutbeam, & McCaffery, 2013; Peerson & Saunders, 2009; Nutbeam, 2008). The following section of this literature review will critically appraise the range of health literacy measurement methods reported in the literature.

2.2 HEALTH LITERACY MEASUREMENT

Early attempts to measure health literacy and a significant proportion of current methods used by researchers in the US, emphasise a clinical orientation towards literacy skills or functional health literacy. Two such measures that were developed

include the Rapid Estimate of Adult Literacy in Medicine (REALM) instrument and the Test of Functional Health Literacy in Adults (TOFHLA). The REALM assessment instrument (Davis, et al., 1993) was developed and validated against standardised reading tests including, the Peabody Individual Achievement Test-Revised (PIAT-R), the Wide Range Achievement Test-Revised (WRAT-R), and the Slosson Oral Reading Test-Revised (SORT-R). Davis and colleagues (1993) recruited 203 participants to test the REALM instrument against these previously validated literacy tests and then assessed for test-retest reliability with 100 participants. The results of the study demonstrated a strong correlation of 0.96 and 0.88 with SORT-R and WRAT-R respectively and a test-retest reliability of 0.99 ($P < .001$). The TOFHLA was specifically created by Parker, Baker, Williams, & Nurss (1995) for a clinical setting. The 22 minute test was developed using authentic hospital health education materials and consists of 50 comprehension (literacy) associated items and 17 numeracy items. The English and Spanish versions of the test were validated against the REALM and WRAT-R instruments, demonstrating correlation coefficients of 0.74 and 0.84 respectively. Participants for the study were 256 and 249 English and Spanish speaking patients respectively from two teaching hospitals (Parker, Baker, Williams, & Nurss, 1995). A potential limitation of the TOFHLA is the amount of time required for administration and a shortened version of 12 minutes duration (S-TOFHLA) has since been developed (Baker, Williams, Parker, Gazmararian, & Nurss, 1999). Researchers have been able to exhibit the reliability and validity of the TOFHLA, S-TOFHLA and REALM instruments which are commonly used in research. Unfortunately, some researchers have been applying these instruments outside clinical environments for community setting health promotion purposes. This is beyond the scope of these instruments, as they were designed for use in clinical settings, primarily focusing on reading ability and comprehension in the case of TOFHLA (Frisch, Camerini, & Diviani, 2011; Rootman & Ronson, 2005).

The Newest Vital Sign (NVS) instrument, which was designed for rapid administration within clinical settings, comprises six questions to determine understanding of information provided within the nutrition panel of a food product (Powell, 2009; Weiss, et al., 2005; Osborn, et al., 2007). A comparative study examining TOFHLA, REALM and NVS revealed moderate correlation, different but

associated constructs and variations in threshold points for identifying poor health literacy (Barber, et al., 2009). Inconsistency in the measurement of health literacy makes comparison of research outcomes difficult, unless relative change is assessed via intra-subject comparisons using the same instrument (Jordan, Osborne, & Buchbinder, 2011). These limitations and their lack of recognition of ecological factors, including culture, prevent the use of REALM, TOFHLA and NVS as comprehensive health literacy measures (Frisch, Camerini, & Diviani, 2011; Nutbeam, 2009; Mancuso, 2009; Baker, 2006; Rootman & Ronson, 2005). These instruments were therefore not suitable for use within this research project.

At a population level, attempts have been made to quantify health literacy. The US was the first country to develop a population level health literacy scale, the Health Activities Literacy Scale (HALS) which was linked to the National Adult Literacy (NAL) survey (Australian Bureau of Statistics, 2008). Since then a revised survey, the National Assessment of Adult Literacy (NAAL) has included a 28 item health literacy component. The HALS survey is more comprehensive than REALM and TOFHLA, but the original version can take up to one hour to administer and it still predominantly reflects a functional literacy skill orientation (Nutbeam, 2008). Similar population level literacy surveys inclusive of a health literacy component have been applied in Canada and Australia, namely the International Adult Literacy and Skills (IALS) survey and Adult Literacy and Life Skills (ALLS) survey respectively (Canadian Council on Learning, 2007; Australian Bureau of Statistics, 2008). Both of these scales are directly comparable; however, the HALS survey is not equivalent (Peerson & Saunders, 2009; Australian Bureau of Statistics, 2008). The 2006 Australian ALLS survey included 191 health-related items, of which 60 were associated with health promotion, 64 with health protection, 18 with disease prevention, 16 with health care maintenance and 32 with systems navigation (Australian Bureau of Statistics, 2008). The outcomes of the 2006 ALLS Survey indicated similar health literacy results between Australian males and females aged 15 to 74 years, suggesting no evidence of gender differences (Australian Institute of Health and Welfare, 2011). However, there were socio-demographic differences, with stronger health literacy associated with employment, higher education levels, socialisation, community participation, higher socio-economic status and an English speaking background (Australian Institute of Health and Welfare, 2012; Australian

Bureau of Statistics, 2008). These socio-demographic factors are also determinants of health evident at the population level within the Australian context (Australian Institute of Health and Welfare, 2012). The ALLS survey incorporated a more extensive coverage of health literacy as defined by Nutbeam's (2000) multidimensional model, although the major emphasis was on isolated functional skills rather than their association with attitudes and behaviours. An alarming result from the Australian survey, was that more than half of the respondents (59%) did not achieve the minimum target of Level 3 proficiency (five level scale) required for managing complex demands of daily life (Australian Bureau of Statistics, 2008).

A small number of qualitative and quantitative studies have attempted to investigate multiple dimensions of health literacy at an individual level. Ishikawa, Takeuchi, & Yano (2008) examined the psychometric properties of newly developed scales for measuring each of the three dimensions of health literacy as defined by Nutbeam (2000) among Japanese diabetic patients. Ishikawa and colleagues (2008) argued that no validated instrument was available to assess a broad skill set associated with receiving and responding to health information. In response, they developed scale items for a self-report questionnaire to directly reflect the three dimensions of health literacy. The results of this research supported the theoretical notion that higher level health literacy functioning requires more advanced skills. A limitation of the study, was the potential for an overestimation of higher health literacy levels, as the study was conducted at a single site with patients who had an established patient-doctor relationship.

Another Japanese study by Ishikawa, Nomura, Sato, & Yano (2008), also acknowledged Nutbeam's (2000) multidimensional health literacy model; however, this iteration was applied outside of the typical clinical context to reflect a health promotion orientation. The research group created, validated and pilot tested a brief self-administered questionnaire for Japanese office workers which primarily assessed IHL, CHL and somatic symptoms. The results of this study indicated that the higher functioning health literacy group were more likely to initiate positive health behaviours, actively solve health related problems, or seek help (Ishikawa, Nomura, Sato, & Yano, 2008). The lower functioning health literacy group reported a significantly greater number of somatic symptoms and were more likely to passively accept health problems (Ishikawa, Nomura, Sato, & Yano, 2008).

A significant proportion of current health literacy research emerging from the US is still associated with FHL, although some US researchers have been focusing attention on IHL and CHL. Friedman & Hoffman-Goetz (2008) acknowledged that few studies of that period had defined or evaluated health literacy using Nutbeam's (2000) multidimensional model. In a subsequent study of prostate cancer knowledge and understanding among 25 African-American men aged 45 or older, Friedman, Corwin, Dominick, & Rose (2009) conducted mixed methods research grounded in Nutbeam's (2000) multidimensional health literacy model. Quantitative research included implementation of the TOFHLA and two modified cloze tests. Qualitative research consisted of interviews and focus groups exploring risk, prevention and screening. Transcripts were reviewed for recurrent themes and analysed using NVivo. This research produced quantitative data for FHL only as IHL and CHL were evaluated using qualitative methods. A limitation of this study was the relatively small sample size. Research requiring larger samples sizes conducted in a workplace environment where it is not possible for extensive access to the workforce necessitates different methodologies.

Advancement of conceptual models of health literacy has been recognised as a significant step forward (Pleasant & Kuruvilla, 2008), and this has helped to distinguish differences between clinical and public health frames of reference. Pleasant & Kuruvilla (2008) acknowledged the clinical orientation of commonly used health literacy metrics, including REALM, TOFHLA and NVS, as well as their restriction to FHL. In response to this, the same authors developed a new measurement instrument, the Public Health Literacy Knowledge Scale which, as suggested by the title, has a public health orientation. The researchers used a range of methods to test the validity and reliability of their instrument including; expert consultation, Flesch-Kincaid readability assessment, correlation testing with a science literacy scale and a test-retest method. The scale required respondents to mark statements associated with topics such as accessing health services, vaccination, injury prevention, hygiene, communicable disease, vector borne disease, antibiotics, general illness, sexual health and cancer prevention as either true or false. Despite advances in establishing a scale for use beyond clinical settings and the application of systematic methods for evaluating validity and reliability, the scale predominantly focussed on functional health literacy, even though the researchers

acknowledged the importance of all three dimensions. Responses were also limited to a dichotomous scale which could reduce the depth of analysis that could be accomplished in comparison to use of either an interval scale or a visual analogue scale (VAS).

A meta-analysis of fifty-one health literacy measurement instruments (Haun, Valerio, McCormack, Sorenson, & Paasche-Orlow, 2014) identified relatively limited coverage of interaction (10/51), information seeking (10/51), decision making (15/51) and self-efficacy (3/51) constructs that are inherent elements of the multidimensional health literacy model. Four of the reviewed instruments incorporated the first two constructs listed above and partial coverage of the latter two. These instruments include the Swiss Health Literacy Survey (Wang, Thombs, & Schmid, 2012), Health Literacy Questionnaire (Osborne, Batterham, Elsworth, Hawkins, & Buchbinder, 2013), The European Health Literacy Questionnaire (Sorenson, et al., 2013) and All Aspects of Health Literacy Scale (Chinn & McCarthy, 2013). These instruments contain discrete response scales ranging from dichotomous to four point scales. Each instrument explicitly incorporated the multidimensional health literacy model (Nutbeam, 2000) and have demonstrated progress towards the expressed need for more comprehensive tools. Despite the associated strengths, some constructs, including self-efficacy have gained limited attention. Of the three instruments cited by Haun, Valerio, McCormack, Sorenson, & Paasche-Orlow (2014) to integrate self-efficacy, the Health Literacy Management Scale (Jordan, et al., 2013) and the Three-Item Health Literacy Screening instrument (Chew, Bradley, & Bokyo, 2004) are restricted to the clinical settings they were designed for.

The concept of health literacy has evolved over the last forty years from an individual, literacy driven focus in clinical settings to one that represents a contemporary health promotion perspective. Nutbeam (2000) and Kickbusch (2001) have drawn attention to health literacy as a core concept within a contemporary health promotion model. They have done this through advocacy and an expressed need for appropriate definitions of the term and suitable measurement instruments. It is clear that the development of a strong evidence base is a necessary step to further strengthen understanding and potential applications of health literacy across a range of settings including workplaces. Due to the inherent complexity, health literacy is

challenging to influence and measure (Peerson & Saunders, 2009). Further development of health literacy measurement is required to support the multidimensional perspective including application in settings for daily living (Nutbeam, Harris, & Wise, 2010; Protheroe, Wallace, Rowlands, & DeVoe, 2009; Abel, 2008a). The majority of previous research has focussed on FHL (Abel, 2008a) and while this has contributed to the field and is useful in certain contexts, there is a need for more research exploring IHL and CHL (Smith, Nutbeam, & McCaffery, 2013; Nutbeam, 2009; Pleasant & Kuruvilla, 2008). Health literacy also needs to be considered as a developmental outcome of applied health education and communication strategies (Nutbeam, Harris, & Wise, 2010; Nutbeam, 2009). Further evolution of health literacy measurement, including new and adapted methods that support the identification of baseline levels allowing monitoring over time is necessary (Nutbeam, Harris, & Wise, 2010; Nielsen-Bohlman, Panzer, & Kindig, 2004). More recent development of comprehensive health literacy measurements with a focus on IHL and CHL has demonstrated progress within the field. Despite this improvement, each carry their own limitations including varying degrees of construct coverage, restriction to specific contexts in many cases and further exploration over longer time scales is required.

2.3 WORKPLACE HEALTH PROMOTION

The health promoting workplace (HPW) has been identified by the WHO (2013) as a priority setting for action in the twenty-first century due to the potential for flow on benefits to the community. A HPW has the capacity for primary, secondary and tertiary prevention by helping apparently healthy workers to maintain their health and by assisting workers requiring risk reduction or management of lifestyle related health behaviours (Goetzel & Ozminkowski, 2008). In addition to the social and ethical reasons for establishing a HPW, the WHO (2010) describes workforce health as an asset for the business or employer.

The traditional focus of the OHS field has been on hazards in the workplace and their potential for illness, injury and mortality (Hymel, et al., 2011; Mearns, Hope, Ford, & Tetrick, 2010). Whilst this is very important for mining and other higher risk industries due to the nature of the work and the environment in which it

occurs, an isolated focus is problematic. An integrated conceptualisation of OHS recognises the total health and safety of workers, including their personal lifestyles and the work environment. This holistic approach emphasises a need for health protection and health promotion (Partnership for European Research in Occupational Safety and Health, 2012).

Looking more broadly than the mining industry, workplace health promotion in Australia evolved significantly during the 1970s to 1990s, from targeted single risk factors through to more comprehensive wellness programs. The predominant focus was on individual behaviour modification, with limited consideration of organisational and cultural factors in the workplace (Chu, Driscoll, & Dwyer, 1997). Health is influenced by a wide range of determinants and it is difficult to isolate them to a single setting (Keleher & MacDougall, 2009). Workplace health promotion activity should therefore acknowledge individual, group and environmental factors, within the workplace and beyond. An ecological approach to health should also be embedded within evaluation methods to take them beyond assessment of health behaviours and biophysical outcomes.

The Australian National Workplace Health Project (NWHP) was Australia's largest workplace health intervention trial when implemented and it provides evidence highlighting the potential for impact generated by health promotion action in the workplace (Simpson, et al., 2000). The NWHP addressed a variety of health issues across a wide range of workplace settings including mining operations, using a randomised controlled trial research method. Outcome evaluation revealed noticeable positive changes to employee perceptions and attitudes, and some data suggested health-promoting behaviour change across all of the sites examined (Harris, Oldenburg, Simpson, & Dobbins, 2000). The study reported the average cost of the program for participants, but acknowledged they were not able to conduct an evaluation of cost effectiveness as a result of the unreliable lost time injury (LTI) and absenteeism data available.

One way of demonstrating the cost effectiveness of health promotion in the workplace is via return on investment (ROI) analysis. There are diverse ROI amounts per dollar spent on HPW programs reported in the literature, with values typically ranging from two to ten dollars for one to five year periods of investment. Limited research methodologies, self-selective populations and potential publication bias

among some of the ROI studies may be responsible for the great variation in reported ROI and potential inflation of ROI (Baicker, Cutler, & Song, 2010; Goetzel & Ozminkowski, 2008; Serxner, Anderson, & Gold, 2004). Nevertheless, there is an economic argument for establishing a HPW, as there is extensive evidence of the medium to long term gains from health promotion programs due to reduced absenteeism, reduced compensation costs and increased productivity (Baicker, Cutler, & Song, 2010; Renaud, et al., 2008; Goetzel & Ozminkowski, 2008). In addition to economic gains, workplace health promotion can lead to benefits for organisational health and safety climate, work ability, job satisfaction, support and motivation among the workforce (Grabovac & Mustajbegovic, 2015; Mearns, Hope, Ford, & Tetrick, 2010; Crimmins & Halberg, 2009; Naumanen, 2006).

Despite the variety of possible gains through an integrated approach to OHS, there is the potential for negative attitudes towards health promotion in the workplace. From an operational perspective, health education could be seen as activity that incurs lost time and economic debt for the employer. The cost of personnel with appropriate expertise to deliver and evaluate health education, resources and time away from work are also identified as significant barriers for some organisations (Grabovac & Mustajbegovic, 2015; Johnson & Denham, 2008). As a counter-measure to the upfront economic cost of additional personnel and insufficient expertise to design, implement and evaluate health promotion in the workplace, Johnson & Denham (2008) have highlighted the benefits that can be gained through partnerships between industry and research academics. Such partnerships could also lead to longer term capacity building and self-sufficiency. Employers may also be philosophically opposed to health promotion in the workplace, believing they should not be interfering with personal lifestyle choices (Goetzel & Ozminkowski, 2008). It is therefore necessary to emphasise to employers that investment of time and resources now can yield future individual and organisational improvements based on voluntary and informed decision making by employees.

Robroek, van de Vathorst, Hilhorst, & Burdorf (2012) conducted research to evaluate potential moral issues and employee resistance associated with health promotion occurring within the workplace setting. Their findings indicated the majority of workers would be supportive of employer attempts to improve workforce

health, regardless of whether they accepted an invitation to participate in a workplace health promotion program or not. The proportion of employees demonstrating this positive attitude towards a HPW was 10 percent higher for program participants (87%) than employees who declined to participate (77%). A neutral attitude was demonstrated by 10% and 20% of the respective groups and a negative attitude was evident for three percent of employees (Robroek, van de Vathorst, Hilhorst, & Burdorf, 2012). General support among the workforce for employer health investment and commitment was also observed within the British offshore oil and gas industry (Mearns, Hope, Ford, & Tetrick, 2010), with a positive relationship identified between health investment practices and the organisational health and safety climate within the thirty-one workplaces that were studied. Importantly, these studies also highlighted the significance of engaging workers and providing a strong rationale outlining the potential benefits of health promotion action. This is necessary for effective workplace health promotion, as attitude typically precedes intentions and behaviours (Morrison, Bennett, Butow, Mullan, & White, 2012).

The Healthy Workplace Model (HWM) presented by the WHO (2010) outlines four key areas of influence on health status including; the physical work environment, the psychosocial work environment, personal health resources, and community involvement. Key factors associated with the physical work environment include hazard identification, engineering controls, administrative controls and personal protective equipment (WHO, 2010). These foci are prominent within the mining industry and dominate the associated OHS literature. The three remaining key areas of the HWM include a focus on organisational culture, health education, resources and health services. The HWM encourages the provision of opportunities for workers "…to support or motivate their efforts to improve or maintain healthy personal lifestyles, as well as to monitor and support their physical and mental health" (WHO, 2010, p.8). Common characteristics among successful workplace health promotion programs include; high level management support that filters down to other levels, HPW program aims that are consistent with objectives of the organisation, constant communication, and relevant evaluation measures (Grabovac & Mustajbegovic, 2015; Johnson & Denham, 2008).

Facilitation of effective health education in an occupational environment, such as a mine site, requires an understanding of adult learning processes. Transformative

learning theory (Mezirow, 1997) can be used to understand and interpret the complex set of factors that influence adult learning. The origins of transformative learning theory can be traced back to Mezirow's (1978) qualitative study of American women returning to tertiary study or the workforce after long periods away from these contexts. Over the past three decades, this theory has been refined to comprise four types of learning including; elaborating existing frames of reference, learning new frames of reference, transforming habits of mind, and transforming points of view (Mezirow, 2003; Kitchenham, 2008). These transformative processes are necessary for informed decision making (Taylor, 2008) and should therefore be incorporated into the planning of health education for adults.

Any learning process that involves transformation requires a strong learner-centred focus. At a fundamental level, learning can be described as a change in knowledge or behaviour as a product of experience (Matlin, 1995). Given the reflective and transformative nature of Mezirow's learning theory, adult learning requires conscious decisions about methods used to gain attention, engage the learner and support motivation. Knowles, Holton, & Swanson (2005) have suggested six principles to consider for the adult learner including; the learner's need to know, self-directed learning, prior experiences of the learner, readiness to learn, orientation to learning and problem solving, and motivation to learn. Table 2.1 lists these andragogical principles and associated constructs derived from examples and descriptions provided by Knowles, Holton, & Swanson (2005).

Table 2.1. Andragogical principles and associated constructs

Andragogical principles	**Associated constructs**
1. The learner's need to know	Relevance
2. Self-directed learning	Control
3. Prior experiences of the learner	Schema
4. Readiness to learn	Necessity
5. Orientation to learning and problem solving	Contextualisation
6. Motivation to learn	Purpose and value

Adults bring to new learning situations, interpretations and emotional responses derived from past experiences which can impact upon new learning

opportunities either positively or negatively (Jarvis, 2004). These prior experiences of the learner translate as schema which form the basis for interpreting and assimilating new information (Knowles, Holton, & Swanson, 2005). Given the reflective nature of adult learning and the corresponding questioning of relevance and validity afforded to new information (Ntiri & Stewart, 2009), the processes involved imply alignment with Freire's (1973) theory of critical consciousness. For example, an adult learner exposed to engaging health education may consciously seek an understanding of the importance of such experiences. Furthermore, negative memories from past learning experiences can unconsciously block or impair new learning opportunities (Cozolino & Sprokay, 2006). This emphasises the need for early engagement and a clearly defined rationale to be communicated with adult learners in the workplace.

The Australian agricultural industry shares some common characteristics with the mining industry including a high proportion of male workers, long work hours and a higher level of injury risk due to manual tasks and the operation of machinery. To address some of these issues, the Sustainable Farm Families (SFF) project was implemented involving a three year trial into the impact of health education and medical assessment on attitudinal change and knowledge (Brumby, Willder, & Martin, 2009). Using a workshop format and opportunities for peer discussion, the SFF project revealed that farmers will engage with health professionals if the information is presented in a manner they perceive is personally relevant (Brumby, Willder, & Martin, 2009). This reflects the first, fifth and sixth andragogical principles and associated constructs presented in Table 2.1. The SFF project successfully highlighted the benefits of meaningful stakeholder collaboration and the need to make health education information relevant to the context and for engagement of the audience. The project implied health literacy improvement based upon change in knowledge. However, improvement in knowledge alone is not an indicator of enhanced health literacy, for it is a more complex concept as revealed in the preceding sections of this chapter. Another limitation, was the absence of any direct form of health literacy measurement and evaluation.

A discussion of workplace health education also requires an understanding of the influence of workplace or occupational culture. Occupational culture represents common perspectives, values and norms as a consequence of shared experiences and

identity (Antonsen, 2009). Culture exists alongside social and family influences as factors which shape attitudes and beliefs (Nielsen-Bohlman, Panzer, & Kindig, 2004). Higher risk occupations tend to exhibit strong occupational cultures that are associated with the dangers of the job and workers are more likely to resist changes suggested by people outside the organisational culture (Van Maanen & Barley, 1984). If engaged and challenged to reconsider their habits of mind and views, workers may be able to exhibit transformative learning by reassessing their perspective and understanding (Mezirow, 2003).

Challenges for men's health evident among Australian blue-collar workers include beliefs of invulnerability, a perceived need to be self-reliant and expected stoicism. These cultural and personal factors are particularly strong among workers in the construction and mining industries (Du Plessis, Cronin, Corney, & Green, 2013). Qualitative research conducted in the Australian mining industry drew attention to an emergent theme of camaraderie among workers in the same roster group when questioned about group dynamics and relationships (McLean, 2012). Trusted individuals from within an organisation, familiar with the occupational culture have a greater chance of engaging others in discussion than external individuals due to shared perspectives. Cultural awareness can therefore add meaning to health communication and strengthen impact (Cullen, 2008; Nielsen-Bohlman, Panzer, & Kindig, 2004; Hansen, 1995). To ensure the validity and reliability of information, workplace health education should draw on specialised expertise, which may require the input of external stakeholders. A balanced combination of individuals from outside the workplace environment, and workers from within, may present an opportunity to proactively facilitate health education learning outcomes. The digital stories developed for this research project reflected this approach through the inclusion of mining industry employees telling their own health related story coupled with embedded information from esteemed health experts. These concepts are discussed further in the following sections of this chapter.

2.4 NARRATIVE HEALTH EDUCATION

Storytelling is a natural form of communication that has been extensively used by countless generations to convey a wide range of knowledge and skills (Haigh &

Hardy, 2011; Hinyard & Kreuter, 2007). Within the health field, the dominant focus of communication has historically been on the provision of epidemiological evidence as a means of persuading and motivating (Hinyard & Kreuter, 2007). Despite this still being the more frequently reported orientation for health communication, there has been growth in the use of narrative methods.

> *"Narrative communication is an emerging form of persuasive communication used in health education that solicits actual stories or narratives from the target population to motivate behaviour change in others."* (Houston, et al., 2011, p.687).

Narrative methods involving the telling or writing of one's experiences integrate cognitive and affective learning, and help to develop shared understandings (Cozolino & Sprokay, 2006). Narratives present a series of events occurring over a time scale, allowing for inferences to be made about the causal relationships (Chang, 2008). They provide opportunities to understand the past, shape current identity and influence future outcomes. Stories allow us to make sense of theoretical information or unfamiliar situations by embedding shared experiences (Haigh & Hardy, 2011). They can achieve this by conveying actions, emotions and outcomes in a manner that embeds culture and context (Scott, 2011; Christiansen, 2011; Moen, 2006; McLellan, 2006).

The use of stories within a narrative communication strategy is supported by constructivist learning theory. Vygotsky's (1978) early research provided a platform for the development and refinement of constructivist learning theory including Bruner's (1996) work on the culture of education. Both have emphasised through their constructivist theories, that humans gain knowledge and meaning from experiences and learning is a social process supported by shared individual perspectives. New learning experiences allow the individual to clarify what they already know or understand, and to alter misconceptions if present (Garmston & Wellman, 1994).

Embedded within the broader paradigm of constructivism is Bandura's (1986) social cognitive theory, which emphasises that a person's behaviour is a result of interaction between three elements including personal characteristics, behavioural patterns and the social environment. The combined influence of these three elements

reflects Bandura's (1997) triadic reciprocal causation model (TRCM) as represented diagrammatically by Figure 2.3.

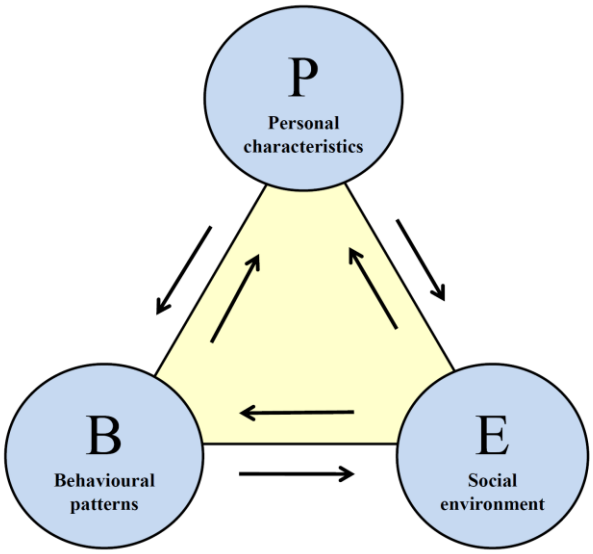

Figure 2.3. A summary of the triadic reciprocal causation model (adapted from Snowman, Dobozy, Scevak, Bryer, & Barlett, 2009)

Social cognitive theory is extensively applied in health promotion as it serves a dual role identifying determinants of health behaviour as well as influencing methods of change (Nutbeam, Harris, & Wise, 2010; Davies & Macdowall, 2006). There are a range of constructs and influential factors associated with the three elements of Bandura's (1997) TRCM. Examples of personal characteristics include self-efficacy, cognition and emotional state. Behavioural factors include reflection, self-evaluation and changes in behaviour. Potential environmental influences include reinforcing factors, barriers to change and modelling by others (Snowman, Dobozy, Scevak, Bryer, & Barlett, 2009).

A social ecological orientation to health research recognises the dynamic interaction between personal characteristics, behaviour and the environment (Lounsbury & Mitchell, 2009). Through a social cognitive theory based constructivist approach, learning is a product of direct and vicarious experience (Schunk, 2008). This experience based approach coupled with critically reflective opportunities is necessary for developing health literacy (Nutbeam, Harris, & Wise, 2010). Self-efficacy can be enhanced by drawing motivation through observations of others that we can identify with (Hergenhahn & Olson, 1993; Bandura, 1986).

Stories can be powerful forces for the construction of ideologies, especially when they involve a range of stakeholders (Mattingly, 2008). Stories can establish a sense of realism or immersion, allowing the audience to imagine the recounted experiences. In doing so, they can also generate a sense of immediacy, despite being about past events (Houston, et al., 2011; Scott, 2011).

Affective learning moves beyond immersion and emotional engagement to include clarification of beliefs, attitudes and values. To reach this stage, the learner must progress through a hierarchy of willingness to receive information, responding to phenomena and internalising values (Anderson & Bloom, 2001). Workers exposed to health related stories of colleagues could potentially respond more favourably due to the influence of workplace culture which advocates for enhancing the health of the workforce (Cullen, 2008). Stories can help to form a sense of group connectedness and facilitate voluntary discussion of topics that may otherwise be met with reluctance (Haigh & Hardy, 2011). An empirical research study into the impact of cancer survivor narratives among African American women revealed that stories which created the greatest sense of homophily or relatedness were more persuasive (Kreuter, et al., 2008). It is therefore important for narrative communication strategies to be authentic, considerate of the target audience needs and reflective of the context in which they are applied. Narrative communication methods perceived as relevant by the audience can overcome resistant attitudes to health information and reduce counter-argument because they are harder to dismiss when they represent the lived experience of another person (Stacey & Hardy, 2011; Kreuter, et al., 2010; Kreuter, et al., 2007).

The preceding example highlights how narratives have been used within the health promotion field to target specific groups from the wider population. Narrative methods have also been used by health promotion practitioners to share success stories and for professional development. Labonte, Feather and Hills (1999) reported use of a practitioner story dialogue method as the basis for professional development workshops. Stories were central to the development of context specific case studies that were subjected to structured dialogue amongst health promotion practitioners. They also acknowledged that application of the method was reviewed in a training context, but mentioned the potential for stories to be incorporated within health promotion planning and evaluation strategies. The potential of success stories as a

persuasive, motivating and enabling strategy has been identified within the health promotion field (Lewis, Johnson, Farris, & Will, 2004). Methodological commentary about capturing and disseminating stories has also been provided, but a focus on evaluation through testing the efficacy of narrative impact on health and by including stories as evidence was warranted.

A Taiwanese study on depression and mental health literacy provided some insight into the potential impact of narrative communication methods. With a sample of 264 college students, Chang (2008) assessed the impact of narrative and argument based advertising presented in a magazine format. The author concluded that the narrative form of advertising was more memorable, increased perceived efficacy to recognise depressive illness symptoms in other people and increased willingness to seek professional help. This study provided a useful contribution to understanding the impact of an advertising based narrative health communication method and supports further exploration through other media. Despite providing a theoretical link to health literacy, a deeper level of evaluation including a focus health literacy impact beyond immediate persuasive assessment was warranted.

A HPW study conducted with US professional firefighters evaluated the outcomes of two health education models including a group format based on social cognitive theory and an individual motivational interviewing technique (Elliot, et al., 2007). Both health education methods focussed on delivery of nutrition information and were matched to a control group. Baseline and twelve month outcome measures included a questionnaire assessing knowledge, behaviours and beliefs associated with nutrition, physical activity and body weight, as well as anthropometric and physiological assessment (Elliot, et al., 2007). The group format involved peer teaching which was supported by training and resources, presenting an opportunity for vicarious learning from an insider with shared cultural understanding as discussed previously (Joy, 2004). The motivational interviewing technique was delivered individually by a trained counsellor. Positive health outcomes including increased fruit and vegetable consumption, increased perception of wellbeing and improved body composition were achieved for both intervention methods with similar results evident (Elliot, et al., 2007). The researchers acknowledged the ownership and engagement benefits that can be gained through peer teaching as well as the cost benefits as the individual motivational interviewing technique incurred greater

expense due to provision of counsellors and the time involved. This project was innovative, being one of the first large scale trials of team based influences on healthy lifestyles in the workplace. Despite this, methods for checking the efficacy of the elected peer leader or the delivery of content were not identified and these are important quality assurance, information consistency and monitoring considerations.

The preceding discussion of literature supports the use of narrative health education methods as an opportunity to develop social and cultural capital, including health literacy, perceptions, beliefs, normative behaviours and support networks (Abel, 2008b). The following section will discuss the emergence of digital stories as a contemporary medium for health communication and present insights from the field of neuroscience into the impact of auditory and visual stimuli on cortical activation.

2.5 DIGITAL STORY HEALTH COMMUNICATION

The onset of digital technology has provided another avenue for developing communication practices in a range of fields including health promotion. Visual communication methods that preceded the digital era included the use of posters, bulletin boards and storyboards. Earlier research literature associated with these health communication methods typically focussed on aesthetic characteristics including design principles, layout and visual appeal (Duchin & Sherwood, 1990; Kisak & Conrad, 2004). With greater diffusion of computer technology, storyboards were adapted to suit digital media and presented as consecutive static slides (Kisak & Conrad, 2004). Academic literature progressed further to include a functional orientation associated with using commercially available slide presentation technology. From a health promotion perspective, the translation and uptake of information, and corresponding impact upon health literacy is of great importance (Gully, 2009). A clear need for further insight into the impact of technology was evident and there was a call for informatics as a science to be applied to health promotion methods to enhance the delivery of information (Coiera, 2003; Englebardt & Nelson, 2002). It was argued that a concurrent focus on communication technology, information transmission and translational effects could lead to more informed use of technology for health promotion purposes. Kickbusch (2001)

identified a significant advantage of incorporating new information and communication technologies being the flexibility to accommodate the varying needs of individuals and groups. The WHO proclaimed the accelerated technological and communication revolution provided an important opportunity to improve health literacy and subsequently health status, but emphasised the need for well-planned and evaluated strategies to inform future practices (WHO, 2008; WHO, 2005a). Results from a recent study (Rowsell, et al., 2015) indicated that an interactive website promoting physical activity for diabetes patients facilitated positive reactions, with little difference evident between respondents classified with low, intermediate and high levels of health literacy. Despite this, perceived credibility and relevance of the amateur style videos varied. Potential solutions include well planned development of audio-visual resources accommodating the sociocultural context of the viewers (Rowsell, et al., 2015; Mackert, Kahlor, Tyler, & Gustafson, 2009).

Digital stories offer a contemporary approach to the time-honoured tradition of narrative communication. Digital stories are brief and dynamic multimedia presentations which can include embedded text, video, still images and narrative soundtracks (Gazarian, 2010; Rossiter & Garcia, 2010; Sylvester & Greenidge, 2009; Gubrium, 2009; Wyatt & Hauenstein, 2008). They provide an opportunity to share captivating accounts of experience from a personal perspective (Gubrium, 2009). Personal stories are well suited to digital media, because they allow for the combination of emotion with factual information in a way that is more easily understood by the audience (Osborne, 2005). In doing so, digital stories are capable of functioning as tools for empowerment (McLellan, 2006) with potential to reduce barriers to effective engagement such as age, cultural background, attention deficit and reading ability (Osborne, 2005).

Much of the early enthusiasm for the application of digital stories occurred in school settings where they were used to develop literacy and media skills (Kajder, 2004; Banaszewski, 2002). Digital stories have also been applied within schools as a health education strategy, although there is limited evidence beyond evaluation of engagement (Wyatt & Hauenstein, 2008). The strategy has been applied in higher education with medicine and nursing students to support reflective practice, transitioning into the workforce and as a problem based learning tool for clinical training (Christiansen, 2011; Haigh & Hardy, 2011; Stacey & Hardy, 2011;

Gazarian, 2010; Sandars, Murray, & Pellow, 2008; D'Alessandro, Lewis, & D'Alessandro, 2004).

Within the field of health promotion, digital stories have been used as a health education strategy in a range of contexts with different population groups. For example, they have been applied as a means for promoting cultural identity and self-esteem among Native Alaskan adolescents and young adults (Wexler, Gubrium, Griffin, & DiFulvio, 2013). Digital story production has also been used to improve knowledge of cancer among community health workers as they developed their own digital stories to facilitate awareness, community based conversations and culturally sensitive health education among Alaska Native people (Cueva, et al., 2013). They have also been shown to be successful as an intervention method for Nigerian and US adolescents and young adults from low socioeconomic backgrounds as a sexual and reproductive health education strategy. The digital stories enabled youth culture to be embedded as a means of engaging young people (Gilliam, et al., 2012). Story based videos have been successfully used as a means for promoting mammography among African American women of low socioeconomic background (Kreuter, et al., 2010). The trialled method elicited greater recall, reduced counter-argument and promoted more breast cancer discussion within families than a non-narrative video presenting equivalent information (Kreuter, et al., 2010).

These studies provide some insights into the potential impact of digital stories when used for health promotion purposes. Although a more complete rationale for their application requires an evidence based examination of emergent neuroscience literature including social-ecological perspectives and responses to technology facilitated narratives. Contrary to previous beliefs about the adult human brain, the identification of neurogenesis and neuroplasticity implies that it is structurally and functionally adaptive throughout the lifespan, not just the developmental years (Kays, Hurley, & Taber, 2012; May, 2011; Kolb, Muhammad, & Gibb, 2011; Slavkin, 2004; Zull, 2002). Neuroplasticity is a dynamic process involving the construction of new neural networks, reorganisation of existing neural networks and corresponding changes in brain chemistry (Azmitia, 2007; Will, Dalrymple-Alford, Wolff, & Cassel, 2007; Cozolino & Sprokay, 2006). The development and refinement of these neural networks is configured by our experiences (Kolb, Muhammad, & Gibb, 2011; Kerr, Cheng, & Jones, 2011; Chen & Nedivi, 2010;

Greenfield, 2000). Cumulative life experiences vary from person to person resulting in unique brain architecture at the individual level (Doidge, 2010). Neuroplasticity is a highly beneficial adaptive process; however, it can also result in maladaptive behaviours as it is experience driven (May, 2011; Kays, Hurley, & Taber, 2012). Culture is one of the experience dependent factors able to shape our brain through neuroplasticity (Doidge, 2010). Neuroplasticity is a response to experience and in the context of this research project, it is necessary to consider the precursory impact of narrative auditory and visual stimuli.

The use of narrative communication methods has the capacity to merge cognitive and affective learning and the potential to strengthen impact upon knowledge, attitudes, values and health behaviour. This can occur by engaging the audience, challenging them to think about their health, allowing them to understand how they feel about their health and motivating them to take action when necessary (Jirojwong & Liamputtong, 2009). Narrative communication also has the capacity to be more memorable. Sleep plays an important role in memory encoding and stage two non-rapid eye movement (NREM) and rapid eye movement (REM) phases are necessary for consolidation to occur (Walker, 2009). Experiences which facilitate an emotional response result in stronger recall, demonstrating an association between attention and retention (Sharot & Phelps, 2004). Both positive and negative stimuli result in greater encoding efficiency following sleep than neutral stimuli (Walker, 2009). This supports the delivery of information from an affective rather than neutral perspective. Functional magnetic resonance imaging (fMRI) research comparing narrative multimedia and emotionally neutral control stimuli has highlighted activation of the limbic system associated with affective processing and greater long term recall (Wallentin, et al., 2011; Cahill, et al., 1996). Activation of the amygdala and thalamus, within the limbic system, can stimulate extensive activity within the frontal lobe of the cortex, an area of the brain responsible for higher order functioning such as reasoning, planning and problem solving (Zull, 2002). Digital media should therefore engage viewers with a balanced combination of educational and emotional content (Osborne, 2005).

The incorporation of still or moving images within digital stories helps to establish a relationship between the narrator and the audience (Rossiter & Garcia, 2010). Single stimuli experimental research has revealed that visual stimuli are more

memorable than auditory stimuli (Cohen, Horowitz, & Wolfe, 2009). Paivio's (1990) dual processing theory proposes two independent systems capable of processing verbal and non-verbal stimuli, simultaneously resulting in enhanced learning when both are cognitively referenced against each other. Multimedia research has shown that verbal and non-verbal communication in combination is more effective than text, audio or images in isolation (Soto Mas, Plass, Kane, & Papenfuss, 2003b).

To fully appreciate more recent emergent research from the field of neuroscience, it is necessary to consider stimulation and interaction from a social-ecological perspective. The theory of brain-to-brain coupling explains the associative and predictive responses towards vicarious narrative stimuli. Stimulus-to-brain coupling occurs when the human brain actively senses stimuli from the physical environment (Hasson, Ghazanfar, Galantucci, Garrod, & Keysers, 2012). Brain-to-brain coupling occurs when the human brain actively senses stimuli from the social environment including signals generated by another human brain (Hasson, Ghazanfar, Galantucci, Garrod, & Keysers, 2012). Stephens, Silbert, & Hasson (2010) demonstrated brain-to-brain coupling in a study that measured the brain activity of storytellers and listeners via functional magnetic resonance imaging (fMRI). Brain activity of the listener mirroring the speaker was identified, with a slight temporal delay associated with information processing. This occurred in areas associated with linguistic comprehension including the superior temporal gyrus, angular gyrus, temporoparietal junction, parietal lobule, inferior frontal gyrus and insula (Stephens, Silbert, & Hasson, 2010). Delayed fMRI mirroring also occurred in areas associated with processing the social and semantic aspects of the story including the precuneus, dorsolateral prefrontal cortex, orbitofrontal cortex, striatum and medial prefrontal cortex (Stephens, Silbert, & Hasson, 2010). This type of brain-to-brain coupling is known as vicarious activation (Hasson, Ghazanfar, Galantucci, Garrod, & Keysers, 2012; Keysers & Gazzola, 2009).

Interestingly, this research also identified brain areas that were activated earlier in the listener than the speaker, indicating a predictive anticipatory response in the striatum, medial prefrontal and dorsolateral prefrontal regions (Stephens, Silbert, & Hasson, 2010). Matching of the fMRI scans to quantitative assessments of story comprehension also showed that greater anticipatory or predictive brain-to-brain coupling resulted in better understanding. This research highlights that narrative

stimuli promotes greater engagement and comprehension, by prompting the listener to rationally and emotionally consider the information. Greater anticipatory or predictive thinking, itself an indicator of active engagement, further enhances learning responses.

Neuroscience research has moved beyond clinical investigations of discrete stimuli to authentic contexts reflecting natural experiences. Natural continuous tasks, such as engaging in conversation or watching a film, reflect greater complexity than micro scale stimuli due to multiple modalities and assessment of valence and context by the listener or observer (Hasson, Nir, Levy, Fuhrmann, & Malach, 2004). Functional magnetic resonance imaging (fMRI) and measurement of blood oxygen level-dependent (BOLD) signals during multimedia stimuli exposure, has presented unique insights into brain activation over longer and varied time scales. Experimental procedures involving comparisons between complete and scrambled audio and visual stimuli indicated the temporal nature of brain activation associated with natural social communication. Through topographic mapping of the human brain, it is evident that such stimuli results in varied processing and activation time scales for different regions of the brain, associated with a range of functional characteristics. Processing time scales increase from low level sensory areas to higher level perceptual and cognitive areas. The shortest processing time scales were evident in the primary auditory and visual processing areas of the temporal and occipital lobes respectively (Lerner, Honey, Silbert, & Hasson, 2011; Hasson, Yang, Vallines, Heeger, & Rubin, 2008). These areas exhibited time scales up to a few hundred milliseconds involving rapid information processing, irrespective of content or meaning (Lerner, Honey, Silbert, & Hasson, 2011). Topographical mapping of the cortex revealed a hierarchical organisation involving gradual transition from short to intermediate and ultimately longer time scales associated with higher level cortical functioning (Lerner, Honey, Silbert, & Hasson, 2011; Hasson, Yang, Vallines, Heeger, & Rubin, 2008). Intermediate time scales were particularly evident in Brodmann areas 39 and 40 of the parietal lobe associated with semantic processing of information (Lerner, Honey, Silbert, & Hasson, 2011). The longest time scales, ranging from 0.5 – 7 minutes in duration were evident within the precuneus area of the parietal lobe and the prefrontal cortex associated with contextual understanding, reflective self-awareness, higher order cognition and behavioural planning (Lerner,

Honey, Silbert, & Hasson, 2011; Crossman & Neary, 2010). These outcomes are the ultimate goal of effective health education which must progress beyond knowledge acquisition. This neuroscience research also supports the previously highlighted need for active engagement and provides an evidence based rationale for digital stories to gradually unfold over time scales of several minutes or longer.

Technology embedded health education methods have the potential to function as effective communication and health promotion strategies (Parker & Thorson, 2009), but there are critical points that must be considered. The enthusiasm for incorporating technology within health education has often overshadowed attention to learning in the past, becoming the primary rather than facilitative focus (Soto Mas, Plass, Kane, & Papenfuss, 2003a). The use of technology within health education, where and when appropriate, should serve a complementary and enabling role, by helping to facilitate the learning process (Gazarian, 2010; Gully, 2009). It is therefore critical that core foci including learning theory, health promotion theory and practice based research are maintained (Soto Mas, Plass, Kane, & Papenfuss, 2003b; Downing, 2001). The accessibility of communication technology is also a critical factor and careful consideration should be given before using technology to ensure that a new set of barriers are not introduced (Parker & Thorson, 2009).

Digital stories offer autobiographical insights into the life of another person and they can be developed by the subject or with the assistance of others. The latter is referred to as facilitated digital storytelling and represents how they were developed for this research project. Kickbusch & Maag (2008) emphasised the need for comprehensible, accessible and culturally appropriate health communication strategies as a means to facilitate personal control over health. Digital storytelling provides an opportunity for embedding these context specific needs. Effective health communication should also be evidence based, incorporating accurate, reliable and valid information (Mancusco, 2008). Embedding key messages from health experts within digital stories can facilitate this.

A limitation of digital storytelling as a health communication strategy is the inability for viewers to directly ask the storyteller questions, which is possible with live storytelling. Despite this acknowledged limitation, there are numerous advantages. Mining is a production driven industry and revenue is dependent upon meeting production targets and client expectations. From a practical perspective,

digital stories offer a time efficient means of communicating health information as they are of short duration. They are able to be displayed using widely available and cost effective technology. Digital stories can also be used as a flexible health and safety communication tool, capable of integration with other methods of health education and safety training. Mining operations within Australia are geographically dispersed and are typically located outside major population concentrations. The remoteness and location of mining operations presents difficulties in gaining access to health services and face to face health education. As such, digital stories offer logistic and economic advantages over live storytelling, allowing simultaneous delivery across many sites negating the need for a storyteller to travel between sites. Digital stories also support consistency of duration and message delivery in different locations (Rossiter & Garcia, 2010). Fundamental consistency is necessary for quality control and assurance processes. Stakeholder involvement in health education programs promotes sustainability (Du Plessis, Cronin, Corney, & Green, 2013) and digital storytelling offers a means for direct participation and engagement.

2.6 SUMMARY AND IMPLICATIONS

Health promotion involves enabling and empowering people to take control of their own health. An ecological approach to health recognises that we function in a range of social environments associated with the various activities we undertake during our lives. Such environments and the inherent range of health determinants, emphasise the multi-disciplinary nature and complexity of health promotion activity. Most health promotion projects draw together knowledge and practice from a range of disciplines including medicine, epidemiology, sociology, anthropology, psychology and education (McQueen, 2000). Conducting field based research in a complex work environment requires such diversity, to ensure that strategies can be developed to meet the unique characteristics of the context. The diversity evident within the relatively young field of health promotion has resulted in extensive academic debate about theoretical frameworks and investigation of practices. Applied methods can be assessed according to strengths and weaknesses; however, they need be considered in the context of the social and political environment, as there can be different organisational structures, priorities and philosophies evident

(Springett, 2001). Recognition of the unique characteristics of research settings and culture is therefore critical.

The Commission on Social Determinants of Health established by the WHO, reported a need for greater public awareness of the social determinants of health, measurement, evaluation of action and expansion of the associated knowledge base through information dissemination (Sparks, 2009). Action research is context specific, involving the implementation of change and subsequent generation of new knowledge through inquiry and critical reflection of practice (Koshy, 2010; Hampshire, 2000). Action research can be applied as a method for improving practice and may involve the input of an external facilitator or independent researcher who can contribute by identifying opportunities for improvement, developing practical solutions and systematically monitoring outcomes of the change process (Koshy, 2010). If external facilitation is utilised in a work environment, it is necessary for researchers to understand the context prior to the change process, including the people, environment and culture, all guiding the effectiveness of the utility of the outcomes. Effective collaboration is critical to the success of group based action research projects, as it is necessary for engagement and supporting contribution (Singh, 2008).

This literature review has drawn together theoretical concepts and applied research from a range of disciplines to support the orientation of this unique health education project developed for the mining industry. The five preceding sections of this chapter have progressively introduced important theoretical concepts, focusing on health literacy, health literacy measurement, workplace health promotion, narrative health education and digital story health communication. A conceptual framework summary is presented as a flow chart (Figure 2.4).

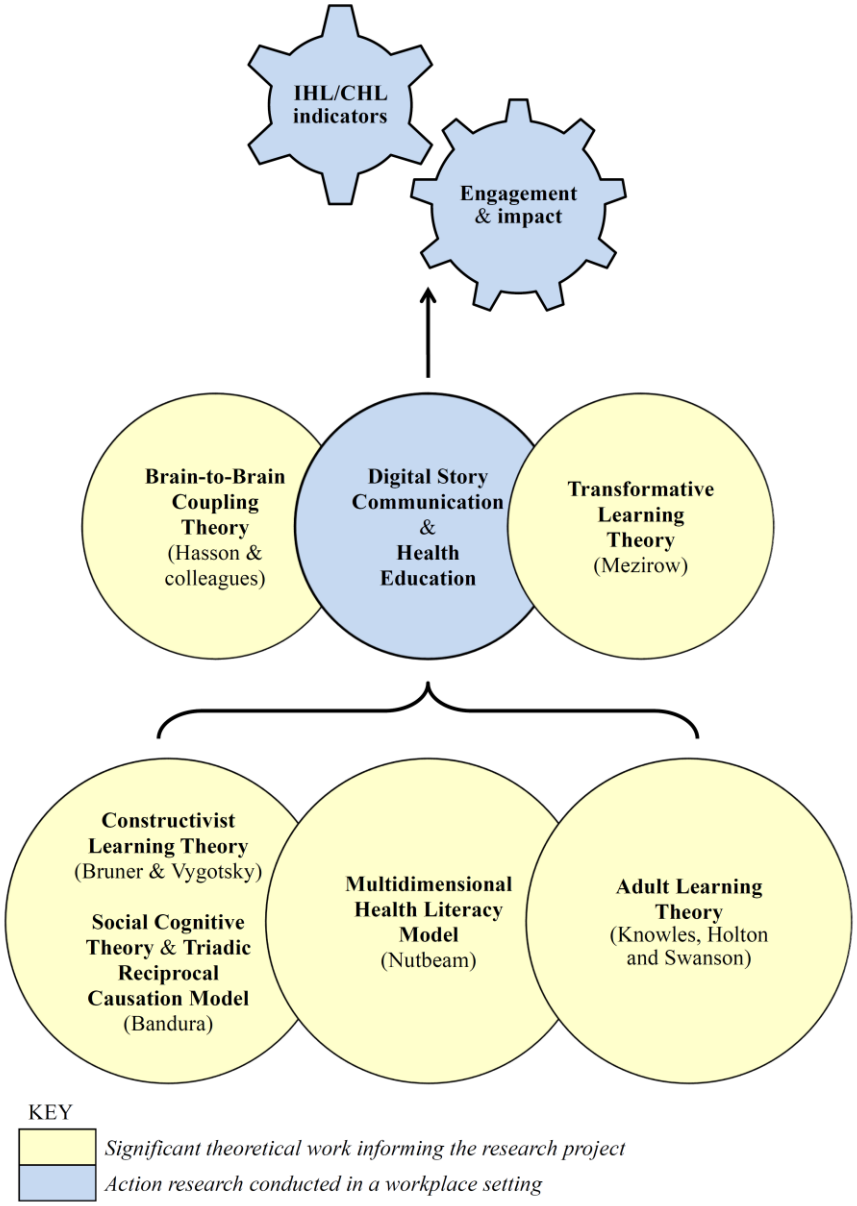

Figure 2.4. Conceptual framework summary

The conceptual framework summary includes two main components as denoted by the key at the bottom of Figure 2.4. The yellow shapes identify the significant theoretical work that has informed this research. They, along with other associated literature were discussed in sections one to five of this chapter. The blue shapes represent the action research component of this project, including the implementation of a digital story health communication strategy and measurement of participant engagement, impact, interactive health literacy indicators and critical health literacy indicators. The bottom row represents the major theoretical work that

supports an ecological approach to health education and presents health literacy as a significant health determinant. The middle row represents the prominent theoretical grounding for digital stories as a mechanism for change, including neural activation and transformative learning research. The top row represents the major foci for outcome evaluation of the research project. These foci were also supplemented by qualitative DCS research involving digital storytellers.

The small but growing body of IHL and CHL research reveals an opportunity to contribute to the field through the development and application of a new context specific instrument for evaluating IHL and CHL indicators. In the absence of any known health literacy research in the mining industry, this project supports a unique investigation of workforce health in a complex occupational setting. In the absence of any known empirical research evaluating the impact of digital story communication on health literacy, this project also offers insights into a novel health education method. Finally, this action research project will generate new industry specific data that can be used to develop recommendations to support evidence based practice in the future.

Chapter 3: Evaluating a new health literacy measurement instrument

3.1 INTRODUCTION

This study was the first of three to be completed for this research project involving health education in the mining industry. Health literacy has been conceptualised as an outcome of health education and communication (Nutbeam, Harris, & Wise, 2010). In the absence of a universally supported comprehensive health literacy measurement instrument for occupational settings and no evidence of associated data collection within the mining industry, it was necessary to develop the Health Communication Questionnaire (HCQ). Accordingly, the aim of this study was to design and test the validity and reliability of a new instrument measuring interactive and critical health literacy indicators with utility in the mining industry. To fulfil this aim, individual HCQ items were evaluated to determine whether they are a valid representation of IHL and CHL constructs. It was also important to determine whether the HCQ is reliable and capable of yielding consistent results with a representative sample of mining industry employees under true work conditions. The study consisted of integrated stages which included gaining an understanding of the mining industry context, questionnaire development, readability assessment, validation procedures, questionnaire refinement and reliability testing.

The overall research project, comprising this and two subsequent studies was granted ethical clearance by QUT Human Research Ethics Committee (approval number 1000000553) and is therefore compliant with the Australian Code for the Responsible Conduct of Research (Queensland University of Technology, 2012). The purpose, commitment and voluntary nature of the research were communicated with respondents in writing via participant information sheets. Written information was also reinforced verbally during site visits and subsequent completion and return of the questionnaire and task sheets was accepted as an indication of consent to participate.

3.2 RESEARCH METHODOLOGY

3.2.1 Questionnaire development and readability assessment

The method of questionnaire development and evaluation was based upon a multistage process including a literature review, item generation, validity testing, item impact analyses and questionnaire revision as utilised by Broder, McGrath & Cisneros (2007). The Australian mining industry is production driven with the majority of sites operating twenty-four hours per day all year round. This presents challenges in conducting research involving the workforce, particularly with respect to the time constraints (Du Plessis, Cronin, Corney, & Green, 2013). To minimise disruption to the production schedule, it was necessary to apply a research method that was consistent and capable of collecting data from a large number of people, across different sites within a relatively short time frame. These objectives have been identified as significant in optimising the outcomes of self-report research methodologies and self-report questionnaires are the most widely used research method in the industrial setting (Cottrell & McKenzie, 2005). Self-report questionnaires can be susceptible to potential limitations including respondents not being truthful, insufficient recall, bias and misinterpretation (Cottrell & McKenzie, 2005). The latter was addressed through face validity and pilot testing. The former were considered and mitigated through reliability testing and the experimental design, which included use of the same questionnaire to detect relative change among the same respondents at different time points.

Due to the location, time constraints and work crews containing up to eighty employees per shift, it was not possible to utilise digital delivery of the questionnaire via tablet devices, computers or e-kiosks. Face to face communication of research aims and participant requirements was more suitable for the context and optimised engagement of the workforce, leading to high response rates. The HCQ was therefore designed as a paper based instrument to collect a substantial amount of data in a relatively short period of time. A completion time of 10 minutes was the aim as this would enable instructions, delivery and return to occur with minimal impact on site production. The HCQ includes two main sections, with further supplementary items collecting information about perceived health status, qualitative elaborations of health behaviour and open-ended comments. The first section included items seeking demographic, organisational, industry and contextual data. Demographic items

covered gender, age, country of birth, residential location (off roster), primary language, ethnicity, Aboriginal or Torres Strait Islander descent, highest level of completed schooling and formal qualifications. The 2011 Census Household Form (Australian Bureau of Statistics, 2011) was used as a reference for preparing and reviewing the demographic items. The Australian Qualifications Framework (AQF) was consulted to ensure the item associated with formal qualifications used terminology and classifications consistent with this nationally recognised framework (Australian Qualifications Framework Council, 2011). Items incorporated to collect organisational, industry and contextual data included length of time working in the industry, length of time working at the site and job category. These descriptions were consistent with phrasing and terminology used within reports of previous questionnaires developed for the mining industry (Parker & McLean, 2012; Parker, Hubinger & Worringham, 2004).

The second section and major component of the HCQ included five indicators of health literacy identified within Table 3.1. These indicators are based on interactive and critical health literacy constructs including efficacy, motivation, self-efficacy, autonomy and empowerment (Nutbeam, 2008). Additionally, they are representative of andragogical constructs including orientation, schema and control (Knowles, Holton, & Swanson, 2005).

Table 3.1. Indicators of health literacy and associated dimensions

	Indicator	**Health literacy dimension**
1	Responding to health information provided by others (RHI)	*Interactive*
2	Discussing health at work, home or with friends (DH)	*Interactive*
3	Seeking health information (SHI)	*Interactive*
4	Achieving control over personal health (ACP)	*Critical*
5	Helping others improve or maintain health (HO)	*Critical*

Questionnaire development was also guided by a range of principles evident in the literature including; clear and concise statements, using language familiar to respondents, no more than one construct per item, user-friendly layout and clustering of items according to commonality (Boynton & Greenhalgh, 2004; Hinkin, 1998; Harrison & McLaughlin, 1993). Adherence to these principles can reduce the risk of respondent fatigue and boredom, increase the clarity and comprehension of items, and reduce the risk of respondent error due to confusion or intra-item influence caused by multiple constructs (Hinkin, 1998). The primary purpose of the validity and reliability testing processes was to ensure that a quality control mechanism was in place to determine the level of precision and accuracy of the HCQ in measuring the required information. The HCQ was designed to include positively and negatively phrased statements, enabling respondents to rate their level of agreement using a visual analogue scale (VAS). The VAS is distinctive from dichotomous and interval scales because it is a continuum that exists between two end points. The associated advantage of the VAS compared to other types of scales is the degree of sensitivity afforded (Headley & Harrigan, 2009; Huang, Wilkie, & Berry, 1996).

Readability assessment provides an opportunity to evaluate the complexity of a document and therefore suitability for a target audience. The Flesch-Kincaid Grade Level (FKGL) test applied within this study offers an efficient method for assessing readability (Walters & Hamrell, 2008) and is defined as:

$$FKGL = (0.39 \times ASL) + (11.8 \times ASW) - 15.59$$

where ‘ASL’ represents average sentence length and ‘ASW’ represents the average number of syllables per word (Microsoft Corporation, 2010). A readability assessment FKGL test score within the range 8.0 – 9.0 was the target for the HCQ. This criterion represents literacy skills that would normally be expected of a thirteen year old. This criterion was selected based on data from a whole of company health and safety climate survey report, generated for the industry partner associated with this research project. The report identified a high proportion of current employees indicating school year 10, 12, or post-schooling qualifications as their highest level of education (Parker & McLean, 2012). Such levels of educational attainment imply that literacy skills should exceed the requirements for comprehension of the HCQ instructions and items. Upon completion of the draft HCQ, the FKGL test was administered using the proofing tools within Microsoft Word software version 2007

(Microsoft Corporation, Washington, US). Following development of the questionnaire and readability assessment, it was subjected to validity testing.

3.2.2 Validity testing

Two forms of validity testing were implemented during this study including application of the Substantive Validity Analysis (SVA) and Content Validity Index (CVI) techniques (Polit, Beck, & Owen, 2007; Waltz, Strickland & Lenz, 2005). They were implemented to assess content validity and to identify the capability of the new measurement instrument to capture the targeted constructs. They also evaluated face validity in combination with pilot testing, to assess the clarity and end-user responsiveness among workers from an open cut mining operation.

SVA is a pre-testing procedure developed by Anderson & Gerbing (1991) to identify whether items within new instruments exhibit ambiguity or bias. The SVA procedure requires respondents to complete a sorting task which involves matching up items from a questionnaire presented in a randomised list, with descriptions of concepts or constructs presented in lay language (Anderson & Gerbing, 1991). After informed consent was gained (refer Appendix A), participants were instructed to read the list of numbered descriptions, identify what they believed was the most appropriate match and record the corresponding number in the box next to the questionnaire item. Anderson & Gerbing (1991) proposed two indices of substantive validity, including the proportion of substantive agreement and the substantive-validity coefficient (C_{SV}), with greater accuracy evident through the latter. The coefficient is defined as:

$$C_{SV} = (n_c - n_o) / N$$

where, 'n_c' represents the number of respondents that assign the item to the intended construct or concept; 'n_o' the highest number of respondents assigning the item to any other construct or concept; and 'N' the total number of respondents (Ashiabi & Hasanen, 2012). Calculated values of C_{SV} fall within a range from -1.0 to +1.0 (Anderson & Gerbing, 1991). Values at the upper end of the range indicate greater agreement with intended matches, as well as less conformity between respondents identifying alternative non-intended matches. Values at the bottom end of the range show less agreement, with intended matches and greater conformity between

respondents identifying alternative non-intended matches. To facilitate data entry and C_{SV} calculation, a spreadsheet including embedded formulas, group data sets and the combined data set was developed using Microsoft Excel software version 2007 (Microsoft Corporation, Washington, US).

The advantage of SVA is that it can be conducted with small groups of 12 to 30 participants who are representative of the target population, as well as non-representative participants, as the task does not require contextual or phenomena based knowledge (Hinkin, 1998; Schriesheim, Powers, Scandura, Gardiner, & Lankau, 1993; Anderson & Gerbing, 1991). For this research project, SVA testing was completed with two groups: a context naïve group and a context familiar group. The context naïve group (n=20) included final year university students majoring in Health Education. The context familiar group (n=20) included mining industry workers, with a distribution of job categories and a demographic profile consistent with research previously conducted with the mining company (Parker & McLean, 2012).

The second form of validity testing within this study, involved application of the CVI developed by Lynn (1986) as a quantitative approach for determining content validity of individual items and whole instruments. It includes expert reviewers rating the relevance of items within a questionnaire, most commonly via an even numbered four point scale. The CVI establishes the level of inter-rater agreement following independent reviews by a minimum of three expert panel members (Jezewski, et al., 2009; Polit & Beck, 2006; Davis, 1992). CVI calculation supports objective decision making about the retention, deletion or modification of questionnaire items. Other advantages include time efficiency, cost effectiveness and flexibility, as reviewers complete the process independently (Polit, Beck, & Owen, 2007; Tojib & Sugianto, 2006). A potential limitation of the CVI is that it may be inflated by random probability of agreement. Whilst the likelihood of this outcome is low, it can be counteracted in three ways. These include engaging a strong panel of reviewers with a high level of expertise, providing clear procedural instructions and requiring universal agreement when there are five or fewer reviewers (Polit, Beck, & Owen, 2007; Tojib & Sugianto, 2006; Lynn, 1986).

After the literature review process was completed, five nationally and internationally renowned health promotion and health literacy experts were identified

as suitable critical reviewers for the CVI process. Each was sent a personal invitation letter which provided a rationale, explained the requirements and identified the estimated time commitment of 20 to 30 minutes. Three accepted the invitation and were provided with follow-up correspondence including detailed instructions of the process. The three members of the expert review panel were sent a digital copy of the HCQ with embedded drop down menus inserted to enable efficient rating of the questionnaire items. They were embedded using the drop-down form field function within Microsoft Word software version 2007 (Microsoft Corporation, Washington, US). The drop down menu provided a four point CVI rating scale including 'highly relevant to IHL/CHL' (Rating 4), 'quite relevant to IHL/CHL' (Rating 3), 'somewhat relevant to IHL/CHL' (Rating 2) and 'not relevant to IHL/CHL' (Rating 1). The CVI rating scale was based on earlier guidelines (Lynn, 1986; Davis, 1992) which have been widely cited in the literature (Polit, Beck, & Owen, 2007). IHL and CHL were added to the scale descriptors to serve as explicit reminders of the foci during the process. An example of the drop down menu with embedded CVI rating scale is presented in Figure 3.1.

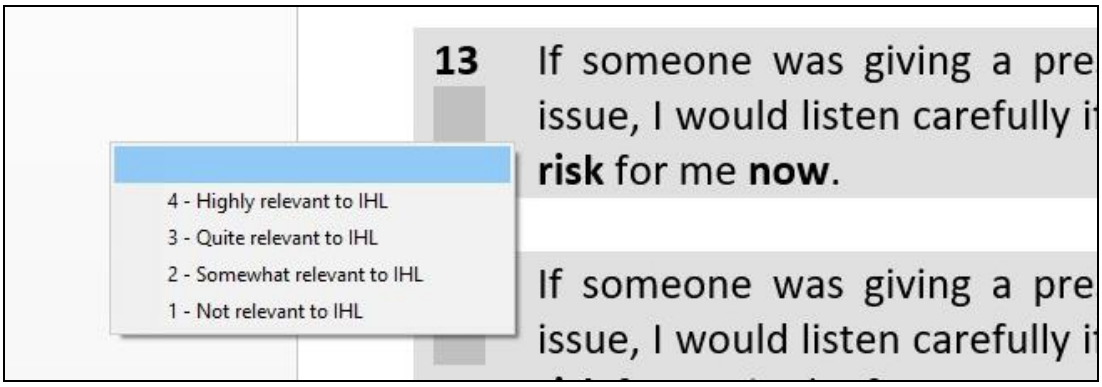

Figure 3.1. Example of the embedded drop down menu with CVI rating scale

Placing the cursor over the grey box below the item number enabled the expert reviewers to reveal the menu. Upon selection of one of the four options, the rating and corresponding description were automatically inserted into the document. When completed, participants were instructed to save the HCQ document with the inserted rating descriptions, to enable it to be returned via email as an attachment. Qualitative feedback was also requested from the reviewers.

Following the expert review process, CVI was calculated for each item within the questionnaire. The item level content validity index is defined as:

$$\text{I-CVI} = A / N$$

where 'A' represents the number of experts assigning a relevance rating of 3 or 4, and 'N' is the number of expert reviewers (Polit, Beck, & Owen, 2007; Polit & Beck, 2006). A spreadsheet was set up using Microsoft Excel software version 2007 (Microsoft Corporation, Washington, US) and the formula function was used to calculate I-CVI. In keeping with Lynn's (1986) criteria for I-CVI as previously cited, the target I-CVI for this research study was 1.00 as the number of reviewers was greater than two, but fewer than six. When six or more reviewers complete the process, the standard can be relaxed slightly, requiring an I-CVI value of 0.78 (Lynn, 1986; Polit & Beck, 2006).

The next round of validity testing involved whole instrument or scale level CVI analysis using averaging (S-CVI/Ave) and universal agreement methods (S-CVI/UA) applied by Polit, Beck, & Owen (2007). The averaging method is defined as:

$$\text{S-CVI/Ave} = \text{Total I-CVI} / N_I$$

where 'Total I-CVI' represents the combined I-CVI values calculated for the instrument and 'N_I' is the number of items in the instrument. The universal agreement method is defined as:

$$\text{S-CVI/UA} = N_{UA} / N_I$$

where 'N_{UA}' represents the number of items where universal agreement for a rating of 3 or 4 exists among expert reviewers and 'N_I' is the number of items in the instrument. New instruments subjected to CVI testing should meet or exceed targets for S-CVI/Ave and S-CVI/UA of 0.90 and 0.80 respectively (Polit, Beck, & Owen, 2007).

3.2.3 Reliability and pilot testing

The purpose of the reliability and pilot testing was to determine whether the questionnaire was reliable and capable of yielding consistent results for health literacy constructs, with a representative sample of mining industry employees under true work conditions. It also provided an opportunity to observe the time taken to

complete the questionnaire. The purpose of the site visit, testing requirements and voluntary nature of participation were provided in advance and repeated on the first day of testing.

VAS based questionnaires reported in the literature are typically structured with a length of 100 millimetres (mm) and in some cases, complemented by end of line reference labels, as used in the methodology reported by Davies & McMillan (2005). The HCQ incorporated a VAS of 60 mm length to accommodate greater space on the page for item descriptions. One of the purposes of the reliability testing procedure applied was to determine if a shorter VAS length of 60 mm can yield consistent test-retest results. Likert reference labels including *strongly disagree, disagree, agree* and *strongly disagree* were provided below the line to assist with the decision making process. Participants were instructed to place a vertical mark at any point along the line that reflected their level of agreement with the statements provided. VAS data has traditionally been measured as the distance from the start of the scale to the respondent's mark using rulers or micrometres (Headley & Harrigan, 2009; Huang, Wilkie, & Berry, 1996). Despite the benefits associated with using a VAS as previously discussed, a limitation is the time associated with direct measurement and data entry (Huang, Wilkie, & Berry, 1996). To reduce the measurement time and improve data entry efficiency, an alternative method was developed for this research project. A 150 mm INSIZE series 1108-150 stainless steel digital calliper (INSIZE Company, Suzhou, China) was used to measure VAS responses. The digital calliper was able to be manually calibrated, displayed a resolution of 0.01 mm and was rated for accuracy of ± 0.03 mm. Data from the digital calliper was uploaded directly to Microsoft Excel software version 2007 (Microsoft Corporation, Washington, US) via a universal serial bus (USB) data entry cable. Figure 3.2 depicts an image of the digital calliper, one touch data entry cable and VAS measurement process.

Figure 3.2. Digital calliper and USB data entry cable

It was necessary to implement a controlled questionnaire printing process to ensure the accuracy of the 60 mm VAS. This was achieved by professional quality laser printing directly from the Microsoft Word software version 2007 (Microsoft Corporation, Washington, US) document, rather than a Portable Document Format (PDF). PDF conversion is commonly used as a means to maintain layout and formatting of documents; however, it can result in slight compression of source page size during the conversion process. Trial printing tests revealed a variation in VAS length of up to 2 mm from a PDF version of the HCQ, compared to accurate printing from the original word processing software file. Reproduction of the questionnaire via photocopying was not permitted, as this could lead to variable lengths of each VAS due to the scanning process.

Pilot testing and reliability assessment of the HCQ involved a test-retest procedure with the same group of participants and an interval of two days. This interval was chosen to avoid changes in affective state that can occur at the start or end of rosters and recollection bias that could occur with a shorter interval. Marx, Menezes, Horovitz, Jones & Warren (2003) identified intervals of two days to two weeks as the most commonly reported in the literature and they determined no statistically significant differences between these intervals for five scales evaluated. In this study, three groups of workers, representative of the full range of work roles at the site were targeted for the test-retest procedure. Crew A, comprising maintenance and production workers completed the questionnaire pre-shift at 06:15 hours. Crew B involving the same work categories, completed the questionnaire pre-

shift at 16:00 hours. Professional staff completed the questionnaire during their shift at 14:00 hours. The 55 item HCQ questionnaire was completed by 58 respondents during the first testing round. Retesting occurred two days later for each group at the same time and equivalent stage in the shift to maintain consistency. Demographic and work related data was used to match respondent questionnaires across both rounds of testing. Respondents who only completed the first round of testing were removed from the survey pool, resulting in a sample size of 46. This group exceeded the sample size of 30 participants recommended by Cottrell & McKenzie (2005).

Correlation measures relationship, but is not necessarily an indicator of agreement, as magnitude can vary even when correlation is high (Bland & Altman, 1986). Repeatability is an estimation of the agreement between two measurements derived via the same method (Bland & Altman, 2003). To achieve the best outcome, the Bland-Altman plot was selected as the most appropriate method to determine intra-subject variability (Euser, Dekker, & le Cessie, 2008; Bland & Altman, 2003). It is a widely used graphical technique for assessing repeatability (Warner, 2012). The test-retest difference was recorded against the y-axis, with increments from -60 to +60 mm. The 0 mm y-axis mid-point represents no intra-subject variability between the two time points. The mean of both test days was recorded against the x-axis with increments from 0 to 60 mm. Individual participants were identified via a scatter plot and a line of mean difference was added to explore the level of bias (Bland & Altman, 2007). For this study, a positive bias represented a higher day two mean response than recorded for day one. Likewise, a negative bias represented a higher day one mean response than for day two. Upper and lower 95% limits of agreement (LoA) were added, to designate the mean difference ±1.96 standard deviations (Euser, Dekker, & le Cessie, 2008). A Bland-Altman plot was generated for each of the thirty-four HCQ items associated with health literacy and regression analysis was completed.

3.2.4 Questionnaire refinement

The multistage process of questionnaire development commences with an original pool of items that exceeds the number required in the final instrument. Following testing, items that do not fulfil the appropriate standard are eliminated from the pool and if necessary, modification of existing items or development of new

items occurs (Broder, McGrath, & Cisneros, 2007). Hinkin (1998) suggested that the final version of a questionnaire should retain four to six items per construct. In the current study, the pool of HCQ items was subjected to ongoing review following each stage of testing. Table 3.2 summarises the number of items included within the questionnaire at each stage of testing and the net change following questionnaire revision.

Table 3.2. HCQ item numbers and net change during validity and reliability testing

Testing stage	Pre-SVA	Pre-CVI	Post validity	Post reliability
Total items	70	72	55	53
Health literacy items	**57**	**59**	**34 (-25)***	**33 (-1)***
General items	13	13	21 (+8)*	20 (-1)*

**Brackets denote net change*

3.3 RESULTS

3.3.1 Questionnaire development and readability assessment

As previously noted and justified in section 3.2.1, a target FKGL test score range of 8.0 – 9.0 was selected in accordance with education level data for the industry partner organisation. Following administration of the FKGL test using Microsoft Word software version 2007 (Microsoft Corporation, Washington, US), the HCQ produced a score of 8.9 which fell within the target range. The readability level of the HCQ was therefore deemed appropriate for the focus population.

3.3.2 Validity testing

The HCQ contained a total of 70 items, including 57 health literacy items and 13 general items at the SVA pre-testing stage. Of the 57 items subjected to the SVA procedure, 48 fell within the upper range 0.00 to 1.00. This range represents greater agreement with intended matches and less conformity between participants

identifying alternative non-intended matches (Polit, Beck, & Owen, 2007). Nine items fell outside this range as identified within Figure 3.3.

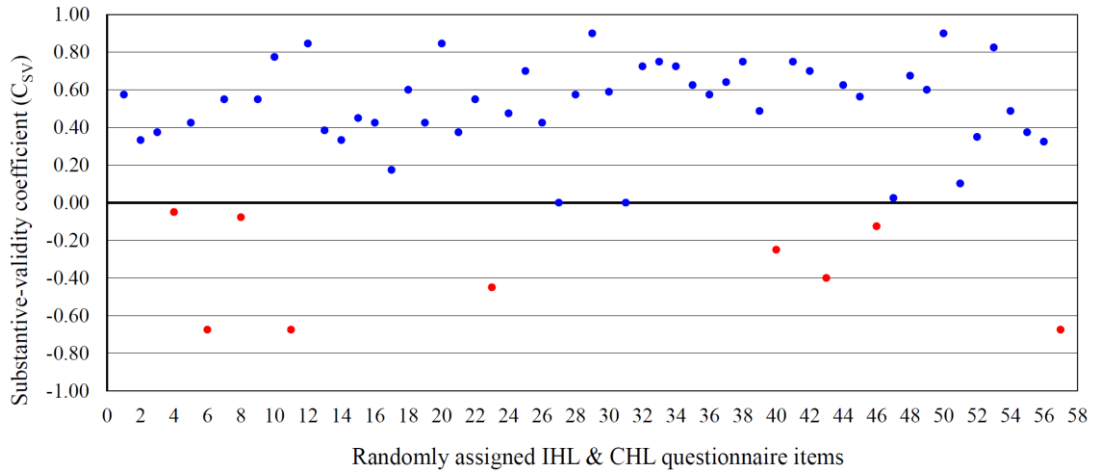

Figure 3.3. Substantive-validity coefficient (C_{SV}) values for IHL/CHL items (n=57)

The second phase of validity testing involved calculation of I-CVI, S-CVI/Ave and S-CVI/UA. I-CVI values are rarely reported in the literature, with authors typically acknowledging scale level values only (Polit & Beck, 2006). The reporting of scale level values by new instrument developers also typically omits the method of scale level calculation (Polit, Beck, & Owen, 2007). In keeping with previous recommendations (Polit & Beck, 2006), item and scale level CVI values are reported, along with the range of I-CVI values for retained questionnaire items.

Following initial assessment of the questionnaire, calculated I-CVI values ranged from a lower level of 0.33 to 0.67 and ultimately an upper level of 1.00. The frequency of these values was 9, 22 and 28 respectively for the 59 IHL/CHL associated questionnaire items. A value of 1.00 represents the aim of seeking universal agreement when five or fewer reviewers complete the process, as stipulated by earlier guidelines (Lynn, 1986). Following I-CVI data analysis, all items generating I-CVI values of 0.33 were removed from the questionnaire, along with 16 of the 22 items that generated I-CVI values of 0.67. The remaining six items with an I-CVI rating of 0.67, were able to be retained and modified slightly through review of the qualitative feedback provided by expert reviewers. Upon completion of the follow-up assessment, I-CVI values ranged from 0.67 to 1.00. The frequency of these

values was 6 and 28 respectively for the remaining 34 IHL and CHL associated questionnaire items.

The more commonly reported S-CVI/Ave method and the more rigorous S-CVI/UA method were both applied within this research study. Following initial assessment of the questionnaire, S-CVI/Ave and S-CVI/UA were calculated at 0.77 and 0.47 respectively. After revision of the questionnaire and item deletion, S-CVI/Ave and S-CVI/UA were re-calculated for the retained IHL and CHL questionnaire items (n=34) at 0.94 and 0.82 respectively. These values exceed the minimum target values of 0.90 (S-CVI/Ave) and 0.80 (S-CVI/UA) stipulated by Polit & Beck (2006). A summary of the analysis, including comparisons between the initial and follow-up assessment completed after questionnaire revision and item deletion is provided in Table 3.3.

Table 3.3. Comparison of CVI data at initial and follow-up assessment stages

	Initial assessment	Follow-up assessment
Number of health literacy related items: N_I	59	34
Number of items with universal agreement: N_{UA}	28	28
Total I-CVI	45.67	32.00
I-CVI range	0.33 – 1.00	0.67 – 1.00
Averaging method: S-CVI/Ave	0.77	**0.94***
Universal agreement method: S-CVI/UA	0.47	**0.82***

**Minimum target values of 0.90 (S-CVI/Ave) and 0.80 (S-CVI/UA) exceeded (Polit & Beck, 2006)*

Following completion of I-CVI and S-CVI analysis and questionnaire revision, reliability and pilot testing was conducted with 62 respondents.

3.3.3 Reliability and pilot testing

A summary of the demographic profile of the mining industry employees that completed both days of reliability and pilot testing (n=46) is presented in Table 3.4. The gender, age and job category profiles represented in the sample group were consistent with previous mining industry based research involving this company (Parker & McLean, 2012).

Table 3.4. Pilot testing demographic profile

Demographic Variable	Values	Result
Gender	Male	93.48% (n=43)
	Female	6.52% (n=3)
Age range		17 – 56 years (*M* = 38.60, *SD* = 10.25)
Job categories	Operator/Vehicle driver	60.87% (n=28)
	Maintenance/Fitter	10.87% (n=5)
	Professional	6.52% (n=3)
	Health, Safety and Environment	4.35% (n=2)
	Plant	4.35% (n=2)
	Deputy/Supervisor	4.35% (n=2)
	Administration	2.17% (n=1)
	Mechanic	2.17% (n=1)
	Estimating/Technical Services	2.17% (n=1)
	Project Operations	2.17% (n=1)
Time working in industry		0.08 – 35 years (*M* = 7.56, *SD* = 7.55)
Time working at current mine site		0.08 – 11 years (*M* = 4.53, *SD* = 3.49)
Country of birth	Australia	91.30% (n=42)
	New Zealand	4.35% (n=2)
	China	2.17% (n=1)
	Ireland	2.17% (n=1)
Main spoken language	English	97.83% (n=45)
	Other	2.17% (n=1)
Aboriginal or Torres Strait Islander (ATSI) identification	Yes	2.17% (n=1)
	No	97.83% (n=45)
Highest level of schooling completed	Year 10	65.22% (n=30)
	Year 12	34.78% (n=16)
Formal qualifications	Certificate	28.26% (n=13)
	Diploma	10.87% (n=5)
	Bachelor degree	8.70% (n=4)
	Postgraduate Masters degree	2.17% (n=1)

Pilot testing also provided an opportunity to monitor HCQ completion time which ranged from 6 to 13 minutes. Eighty-nine percent of participants completed the HCQ within the estimated time of 10 minutes. Participant clarification questions were monitored to determine whether formatting or instructional changes were required. Two respondents asked whether they should circle the interval reference statements on the scale, or mark the line as instructed. Following this, the instruction and example provided in the HCQ were reformatted to improve clarity.

The digital calliper data entry method developed for this research project (section 3.2.3) supported greater data entry efficiency. Using a digital calliper with one touch data entry via USB cable, removed an extra step required for manual measurement and numerical entry methods. Mean entry time using the digital calliper method, was 6.94 seconds per item and 8.33 minutes for the whole questionnaire. Trial testing of a manual method produced means of 9.31 seconds and 11.17 minutes respectively, representing a benefit of 2.84 minutes per questionnaire using the digital method.

Macro level regression analysis of the pooled data, exhibited a correlation coefficient of .72 ($p < .001$), which is consistent with typical values accepted in behavioural and social science research. Although as previously noted, correlation alone is not sufficient for testing the reliability of a new instrument. Intra-subject agreement was therefore evaluated via Bland-Altman plots generated for each of the thirty-four HCQ items associated with IHL and FHL remaining after validity testing. An example plot for HCQ Item 31: *'I feel confident talking to health professionals and asking them questions'*, is provided in Figure 3.4.

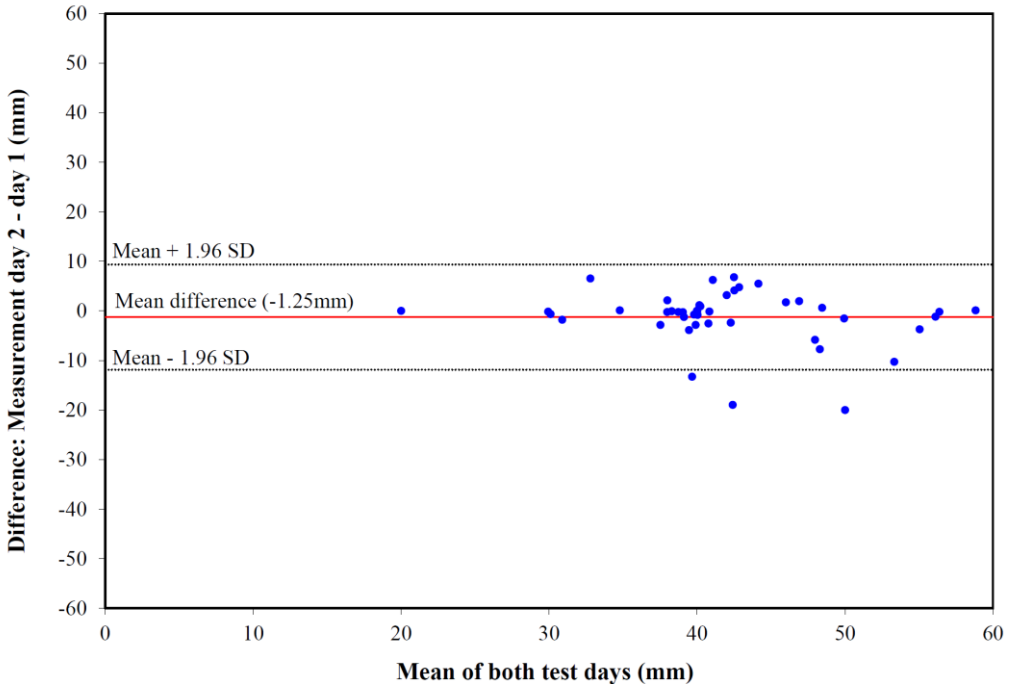

Figure 3.4. Bland-Altman plot for repeatability of Item 31, with mean difference and 95% limits of agreement

In this example, the mean difference of -1.25 mm, represented a bias towards a slightly lower rating on the first day, plotted as the solid horizontal line in Figure 3.4. Ninety-five percent limits of agreement (LoA) were plotted as dashed horizontal lines in Figure 3.4. The upper LoA (*M* + 1.96 *SD*) for this questionnaire item was 9.37 mm and the lower LoA (*M* - 1.96 *SD*) was -11.87 mm. A summary of the bias values, upper LoA and lower LoA for all thirty-four health literacy associated HCQ items is presented in Figure 3.5.

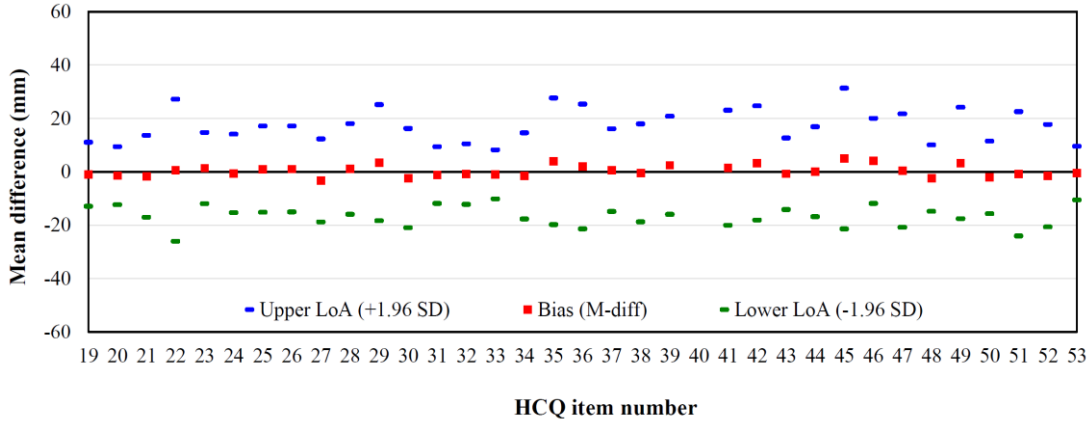

Figure 3.5. Summary of Bland-Altman plot data

The data presented in Figure 3.5 represents a bias range of -3.26 to 4.93 mm (*M* = 0.33, *SD* = 2.10), upper LoA range of 8.18 to 31.32 mm (*M* = 17.42, *SD* = 6.17) and lower LoA range of -26.05 to -10.2 mm (*M* = -16.76 mm, *SD* = 3.89). To understand the data in relative terms, more than one-third (35.29%) of all items were within a bias range of 0.00 to 0.99 mm. A further 32.35% of HCQ items were within the 1.00 to 1.99 mm range, 11.76% within the 2.00 to 2.99 mm range, 14.71% within the 3.00 to 3.99 mm range and 5.88% within the 4.00 to 4.99 mm range. All questionnaire items exhibited a relative bias less than 5 mm, which represents less than one quarter of the distance between two interval reference points on the VAS. These VAS reference points align with the 0, ±20, ±40 and ±60 mm horizontal grid lines in Figure 3.5.

3.4 DISCUSSION

The aim of this study was to design and test the validity and reliability of a new instrument designed to measure interactive and critical health literacy indicators of workers in the mining industry. Comprehensive data collection and analysis methods supported informed evaluation of HCQ efficacy. As previously discussed, a significant amount of time was invested during this research project to develop an understanding of the industry and actively engage with stakeholders. The former included learning about the contextual characteristics, barriers and potential enabling factors. The latter was necessary to facilitate implementation and contributed to high response rates.

3.4.1 HCQ validation

Combined use of SVA and CVI analyses provided a systematic and robust validation method for critical review of the questionnaire items. The first round of validity testing via the SVA method was implemented to identify whether the questionnaire items were framed appropriately for the target audience. Secondly, it was used to identify potential ambiguity through application of an objective and contextually based method. Eighty-four percent of questionnaire items fell within the upper C_{SV} range (0.00 – 1.00), with the majority at the mid-point or higher. For these HCQ items, this reflects a high level of agreement among participants concerning

association with intended IHL and CHL constructs. The SVA results also supported objective identification of HCQ items for review. With respect to implementation of the SVA method, commencing with a non-representative sample of tertiary education students, assisted with refining the process and improving efficiency. This supported greater procedural clarity and time efficiency for the mining industry participants during the next stage of testing. The dual group SVA process also provided an indication of the future potential for wider application of the HCQ instrument with other populations.

Application of the CVI method involving expert reviewers, in combination with the SVA method provided a strong evidence based case for item retention, or removal during the prospective questionnaire refinement process. The original pool of items intentionally exceeded the number required per construct, to ensure a higher level of validity for the final instrument. This approach supported informed review and modification. Upon completion of the evidence based refinement process, the HCQ instrument demonstrated a high level of content validity, by exceeding the minimum target values of 0.90 (S-CVI/Ave) and 0.80 (S-CVI/UA) stipulated by Polit & Beck (2006). It should be noted that this S-CVI/Ave target is a higher benchmark than the targets commonly reported in the literature (Polit, Beck, & Owen, 2007).

An efficient and user-friendly process was developed for this research study to support completion of the CVI method. Embedding drop-down menus of rating scales into a digital copy of the questionnaire enabled faster turn-around for expert reviewers who were based in different domestic and international locations. This strategy addressed a fundamental and critical need for clear instructions to be communicated with expert reviewers, expressed by Lynn (1986), Polit & Beck (2006).

Validity determines confidence in the use of new instruments through evaluation of how well they measure what they were designed for (Mayo, 2015; Cheney, 2000). These strong outcomes reflecting the validity of retained IHL and CHL questionnaire items (n=34), confirm that the HCQ instrument is indeed a valid representation of interactive and critical health literacy constructs. This outcome enabled the reliability testing stage of this study to proceed.

3.4.2 HCQ reliability and context suitability

Demographic and work profile data for the sample group identified in the results were representative of those involved in larger scale research conducted within the Australian mining industry (Parker & McLean, 2012). These characteristics included similar job category, age, gender, education level and industry experience profiles. The education level data generated for this study exceeded the FKGL test result of 8.9, indicating that literacy skills should not have been a barrier to HCQ completion. Study one testing procedures were applied under true work conditions, consistent with those under which the action research project was implemented for study two. These conditions included delivery during toolbox talks and pre-start sessions within shift time, alongside other competing priorities, such as safety briefings with an emphasis and a focus on work tasks.

A digital mode of questionnaire delivery was not possible due to contextual constraints. Anecdotal comments from participants revealed they had limited or no previous experience with using VAS in questionnaires. Observations of participants during testing and review of responses established that they were able to adequately complete the process. As previously reported (section 3.2.3), the 60 mm length VAS used within the HCQ is different to the typically reported length of 100 mm. While no direct experimental comparison was made between the utilised 60 mm VAS and a 100 mm alternative, repeatability testing showed that it produced consistent results across the two day interval. The digital calliper data entry and upload method increased efficiency over manual measurement and data entry. This strategy was implemented as an application goal resulting in a mean time saving of 2.84 minutes per questionnaire.

Macro level evaluation of the HCQ produced a correlation coefficient that exceeded a target of .70 for newly developed measures and consistency, with values typically accepted in behavioural and social science research (Hinkin, 1998). As previously discussed, correlation may not be an indication of intra-subject agreement. Therefore a more rigorous interrogative methodology was necessary. Bias calculation provides an objective way of investigating consistency. A mean bias of 0.33 mm (SD = 2.10) for the HCQ reflects 0.55% variability. Whilst this instrument level outcome is very positive, item level analysis is crucial for true assessment of reliability (Polit, Beck, & Owen, 2007). The thirty-four Bland-Altman

repeatability plots produced during the micro level evaluation enabled a more comprehensive review of the questionnaire through critical appraisal of each item. Following completion of the validity and reliability testing, one HCQ item was deemed redundant as it represented the same construct evaluated by another item. The revised HCQ included a total of thirty-three items associated with IHL and CHL indicators.

Previous justification of the VAS within the HCQ was related to the degree of sensitivity over dichotomous and interval scales. All HCQ items exhibited a unidirectional bias less than five millimetres. From a functional perspective, this provides greater precision than a thirteen point interval scale. Two-thirds of the total HCQ items carried a unidirectional bias less than two millimetres. This represents greater precision than a thirty-one point interval scale. Of these items, half exhibited a bias less than one millimetre. In the applied context of using the VAS, this equates to less than the standard width of a stroke produced by a medium point pen. This level of sensitivity for the whole instrument and high degree for the majority of items is a successful outcome. It justifies the use of VAS in the HCQ over dichotomous and interval scales.

3.4.3 Summary of key findings

The results of this research instil confidence in the use of this new instrument for measuring indicators of interactive and critical health literacy in an industry setting. The following points summarise the key findings of this study.

- Systematic evaluation and refinement of the HCQ produced an instrument demonstrating interactive and critical health literacy content validity, by exceeding targeted thresholds which were comparatively higher index benchmarks than commonly reported in the literature.
- HCQ face validity was evident via a range of quality control research methods conducted with a representative group of mining workers.
- Outcomes verify that the HCQ is reliable and capable of yielding consistent data across two time points when tested under true work conditions.

- The low level of bias evident within the HCQ visual analogue scales enables greater discernibility than dichotomous and Likert interval scales commonly included within questionnaires.
- It has been comprehensively shown that the HCQ is appropriate for use within the mining industry to assess the impact of a novel contextualised health education and communication strategy, as reported in the following chapter.

Chapter 4: Digital stories as a strategy for health education

4.1 INTRODUCTION

The preceding literature review highlighted the need for workplace health promotion and the corresponding benefits that can be gained from contextualised projects. It emphasised the evolution of health literacy and inception as a core focus within a contemporary approach to health promotion. Despite rapid growth in health literacy related publications during the previous five years, the field of health literacy measurement is still evolving and greater intervention development for a broader range of settings is required (Nutbeam, 2015). The literature review also identified the potential of digital stories as a narrative communication strategy and a persuasive form of health education. This included a focus on a social ecological orientation to health and emergent neuroscience research, demonstrating narrative engagement via cortical activation.

This action research study brings together these elements of the literature review and builds upon the work that was undertaken during the previous study. In the mining industry context, the necessity for a focus on health as an integral part of OHS has been emphasised. An understanding of the bidirectional relationship between health and safety is essential to fulfil this. In the broader Australian context, the exigent need for action to promote willingness to consider medical advice, positive health behaviours and the development of health literacy skills among men has been highlighted (Smith & Bollen, 2009). Mining is a male dominated industry with a strong masculine culture which is, of even greater importance when considering health improvement interventions due to the potential for resistance and perceived invincibility. The mining industry also has an important set of collective contextual characteristics that need to be accommodated through the development of health education strategies. These include physical and mental demands of work tasks, environmental conditions, organisational work site operations and roster schedules. Toolbox talks are group discussions that focus on specific health and safety topics. Ideally, they should challenge thinking, practices and behaviours through two way communication and active discussion. The reality is, they often

transpire as one way information delivery (Shannon & Parker, 2012). Toolbox talks also commonly occur at the start of a shift prior to commencing work tasks, or at the conclusion of a shift before leaving the site. At the start of a shift, new safety briefings and manager directed work plans are likely to dominate attention and thinking. At the end of a shift, mental and physical fatigue can also be major barriers.

During 2009, the digital story concept was originally proposed to key stakeholders of the mining industry partner organisation as a potential strategy for communication efficiency, consistency and effectiveness. It was suggested that implementation of the digital story health education strategy within toolbox talks, would enable it to be tested against more traditional non-narrative communication methods. It was envisaged that the application of digital stories could draw on workplace culture in a positive way, by allowing workers from within the industry to share their experiences leading to greater engagement across the workforce. Including stakeholders in co-creation of solutions and prioritising local culture has been identified as a fundamental health literacy principle for effective health promotion activity (World Health Organization, 2015). The recruitment of storytellers, specialised health experts and development of digital stories were important initial stages of this research. Each required careful planning and the involvement of a range of stakeholders.

The aim of this study was to evaluate the impact of a digital story embedded communication strategy on worker engagement and its effect on interactive and critical health literacy indicators in the mining industry.

4.2 RESEARCH METHODOLOGY

4.2.1 Digital story development

A significant research challenge associated with digital story projects is the recruitment and retention of storytellers and this study involved a series of steps to support this process (Gubrium, 2009). Following initial acceptance of the approach by management of the industry partner organisation, further discussion with a wider set of stakeholders was conducted during 2010 to raise awareness of the strategy and seek support for implementation. A story template, inclusive of examples, was produced to action these outcomes and help identify suitable stories and storytellers.

The recruitment process involved active discussion and cooperation between the researcher, key stakeholders within the industry partner organisation and site personnel.

Other facilitative actions included digital story recruitment posters, to raise awareness at site level and the provision of information flyers for distribution to workers interested in finding out more about the strategy and its implementation. Prospective stories were reviewed to determine their suitability for application within the mining industry. The three digital stories that were selected at the time of preparing for study two involved experienced male and female workers from the Australian mining industry.

Following the recruitment stage, the three digital storytellers were provided with a participant information document to explain the project and enable informed consent (refer to Appendix B). They were asked to complete a digital story preparation form which requested information regarding the topic, key messages to be shared and a summary of their story. Photographic images can serve an important role within digital stories by breaking the video footage up and helping the viewer to immerse themselves in it. These benefits were explained to the storytellers and they were asked to consider whether they could provide personal photographs aligned with the discussion points identified within the digital story preparation form. Concurrent recruitment of leading researchers and academics from their respective fields occurred to facilitate the inclusion of validated information and evidence based messages within the digital stories. All digital storytellers and health experts completed an image consent form (refer to Appendix C). This important step granted permission for the inclusion of video footage, audio voice recordings and personal photographs in the completed digital stories.

A bank of eighteen questions and statements were developed as an interview guide for use during the digital story filming process. These questions, as presented in Table 4.1, were grouped to generate responses eliciting subject familiarisation, background information, unpacking the health story and reinforcement of the health messages. They were generic questions, able to be paraphrased or elaborated upon, based on the health topic, circumstances and discussion points raised by the interviewee.

Table 4.1. Digital story filming – Digital storyteller interview guide

Familiarisation and the backstory	
1	*How would you describe yourself to someone you just met?*
2	*What was important to you when you were growing up?*
3	*What is important to you now?*
4	*What do you like doing when you are not at work?*
5	*How long have you been working in the mining industry?*
6	*What type of work do you do and how does your role contribute to the operation of your work site?*
Unpacking the health story	
7	*What is the main health message you would like to share with other mining industry workers?*
8	*Tell me about your health experience and how it affected your life.*
9	*Was there any impact on other people in your life?*
10	*Were there any health services that you used during this time?*
11	*How easy or difficult was it to find health information that was relevant for you?*
12	*Is there any important health information that you believe mining industry workers should know about?*
13	*Have you had any open discussions with family members or friends about your health experience?*
14	*Have you previously talked to any of your co-workers about your health experience?*
15	*Why is your health story one that should be heard and seen by others?*
16	*Who needs to hear and see your story?*
17	*Looking ahead to the future, how would you like to see the next chapter of your story pan out?*
Reinforcing the health message	
18	*If you could sum up the message of your health story in a few words or sentences, what would you say?*

Due to the specific nature of the interviews with the leading researchers and academics, independent sets of foundation questions and notations for prompting were developed for each. Given their depth of knowledge and extensive experience in discussing the focused health topics, less questions were required than the interview guide for the digital storytellers. The developed questions primarily served as a reminder of the main foci. Further impromptu questions based on the ensuing discussion emerged during the interview and filming process. Examples of foundation questions and prompts from one of the health expert interviews are provided in Table 4.2.

Table 4.2. Digital story filming – Example health expert interview guide

	Questions
1	*What is the prostate gland, where is it located and what is the function of it?*
2	*What is currently known about prostate cancer and is it a complex disease?*
3	*What treatments and screening are available?*
4	*What are you trying to achieve through your research and the work that is carried out at the Australian Prostate Cancer Research Centre?*
5	*Why did you initiate the establishment of the Prostate Cancer Foundation of Australia (PCFA) and what is the purpose of the organisation?*
6	*Through your discussions with support groups, what are the main types of questions that people ask about prostate cancer?*
	Resources and prompts
7	Prostate anatomical model Graphs showing progression of cancer and other relevant information
8	Support service advocacy: *PCFA rural nursing program*

The digital stories were filmed by a professional video production company based in Brisbane. They provided a producer, videographer and sound technician to generate the raw footage, and editing staff for the post production work. Each of the storyteller and health expert interviews required several hours of location based time to enable the film crew to set up, preparation time for the producer and completion of the interview process. Storytellers and health experts were asked to preview the edited digital story and provide feedback if required, as an assent and quality control mechanism. The digital story delivered to intervention group participants during this study focussed on cardiovascular health and was 9 minutes 19 seconds duration. Sample screenshots from this digital story, featuring the storyteller with identifiable characteristics obscured and a re-enactment are presented in Figure 4.1.

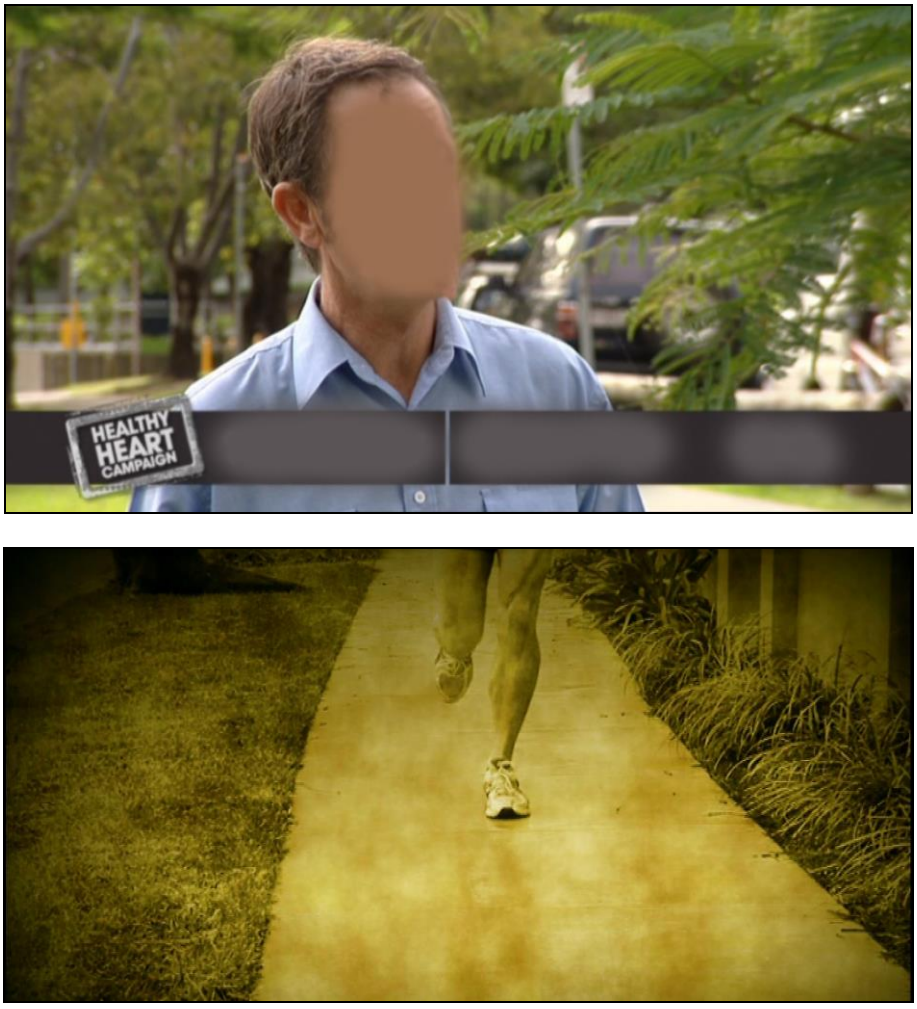

Figure 4.1. Digital story sample screenshots

These storyteller recruitment and digital story development processes preceded the applied empirical research methodology. This study included baseline data collection, delivery of the digital story intervention and corresponding impact and follow-up data collection. Further information about these stages is provided in the following section.

4.2.2 Study design

A quasi-experimental parallel time series research design, including intervention and control groups at each of the open cut and underground mine sites was implemented for this study. Distinct advantages of quasi-experimental research include authentic, setting focussed investigation and corresponding ecological validity, while still controlling as many threats to internal validity as possible (Rovai, Baker, & Ponton, 2014; Thomas & Nelson, 2011). This research design was selected as a control mechanism for potential confounding variables associated with variability between work sites. The intervention group observed a multimodal health education presentation which included one of the digital stories previously identified and discussed in this chapter. The control group received the same health information communicated in a non-narrative manner, reflective of typical OHS communication within the mining industry.

Data collection occurred using the previously validated and reliable HCQ instrument developed for study one. The HCQ instrument was utilised at three intervals, including pre and post-intervention testing. Baseline data collection occurred two weeks prior to delivery of the health education presentations. Impact data collection occurred immediately after the presentations and follow-up data collection occurred two months post implementation. The independent variable for this research study was exposure to the digital story communication strategy. Dependent variables included engagement and the five interactive and critical health literacy indicators discussed within chapter three. A timeline representing these stages is presented in Figure 4.2.

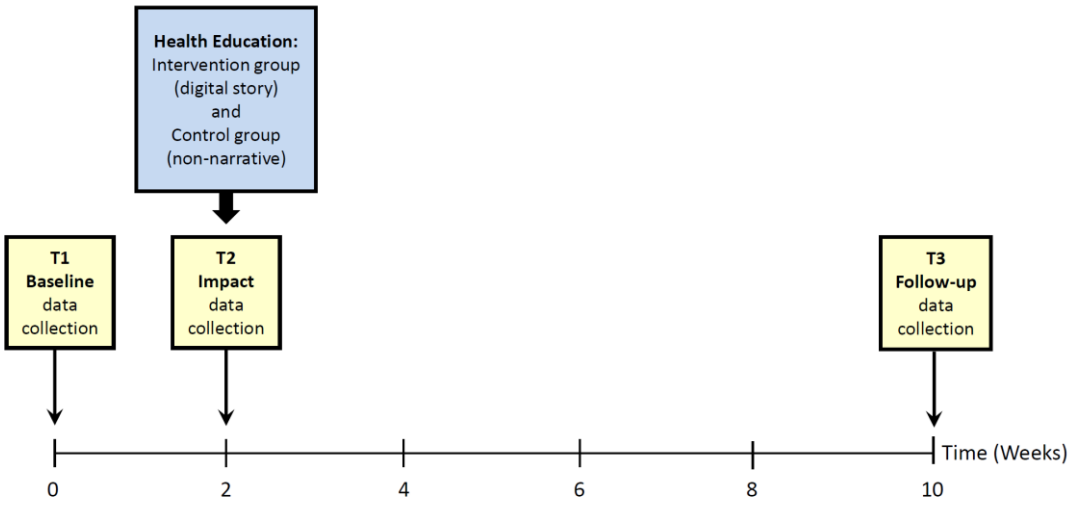

Figure 4.2. Study two timeline

A structured criterion based selection process was undertaken to identify potential sites for implementation of this study. This was necessary to ensure that research group profiles were reflective of the industry workforce, potential confounding variables could be controlled, and required sample sizes could be met. Results from a large OHS climate survey data set incorporating the mining industry partner organisation sites were reviewed to support the site selection process reported (Parker & McLean, 2012). Eighteen sites were identified in the associated report and each was subjected to an initial round of exclusion criteria to generate a short list of sites suitable for the study. This was followed by review of the remaining sites against a set of inclusion criteria to select the research locations.

The two exclusion criteria applied to eighteen sites during the first round of selection process are presented in Table 4.3. The outcome summary identifies the number of sites that were excluded. After application of the first round exclusion criteria, eight sites remained from the original eighteen reviewed. These short-listed sites were then subjected to a second round review.

Table 4.3. Site selection – First round exclusion criteria

Criteria for exclusion	Outcome summary
1. Sites that did not have the typical range of workforce categories including: a) *Maintenance and fitter;* b) *Professional, technical, administration and supervisor;* c) *Operator and mine worker;* d) *Drill and blast.*	*Sites eliminated following application of criterion 1:* n=6
2. Sites that did not have sufficient staff numbers to meet the required sample sizes.	*Sites eliminated following application of criterion 2:* n=4

The OHS climate survey data set included eight survey categories comprising a total of thirty-five questionnaire items (Parker & McLean, 2012). Sixteen items from six of the survey categories were isolated and reviewed as they were associated with the pending research study. The data also supported demographic and work organisation profiling including information about gender, age, education, job categories, time with the employer and time working in the industry. One site was withdrawn due to cessation of mining at the site during 2012, leaving seven sites to be subjected to two criteria for inclusion as listed in Table 4.4.

Table 4.4. Site selection – Second round inclusion criteria

Criteria for inclusion	Outcome summary
1. Sites with equivalent demographic profiles to others within the pool.	
2. Sites with equivalent health climate survey data to others within the pool.	*Sites eliminated following application of both criteria:* n=4

After this second round review process, three remaining sites were identified with equivalent profiles. Consultation with key stakeholders from the industry

partner organisation was undertaken, to determine whether operational constraints and production schedules could facilitate the timely delivery of each stage of the study. This led to the selection of two sites located in regional Queensland, including an open cut coal mine and an underground metalliferous mine. Both sites were continuous mining operations with an even time roster. Site one employed mainly fly-in fly-out (FIFO) personnel with a small proportion of local residential commuting personnel and site two personnel were all FIFO.

Sample size calculation is necessary to determine the number of participants required for sufficient statistical power whilst considering the resource implications for conducting the research (Fitzner & Heckinger, 2010). Required sample size was calculated using the following formula (Battistutta, 2007).

$$\text{Required sample size} = (21.0 \times SD^2) / (M_1 - M_2)^2$$

Pilot data produced a combined mean of 1604.07 mm for the health literacy associated HCQ items with standard deviation (SD) of 330.69 mm. An expected post intervention mean difference of 170 mm was selected as the target and this represents ability to detect a change of 5 mm on the 60 mm VAS for each HCQ item. This mean difference is greater than the variability established for all HCQ items during reliability testing. The calculated sample size was 79.46, rounded up to 80 participants required for each group. This sample calculation was checked against an effect size curve using a power level of 0.9 and an effect size of 0.51 calculated via the following formula (Rovai, Baker, & Ponton, 2014; Thomas & Nelson, 2011).

$$\text{Effect size (ES)} = (M_1 - M_2) / SD$$

An effect size curve published by Thomas & Nelson (2011) confirmed that the calculated required sample size of 80 was appropriate.

An inflation factor was applied to the required sample size, to allow for a realistic response rate and the potential for incomplete time series data. An inflation factor of 1.69 was calculated from a minimum seventy percent response rate (1.3) and a seventy percent follow-up rate (1.3). Targeted sample size was calculated by multiplying the required sample size and inflation factor (Battistutta, 2007). This resulted in a calculated target sample size of 135.2, rounded up to the nearest whole number of 136 participants per research group. Based on these sample size calculations, this initial target was necessary to exceed the requirement of 80

participants required per group for 90% power, with significance of .05 and a type I error of 5% (Battistutta, 2007). This power level exceeds targets of .80 typically reported in quantitative behavioural science research, including Kolbe-Alexander and colleagues (2012), who also investigated the impact of a CVD focussed workplace health promotion project. The applied power level of .90 is more commonly set as the expected target for clinical research (Fitzner & Heckinger, 2010).

4.2.3 Participants

Both research sites operated a work roster that managed four crews. Site one operated split crews out of two different locations on site, resulting in eight sub-groups of participants. Crews A1, B1, B2 and C1 were assigned to the intervention group. Crews A2, C2, D1 and D2 were assigned to the control group. Site two also operated a split crew structure comprising maintenance and production personnel. Crews B1, C1, B2 and C2 were assigned to the intervention group. Crews A1, D1, A2 and D2 were assigned to the control group. A total of 461 workers were employed at the two sites according to 2011 company data. Participant information was provided in writing, to gain informed consent (refer Appendix D). Response rates of 90.24% (n=416/461) at baseline assessment, 86.12% (n=397/461) at impact assessment and 85.25% (n=393/461) at follow-up assessment were achieved for this study. These strong response rates were gained through systematic correspondence strategies explained in section 4.3.3. During the three stages of baseline, impact and follow-up testing, a total of 1,206 questionnaires were completed and returned.

Although staff numbers were consistent during the 10 week data collection period, it is possible that mine site staff profiles may change, presenting difficulties in completing all three data collection stages. Reasons for staff profile variability include transient sub-contract workers hired for on-demand work tasks; workers commencing after baseline data collection; workers transferring to another site before completion of testing; and absence during one or more of the data collection stages due to annual leave, illness or injury. In consideration of the identified industry and contextual factors which can change the staff profile in a relatively short period of time, it was necessary to control them. This was achieved by applying a per protocol method, limiting analysis to only those participants who were present for and completed all three stages of data collection (Parker & Berman, 2003). This

involved matching participant responses based on provided demographic data and assigning a unique participant identification code. After completion of this cross matching and coding process, the total sample size was 175, including 90 participants in the control group and 85 participants in the intervention group. A summary of the characteristics of retained intervention and control group participants after application of this protocol is presented in Table 4.5.

Table 4.5. Participant demographic profile

	Control group (n=90)	**Intervention group** (n=85)
Gender		
Male	92.20 % (n=83)	94.10 % (n=80)
Female	7.80 % (n=7)	5.90 % (n=5)
Age range	18 – 66 years (M = 40.26, SD = 10.91)	20 – 65 years (M = 40.81, SD = 11.74)
Job categories		
Operator / vehicle driver	68.9% (n=62)	62.8% (n=54)
Maintenance	11.1% (n=10)	20.4% (n=17)
Drill and blast	14.4% (n=13)	6.0% (n=5)
Project operations	5.6% (n=5)	9.6% (n=8)
Other	0.0% (n=0)	1.2% (n=1)
Time working in industry	0.08 – 42.58 years (M = 8.21, SD = 9.14)	0.17 – 42.00 years (M = 6.82, SD = 7.94)
Time working at current mine site	0.08 – 8.67 years (M = 1.89, SD = 2.10)	0.08 – 7.50 years (M = 1.72, SD = 1.80)
Country of birth		
Australia	86.8% (n=78)	88.2% (n=75)
New Zealand	11.0% (n=10)	4.7% (n=4)
Scotland	1.1% (n=1)	1.2% (n=1)
Papua New Guinea	1.1% (n=1)	0.0% (n=0)
Malta	0.0% (n=0)	1.2% (n=1)
Canada	0.0% (n=0)	1.2% (n=1)
Germany	0.0% (n=0)	3.5% (n=3)

Main spoken language		
English	100.0% (n=90)	100.0% (n=85)
Other	0.0% (n=0)	0.0% (n=0)
Aboriginal or Torres Strait Islander (ATSI) identification		
Yes	6.7% (n=6)	3.5% (n=3)
No	93.3% (n=84)	96.5% (n=82)
Highest level of schooling completed		
Year twelve or equivalent	33.7% (n=30)	42.4% (n=36)
Year ten or equivalent	59.6% (n=54)	51.8% (n=44)
Year eight or equivalent	5.6% (n=5)	2.4% (n=2)
Year seven or below	1.1% (n=1)	3.5% (n=3)
Highest qualification		
Certificate	24.0% (n=22)	31.8% (n=27)
Diploma	5.6% (n=5)	8.3% (n=7)
Bachelor degree	1.1% (n=1)	2.4% (n=2)
Nil	69.3% (n=62)	57.5% (n=49)

The demographic and work profile summary for the study two research groups is consistent with study one and previous industry based research (Parker & McLean, 2012).

4.2.4 Intervention and data collection

A pre-visit communication strategy was implemented to raise awareness about the purpose of the research and to strengthen the response rate. This included phone and email communication with key site based stakeholders, including HSET and site management personnel. Following this initial contact, 297 mm x 420 mm posters and 210 mm x 297 mm flyers were sent by mail to the sites for display and distribution, two weeks prior to the site visits. These materials identified the rationale for the research, the focus of investigation, and emphasised the voluntary and confidential nature of the data collection method. This strategy had been successfully applied

during previous research conducted by the QUT Workforce Health Innovation group. It was also deemed to be successful for this research project, generating very strong response rates. These were greater than 90 percent at baseline data collection and greater than 85 percent at the impact and follow-up evaluation stages, as identified previously in this chapter.

The parallel time series design of this study required a total of six site visits for the two research sites located in regional Queensland. Each site visit was three to four days duration, including travel time and they occurred during the period of August to December 2012. The study provided equivalent health information via two different methods of delivery, implemented as intervention and control groups. An information brochure summarising the key messages of the presentations was produced and distributed to all participants to provide them with a reinforcing health education resource. This type of resource was deemed an important element of an occupational health education strategy; however, it was not a research focus and therefore was not subjected to testing as an independent variable. To avoid introducing a potential confounding variable, an identical version of the brochure was produced for both participant groups.

The four page 148 x 210 mm colour brochure summarised key health messages and provided recommendations for seeking further information or advice from health professionals. Quick Response (QR) codes were embedded into the brochure to enable direct access to online information and resources for people with smartphones. Information and contact details were also listed for people who did not have access to this technology. QR codes are two dimensional or matrix barcodes and the technology was originally developed as an efficiency strategy for the Japanese automotive industry (Burke, O'Callaghan, & Quigley, 2013). More recently, they have been used as a communication, advertising and marketing strategy. Web enabled devices with an installed QR code reader application, use a camera to scan the code and open up data, such as a website link in an internet browser. The QR codes included in the brochure were developed using a QR code generator website (Kaywa AG, 2014). An extract from the brochure including examples of three QR codes is presented in Figure 4.3.

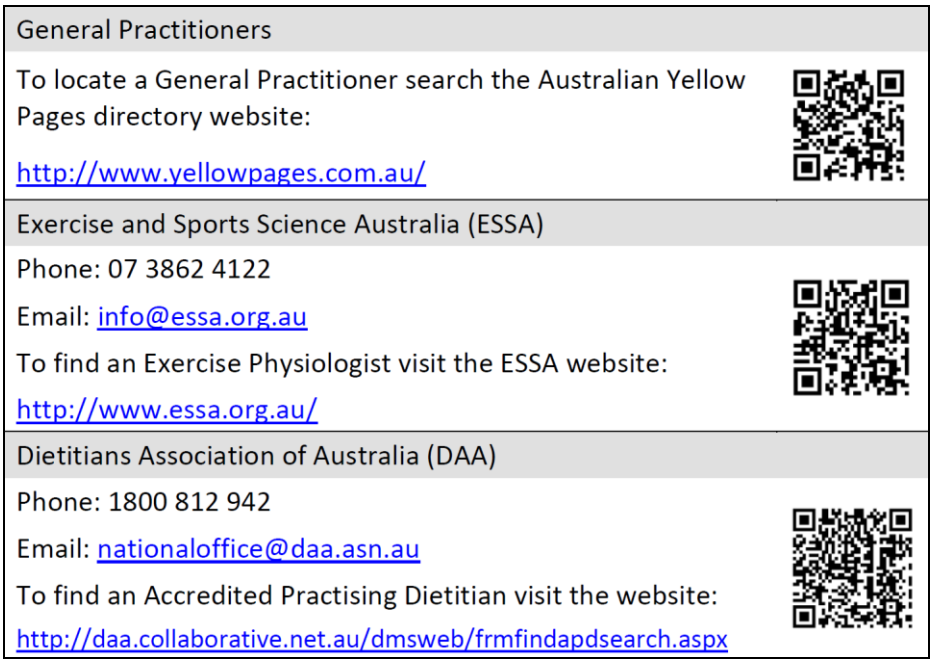

Figure 4.3. Brochure extract including QR codes

A core set of presentation slides were also prepared as a standard resource for the intervention and control groups. They included an elaboration of the key information and messages identified within the distributed brochure. Intervention group specific slides, were also generated and integrated with the core set of slides. They consisted of digital story focussed information and discussion points for the intervention group, delivered as a multimodal presentation. They included equivalent information framed in a non-narrative manner. Digital story based presentations were implemented for each of the eight sub-groups within the intervention group. Equivalent, non-narrative presentations were implemented for each of the eight sub-groups within the control group. All sixteen health education presentations were delivered by the researcher, to ensure consistent application and avoid the introduction of a confounding variable that could emerge with different presenters.

Baseline, impact and follow-up data collection occurred via the validated HCQ instrument. Questionnaire administration protocols were developed to ensure consistent delivery and accurate tracking of assigned research groups. The guidelines for administration as presented in Appendix E, stipulate supervision, conditions, dialogue and batching instructions. The questionnaire was administered by the researcher on three-quarters of all occasions and authorised HSET personnel assisted on the other occasions, due to split groups operating concurrently from different crib

rooms. The authorised HSET personnel followed the HCQ administration guidelines and completed a batch sheet to prevent questionnaires being assigned to the wrong group. A copy of the batch sleeve is provided in Appendix F.

4.2.5 Data analysis

The data analysis method applied to the study focussed on mean differences for the dependent variables at three time intervals. HCQ data was managed and analysed using SPSS software version 21 (IBM Corporation, New York, US). The thirty-three HCQ items associated with IHL and CHL indicators were entered as scale measures using the digital calliper entry technique described in chapter three. Demographic and other HCQ items were entered as nominal and ordinal measures.

Pre-analysis data management included reverse scoring for negatively phrased HCQ items. This was achieved using the compute variable function within SPSS and application of the formula 60 – x, where x equals the measured value in millimetres. This simple formula was derived from the HCQ visual analogue scale length of 60 mm, as discussed in chapter three. Syntax was entered into SPSS and the reverse scored values were calculated for nine of the HCQ items (21, 27, 28, 32, 33, 38, 39, 45 and 48). The HCQ comprised five sub-scales representing the health literacy indicators developed for this research project, as previously identified within chapter three. They include: *responding to health information provided by others* (1-RHI); *discussing health at work, home or with friend*s (2-DH); *seeking health information* (3-SHI); *achieving control over personal health* (4-ACP); and *helping others improve or maintain health* (5-HO). The number of items within subscales 1-RHI, 2-DH, 3-SHI, 4-ACP and 5-HO was 6, 6, 7, 6 and 8 respectively. Additional pre-analysis data management included calculation of subscale means for each of the three time intervals. The number of items within each of the five subscales varied, therefore the mean was calculated using the compute variable function within SPSS, rather than total values.

Analysis of variance (ANOVA) is a parametric procedure that involves comparison of two or more means and can be used to determine whether they are statistically different. Repeated measures ANOVA supports comparison of the same dependent variable measured more than once. There are distinct advantages of using

repeated measures ANOVA, including controlling for individual differences and direct study of dependent variables over time. The former is controlled by identifying individual difference variation and separating it from the error term leading to increased power. This allows the procedure to be conducted with fewer participants, supporting efficient data collection and analysis (Rovai, Baker, & Ponton, 2014; Thomas & Nelson, 2011).

Before conducting one-way repeated measures ANOVA, there are three assumption based criteria that should be met including normality, homogeneity of variance and sphericity. Repeated measures ANOVA statistics are sensitive to violations of these assumptions when the research groups are unbalanced (Keselman, Algina, & Kowalchuk, 2001). Similar sized control (n=90) and intervention (n=85) groups were evaluated during this study. The normality criterion assumes normal distribution of the dependent variable. Potential violations were assessed via Levene's Test of Equality of Error Variances using SPSS outputs and significance < .05 indicates normality violation. Small to moderate violations are generally tolerable; however, major violation may require use of the non-parametric Friedman two-way ANOVA (Allen & Bennett, 2012; Thomas & Nelson, 2011). Homogeneity implies similar variability for each set of values. SPSS does not include a test of homogeneity of variance for repeated measures ANOVA, therefore Hartley's F_{max} Test was conducted. F_{max} can be manually calculated via the following formula:

$$F_{max} = \text{largest sample variance / smallest sample variance}$$

where largest sample variance is the largest SD squared and smallest sample variance is the smallest SD squared. Calculated F_{max} values < 10 denote homogeneity. Repeated measures ANOVA is sensitive to large homogeneity of variance violations, but can tolerate small and moderate violations (Tabachnick & Fidell, 2007; Allen & Bennett, 2012). Sphericity represents equal variability in the differences between combinations of groups (Allen & Bennett, 2012). Potential violations were assessed via Mauchly's Test of Sphericity using SPSS. Significance < .05 indicates sphericity violation and the corresponding action is to review and report Huynh-Feldt or Greenhouse-Geisser epsilon (ε) adjustments. An ε value > .75 is ideal for repeated measures research studies (Rovai, Baker, & Ponton, 2014).

Following normality, homogeneity of variance and sphericity criteria assessment, SPSS was used to conduct one-way repeated measures ANOVA to

investigate time, group and interaction effects. Further insights into time and group effects at the interval level were determined through Cohen's *d* and Pearson correlation coefficient *r* calculation. Cohen's *d* and Pearson's *r* scores were compared with conventional effect size values to evaluate outcomes as either insignificant, or significant at small, medium and large levels of effect.

4.3 RESULTS

4.3.1 Digital story engagement

Digital story engagement was evaluated via one-way repeated measures ANOVA for HCQ Item 20. This item included a focus on whether the respondent perceived the health communication mode to be useful and whether it prompted them to think about their health. Normality, homogeneity of variance and sphericity were evaluated and all three criteria were met. Levene's Test of Equality of Error Variances produced significance values of .134 to .208, indicating normal distributions. Hartley's F_{max} Test was conducted via manual calculation demonstrating an F_{max} value of 3.82 indicating homogeneity of variance. Mauchly's Test of Sphericity revealed a W value of .996 as presented in Table 4.6. Significance levels greater than .05 established the assumption of sphericity, therefore the ε adjustments reported in Table 4.6 were not required.

Table 4.6. Mauchly's Test of Sphericity – HCQ Item 20 (Engagement)

Measure	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Item 20	.996	.650	2	.722	.996	1.000	.500

Following demonstration of normality, homogeneity of variance and sphericity criteria being met, one-way repeated measures ANOVA was conducted. Estimated marginal means for each group at baseline (T1), impact (T2) and follow-up (T3) are presented in Table 4.7.

Table 4.7. Estimated marginal means – HCQ Item 20 (Engagement)

Group	Time[a]	Mean (mm)	SD	SE	95% CI	
					Lower Bound	Upper Bound
Control	T1	31.440	15.848	1.611	28.256	34.623
	T2	34.272	14.512	1.311	31.682	36.863
	T3	33.066	13.696	1.467	30.167	35.965
Intervention	T1	31.480	13.666	1.839	27.846	35.114
	T2	49.114	8.112	1.497	46.157	52.072
	T3	39.525	13.483	1.675	36.216	42.834

[a]*T1 = baseline (0 weeks), T2 = impact (2 weeks) & T3 = follow-up (10 weeks)*

Estimated marginal means for the control and intervention groups were graphed to explore change over time and group differences (refer Figure 4.4). Means (mm) were plotted against the y-axis of the graph, reflective of the continuous 60 mm HCQ visual analogue scale (VAS). Responses in the upper half of the VAS reflected increasing positivity approaching the 60 mm end point. Responses in the lower half of the VAS reflected increasing negativity approaching the 0 mm end point. The timing of data collection was plotted against the x-axis, including baseline (T1 = 0 weeks), impact (T2 = 2 weeks) and follow-up (T3 = 10 weeks) stages.

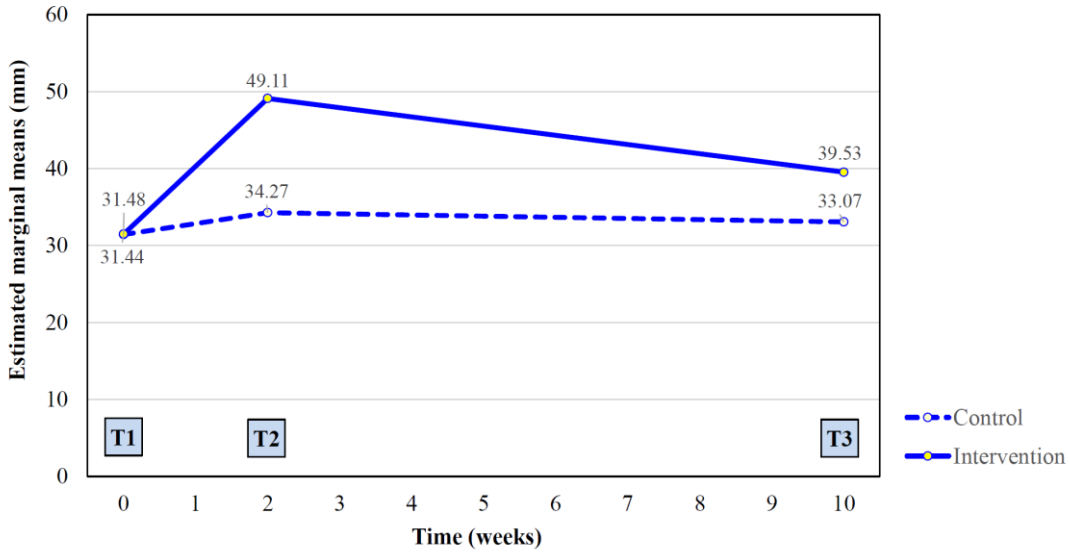

Figure 4.4. Baseline, impact and follow-up means – HCQ Item 20

Appendix G highlights results of the ANOVA Test of Between-Subjects Effects for HCQ Item 20, with an alpha level of .05. Significant differences were observed between groups, F (1, 150) = 28.083, $p < .001$, $\eta_p^2 = .158$. This Partial Eta Squared value exceeds the conventional large effect size (ES) rating of .140 (Rovai, Baker, & Ponton, 2014; Tabachnick & Fidell, 2007). Appendix H highlights results of the repeated measures ANOVA Test of Within-Subjects Effects for HCQ Item 20, with an alpha level of .05. Given the assumption of sphericity was not violated, epsilon adjusted tests were not required and the sphericity assumed rows were used. Significant differences were observed between time periods, F (2, 300) = 22.096, $p < .001$, $\eta_p^2 = 0.128$, and a significant time and group interaction effect was also observed, F (2, 300) = 11.613, $p < .001$, $\eta_p^2 = .072$. These Partial Eta Squared values exceed the conventional medium effect size rating of .060 (Rovai, Baker, & Ponton, 2014; Tabachnick & Fidell, 2007).

To gain further insights into interval level effects, ES comparisons were made by calculating Cohen's d and Pearson correlation coefficient r values from the data presented within Table 4.7. The calculated Cohen's d values, r values and ES are reported in Table 4.8. Descriptive effect sizes were based upon a widely applied index of conventional levels for small, medium and large effects sizes, as stipulated by Cohen (1992).

Table 4.8. Summary of effect size comparisons – HCQ Item 20 (Engagement)

Group	Times[a]	Cohen's *d*	Pearson's *r*	Effect size[bc]
Control	T1 & T2	.186	.093	Small
Control	T1 & T3	.110	.055	Not significant
Intervention	T1 & T2	1.569	.617	Large
Intervention	T1 & T3	.590	.284	Medium

[a]*T1 = baseline (0 weeks), T2 = impact (2 weeks) & T3 = follow-up (10 weeks)*
[b]*Conventional ES values for d: small = .20, medium = .50 & large = .80 (Cohen, 1992)*
[c]*Conventional ES values for r: small = .10, medium = .30 & large = .50 (Cohen, 1992)*

Near identical baseline (T1) means of 31.44 mm (*SD* = 15.85) and 31.48 mm (*SD* = 13.67) for control and intervention respectively, were evident for HCQ Item 20. Both groups displayed a similar time series pattern with a higher mean at impact (T2) than baseline (T1), and a follow-up (T3) mean demonstrating some decline, falling to a level between T1 and T2 values. Variance between the two groups was the magnitude of difference and effect size.

The results highlighted significantly greater engagement at impact (T2) with the digital story communication method (*M* = 49.11, *SD* = 8.11), than the comparable non-narrative communication method (*M* = 34.27, *SD* = 14.51). Both groups demonstrated a decline in mean from impact (T2), including follow-up (T3) with means of 33.10 mm (SD = 13.70) and 39.53 mm (SD = 13.48) for the control and intervention groups respectively. A small effect size was observed between T1 and T2 for the control group and no significant effect was evident between T1 and T3. In contrast, a large effect size was observed between T1 and T2 for the intervention group and a medium effect size was evident between T1 and T3. Following evaluation of digital story engagement, impact on health literacy indicators was determined through analysis at the questionnaire sub-scale level.

4.3.2 Digital story impact on health literacy indicators

Digital story impact on health literacy indicators was evaluated via one-way repeated measures ANOVA for the five HCQ sub-scales identified in section 4.2.5.

Initial data screening included searching for missing data, checking for extreme univariate outliers and tests of normality, homogeneity of variance and sphericity (Rovai, Baker, & Ponton, 2014; Allen & Bennett, 2012).

Normality, homogeneity of variance and sphericity were evaluated and all three criteria were met. Levene's Test of Equality of Error Variances produced significance values of .071 to .951, indicating normal distributions. Hartley's F_{max} Test was conducted via manual calculation, demonstrating an F_{max} value of 2.81 indicating homogeneity of variance. Further inspection of the data was conducted via boxplots for each of the HCQ sub-scales and the generation of Q-Q plots and histograms, to evaluate normality through graphical examination of linearity, skewness and kurtosis. An example boxplot for all HCQ sub-scales at baseline (T1) is presented in Figure 4.5.

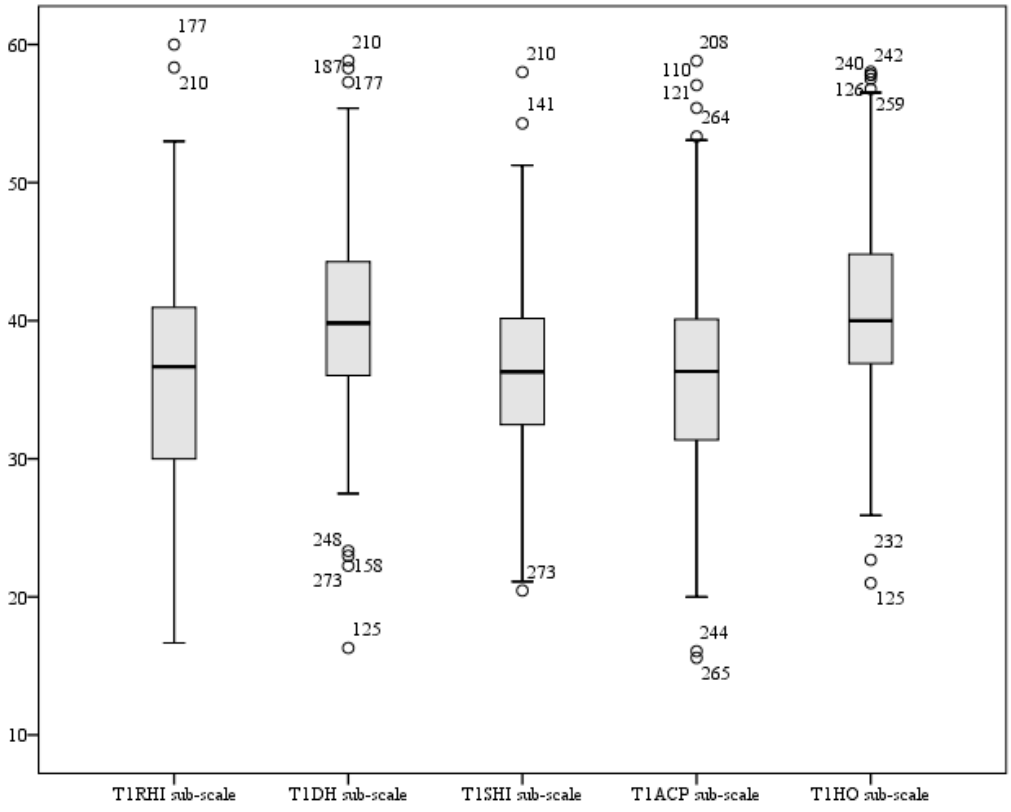

Figure 4.5. Baseline (T1) HCQ sub-scale boxplots

An example histogram and Q-Q plot for the 1-RHI sub-scale at T1 (baseline) is presented as Figures 4.6 and 4.7 respectively. Small but acceptable deviations of normality were evident.

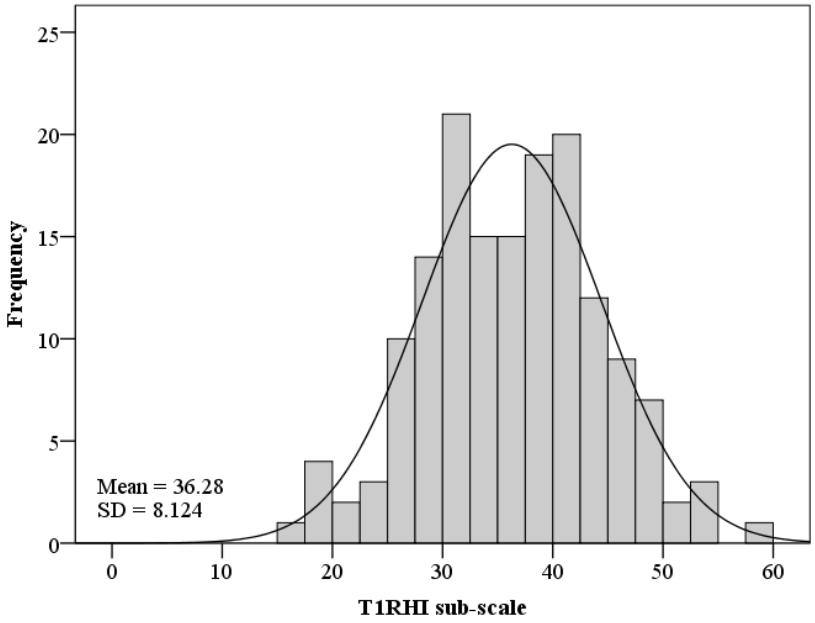

Figure 4.6. Baseline (T1) HCQ RHI sub-scale histogram with normal curve overlay

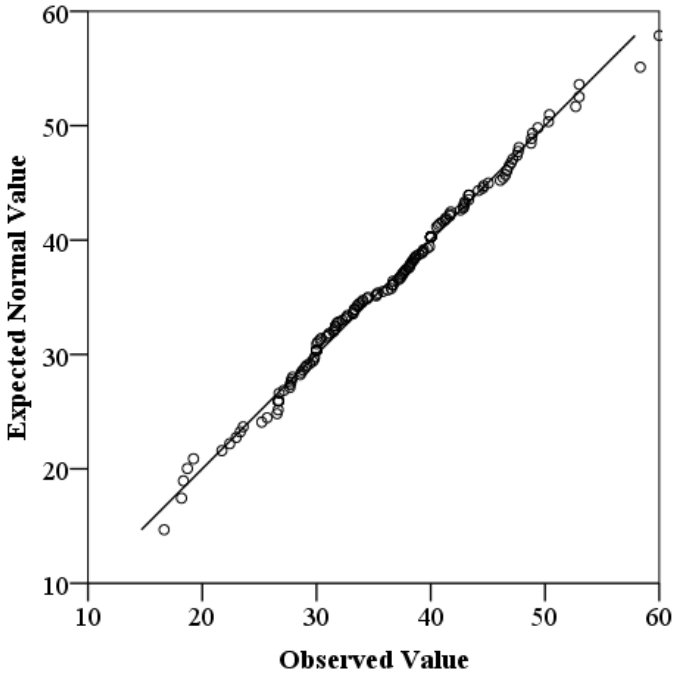

Figure 4.7. Normal Q-Q plot of HCQ RHI sub-scale at baseline (T1)

Further data screening for the HCQ sub-scales included Mauchly's Test of Sphericity. This assessment revealed Mauchly's W values of .956 to .994 as presented in Table 4.9. Significance levels greater than .05 confirmed the assumption of sphericity, therefore the ε adjustments reported in Table 4.9 were not required.

Table 4.9. Mauchly's Test of Sphericity – HCQ Sub-scales

Measure	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
1-RHI	.994	.553	2	.758	.994	1.000	.500
2-DH	.980	1.747	2	.418	.981	1.000	.500
3-SHI	.985	1.328	2	.515	.985	1.000	.500
4-ACP	.974	2.360	2	.307	.974	1.000	.500
5-HO	.956	3.964	2	.138	.958	.989	.500

After satisfying the criteria for normality, homogeneity of variance and sphericity, one-way repeated measures ANOVA was conducted for each of the HCQ items and sub-scales. A summary of the descriptive data generated for the two research groups and five HCQ sub-scales at each time interval is presented in Table 4.10. Detailed descriptive data including mean, median, range and standard deviation for all HCQ items and sub-scales is presented in Tables AI.1 to AI.6 (refer Appendix I).

Table 4.10. Estimated marginal means – HCQ Sub-scales

Group	Measure	Mean (SD)		
		T1[a]	**T2[b]**	**T3[c]**
Control	1-RHI	35.99 (8.45)	38.96 (8.41)	37.25 (7.81)
	2-DH	39.80 (7.21)	39.17 (6.90)	39.86 (6.66)
	3-SHI	37.24 (6.50)	37.37 (5.70)	37.17 (5.66)
	4-ACP	36.87 (7.54)	35.50 (8.36)	36.01 (7.70)
	5-HO	40.61 (6.67)	40.34 (6.76)	40.05 (6.44)
Intervention	1-RHI	36.61 (7.78)	46.88 (7.47)	37.18 (7.46)
	2-DH	39.82 (7.51)	42.03 (7.68)	41.33 (7.49)
	3-SHI	36.56 (6.40)	37.59 (5.98)	38.07 (6.15)
	4-ACP	36.37 (7.97)	35.73 (8.56)	36.39 (7.99)
	5-HO	41.40 (7.92)	42.16 (6.17)	41.51 (6.54)

SI unit of measurement: mm

[a]T1 = baseline (0 weeks), [b]T2 = impact (2 weeks) & [c]T3 = follow-up (10 weeks)

Estimated marginal means for the control and intervention groups were graphed to explore change over time and group differences. Graphs of sub-scales 2 to 5 demonstrating limited or minimal variability are presented as Figures AJ.1 to AJ.4 of Appendix J. Sub-scale 1-RHI displayed the greatest variability and the graph is presented as Figure 4.8. It highlights a similar baseline mean between control and intervention groups, clear separation two weeks later at the impact data collection stage and similarity between groups and baseline levels at the 10 week follow-up data collection stage.

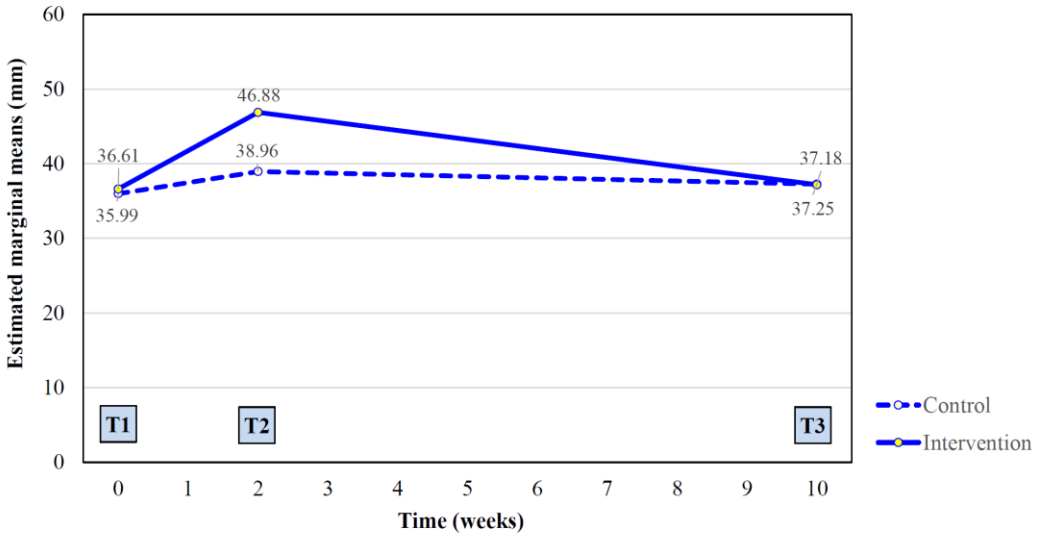

Figure 4.8. Baseline, impact and follow-up means – HCQ sub-scale 1

Appendix K includes results of the repeated measures ANOVA Test of Within-Subjects Effects for HCQ sub-scales with an alpha level of .05. Given the assumption of sphericity was not violated, epsilon adjusted tests were not required and the sphericity assumed rows were used. Significant differences were observed between time periods for sub-scale 1-RHI, F (2, 178) = 18.146, p < .001, η_p^2 = .169. This Partial Eta Squared value of .169 exceeds the conventional large effect size rating of .140 (Rovai, Baker, & Ponton, 2014; Tabachnick & Fidell, 2007). No significant differences were observed between time periods for sub-scales 2-DH, 3-SHI, 4-ACP and 5-HO. A significant time and group interaction effect was observed for sub-scale 1-RHI, F (2, 178) = 9.322, p < .001, η_p^2 = .095. This Partial Eta Squared value of .095 exceeds the conventional medium effect size rating of .060 (Rovai, Baker, & Ponton, 2014; Tabachnick & Fidell, 2007). No significant time and group interaction effect was observed for sub-scales 2-DH, 3-SHI, 4-ACP and 5-HO.

To gain further insights into interval level effects, effect size comparisons were made by calculating Cohen's *d* and Pearson correlation coefficient *r* values from the data presented within Table 4.9. The calculated Cohen's *d* values, *r* values and ES are reported in Table 4.11. Descriptive effect sizes were based upon a widely applied index of conventional levels for small, medium and large effects sizes as stipulated by Cohen (1992).

Table 4.11. Summary of effect size comparisons – HCQ Sub-scales

Group	Measure	Times[a]	Cohen's *d*	Pearson's *r*	Effect size[bc]
Control	1-RHI	T1 & T2	.352	.173	Small
		T1 & T3	.155	.077	Not significant
	2-DH	T1 & T2	-.089	-.045	Not significant
		T1 & T3	.009	.004	Not significant
	3-SHI	T1 & T2	.021	.011	Not significant
		T1 & T3	.011	.006	Not significant
	4-ACP	T1 & T2	-.172	-.086	Not significant
		T1 & T3	-.113	-.056	Not significant
	5-HO	T1 & T2	-.040	-.020	Not significant
		T1 & T3	-.085	-.043	Not significant
Intervention	1-RHI	T1 & T2	1.347	.559	Large
		T1 & T3	.075	.037	Not significant
	2-DH	T1 & T2	.291	.144	Small
		T1 & T3	.201	.100	Small
	3-SHI	T1 & T2	.166	.083	Not significant
		T1 & T3	.241	.119	Small
	4-ACP	T1 & T2	-.077	-.039	Not significant
		T1 & T3	.003	.001	Not significant
	5-HO	T1 & T2	.107	.053	Not significant
		T1 & T3	.015	.008	Not significant

[a]*T1 = baseline (0 weeks), T2 = impact (2 weeks) & T3 = follow-up (10 weeks)*
[b]*Conventional ES values for d: small = .20, medium = .50 & large = .80 (Cohen, 1992)*
[c]*Conventional ES values for r: small = .10, medium = .30 & large = .50 (Cohen, 1992)*

The results identified a large effect size for time for the HCQ sub-scale 1-RHI. This indicator, *responding to health information* is representative of interactive health literacy. The complete time series results, as evidenced by time and group interaction, revealed a moderate effect size, tempered by a return to near baseline

levels at follow-up (T3). Interval based exploration via Cohen's *d* and Pearson's *r* calculation indicated no significant effect for nine of the 10 control group comparisons within the control group, as evidenced within Table 4.11. The only significant interval level effect within the control group was a small effect size occurring between T1 and T2 for HCQ sub-scale 1-RHI. The same sub-scale and interval comparison within the intervention group highlighted a large effect size. A small interval level effect size was observed within the intervention group for HCQ sub-scale 2-DH between T1 and T2, T1 and T3, and for sub-scale 3-SHI between T1 and T3. No significant effect was evident for the remaining intervention group interval comparisons, as displayed within Table 4.11.

4.3.3 Critiquing health information, demographic and organisational factors

HCQ Item 37 asked participants who had attempted to find health information, if they could describe via open ended response, how they decided if the information was relevant, or could be trusted. Participant responses were coded to identify self-reported methods for determining information relevance or source reliability as reported within Table 4.12. A total of 165 responses were provided for HCQ Item 37, across all three data collection intervals, representing an item response rate of 31.4%.

Table 4.12. Methods for determining information relevance or source reliability

Categorised methods	Occurrence
Consulting with medical and allied health professionals	47.88% (n=79)
Considering experience and reputation of source	6.67% (n=11)
Checking credentials	6.67% (n=11)
Cross referencing multiple information sources	6.67% (n=11)
Accessing government resources	3.03% (n=5)
Internet forums	1.21% (n=2)
Asking peers and follow-up research	0.60% (n=1)
Scanning websites and conducting follow-up research	0.60% (n=1)
Observing role models	0.60% (n=1)
Non-specific / insufficient detail provided	26.06% (n=43)

Further analysis of digital story engagement was undertaken to determine whether significant sub-group differences, based upon demographic and work related variables, were observable. One-way ANOVA for HCQ Item 20 at T2 was completed, with an alpha level of .05. Tests of Between-Subjects Effects revealed no discernible variability due to age, gender, level of education completed, ATSI identification, work categories, time working in the industry or time working at the site. These observations, coupled with the results presented within section 4.3.1, suggest that digital storytelling was uniformly engaging, irrespective of the demographic and work related variables evident among individuals within the research group. While not conclusive due the predominantly small sub-group sizes evident after categorical segregation, these cautionary observations could be tested in the future with larger sub-group sample sizes.

The same statistical analyses were conducted for supplementary investigation into the effect of demographic and work related variables on health literacy indicators via the five HCQ sub-scales. No significant effects due to age, gender, work categories, level of schooling completed or time working at the site were evident. A between subjects effect was evident for HCQ sub-scale 4-ACP (*Achieving control over personal health*) based upon time working in the industry. Variation in VAS mean (mm) observed included; < 1 year (M = 39.97, SE = 1.52), 1 – 4.9 years (M = 36.87, SE = 0.98), 5 – 9.9 years (M = 35.84, SE = 1.52) and 10 – 19.9 years (M = 32.39, SE = 1.80). This indicates a potential inverse association between time working in the industry and perceived ability to achieve control over personal health; however, further research would warrant larger sub-group sizes. No significant effects on the remaining four HCQ sub-scales were observed for time working in the industry. A positive between subjects effect was evident for HCQ sub-scales 2-DH (*Discussing health at work, home or with friends*) and 5-HO (*Helping others improve or maintain health*) based upon ATSI identification. This may indicate greater propensity for interaction by ATSI workers at these mine sites.

All of these observations presented in section 4.3.3, whether significant or not, are informative; however, they must not be interpreted as conclusive evidence due to the size of the sub-groups. These preliminary findings provide a catalyst for further research in this area.

4.3.4 Supplementary reliability analysis

Although the validity and reliability of the HCQ instrument were confirmed in the previous study, the size of the data set generated for this study provided an opportunity for further testing of the newly developed instrument. Supplementary evaluation included Cronbach's alpha analysis to test internal consistency. Cronbach's alpha is defined as:

$$\alpha = n / n - 1 \, (1 - \sum S_i^2 / S_{Test}^2)$$

where n represents the number of items, S_i^2 represents the variance of scores for each item and S_{Test}^2 represents the total variance for the total items (Rovai, Baker, & Ponton, 2014).

Cronbach's alpha analysis was completed for each of the HCQ sub-scales using SPSS. Alpha levels of .76, .74, .71, .80 and .86 were observed for the respective 1-RHI, 2-DH, 3-SHI, 4-ACP, 5-HO sub-scales. All of the sub-scale alpha levels exceeded the widely accepted minimum level of .70 which reflects a standard error of measurement of .55 (Rovai, Baker, & Ponton, 2014). This supplementary analysis provides further evidence of the reliability of the HCQ instrument.

4.4 DISCUSSION

Following development of the health literacy instrument, digital stories and presentations, this phase of the research project was designed to evaluate the impact of a digital story embedded health communication strategy, and the effects on health literacy indicators in the mining setting.

4.4.1 Digital story impact

The findings indicated that the digital stories generated stronger discussion during the presentations and unsolicited feedback received from participants afterwards was supportive of the use of digital stories. While these outcomes were positive, they do not provide a comprehensive or objective indication of the immediate and sustained impact of the tested narrative strategy.

The quantitative data generated provided a strong empirical basis for evaluating impact. The first research question developed for this study was as follows. *Can a digital story health education strategy facilitate greater engagement and perceived impact than a non-narrative comparable method, and if so, is the effect maintained with time?* The following discussion will therefore focus on digital story engagement and sustainability.

It is clear from the preceding results, that narrative and equivalent non-narrative health education communication methods can both facilitate engagement. Futhermore, the findings indicated significantly greater impact for the digital story based intervention group. The strategy also yielded a reasonable degree of sustainability or maintenance two months after the impact assessment. The same outcome was not found within the control group which returned to near baseline level at the follow-up assessment stage. This was evidenced by small versus large effect sizes between baseline (T1) and impact (T2) for the control and intervention groups respectively, and non-significant versus medium effect sizes between baseline (T1) and follow-up (T3). These findings support the rationale for application of digital stories as a strategy for engaging workers with persuasive and authentic personal accounts from people with a shared perspective. Stories also support interpretation of theoretical information by contextualising it (Houston, et al., 2011; Haigh & Hardy, 2011).

4.4.2 Interactive and critical health literacy indicators

The second research question focussed on whether digital stories can generate positive effects on IHL and CHL indicators in a mining setting. The observed repeated measures ANOVA data and effect size comparisons established greater overall impact on health literacy indicators for the intervention group. This was evidenced by large versus small effect size within the *responding to health information* (RHI) indicator for the intervention and control groups respectively. Some impact on the other two interactive health literacy (IHL) indicators, *discussing health at work, home or with friend*s (DH) and *seeking health information* (SHI) was also evident, albeit at the small effect size level for the intervention group only. These outcomes demonstrate that a point in time, group based digital story health education presentation, can generate positive effects on IHL indicators. These effects

were markedly different to the control group and evidenced by calculated effect sizes. Sub-scale 1-RHI effects diminished over time, returning to baseline or near baseline levels after a two month interval between intervention and follow-up data collection stages. Small effect sizes were also evident at follow-up for the 2-DH and 3-SHI sub-scales within the intervention group but not for the control group. This indicates modest, but greater activity associated with the discussion of health and seeking health information in the two month period after exposure to the digital story based presentation.

The results indicated no significant impact on both of the critical health literacy (CHL) indicators, *achieving control over personal health* (ACP) and *helping others improve or maintain health* (HO) within the intervention or control group. According to Nutbeam's (2000) multidimensional model of health literacy, CHL is placed above IHL within a hierarchy of increasing autonomy and empowerment. The results of this study support this hierarchical approach, with significant effect observed for the mid-range dimension IHL but no effect observed for the higher-order dimension CHL. As shown in table 4.9 and the time series graphs (Figure 4.7 and Appendix J), the HCQ sub-scale means show a range of only 1.37 and 0.56 mm respectively for ACP and HO indicators within the control group. The equivalent ranges for the intervention group were 0.66 mm and 0.76 mm respectively. When these ranges are considered as a proportion of the VAS length, it is clear that the ACP and HO indicators at a group level were stable over time, regardless of the method of health education delivery.

4.4.3 Summary of key findings

Strengths of this research include high response rates, comprehensive quantitative data collection, and contextually innovative application of the health education strategy and health literacy indicator measurement. The following points summarise the key findings of this study.

- Group format, digital story based health education produced a high level of mining worker engagement evident via a large effect size.

- Equivalent non-narrative health education was comparatively less engaging than digital story embedded health education (small effect size).

- A medium size legacy engagement effect was observed two months post digital story implementation, highlighting sustained impact. No significant ongoing engagement effect was evident among workers who received non-narrative health education.
- Digital stories promoted greater response to health information (IHL) at impact stage, evident via a large versus small effect size within the non-narrative health education group.
- In contrast with non-narrative health education, digital stories prompted active discussion of health (IHL) within work and other contexts at impact and follow up stages.
- Digital stories facilitated health information seeking behaviour (IHL) captured at follow up stage, with no significant change observed within the non-narrative health education group at the same time point.
- No significant group level effect was evident for the higher order CHL indicators among control or intervention treatments. Further research could evaluate the potential for ongoing post digital story health education support to enable CHL indicator change.

Chapter 5: Digital storytellers and their narratives

5.1 INTRODUCTION

Qualitative research conducted within the mining industry has focussed on a wide range of OHS topics. Examples include investigation of the relationship between commuting and psychosocial health, mental health and wellbeing among resident mine workers, OHS management, family wellbeing, and community health issues during the peaks and troughs of industry cycles (Torkington, Larkins, & Gupta, 2011; McLean, 2012; Bahn & Rainnie, 2013; Sharma, 2009; Shandro, Veiga, Shoveller, Scoble, & Koehoorn, 2011). In the absence of any known qualitative research concerning digital story based health education within the Australian mining industry, this study investigated the phenomenon of digital storytelling.

A phenomenon is a sensory experience that leads to manifestation of perception for an observer (Larsson & Holmstrom, 2007; Australian National Dictionary Centre, 2004). Given the situated nature of experience, case study research supports exploration of associated empirical data. Case studies facilitate intensive exploration of social phenomena, contribute new knowledge and enable deeper level understanding of contextual factors (Yin, 2009; Swanborn, 2010).

The aim of this study was to investigate the lived experience of mining industry employees who shared their health related story with colleagues via a digital communication strategy. This was facilitated by capturing the experiences, perceptions and beliefs of digital storytellers prior to and following implementation and sharing of information within the mining industry.

5.2 RESEARCH METHODOLOGY

5.2.1 Study design and participants

Like other forms of case study research, the descriptive case study (DCS) method requires the researcher to clearly and non-judgementally articulate the lived experience of participants (Neuman, 2011; Tobin, 2012). What differentiates DCS

from other case study methods, is the theory-driven lens that is applied. The research literature and theoretical constructs inform the data collection method, the analytical process and discussion of concepts (Tobin, 2012). In this study, qualitative interviews and DCS methods were applied, involving investigation of digital stories as phenomena, first order storyteller experience and their observations.

To fulfil the stated aim, six semi-structured interviews were conducted with experienced mining industry workers (n=3) recruited for the digital story development phase described within chapter four. DCS inquiry supports intra and inter-participant comparison over time, and this was enabled via initial and follow-up interviews with each digital storyteller. The digital storytellers were self-selecting participants for this study as it was a qualitative investigation of the digital story phenomenon.

Qualitative research can be open to interpretive bias if not adequately controlled and a range of procedural steps were undertaken to minimise this risk. Firstly, the interviews were conducted by a researcher independent of the partner organisation to maintain the integrity of the data (McLean, 2012). Other applied methods included the use of interview guides to maintain focus on the research questions, verbatim transcription, an iterative coding process to identify emergent themes, and the inclusion of extracts to let the dialogue speak for itself.

The purpose of the research and voluntary nature were communicated in writing to participants in advance of the initial interview (refer Appendix B). This was reiterated verbally immediately prior to commencement of the semi-structured interviews and participants were given the option to decline participation or withdraw after commencing. The participants were not personally known by the researcher who was able to conduct the interviews independently of the industry partner organisation. This ensured that participant perceptions, beliefs, attitudes and values were not able to be pre-determined and this served as a mechanism for mitigating the risk of interpreter bias.

For the purpose of differentiating data sources and de-identifying participants, they have been labelled as P1, P2 and P3. Two of the research participants are male and one is female. They were the subjects of digital stories that focussed on cardiovascular health (P1) as utilised for the second study and cancer screening (P2 & P3). Participants travelled to Brisbane where filming of the digital stories was

carried out at three different locations. Each of the film sessions were two to three hours duration. The initial interviews were conducted in person, immediately after digital story filming concluded. Follow-up interviews occurred at a six month interval for all participants. They were conducted via telephone as participants were based at sites across Australia. Interview duration for both time points ranged from 12 – 13 minutes for P1, 8 – 10 minutes for P2 and 10 – 21 minutes for P3.

The semi-structured interviews were supported by two guides including core questions and statements as demonstrated within Tables 5.1 and 5.2. The guides provided a framework for structuring the interview and were open to subtle variations for personalisation, contextualisation and to facilitate elaboration (Given, 2008). These reflexive adjustments are adaptive responses necessary for effective semi-structured interviews. They require the interviewer to actively listen, allow the narrative to flow, seek clarification and probe for deeper thinking when required (Galletta, 2013). The application of these responsive skills supports elaboration which was an influential factor for the evident variations in interview duration. The initial interview guide consisted of twelve core questions and statements as presented in Table 5.1.

Table 5.1. Initial interview guide

Foci	Core questions and statements
1	*How would you describe your personality to someone who doesn't know you?*
2	*Are you someone who likes sharing stories with other people?*
3	*Why did you agree to share your health story?*
4	*What did it feel like to share your story on camera for this project?*
5	*Prior to the filming, did you tell anyone about what you would be doing? How did they respond? (if relevant)*
6	*In your opinion, how meaningful will it be for workers to see someone from their own industry in the digital story (video)?*
7	*Do you think your story will motivate viewers to stop and think about their own health or the health of others?*

8	*Do you think your story will challenge workers to place a high priority on their health, regardless of how healthy they currently are?*
9	*Do you think your story will inspire others to be more open about their health by talking to family, friends or co-workers?*
10	*Do you think your story will encourage people in the industry to be informed about their health and seek advice from health professionals?*
11	*I would like to find out your thoughts about what your health means to you at this point in time. I'm going to give you three words and I would like you to finish this statement. My health is...*
12	*Is there anything else you would like to say about this project or your involvement?*

Participants were provided with an opportunity to preview and approve the edited digital story before use as an applied health communication strategy. This step occurred prior to the follow-up interview and was necessary to ensure that participants were satisfied with the manner in which their story would be shared. It also enabled reflective responses to be captured in the follow-up interviews, as the participants could comment on their digital story after they had viewed it and had time to think about it. The follow-up interview guide consisted of thirteen foci as presented within Table 5.2. The statement associated with focus 11, as shown in Table 5.2, was personalised for each participant to accommodate responses to the initial interviews.

Table 5.2. Follow-up interview guide

Foci	Core questions and statements
1	*What were your initial thoughts after seeing your edited digital story (video) for the first time?*
2	*Has anyone else spoken to you since they watched the video? What did they say about it? (if relevant)*
3	*Since we filmed your story, have you talked to any family members or friends about the experience?*
4	*Have any colleagues in the mining industry spoken to you about your involvement with the digital story project? What comments have they made? (if relevant)*
5	*Have you noticed directly or heard indirectly through others that the digital story (video) has had a positive impact on health related attitudes, intentions, motivation or actions? If so, provide examples.*
6	*Has your involvement with this project influenced the way you think of health in the work setting?*
7	*How would you describe your attitude to your own health at this point in time? Has your participation in this project had any influence?*
8	*If you could go back to the time when you agreed to share your health story, would you do it again?*
9	*Would you encourage other mining industry workers to share their story if there was an opportunity?*
10	*Since you shared your story for this project, have you been more mindful of the health of colleagues at your work site?*
11	*When I last interviewed you, I asked what your health meant to you at that point in time. I gave you the words "My health is..." and asked you to finish the statement. Your response was: _____.* *What does your health mean to you now? Would you add to or change anything from your previous statement?*
12	*Can you think of any other ways to achieve a positive influence on the health related attitudes, intentions, motivation or actions of workers in the mining industry?*
13	*Is there anything else you would like to say regarding your involvement with this digital story project?*

5.2.2 Data collection and analysis

Participant interview responses were captured with permission using a digital voice recorder and external microphone. The option of manual recording was offered to each participant as an alternative, if they felt uncomfortable with audio recording and this was declined by all. Audio recordings were transcribed to generate a complete account of researcher and participant dialogue. Coding was completed manually and via NVivo software version 10 (QSR International, Melbourne, Australia).

The coding process commenced with an initial broad review of the transcripts to facilitate data familiarisation and grounding. Descriptive and analytical coding was then conducted and repeated until saturation points were reached and no further coding could be applied. Descriptive coding supported case identification including participants, locations or entities. Analytical coding and memos supported interpretive review, understanding contextualised meaning and observational tracking (QSR International, 2014). Qualitative data analysis is a recursive and iterative process requiring the researcher to reflect upon concepts and themes, while continually returning to the data for deeper level exploration and understanding (Galletta, 2013). It is an exploratory procedure that may involve clustering, collapsing and renaming codes as the data is interpreted and patterns are investigated. Theoretical constructs associated with health promotion, health education, health literacy, adult learning and transformative learning discussed within chapter two and summarised within Figure 2.4, informed the analytical process and discussion of results. Applying a theory-driven lens fulfilled this fundamental principle of DCS analysis (Tobin, 2012).

The following results and discussion sections document the phenomenon of digital storytelling within the mining industry and highlight valuable insights gained via this study.

5.3 RESULTS

After coding completion, iterative clustering and collapsing processes, three themes were evident. These were:

- Interactive communication, schema and motivation;
- Critical reflection, self-evaluation and exerting control;
- Supportive environments, empowerment and strengthening capacity.

The following sub-sections explore these emergent themes and are inclusive of descriptive data, observations, dialogue extracts, intra-participant comparisons and inter-participant comparisons. They represent a range of constructs associated with this research project as discussed within the literature review.

5.3.1 Interactive communication, schema and motivation

All participants indicated being comfortable with experience based narrative discussion during daily activity, particularly in social settings. When asked what personal attributes and characteristics defined them, P1 identified positivity, honesty, diligence, employer loyalty, professionalism, support and being receptive to advice. P2 described a tendency to be initially reserved, but will open up with increasing familiarity with others and P3 identified being motivated, driven and generally positive.

When asked about the reasons for agreeing to share their personal stories, there was a range of motivating factors and affective responses. P2 believed there was a greater need among the broader population for advocacy, health related knowledge and awareness of health issues, citing observations of significant negative health outcomes among co-workers, family, friends and the broader community. P2 indicated support for the intentions of the digital story project and a willingness to contribute. P1 identified a need for health awareness, but suggested that media campaigns will not have an impact unless the audience can relate to them. P1 stated that it was a privilege to be asked to contribute to the digital story project. P1 shared a strong belief in the concept of integrated health and safety, and described the importance of valuing it across all settings, as reflected in the following extract.

> *"We work in an industry where health and safety should be, and is one of our inherent values, so I believe that we should be able to take that value from the workplace and also apply it in the home and our lifestyle as well."* (P1)

P1 also reported that the digital story strategy aligns well with the company values they believe in and this influenced their decision to 'give back' to their organisation. P3 discussed self-awareness regarding health and the importance of consulting with medical and allied health professionals. P3 mentioned that the digital story strategy was worthwhile and the messages are important.

> *"I think it's a really good initiative. I think it brings it home and makes it more personal and that's what's going to work."* (P3)

P1 felt that health related communication and self-awareness is particularly important for males. When asked why, P1 discussed that it can allow men to gain control of their health and help them take advantage of services available. This belief was based on recalled observations of males in work and other settings.

> *"Communication is pretty important. If you don't want to speak to your friends or your workmates or blokes in the workplace, go to a doctor because it's confidential."* (P1)

Despite strong feelings about the potential and importance of the strategy, P3 recalled initial reluctance to participate and reservations about being the focus of attention for others. P3 described corresponding feelings of nervousness and associated concern, suggesting their story might be interpreted by observers as attention or sympathy seeking. The thoughts shared by P3 represented cognitive dissonance associated with the process. The same has also been observed among allied health professionals participating in a digital story project early in their career, with some reporting they struggled with personal disclosure in a public arena (Stacey & Hardy, 2011).

> *"I don't want the sympathy thing. I'm past it anyway, you know, so I don't want it taken like that and I don't want it to be an excuse for anything, so that's probably why. If I saw someone else doing it, I wouldn't think of it like that. I suppose it's your own insecurities."* (P3)

As demonstrated by the preceding interview extract, P3 acknowledged they would not interpret the stories of others in the way they feared their own could be.

Each participant freely discussed their participation in the digital story project prior to filming with three or more people including family, friends and trusted work colleagues. All reported a positive response from others regarding their involvement in the project and the feedback they received was encouraging and supportive. Participants recalled others saying it was a good initiative and the key messages were necessary for others to hear and benefit from. When asked whether there were any negative responses or concerns expressed by others prior to filming, each participant reported no occurrence during the discussions that took place. Additionally, P1 identified there was great interest in the digital story method with lengthy discussion regarding the merit of the strategy and potential for it to be applied in different industries and contexts. This was reiterated during the follow-up interview with P1. P2's follow-up interview included a description of the pride that others exhibited and P3 identified that family and friends were very supportive of what was trying to be achieved.

> *"I was a bit reluctant to go ahead with it, but a lot of them have said that it is a really good cause, because it is personal."* (P3)

To fulfil the ethical requirements of this project, all digital storytellers were given the option to withdraw during the process. Each maintained their involvement and were supportive of the use of their digital story as a health education resource for the workforce after previewing it. When prompted to describe their thoughts after first seeing their own digital story, each participant identified a clear emotional response. P3 described experiencing mild anxiety, reflective of the concerns about potential viewer perceptions as previously discussed. Feelings recalled by P1 and P2 after viewing their digital stories are captured by the following interview extracts.

> *"I was a bit shocked you know seeing myself on film and being interviewed, but I really believed the message that I was trying to send."* (P2)

> *"Yeah well, I took it to heart there a little bit. It sort of hit home you know, standing back watching myself say all that and it took a little while to take it all in actually."* (P1)

At a surface level, these responses would be expected of someone who is not accustomed to featuring in media based productions. At a deeper level, they reveal that the digital story generated a personal response which highlighted and reinforced the significance of the underlying meaning and messages.

In an effort to draw out further reflective commentary regarding their involvement, they were asked whether they would participate in the digital story project if they had their time again. All responded quickly in the affirmative, acknowledging they would make the same choice again. Each participant reaffirmed their belief in the potential of the strategy. P1 and P2 advised they would do so without reservation and P1 justified their response by recounting previously stated benefits. P3's initial response was consistent with that of the other participants; however, it was followed by a reflective pause, which was in contrast with the assured response of P1 and P2. After quickly responding in the affirmative, P3 mentioned they would do things differently next time and suggested they would place greater emphasis on the support provided by friends and family.

5.3.2 Critical reflection, self-evaluation and exerting control

When asked to comment on attitude towards their own health, all participants displayed evidence of critical reflection, self-evaluation and prioritisation. P1 described a future focus stating their reason for valuing health is about being able to spend time with family and friends, and being in a better physical state to handle the effects of aging on the human body. In contrast, P1 discussed an observation of the reactive nature and dismissive attitude that some people have towards their health.

> *"You can't eat fast food all the time, but yet we still do it, and it takes something negative to make us stop and think. Although we are intelligent creatures and at the top of the chain, we're pretty dumb because we only change when something hurts us."* (P1)

P1 also observed that people can downplay the significance of health risks and emphasised a need for greater self-awareness and conviction.

> *"I don't think we really understand the meaning of no. We choose to put things in various parts of our mind and sort of go, well I know I shouldn't be doing that, but it is not that bad. Realistically we are only fooling*

ourselves for the simple fact that if health professionals can get on TV that have been, you know, involved in say cancer or heart disease or whatever for so many years and say, this is really bad for you, how can we as non-professional people put it in a compartment and say oh that's okay? We actually need to wake up to ourselves and say no." (P1)

This extract establishes evidence of critical observation and introspective reflection. It highlights self-awareness and a deeper level understanding of behaviours and their corresponding determinants.

At follow-up, P1 described the same high level of prioritisation of health but stated this was reinforced after a significant birthday which highlighted the critical importance of good health for proactively managing ageing. P3 established that personal health is important and this was recently emphasised by a health complication that made them more attuned to what can influence it. P2 stated during the initial interview that they valued life and their health after experiencing a personal health issue. During the follow-up interview, P2 reinforced the same values and described how viewing one of the other digital stories had since influenced efforts to improve associated health behaviours. P2 acknowledged there was room for further improvement but the behavioural and lifestyle changes achieved so far were noticeable, effective and motivating.

5.3.3 Supportive environments, empowerment and strengthening capacity

All three participants articulated during the initial interview that they valued the focus on workforce health adopted by their employer and the support given to preventive strategies such as this. P3 considered participation in this project a means of demonstrating gratitude to the employer, in recognition of the assistance provided while attempting to manage a personal health issue.

When asked about perceived impact during the initial interview, all participants thought the digital stories would have an overall impact at a collective level. P1 and P2 elaborated, describing the potential for the digital stories to engage, raise awareness, motivate others, prioritise health and encourage discussion. P1 placed great value on the strategy, suggesting that if the thinking of others is reinforced, or changed in a positive way, the method will be justified. P1 also believed that people

would listen whether they personally knew the storytellers or not, as they are from within the same industry. P3 believed it would have a positive impact on most, describing the strategy as potentially powerful and confronting.

Belief in the strategy and potential for positive impact dominated participant dialogue; however, each expressed that some individuals may not be responsive. P2 suggested that older workers may be less likely to change their attitude towards personal health if it is negative or dismissive, as they may be set in their ways. P3 thought the messages may be lost on those that overrate their health status and P1 acknowledged the perception of invincibility evident among some, particularly younger workers.

> *"I think it is important that we have to remember that we're not 10 foot tall and bullet proof, we're just normal people."* (P1)

P2 discussed observing this attitude change over time among middle-age workers as they were starting to experience the impact of ageing and consequently thinking more about their health. P2 also suggested that advocacy via the media and 'cause' focussed events may play a role in this attitudinal change. P3 shared that some people engage in negative health behaviours despite knowing their health is, or could be compromised.

> *"I think some people will never care, some people could be out there coughing their lungs up and still be having a durry (cigarette) at the same time."* (P3)

P1 mentioned that most people will have a vice that can and should be addressed, and believed that a message from someone that is relatable might get through to those who are apathetic or in denial.

> *"How do you get through to somebody that thinks it's never going to happen to them? Well that was my mentality until it did happen and luckily I was reasonably fit enough to get through it, but hopefully the message from just a normal bloke gets through."* (P1)

During the initial interview, participants unanimously indicated a belief that the strategy would generate a positive impact on the majority, and P1 adopted a positivist approach stating that even if the number of people beneficially influenced is small, it will be worth the effort.

When asked whether their digital story generated any observable dialogue or responses among co-workers, each participant recalled examples. P1 revealed that it was well received and some were surprised that the health issue emerged for them given that some of their behaviours were health enhancing.

> *"I've had a few people at the (event removed) say to me it's actually quite moving. They were quite impressed with it."* (P1)

P2 observed that it took some time for people to process what they had seen. The digital story prompted reflective thinking as evidenced by follow-up questions about screening and health management in the days after viewing it. This was followed by preventive action for several weeks afterwards, as co-workers indicated to P2, they had consulted with medical and allied health professionals after seeing the digital story.

P3 recalled positive dialogue for their own digital story and the same for a digital story featuring another participant, but highlighted a defensive response to it by one viewer. A co-worker blamed the family history of the featured storyteller as the sole contributing health determinant, while dismissing their own personal choice to engage in a high risk health behaviour. This occurred despite the discussion of a range of health determinants by the storyteller and a health expert within the digital story. Whether aware of it or not, they were trying to counter-argue the message within the digital story as a means to justify high risk health behaviour. This generated intense discussion from others who challenged this dismissive attitude. P3 pointed out that things eventually settled down and provided a description of the unfolding events that can be summarised as constructive and cathartic.

P3 also indicated that the digital stories prompted constructive health related dialogue about a broader set of priorities beyond the topics at hand, as workers felt comfortable engaging in discussion. This suggests that in addition to prompting interactive discussion about the focus topic, the digital stories served as an impetus for more extensive critical thinking about health. This response may be representative of a deeper level of engagement and perceived need to prioritise health.

Self-reflection following digital story production and viewing revealed influences on personal behaviour, advocacy and attitude. P3 described how

involvement reinforced an already heightened focus on health and wellness. P2 expressed that participation provided an opportunity to reflect on why some people can be reluctant to undertake preventive and consultative action regarding their health. This prompted P2 to engage in advocacy based community action by organising awareness raising events for co-workers. P1 acknowledged the impact of digital story involvement as a reinforcing factor for maintaining adopted positive health behaviours. They also described it as a motivating factor for responding to their own risk associated health determinants, evident after viewing the embedded commentary and advice provided by a health expert. P1 mentioned that participation in the digital story project, prompted them to think about how they could modify the work environment to support others to make health enhancing decisions. P1 also reported that digital story participation heightened their motivation to speak on a personal level to workers who exhibit compromising health behaviours, in an effort to encourage them to seek professional guidance.

When asked if they would encourage other workers from the mining industry to share their own personal stories, all participants agreed they would. P1 and P2 said they would encourage anyone who has a beneficial story to share and P3 felt the same, but emphasised that intrinsic factors needed to be greater than extrinsic factors.

5.4 DISCUSSION

The title of this thesis: *'The effects of digital story communication on health literacy indicators in the mining industry'* reflects the collective focus of studies one, two and three of this research project. The former two studies have explored the development and application of quantitative data collection methods assessing the direct impact of digital stories. This qualitative study investigated the observed effects of digital storytelling on others and the lived experience of the digital storytellers. Both of these orientations can be related back to the five health literacy indicators developed for this research project, as previously identified in chapter three.

5.4.1 Interactive and critical health literacy indicators

All participants reported evidence of *Indicator 1: Responding to health information provided by others*, which reflects interactive health literacy. This included observations of co-workers who had demonstrated modified behaviour and direct feedback from viewers about how they were applying the advice. This level of impact was not restricted to their own digital stories, as one participant indicated how another digital story generated the same type of impact on them. Each participant recognised potential barriers to the first indicator including apathy, denial, dismissive attitude and perceived lack of vulnerability. While they were able to recount examples of these barriers, each participant acknowledged they were heavily outweighed by positive effects.

Dialogue associated with *Indicator 2: Discussing health at work, home or with friends* was quite extensive. All participants freely and openly discussed their own participation with others during different stages of this project and extrinsic feedback was supportive and positive. Two participants shared their belief in the importance of health related discussion, highlighting cultural factors that make this even more important for Australian males. They highlighted invulnerable attitudes, perceived need to be self-sufficient and expected stoicism, all of which have been shown to be strong among male blue collar workers in the Australian construction and mining industries (Du Plessis, Cronin, Corney, & Green, 2013). Despite the common translation of these normative cultural factors into limited help seeking behaviour and reluctance to discuss personal health, male Australian blue collar workers appear to more interested in their health than previous studies would suggest (Du Plessis, et al., 2013). It was therefore enlightening to learn from all participants that their digital stories facilitated discussion during toolbox talks and generated questions that prompted reflective thinking and direct feedback. In some cases, the spontaneous interactive health discussion initiated by co-workers was reported to be sustained for several weeks afterwards. This voluntary discussion of personal health, reflects the sense of affinity able to be facilitated by stories as highlighted by Haigh & Hardy (2011).

During the interview process, one participant reported evidence reflecting a defensive, counter-arguing and dismissive attitude by an individual after they viewed a digital story. This initial negative response prompted a strong and passionate

discussion among co-workers which helped bring these barriers to conscious attention. The observed group response aligns with a previously established assertion that narrative communication methods deemed relevant and relatable, promote empathy and are harder to dismiss when they represent the lived experience of another person (Stacey & Hardy, 2011; Kreuter, et al., 2010; Kreuter, et al., 2007).

Qualitative data gathered included examples demonstrating *Indicator 3: Seeking health information*, the last of three associated with interactive health literacy. P1, P2 and P3 each indicated they were aware that multiple viewers voluntarily consulted with medical and allied health professionals after viewing a digital story. This was consistent with outcomes of other narrative based health communication strategies that showed a strong sense of homophily, or relatedness, between the viewer and subject (Kreuter, et al., 2008).

The digital stories themselves reflected narrative expression of *Indicator 4: Achieving control over personal health*, the first of two associated with the critical dimension of health literacy. Strong feelings about the need to take control were evident, as reflected in the comments and observations presented within the results section. This was associated with intrinsic and extrinsic motivating factors, including quality of life, relationships and health status. This aspirational focus was tempered by the realisation that while positive efforts to gain control over health were being made, there was still room for improvement. Examples of observed efforts and feedback from co-workers to gain control over their health were reported by each of the digital storytellers following delivery. This is not a measure of impact, as there may be others who were attempting to exert control without any overt indication, but it does provide some insight into the motivating influence of the digital stories. The semi-structured interviews additionally revealed that the storytellers were also interested in the other digital stories produced and viewing them prompted behaviours to proactively manage their health.

The final critical health literacy focus, *Indicator 5: Helping others improve or maintain their health* was also reflected in the results. Two of the three participants freely identified efforts to achieve this outcome through methods that are reflective of strengthening community action and creating supportive environments, consistent with the Ottawa Charter for Health Promotion (WHO, 1986). Examples included, proactive organisation of awareness raising events, suggestions for modifying the

work environment to be more conducive towards healthy choices and the confidence to encourage others to value their health and seek professional guidance as required. These demonstrations are reflective of empowerment, a priority of the WHO and an inherent goal of strategies to develop critical health literacy (Nutbeam, Harris, & Wise, 2010; WHO, 2009; Nutbeam, 2008). The reported reasons for participating in this project and these outcomes highlight the phenomenon of reciprocity. When members of an organisation feel they are surrounded by a supportive health and safety culture, they may be motivated to help others and give back to their employer (Mearns, Hope, Ford, & Tetrick, 2010).

5.4.2 Outcomes and affective learning

Workplace based health promotion initiatives, involving health assessment and screening by site based medical and allied health professionals, have been shown to have a positive impact on self-efficacy and control (Lomas & McLuskey, 2005). Although this project did not provide workers with direct personal consultation, professional advice from experts within their fields was embedded into the digital stories as a substantiation and quality control strategy. All three participants identified increased effort to control a broader range of health determinants following digital story filming and viewing, in addition to associated improvements in confidence.

The interview questions prompted introspection, and subsequently cognitive dissonance (CD) was an observed phenomenon experienced by P3. CD has been described as the "…discomfort that occurs when two opposing opposing beliefs are held simultaneously. When this conflict arises, one of the opposing beliefs must be altered or dropped in order to reduce the discomfort (Richter & Ferraro, 2015, p. 115)". The participant described initial concerns about how their story may be perceived by others while concurrently holding strong beliefs of the importance and value of the narrative health communication strategy. Whilst the concerns did not prompt them to withdraw from participating as a digital storyteller, there was some associated anxiety which they reportedly discussed with family, friends and selective co-workers. Reflecting upon the six month period between initial and follow-up interviews, P3 described a reduction in anxiety as the stages of digital story filming, previewing and distribution emerged. This change was most evident when P3

received positive feedback from co-workers that viewed the digital story they featured in. These personal challenges may be a product of the significance of a health focus and the perceived vulnerability that may be associated with authentic discussion of experience. This highlights the delicate balance between exposing oneself to a broader audience and the richness of personal narratives. Further research of these phenomena could be undertaken in the future, to generate greater understanding of CD that may be associated with digital storytelling.

The digital stories developed for this project enabled the modelling of self-reflection by the storytellers, coupled with verified information provided by the health experts. Qualitative data established that this social environmental influence stimulated corresponding personal characteristic and behavioural pattern influence among the target audiences. This was evidenced through first order observation by the storytellers and reported unsolicited stakeholder interaction. This included open and often recurrent dialogue generated by digital story viewers, focussing on reflective thinking and self-evaluation. It also included shared accounts of personal behavioural intentions and actions that unfolded over time. Discussion of outcomes associated with the digital stories is indicative of interactive effects between the three elements of Bandura's (1997) Triadic Reciprocal Causation Model (TRCM). They include the personal characteristics of individuals, their behavioural patterns and the social environment in which the health education strategy was implemented (Snowman, Dobozy, Scevak, Bryer, & Barlett, 2009).

Facilitation of learning should be a primary goal of health education with intent to enable knowledge development, strengthen health literacy and promote life skills (WHO, 1998). Authentic learning is more than a cognitive process, acknowledged through the seminal work of Krathwohl, Bloom, & Masia (1956) which presented cognitive and affective domains of learning. The affective domain exists as a hierarchy which has been adapted and summarised in Table 5.3.

Table 5.3. Taxonomy of educational objectives – The affective domain

Level 3	Internalising values (characterisation) *Integrating values, advocacy, enabling, influencing & philosophical positioning.*
Level 2	Valuing and organisation *Prioritising, initiating, endorsing, proposing, appreciating, assuming responsibility & behavioural adaptation.*
Level 1	Receiving and responding to phenomena *Observing, acknowledging, attending, responding, cooperating, considering, participating, exploring, engaging & contributing.*

Source: Shannon & Brown, 2009 (adapted from Anderson, et al., 2001; Krathwohl, Bloom, & Masia, 1964)

Observational data and feedback from viewers has demonstrated evidence of level 1 and 2 affective impact including responsiveness to the digital stories and value-based discussion. The storytellers themselves demonstrated evidence of level 1, 2 and 3 affective outcomes. At the first level, they were directly involved in the phenomena, as the subjects of the digital stories. It was clear from the data that each participant currently placed a high value on their health, despite variations in past reported value. All participants showed evidence of adaptive responses, although each appeared to be at different stages of personal development. Each participant also exhibited characterisation which reflects the embodiment of values and is the pinnacle of the affective learning domain hierarchy (Shannon & Brown, 2009). Two participants were particularly vocal about their post digital story action and one clear articulated their philosophical positioning about health, behaviour, determinants and the applied narrative health communication strategy.

Effective narrative health communication strategies are those that incorporate tangible information, link people to valid resources and promote constructive peer discussion (Wilkin & Ball-Rokeach, 2006). This research has highlighted evidence of interactive and critical health literacy indicators within the group of digital storytellers and observational reflection of the audiences that were exposed to the

stories. It generated insights into the application of a specialised strategy which could not be gained through quantitative methods. The outcomes therefore complement the quantitative work presented in the aforementioned studies and assist in gaining a rounded perspective of the trialled digital story health education strategy.

5.4.3 Summary of key findings

This is the first known study to qualitatively evaluate the implementation of digital stories as a health education strategy in the mining industry and apply a theoretical lens to the insights of storytellers. It also provides further evidence of the impact and benefit of narrative health communication using a digital story strategy shown to enable efficient, widespread and consistent delivery of health-related messages and information. The following points summarise the key findings of this study.

- Digital storytelling enabled self-reflection and discussion, resulting in reinforced appreciation of health and motivation to adopt additional positive health behaviours (IHL and CHL).
- Digital storytellers were empowered by the process, evident through health-related advocacy, proposing and enabling workplace changes, and greater confidence to opportunistically encourage others to value and prioritise their health (IHL and CHL). In addition to the prominent health literacy impact, these changes reflect characterisation, a higher order affective learning outcome (refer Table 5.3).
- Digital storytelling led to the emergence of cognitive dissonance for one storyteller. This reflected simultaneous recognition of potential benefits of the strategy for others and concerns about how their personal story may be perceived. Supported and sustained involvement was shown to be cathartic and beneficial for self-awareness and self-efficacy.
- Digital stories facilitated impromptu discussion of health (IHL) and self-reported positive changes to health-related attitudes, values, motivation and behaviour by individual co-workers (CHL). This impact was observed by storytellers during a six month post implementation period and revealed evidence of transformative learning at an individual level among viewers.

- Counter-argument to health related digital stories was limited, but led to constructive and thought provoking conversations. Digital stories are therefore able to be a catalyst for alternative thinking and attitudinal change among mining workers who are initially resistant.

Chapter 6: Summary and conclusions

6.1 SUMMARY AND CONCLUSIONS

The contemporary approach to health promotion recognises the complexity of health behaviour and underlying health determinants. It calls for context focused needs assessment, evidence based strategic planning and thorough impact focussed evaluation methods. International charters and declarations have emphasised the importance of facilitative action, empowerment and social ecological determinants. Theories of behaviour change preceded rapid growth in the body of empirical research associated with determinants of health during the 1990s (WHO, 2009; Keleher & Murphy, 2006). This was an important period of development, leading to greater understanding of factors capable of enhancing and compromising health.

Health literacy was identified as a critical determinant of health and a necessary focus for capacity building action (Frisch, Camerini, & Diviani, 2011). At the turn of the century, a comprehensive, multidimensional model of health literacy emerged, inclusive of functional, interactive and critical forms (Nutbeam, 2000). It was presented as a continuum of increasing autonomy and empowerment, inclusive of ecological influences not recognised in previous definitions and models of health literacy. These dimensions integrated additional foci including culture, motivation, self-efficacy, critical analytical skills and responsiveness. This differed greatly from the clinically oriented perspective focussing solely on practitioner-patient interactions and comprehension that initially emerged during the 1970s. With broadened scope, came calls for ongoing discussion and research, focussed on measurement of health literacy and the development of suitable instruments (Kickbusch & Maag, 2008; Berkman, Davis, & McCormack, 2010; Nutbeam, 2008).

Historically, much of the literature associated with health literacy measurement has been concerned with functional health literacy, the first level within Nutbeam's (2000) multidimensional model. A range of instruments have been developed to measure health literacy, however, their capacity is restricted to the context and purpose for which they were designed and all exhibit inherent strengths and limitations. A relatively small, but growing, volume of IHL and CHL focussed research has emerged during the past decade, responding to the call for further

evolution of health literacy measurement. Research has included a combination of quantitative and qualitative studies that have focussed on socioeconomic status, critical skill development and decision making (Smith, Nutbeam, & McCaffery, 2013; Mogford, Gould, & Devoght, 2011; Berkman, Davis, & McCormack, 2010; Nutbeam, Harris, & Wise, 2010; Ishikawa, Nomura, Sato, & Yano, 2008). Although the information is of value in advancing knowledge in the area, there remains a need for further evolution of health literacy measurement strategies and instruments. For example, relatively limited attention has been given to some IHL and CHL constructs including self-efficacy which remains evident within the broader field of literature (Haun, et al., 2014). Furthermore, contemporary health promotion focussed instruments are either too general for use in situations with a unique workplace culture or highly specialised for particular settings and functions, limiting their validity to those contexts and applications. In recognition of the dynamic nature of health literacy, responsive to circumstances, experience and context (Smith, Nutbeam, & McCaffery, 2013), it was necessary to develop and evaluate the efficacy of a new instrument for this industry specific project.

Importantly, the health promoting workplace has been identified by the WHO (2013) as a priority setting for improvement in the health of the workforce and community. If successful, such settings have the capacity for sustainable impact on individual health status, return on investment for employers and flow on benefits at the population level. This can be achieved via primary, secondary and tertiary prevention by helping apparently healthy workers to maintain their health and by assisting workers with risk reduction or management of lifestyle related health behaviours (Goetzel & Ozminkowski, 2008). Notwithstanding this potential opportunity, health typically concedes a lower profile to safety within the mining industry, despite the bidirectional relationship that can exist when both are prioritised. Although suitable OHS initiatives have been implemented within the mining industry, they tend to involve one way forms of communication and may be ad hoc, reactive and unsustainable. Of equal concern is the absence or high variability of evaluation methods applied to health and safety communication practices within the industry, with limited outcomes indicating the utility of the information across the diverse workforce and its impact on health and safety outcomes (Shannon & Parker, 2012; Cullen, 2008; Parker, Hubinger, &

Worringham, 2004; Somerville & Abrahamsson, 2003). Effective communication strategies are also essential and are dependent on the knowledge base of the audience in their design, implementation and evaluation. This project therefore included the development, validation, reliability assessment and pilot testing of a new health literacy instrument, designed for application within the mining industry to evaluate applied health education.

Transformative learning can reflect changes in knowledge, attitudes, beliefs and perspectives which can support informed decision making. It is a priority of health education and dependent upon engagement, which is more likely to occur for an adult learner when information is delivered in a manner that is self-directing and emphasises relevance, necessity, contextualisation, purpose and value (Knowles, Holton, & Swanson, 2005; Mezirow, 2003). Narrative health education provides an opportunity to facilitate these outcomes through vicarious and situated learning that promotes shared understanding and meaningfulness. When delivered in this manner, health education aligns the ecological, personal and behavioural elements of the triadic reciprocal causation model embedded within Bandura's (1997) social cognitive theory. Digital stories support efficient and consistent delivery of narrative based health education.

Digital stories are brief and dynamic multimedia presentations which can include embedded text, video, still images and narrative soundtracks. They provide an opportunity to share captivating accounts of experience from a personal perspective (Gazarian, 2010; Rossiter & Garcia, 2010; Sylvester & Greenidge, 2009; Gubrium, 2009). Their use is supported by neuroscience research, including vicarious cerebral cortex activation referred to as brain-to-brain coupling and higher order cortical activation evident through topographical mapping (Lerner, Honey, Silbert, & Hasson, 2011; Hasson, Yang, Vallines, Heeger, & Rubin, 2008).

Beliefs of invulnerability, a perceived need to be self-reliant and expected stoicism are evident in the male dominated mining and construction industries, presenting challenges for worker health (Du Plessis, Cronin, Corney, & Green, 2013). Mining activity is often undertaken in remote locations and is classified as a higher risk occupation, despite strong injury prevention practices in the Australian industry. McLean (2012), observed camaraderie among workers in the same roster group when questioned about group dynamics and relationships which was seen as a

strong cultural factor at an Australian mining site. Digital stories were incorporated in this project as a means of using workplace culture in a positive and facilitative manner. It was hypothesised that shared perspectives and familiarity, supported by mining workers telling their own health stories, would draw upon workplace culture in a positive way by enabling greater engagement. Well renowned health experts also featured in the digital stories, to demonstrate validity of the information communicated and promote credibility.

This mixed methods action research project included three complementary studies. The aim of the **first study** (chapter three), was to design and test the validity and reliability of a new instrument for the measurement of interactive and critical health literacy indicators, with utility in the mining industry. The Health Communication Questionnaire (HCQ), comprising five IHL and CHL subscales, was developed and subjected to readability assessment via Flesch-Kincaid Grade Level (FKGL) testing. Two forms of validity testing were implemented during this study, including application of Substantive Validity Analysis (SVA) and Content Validity Index (CVI) techniques. Pilot testing and reliability assessment of the HCQ involved a test-retest procedure with a representative sample of mining industry personnel under true work conditions.

Readability assessment fell within the target range, indicating that it was appropriately matched to the educational background of participants. SVA results reflected a high level of agreement among participants about association with intended health literacy constructs indicating a low level of ambiguity. CVI scores following instrument refinement exceeded the minimum target values indicating that the HCQ is a valid representation of interactive and critical health literacy constructs. The HCQ correlation coefficient of .72 ($p < .001$) exceeded the target for newly developed instruments and Bland-Altman plots revealed a low level of bias. Visual analogue scales incorporated into the HCQ enabled greater capacity for detecting variability than could be achieved with either five or seven point Likert scales. Based on the key findings of the first study, the following conclusions can be drawn.

- The five HCQ sub-scales are valid indicators of interactive and critical health literacy constructs.

- The HCQ is a reliable and contextually valid instrument, evident via testing with a representative sample of mining industry employees implemented under true work conditions.
- Inclusion of visual analogue scales within the HCQ was justified, offering greater discernibility than dichotomous and interval scales.

The aims of the **second study** (chapter four) were: 1. to evaluate engagement and impact of a digital story embedded communication strategy, and 2. to evaluate effects on interactive and critical health literacy indicators in the mining industry. The study commenced with the recruitment of digital storytellers and development of digital stories featuring mining industry workers and health experts. A quasi-experimental parallel time series design was implemented at two sites, including intervention and control groups at each. The intervention group observed a multimodal health education presentation which included an embedded digital story. The control group received the same health information communicated in a non-narrative manner, reflective of more common communication practices within the mining industry. Time series data collection occurred at baseline, impact and follow-up stages via the HCQ instrument developed and tested during study one. High response rates exceeding ninety percent at baseline, and eighty-five percent at impact and follow-up assessment were achieved through early and active engagement. Mean differences for the dependent variables at three time intervals were compared, via repeated measures analysis of variance (ANOVA). Effect size comparisons were made using descriptive ANOVA data, and calculation of Cohen's *d* and Pearson correlation coefficient *r* values.

Repeated measures ANOVA revealed greater engagement with the digital story based intervention strategy. This was evidenced by large versus small effect sizes between baseline and impact for the intervention and control groups respectively. Additionally, the digital story health education strategy yielded ongoing engagement and responsiveness, through demonstration of medium effect size, two months post impact assessment. The same was not evident for the control group, which returned to near baseline level at the follow-up assessment stage.

Greater impact on health literacy indicators was also evident for the digital story intervention group. Small to large effect sizes were evident at impact and follow-up assessment stages for the three interactive health literacy indicators represented by the subscales 1-RHI, 2-DH and 3-SHI. This contrasted greatly with the control group that recorded only a small effect size at impact assessment for the 1-RHI sub-scale with no other significant effects observed for interactive health literacy at impact and follow-up stages. No significant effect sizes were observed within the control and intervention groups for critical health literacy indicators. Based on the key findings of the second study, the following conclusions can be drawn.

- Narrative health education delivered via digital stories was shown to be an efficacious communication strategy, generating markedly greater immediate engagement of mining workers than the non-narrative method and ongoing impact over a two month period.
- Digital storytelling within male dominated mining workplaces yielded immediate and ongoing interactive health literacy indicator effect over a two month follow-up period, in contrast with no significant ongoing effects evident for the non-narrative health education group. A range of positive associated outcomes included health consciousness, interactive discussion across a range of settings and information seeking behaviour.
- Digital stories are a beneficial investment in raising the workforce health profile, for they utilise mining workplace culture, professional expertise and associated social capital in a positive and enabling manner. Furthermore, they facilitate efficient and quality assured communication which are also important contextual considerations, as discussed within this thesis.

The aim of the **third study** (chapter five), was to investigate the lived experience of mining industry workers who shared their health related story with colleagues via a digital communication strategy. This qualitative study captured the insights and observations of digital storytellers via two semi-structured interviews, with an interval period of six months. DCS analysis of interview transcripts established three emergent themes. These themes incorporated a range of foci

including; interactive communication, schema, motivation, critical reflection, self-evaluation, exerting control, supportive environments, empowerment and strengthening capacity (Nutbeam, 2008; Knowles, Holton, & Swanson, 2005; Mezirow, 2003). The observed effects of digital storytelling on others included, impact on four of the five health literacy indicators developed for this project, and value based affective learning outcomes.

Personal reflection revealed evidence of impact on all five health literacy indicators, and a higher order affective learning outcome of characterisation among the digital storytellers. Interestingly, the study also captured cognitive dissonance expressed by one of the digital storytellers and observed resistance, evident as counter-argument from a digital story viewer. The latter generated constructive dialogue between co-workers and engagement in robust discussion. These outcomes reflect the personal challenge and vulnerability that can come with authentic discussion of health, and the potential power of narrative communication for deeper level engagement and thinking. The qualitative personal and observed insights gained from the study provide additional data about impact that was not able to be captured during the second quantitative study. Based on the key findings of the third study, the following conclusions can be drawn.

- Digital storytelling facilitated transformative learning and evidence of interactive health literacy among storytellers, evident via enhanced self-awareness, introspection, valuing personal health, self-efficacy and health enhancing behaviours.
- Evidence of higher level critical health literacy and transformative learning among digital storytellers included empowerment and active encouragement of co-worker health prioritisation. Additional verification included digital storytellers proposing, collaboratively planning and implementing workplace health initiatives.
- Digital story viewing generated counter-argument and resistance among a minority of workers, which ultimately led to constructive discussion of barriers to change. Digital stories were therefore shown to be a catalyst for attitudinal change and challenging resistance, providing evidence of interactive health literacy.

- Digital storytelling produced observable and unsolicited self-reporting of positive effects upon health-related attitudes, values, motivation, behaviour and personal control among co-workers. Changes evident among co-workers reflect the capacity for interactive and critical health literacy impact at the individual level.

6.2 PROJECT STRENGTHS

Research design, implementation and innovation strengths associated with this work include the following.

- The mining industry is a complex setting for action research due to production driven time constraints, work scheduling, site locations and workplace culture. Extensive planning has led to recognition and integration of these factors within the implemented method and strategy.
- In the absence of a universally supported comprehensive health literacy measurement instrument for occupational settings and no evidence of applications in mining, it was necessary to design and evaluate a new instrument. This required application of a comprehensive, evidence based multistage process which included testing under authentic and consistent work conditions with a representative sample of mine workers, and systematic review of items via health literacy experts. Robust methods and informed decision making about the retention, deletion or modification of questionnaire items were also critical in determining the validity, reliability and utility of the instrument.
- In an industry setting, research participation rates may be impacted by fear of surveillance or apathy. High response rates were achieved, and veracious responses encouraged, through active engagement with key stakeholders, clear and purposeful communication with the workforce, data collection facilitated by an independent researcher and reporting of aggregated data.
- A strength of quasi-experimental research is the potential for authentic observation, monitoring and evaluation within real world settings. Systematic criterion based site selection processes ensured that samples were

representative and all testing and health education occurred under authentic and consistent work conditions. Control and intervention treatments were assigned to specified work crews at each site, facilitating similar sized comparative groups and controlled for site variability and type of mining operations. The parallel time series research design enabled a higher degree of confounding variable control, strengthening the efficacy of study two.

- Comprehensive quantitative data collection enabled critical discernment and evidence of the efficacious impact of digital storytelling upon worker engagement and health literacy indicators.
- The application of a mixed methods project design, provided complementary qualitative data demonstrating unique insights into the lived experience and workplace observations of digital storytellers. Descriptive case studies supported a more extensive and holistic investigation of the phenomenon.

6.3 SIGNIFICANCE

This project has led to a range of outcomes, including a contribution to raising the health profile within the mining industry. Specific examples of the significance of this work are highlighted within the following bullet points.

- Health literacy should be considered as a developmental outcome of applied health education and communication strategies; however, it is challenging to influence and measure. Application of the HCQ instrument, subjected to a range of validity and reliability testing procedures during the first study, enabled a novel and evidence based case for the benefits of efficacious digital story based health education within the mining industry. Digital story utility in mining should be recognised as an important investment in workforce health. The work undertaken also offers a valuable contribution to the small, but growing, body of IHL and CHL research as discussed within the literature review.
- The application of digital stories provided a unique opportunity to utilise workplace culture and social capital in a positive and enabling manner. The second study is the only known comprehensive quantitative exploration of

worker engagement with digital storytelling and impact on IHL and CHL indicators within the Australian mining industry.

- Digital story development enabled efficient and consistent delivery of quality assured health information, while generating significant effects. This is an important consideration for workplace settings that carry stringent OHS training requirements, are geographically dispersed and influenced by productivity demands.
- Study three is the first known to facilitate DCS inquiry into the application of digital stories as a health education strategy within the Australian mining industry. It builds upon evidence of engagement exhibited through the application of digital stories in other settings (Christiansen, 2011; Stacey & Hardy, 2011). The findings confirm transformative learning among digital storytellers and viewers, evident via self-awareness, critical consciousness, schema adjustment and self-regulation.
- In addition to the value of establishing organisation level partnerships for industry based action research, this project has highlighted the power of actively engaging 'workers as partners' in health education and communication.
- Progressive dissemination of research findings and recommendations has occurred via industry publication (Shannon & Parker, 2012), facilitated workshops, site reports, conference papers and presentations. The latter includes the Queensland Mining Industry Health and Safety Conference, one of the largest in the southern hemisphere, attracting approximately eight hundred delegates each year (Queensland Resources Council, 2013). Fulfilment of these outcomes supports informed discussion, evidence based practice and reflects the commitment to feedback and feed-forward mechanisms, as represented within the five stage action research model developed for this thesis (refer Figure 1.2).

6.4 PROJECT LIMITATIONS

A potential limitation of the first study, was the test-retest interval of two days which was necessary to align work roster schedules and enable all work crews to be included. There was a sound basis for the decision, which is supported by research literature demonstrating no significant difference between two day and two week intervals (Marx, Menezes, Horovitz, Jones & Warren, 2003). Comparative testing could have confirmed if this is also true in the mining industry context.

Sample sizes for studies one and two were sufficient for investigating the research questions; however, the reported results and conclusions are limited to the research sites. They are therefore unable to be generalised across the industry or to other industries with similar demographic profiles and culture. Supplementary analysis included investigation of sub-group categorical variables based upon demographic and work-related characteristics. Due to the range of classifications associated with many of the categorical variables captured by the HCQ (n=14), the total sample size required would have been exponentially greater to accommodate the necessary sub-group sample sizes to generate conclusive evidence. Achieving such a large total sample size would warrant whole of workforce data from the industry partner organisation and was therefore beyond the scope of this research project.

The third study supported interesting qualitative investigation of digital storytelling from a first order perspective. DCS inquiry was limited to the observed effects of the digital stories upon co-workers, as reported by the digital storytellers themselves. Qualitative perspectives of digital story viewers or family members of digital storytellers were not captured.

6.5 RECOMMENDATIONS FOR FUTURE RESEARCH

This project provides a strong foundation for ongoing lines of inquiry and the initiation of new research questions. Included below are examples of future research that could emerge from this thesis.

- Expand the quantitative and qualitative data pool to include a greater number of mine sites and workers, providing additional substantiation for prospective

industry focussed recommendations and ability to conclusively investigate the effects of demographic and work-related variables.

- Conduct further qualitative DCS research to investigate digital story viewer perspectives via semi-structured interviews or focus groups.
- Increase data pool diversity by including family members of mining personnel, enabling investigation of inter-subject influences across work and home environments.
- Produce second generation digital stories capturing the facilitative impact of digital story viewing on attitude and health behaviour change, to compare and contrast the efficacy of first generation digital stories.

6.6 CLOSING STATEMENT

~ Scientia et sapientia ~

A fundamental purpose of the PhD candidature is to engage in rigorous scientific inquiry leading to novel or substantial contribution to the field. My journey, seeking knowledge and wisdom, has transcended the focus of investigation to further develop my quantitative and qualitative research skills, experience and self-efficacy for ongoing work in academia. Additionally, this challenging but rewarding process has strengthened personal attributes including determination and self-belief. For all of these outcomes, I am grateful.

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Appendices

Appendix A: Informed consent – Questionnaire validation (Study One)

Queensland University of Technology
Brisbane Australia

PARTICIPANT INFORMATION FOR QUT RESEARCH PROJECT

Questionnaire validation – Mining Industry

RESEARCH TEAM CONTACTS

Hugh Shannon – Researcher
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DESCRIPTION

This project is being undertaken as part of the 'Enhancing Health @ Downer EDi Mining' initiative. The project is supported by QUT and Downer EDi Mining. These groups will not have access to personally identifiable information about you.

The purpose of this research is to ensure that a health communication questionnaire being developed for use at mining sites accurately measures what it is intended to.

The research team requests your assistance because the questionnaire has been developed for the mining industry and the testing process requires input from workers in the industry.

PARTICIPATION

Your participation in this project is voluntary. If you do agree to participate, you can withdraw during the project without comment or penalty. Once the questionnaire matching task sheet has been submitted it will not be possible to withdraw. Your decision to participate will in no way impact upon your current or future relationship with QUT or with Downer EDi Mining.

Your participation will involve reading items from a newly developed questionnaire and matching them with numbered descriptions provided on a separate list. ***You are not required to answer the questions.*** It is estimated that this task will require approximately 10 – 15 minutes of your time.

EXPECTED BENEFITS

It is not expected that this project will benefit you directly. Your involvement however will help to refine and modify a questionnaire that may be used at this site and other mine sites in the future.

RISKS

There are no risks beyond normal day-to-day living associated with your participation in this project.

CONFIDENTIALITY

All comments and responses are anonymous and will be treated confidentially. The names of individual persons are not required in any of the responses.

CONSENT TO PARTICIPATE

The return of the completed questionnaire matching task sheet is accepted as an indication of your consent to participate in this project.

QUESTIONS / FURTHER INFORMATION ABOUT THE PROJECT

Please contact one of the research team members named above to have any questions answered or if you require further information about the project.

CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT

QUT is committed to research integrity and the ethical conduct of research projects. However, if you do have any concerns or complaints about the ethical conduct of the project you may contact the QUT Research Ethics Unit on (07) 3138 5123 or email ethicscontact@qut.edu.au. The QUT Research Ethics Unit is not connected with the research project and can facilitate a resolution to your concern in an impartial manner. QUT Ethics Approval Number: 1000001148.

Thank you for helping with this research project. Please keep this sheet for your information.

Appendix B: Informed consent – Digital stories (Studies Two and Three)

Queensland University of Technology
Brisbane Australia

PARTICIPATE IN RESEARCH
Information for Prospective Participants

The following research activity has been reviewed via QUT arrangements for the conduct of research involving human participation.

Digital story development and evaluation

Research Team Contacts

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Please contact the research team members to have any questions answered or if you require further information about the project.

What is the purpose of the research?

This project serves two purposes. Firstly, it involves the development of a series of digital stories which are short videos lasting several minutes. Video, photographs, audio and text can be compiled together to create digital stories. They will allow the health related stories and experiences of miners to be shared with other employees at sites associated with Downer EDi Mining and their impact will be evaluated via a questionnaire. Secondly, we would like to know what the workers involved in the process of developing a digital story thought about the experience and whether it influenced their own health literacy.

Are you looking for people like me?

Your story could be a valuable one to share with others in the mining industry. Employees at sites associated with Downer EDi Mining could benefit from and be motivated by your health related insights and experiences. It is important for this research project that the actual stories of people in the mining industry are communicated rather than hypothetical case studies.

The digital story could be about something that has happened in the past or something that you are experiencing now. It could be associated with physical health or mental health and be either about you or a group. The digital story could be used to share either positive health related experiences, negative health related experiences or a combination of both. The most effective digital stories are likely to be the ones that represent a journey, outline the circumstances, identify challenges faced, and explain the motivations involved. The main thing is that there is an underlying message that workers from a range of different mine sites could benefit from understanding.

If you have a story that you would like to share, it would be best told by you, however your story can still be shared anonymously if you do not want to be identified.

What will you ask me to do?

Your participation would involve an informal interview where you would be asked a series of questions to help others understand your experiences. The answers that you provide to these questions will form the basis of the video content. If you have any photographs that relate to your story, you are encouraged to consider providing them also. Photographs can serve an important role in a digital story by helping the audience understand the important parts of it. It is estimated that your time commitment for this stage of this project would be approximately one hour.

The second part of this project involves an interview completed after the digital stories have been produced to discuss your experiences and valuable insights from the process. It is expected that the final interview would require approximately 30 minutes of your time.

Are there any risks for me in taking part?

There are minimal risks associated with your participation in this project. If you do agree to participate, you can withdraw during the project without comment or penalty.

Are there any benefits for me in taking part?

It is not expected that there will be direct personal benefits from participating although you may find the process interesting. It is anticipated however that the series of digital stories developed will provide a more meaningful and effective way of sharing health information with workers in the mining industry. If this occurs, there will be a benefit to the workforce within your organisation.

Thank You!

QUT Ethics Approval Number: **1000001148**

Appendix C: Image consent form – Digital stories (Studies Two and Three)

Queensland University of Technology
Downer EDi Mining Digital Story Project

Consent form – Use of image for project videos

A photographic image (including a video recording) which is sufficiently clear to enable you to be identified as an individual is personal information. QUT has obligations under its privacy policy to ensure that personal information is used and disclosed only in ways which are consistent with privacy principles. In general, personal information is not disclosed or published unless the University has obtained the consent of the individual concerned.

Photographs, video images and audio will be used to produce a digital story. The digital story will be shown at work sites associated with Downer EDi Mining to convey health related information and experiences. The digital story may also be used in part or full to demonstrate the health communication strategy at QUT research seminars or industry conferences.

The QUT researcher coordinating this project would like to use one or more photographs, video images or voice recordings of you for these purposes and is seeking your consent to do so. If you agree to this, please read and complete the consent below.

Consent

I agree to the University using, reproducing and disclosing my photographic image, video image or voice recording as explained above. I agree that I will make no claim against QUT for any payment or fee for appearing in promotional material and release QUT from any other claims arising out of the University's use of the images of me.

Full name: _____

Signature: _____ Date: _____

PLEASE RETURN THIS FORM TO THE QUT RESEARCHER

Appendix D: Informed consent – Questionnaire (Study Two)

Queensland University of Technology
Brisbane Australia

PARTICIPANT INFORMATION FOR QUT RESEARCH PROJECT

Health Communication Questionnaire – Mining Industry

RESEARCH TEAM CONTACTS

Hugh Shannon – Researcher
Phone: (07) 3138 3577
Email: h.shannon@qut.edu.au

Tony Parker – Research supervisor
Phone: (07) 3138 6173
Email: t.parker@qut.edu.au

DESCRIPTION

This project is being undertaken as part of the 'Enhancing Health @ Downer EDi Mining' initiative. The project is supported by QUT and Downer EDi Mining. These groups will not have access to personally identifiable information about you.

The purpose of this research is to gain a greater understanding of how workers in the mining industry access health information, apply it to their lives and to evaluate the impact of a new communication strategy.

PARTICIPATION

Your participation in this project is voluntary. If you do agree to participate, you can withdraw during the project without comment or penalty. Once the questionnaire has been submitted it will not be possible to withdraw. Your decision to participate will in no way impact upon your current or future relationship with QUT or with Downer EDi Mining.

Your participation will involve completing the items contained within this questionnaire. It is expected that approximately 10 – 15 minutes of your time will be required to complete the questionnaire. The questionnaire will be used again in the future on two more occasions approximately three months apart to see if any changes occur during this time.

EXPECTED BENEFITS

It is not expected that completion of this questionnaire will benefit you directly. Your involvement however will help to gain an understanding of the impact of new methods for communicating health information in the mining industry. There may be benefits gained from the process for this work site and other locations in the future.

RISKS

There are no risks beyond normal day-to-day living associated with your participation in this project.

CONFIDENTIALITY

All comments and responses will be treated confidentially. No individuals will be identified through any data or reports produced for this project. Non-identifiable information from this project may be used for comparative purposes in future research projects.

CONSENT TO PARTICIPATE

The return of the completed questionnaire is accepted as an indication of your consent to participate in this project.

QUESTIONS / FURTHER INFORMATION ABOUT THE PROJECT

Please contact one of the research team members named above to have any questions answered or if you require further information about the project.

CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT

QUT is committed to research integrity and the ethical conduct of research projects. However, if you do have any concerns or complaints about the ethical conduct of the project you may contact the QUT Research Ethics Unit on (07) 3138 5123 or email ethicscontact@qut.edu.au. The QUT Research Ethics Unit is not connected with the research project and can facilitate a resolution to your concern in an impartial manner. QUT Ethics Approval Number: 1000001148.

Thank you for helping with this research project. Please keep this sheet for your information.

Appendix E: Health Communication Questionnaire – Administration guidelines

QUT ihbi
Institute of Health and Biomedical Innovation

Enhancing Workforce Health @ Downer EDI Mining

Health Communication Questionnaire 2012

GUIDELINES FOR ADMINISTRATION

To ensure reliability and consistency of the data collected, the following procedures must be followed.

1. A high response rate will achieve a more representative sample of the Downer EDI workforce. It is important that all workers on site are given an opportunity to participate.
2. The questionnaires should be distributed by a single authorised person.
3. The questionnaires should be administered under supervision and participants must not take the questionnaires away to complete.
4. If participants have not previously received the 'Participant information sheet', provide a copy and direct them to read the information in it.
5. The confidentiality and voluntary nature of the questionnaire should be emphasised to participants.
6. Participants should be told the questionnaires will be returned to QUT and only aggregated information will be presented to management.
7. Complete the details on the 'Batch Sleeve', bundle the completed and unused questionnaires together and return to the address listed.

RETURN ADDRESS:	Mr H. Shannon Queensland University of Technology School of Exercise and Nutrition Sciences Victoria Park Road Kelvin Grove 4059

Appendix F: Health Communication Questionnaire – Batch sleeve

Health Communication Questionnaire 2012

BATCH SLEEVE

Date: _____

Time of questionnaire completion: _____ am/pm

Batched by – Name: _____

RESEARCHER USE ONLY

Timing: Baseline / Impact / Follow-up

Group: Intervention (video) / Control (no video)

Quantity: _____

Appendix G: Test of Between-Subjects Effects (HCQ Item 20)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	596431.185	1	596431.185	2954.501	.000	.952	2954.501	1.000
Group	5669.162	1	5669.162	28.083	.000	.158	28.083	1.000
Error	30280.806	150	201.872					

[a]*Computed using alpha = .05*

Appendix H: Test of Within-Subjects Effects (HCQ Item 20)

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Time	Sphericity Assumed	7829.102	2	3914.551	22.096	.000	.128	44.192	1.000
	Greenhouse-Geisser	7829.102	1.991	3931.599	22.096	.000	.128	44.000	1.000
	Huynh-Feldt	7829.102	2.000	3914.551	22.096	.000	.128	44.192	1.000
	Lower-bound	7829.102	1.000	7829.102	22.096	.000	.128	22.096	.997
Time * Group	Sphericity Assumed	4114.719	2	2057.360	11.613	.000	.072	23.226	.994
	Greenhouse-Geisser	4114.719	1.991	2066.319	11.613	.000	.072	23.125	.994
	Huynh-Feldt	4114.719	2.000	2057.360	11.613	.000	.072	23.226	.994
	Lower-bound	4114.719	1.000	4114.719	11.613	.001	.072	11.613	.923
Error (Time)	Sphericity Assumed	53148.186	300	177.161					
	Greenhouse-Geisser	53148.186	298.699	177.932					
	Huynh-Feldt	53148.186	300.000	177.161					
	Lower-bound	53148.186	150.000	354.321					

[a]*Computed using alpha = .05*

Appendix I: HCQ data tables according to time and group

Table AI.1. Time 1 (baseline) HCQ data for the control group (n=90)

Item / Sub-scale	M	Mdn	Min	Max	Range	SD
T1RHI18Pos	43.32	42.12	0.00	60.00	60.00	10.19
T1RHI19Pos	45.03	44.92	18.89	60.00	41.11	8.88
T1RHI20Pos	31.27	30.48	0.00	60.00	60.00	15.70
T1RHI21Neg_R	32.93	35.36	0.00	60.00	60.00	12.64
T1RHI22Pos	31.82	31.38	0.00	60.00	60.00	13.47
T1RHI23Pos	31.86	31.12	0.00	60.00	60.00	13.46
T1RHI Sub-scale	35.99	36.24	18.18	60.00	41.82	8.45
T1DH24Pos	34.19	38.32	0.00	60.00	60.00	12.14
T1DH25Pos	35.96	39.62	0.00	60.00	60.00	12.32
T1DH26Pos	45.99	44.80	0.00	60.00	60.00	9.82
T1DH27Neg_R	38.48	40.00	12.12	60.00	47.88	11.07
T1DH28Neg_R	43.03	40.70	10.00	60.00	50.00	11.42
T1DH29Pos	41.15	40.10	20.00	60.00	40.00	8.37
T1DH Sub-scale	39.80	39.78	16.30	58.29	41.99	7.21
T1SHI30Pos	43.68	40.84	12.11	60.00	47.89	9.80
T1SHI31Pos	45.46	44.02	11.24	60.00	48.76	8.81
T1SHI32Neg_R	37.09	39.98	6.51	60.00	53.49	12.78
T1SHI33Neg_R	31.13	29.82	3.60	60.00	56.40	12.32
T1SHI34Pos	35.06	39.29	9.94	60.00	50.06	10.43
T1SHI35Pos	35.05	39.33	13.87	60.00	46.13	10.28
T1SHI36Pos	33.46	36.26	13.00	58.07	45.07	10.16
T1SHI Sub-scale	37.24	36.28	21.11	57.88	36.77	6.50
T1ACP38Neg_R	30.30	29.78	1.61	60.00	58.39	13.24

T1ACP39Neg_R	37.86	39.57	13.27	60.00	46.73	12.32
T1ACP40Pos	41.76	40.08	19.12	60.00	40.88	8.89
T1ACP41Pos	39.31	40.00	13.25	60.00	46.75	9.85
T1ACP42Pos	33.97	32.84	10.00	59.31	49.31	11.21
T1ACP43Pos	37.77	39.80	9.91	57.66	47.75	9.90
T1ACP Sub-scale	36.87	36.67	20.00	57.06	37.06	7.54
T1HO44Pos	40.57	40.00	20.00	60.00	40.00	8.20
T1HO45Neg_R	35.15	37.68	9.34	60.00	50.66	10.81
T1HO46Pos	39.63	40.00	10.66	60.00	49.34	8.93
T1HO47Pos	46.06	45.23	4.85	60.00	55.15	10.17
T1HO48Neg_R	38.70	40.12	0.00	60.00	60.00	13.92
T1HO49Pos	44.70	42.39	12.08	60.00	47.92	9.08
T1HO50Pos	36.11	39.81	0.00	59.18	59.18	11.23
T1HO51Pos	43.85	40.96	27.66	60.00	32.34	8.08
T1HO Sub-scale	40.61	40.00	21.00	57.80	36.80	6.67

SI unit of measurement: mm

Table AI.2. Time 1 (baseline) HCQ data for the intervention group (n=85)

Item / Sub-scale	M	Mdn	Min	Max	Range	SD
T1RHI18Pos	44.64	42.39	0.00	60.00	60.00	9.46
T1RHI19Pos	45.41	44.08	0.00	60.00	60.00	9.53
T1RHI20Pos	30.93	35.39	0.00	60.00	60.00	14.01
T1RHI21Neg_R	34.20	37.42	0.00	60.00	60.00	11.65
T1RHI22Pos	31.99	34.55	0.00	60.00	60.00	12.62
T1RHI23Pos	31.90	35.68	0.00	60.00	60.00	12.92
T1RHI Sub-scale	36.61	37.73	16.67	58.33	41.67	7.78
T1DH24Pos	34.80	39.83	0.00	60.00	60.00	10.11
T1DH25Pos	35.50	40.00	1.85	60.00	58.15	12.25
T1DH26Pos	45.60	41.69	1.85	60.00	58.15	10.46
T1DH27Neg_R	40.35	40.00	15.68	60.00	44.32	11.87
T1DH28Neg_R	40.91	40.00	0.00	60.00	60.00	13.38
T1DH29Pos	41.27	40.00	16.26	60.00	43.74	9.77
T1DH Sub-scale	39.82	40.00	20.62	58.83	38.22	7.51
T1SHI30Pos	41.35	40.00	3.28	60.00	56.72	10.42
T1SHI31Pos	43.82	40.00	3.28	60.00	56.72	10.02
T1SHI32Neg_R	34.75	40.00	2.22	59.56	57.34	12.27
T1SHI33Neg_R	33.75	34.68	0.00	58.50	58.50	12.16
T1SHI34Pos	35.47	40.00	2.17	60.00	57.83	11.75
T1SHI35Pos	34.23	39.90	0.88	58.42	57.54	10.46
T1SHI36Pos	32.55	33.81	0.00	58.42	58.42	10.56
T1SHI Sub-scale	36.56	36.38	17.74	58.00	40.26	6.40
T1ACP38Neg_R	29.34	25.79	2.81	60.00	57.19	13.28
T1ACP39Neg_R	37.46	40.00	10.00	60.00	50.00	11.38

T1ACP40Pos	41.00	40.00	18.94	60.00	41.06	9.53
T1ACP41Pos	40.21	40.00	3.63	60.00	56.37	10.40
T1ACP42Pos	34.15	36.64	4.95	60.00	55.05	11.99
T1ACP43Pos	36.00	40.00	4.95	60.00	55.05	10.60
T1ACP Sub-scale	36.37	36.26	15.59	58.82	43.23	7.97
T1HO44Pos	42.03	40.00	1.85	60.00	58.15	10.10
T1HO45Neg_R	38.11	40.00	0.00	60.00	60.00	11.92
T1HO46Pos	40.13	40.00	1.85	60.00	58.15	10.06
T1HO47Pos	45.29	40.00	1.85	60.00	58.15	10.58
T1HO48Neg_R	39.70	40.00	10.00	60.00	50.00	13.14
T1HO49Pos	44.25	40.00	0.00	60.00	60.00	10.66
T1HO50Pos	37.54	40.00	1.79	60.00	58.21	10.25
T1HO51Pos	44.11	40.00	1.79	60.00	58.21	9.48
T1HO Sub-scale	41.40	40.00	15.68	58.14	42.46	7.92

SI unit of measurement: mm

Table AI.3. Time 2 (impact) HCQ data for the control group (n=90)

Item / Sub-scale	M	Mdn	Min	Max	Range	SD
T2RHI18Pos	43.88	40.22	7.33	60.00	52.67	8.87
T2RHI19Pos	44.98	43.48	18.22	60.00	41.78	8.11
T2RHI20Pos	34.52	40.00	.00	60.00	60.00	14.62
T2RHI21Neg_R	35.21	40.00	3.28	60.00	56.72	12.00
T2RHI22Pos	34.49	38.01	0.00	60.00	60.00	12.27
T2RHI23Pos	31.86	31.12	0.00	60.00	60.00	13.46
T2RHI Sub-scale	38.96	39.41	20.26	58.46	38.20	8.41
T2DH24Pos	35.76	38.89	10.78	60.00	49.22	9.73
T2DH25Pos	36.25	40.00	10.00	60.00	50.00	9.79
T2DH26Pos	44.29	42.91	7.17	60.00	52.83	9.61
T2DH27Neg_R	37.06	40.00	7.70	58.34	50.64	11.60
T2DH28Neg_R	40.67	40.00	13.94	60.00	46.06	10.55
T2DH29Pos	40.80	40.00	8.02	60.00	51.98	10.13
T2DH Sub-scale	39.17	40.00	22.33	56.37	34.04	6.90
T2SHI30Pos	43.49	40.19	20.00	60.00	40.00	8.08
T2SHI31Pos	44.85	44.11	20.00	60.00	40.00	7.92
T2SHI32Neg_R	35.94	40.00	1.10	60.00	58.90	14.15
T2SHI33Neg_R	32.11	33.38	11.79	56.57	44.78	11.18
T2SHI34Pos	34.80	40.00	3.49	60.00	56.51	10.53
T2SHI35Pos	34.84	39.69	7.12	60.00	52.88	9.86
T2SHI36Pos	34.912	37.840	17.680	56.04	38.360	8.780
T2SHI Sub-scale	37.37	38.02	22.81	54.29	31.47	5.70
T2ACP38Neg_R	30.40	30.00	3.94	60.00	56.06	12.77
T2ACP39Neg_R	32.05	30.00	0.00	60.00	60.00	13.74

T2ACP40Pos	41.15	40.00	20.00	60.00	40.00	9.50
T2ACP41Pos	39.16	40.00	4.24	60.00	55.76	10.32
T2ACP42Pos	33.64	30.00	13.17	60.00	46.83	11.08
T2ACP43Pos	36.35	40.00	6.43	60.00	53.57	10.88
T2ACP Sub-scale	35.50	34.97	18.23	60.00	41.77	8.36
T2HO44Pos	40.31	40.00	17.76	60.00	42.24	8.01
T2HO45Neg_R	35.45	40.00	12.94	60.00	47.06	11.50
T2HO46Pos	39.60	40.00	9.05	60.00	50.95	9.03
T2HO47Pos	44.84	42.14	9.05	60.00	50.95	8.92
T2HO48Neg_R	37.83	40.00	0.00	60.00	60.00	13.67
T2HO49Pos	44.32	41.77	20.00	60.00	40.00	8.42
T2HO50Pos	37.26	40.00	11.28	60.00	48.72	9.33
T2HO51Pos	42.41	40.00	7.91	60.00	52.09	8.40
T2HO Sub-scale	40.34	40.00	23.90	60.00	36.10	6.76

SI unit of measurement: mm

Table AI.4. Time 2 (impact) HCQ data for the intervention group (n=85)

Item / Sub-scale	M	Mdn	Min	Max	Range	SD
T2RHI18Pos	47.49	47.57	20.00	60.00	40.00	9.52
T2RHI19Pos	48.54	48.41	27.71	60.00	32.29	8.64
T2RHI20Pos	48.69	50.00	24.05	60.00	35.95	8.51
T2RHI21Neg_R	47.60	48.31	19.41	60.00	40.59	9.34
T2RHI22Pos	44.02	40.00	19.98	60.00	40.02	10.03
T2RHI23Pos	31.90	35.68	0.00	60.00	60.00	12.92
T2RHI Sub-scale	46.88	46.39	25.37	60.00	34.64	7.47
T2DH24Pos	37.44	40.00	3.07	60.00	56.93	10.96
T2DH25Pos	37.38	40.00	0.00	60.00	60.00	12.47
T2DH26Pos	47.11	45.57	24.67	60.00	35.33	9.20
T2DH27Neg_R	41.40	40.00	3.00	60.00	57.00	13.54
T2DH28Neg_R	45.88	43.98	11.50	60.00	48.50	11.39
T2DH29Pos	42.16	40.00	6.00	60.00	54.00	10.08
T2DH Sub-scale	42.03	40.85	23.33	58.30	34.97	7.68
T2SHI30Pos	43.21	40.14	20.00	60.00	40.00	9.31
T2SHI31Pos	45.00	41.29	2.51	60.00	57.49	9.89
T2SHI32Neg_R	34.88	40.00	0.00	60.00	60.00	13.21
T2SHI33Neg_R	31.11	30.24	7.12	57.49	50.37	11.62
T2SHI34Pos	36.87	40.00	7.57	60.00	52.43	10.32
T2SHI35Pos	36.63	40.00	0.00	60.00	60.00	10.31
T2SHI36Pos	34.63	39.00	0.00	58.00	58.00	10.36
T2SHI Sub-scale	37.59	37.14	25.70	57.05	31.35	5.98
T2ACP38Neg_R	31.33	30.03	3.64	60.00	56.36	15.15
T2ACP39Neg_R	33.15	35.49	10.39	60.00	49.61	12.27

T2ACP40Pos	41.19	40.00	18.49	60.00	41.51	9.62
T2ACP41Pos	40.07	40.00	11.08	60.00	48.92	10.49
T2ACP42Pos	32.85	32.18	1.56	58.46	56.90	12.34
T2ACP43Pos	36.87	40.00	9.01	58.52	49.51	11.17
T2ACP Sub-scale	35.73	35.69	16.25	56.81	40.55	8.56
T2HO44Pos	42.51	40.00	20.00	60.00	40.00	8.49
T2HO45Neg_R	36.92	40.00	2.48	60.00	57.52	12.01
T2HO46Pos	41.43	40.00	20.00	60.00	40.00	8.45
T2HO47Pos	48.01	47.82	30.00	60.00	30.00	8.59
T2HO48Neg_R	39.10	40.00	0.00	60.00	60.00	14.64
T2HO49Pos	45.71	40.18	11.76	60.00	48.24	9.20
T2HO50Pos	37.33	40.00	17.35	60.00	42.65	9.41
T2HO51Pos	45.08	40.00	30.00	60.00	30.00	8.26
T2HO Sub-scale	42.16	41.07	31.63	58.61	26.98	6.17

SI unit of measurement: mm

Table AI.5. Time 3 (follow-up) HCQ data for the control group (n=90)

Item / Sub-scale	M	Mdn	Min	Max	Range	SD
T3RHI18Pos	43.27	40.00	20.00	60.00	40.00	8.09
T3RHI19Pos	42.85	40.00	12.20	60.00	47.80	8.86
T3RHI20Pos	32.93	35.14	0.00	60.00	60.00	13.65
T3RHI21Neg_R	33.76	39.68	7.35	60.00	52.65	12.31
T3RHI22Pos	33.67	32.36	0.00	60.00	60.00	11.59
T3RHI23Pos	36.22	40.00	10.00	60.00	50.00	12.04
T3RHI Sub-scale	37.25	36.67	23.92	60.00	36.08	7.81
T3DH24Pos	36.15	40.00	0.00	59.60	59.60	10.23
T3DH25Pos	36.27	40.00	5.58	60.00	54.42	11.22
T3DH26Pos	45.64	44.34	11.04	60.00	48.96	8.74
T3DH27Neg_R	38.36	40.00	11.52	60.00	48.48	11.53
T3DH28Neg_R	41.21	40.00	14.71	60.00	45.29	11.34
T3DH29Pos	40.95	40.00	0.00	60.00	60.00	9.58
T3DH Sub-scale	39.86	39.92	27.47	59.36	31.89	6.66
T3SHI30Pos	42.64	40.00	0.00	60.00	60.00	9.68
T3SHI31Pos	43.85	40.88	0.00	60.00	60.00	9.88
T3SHI32Neg_R	34.42	39.38	0.00	60.00	60.00	12.25
T3SHI33Neg_R	29.81	30.00	7.30	56.42	49.12	10.34
T3SHI34Pos	35.89	40.00	12.24	60.00	47.76	9.27
T3SHI35Pos	35.67	40.00	14.40	60.00	45.60	9.18
T3SHI36Pos	34.73	38.07	11.95	60.00	48.05	9.01
T3SHI Sub-scale	37.17	37.14	25.51	54.29	28.77	5.66
T3ACP38Neg_R	30.78	30.00	0.00	60.00	60.00	12.93
T3ACP39Neg_R	33.39	34.25	0.00	60.00	60.00	13.07

T3ACP40Pos	40.37	40.00	20.00	60.00	40.00	8.06
T3ACP41Pos	39.51	40.00	20.00	60.00	40.00	8.46
T3ACP42Pos	34.74	34.45	13.15	57.93	44.78	9.78
T3ACP43Pos	37.20	40.00	13.95	60.00	46.05	8.61
T3ACP Sub-scale	36.01	35.75	18.61	54.41	35.81	7.70
T3HO44Pos	39.77	40.00	7.90	60.00	52.10	8.83
T3HO45Neg_R	35.10	37.51	0.00	60.00	60.00	12.26
T3HO46Pos	38.98	40.00	20.00	60.00	40.00	8.11
T3HO47Pos	44.90	43.40	27.98	60.00	32.02	7.83
T3HO48Neg_R	38.16	40.00	0.00	60.00	60.00	12.47
T3HO49Pos	42.01	40.00	17.79	60.00	42.21	9.43
T3HO50Pos	36.54	40.00	3.46	60.00	56.54	9.86
T3HO51Pos	42.13	40.00	20.00	60.00	40.00	7.96
T3HO Sub-scale	40.05	40.00	27.65	60.00	32.35	6.44

SI unit of measurement: mm

Table AI.6. Time 3 (follow-up) HCQ data for the intervention group (n=85)

Item / Sub-scale	M	Mdn	Min	Max	Range	SD
T3RHI18Pos	41.50	40.00	3.84	60.00	56.16	13.44
T3RHI19Pos	39.99	40.22	2.04	60.00	57.96	15.34
T3RHI20Pos	40.74	40.00	1.72	60.00	58.28	13.99
T3RHI21Neg_R	19.68	20.00	0.00	60.00	60.00	13.93
T3RHI22Pos	41.18	40.00	1.27	60.00	58.73	12.39
T3RHI23Pos	40.02	40.00	0.00	60.00	60.00	14.68
T3RHI Sub-scale	37.18	39.58	16.20	52.67	36.47	7.46
T3DH24Pos	37.24	39.88	16.17	60.00	43.83	9.57
T3DH25Pos	37.72	40.00	0.00	60.00	60.00	12.32
T3DH26Pos	45.83	45.26	3.43	60.00	56.57	9.87
T3DH27Neg_R	41.66	40.00	19.14	60.00	40.86	10.94
T3DH28Neg_R	42.80	40.38	1.89	60.00	58.11	12.61
T3DH29Pos	42.68	40.00	1.57	58.96	57.39	8.32
T3DH Sub-scale	41.33	40.14	18.19	57.22	39.03	7.49
T3SHI30Pos	43.45	41.02	24.22	58.96	34.74	8.06
T3SHI31Pos	44.88	42.60	20.31	60.00	39.69	8.29
T3SHI32Neg_R	33.79	37.30	2.96	60.00	57.04	13.13
T3SHI33Neg_R	31.06	30.00	0.00	59.44	59.44	11.45
T3SHI34Pos	37.73	40.00	12.26	60.00	47.74	9.53
T3SHI35Pos	37.38	40.00	12.26	60.00	47.74	9.95
T3SHI36Pos	36.09	39.40	12.26	60.00	47.74	9.81
T3SHI Sub-scale	38.07	36.83	27.91	59.62	31.71	6.15
T3ACP38Neg_R	30.48	29.97	0.80	60.00	59.20	13.09
T3ACP39Neg_R	33.79	36.13	5.18	60.00	54.82	12.36

T3ACP40Pos	41.59	40.03	19.56	60.00	40.44	8.52
T3ACP41Pos	39.50	40.00	11.97	60.00	48.03	10.05
T3ACP42Pos	35.52	38.42	0.00	60.00	60.00	11.30
T3ACP43Pos	37.44	40.00	16.57	60.00	43.43	9.61
T3ACP Sub-scale	36.39	36.46	18.37	56.87	38.50	7.99
T3HO44Pos	42.17	40.00	20.15	60.00	39.85	8.26
T3HO45Neg_R	37.89	40.00	1.13	60.00	58.87	10.52
T3HO46Pos	41.62	40.00	21.95	60.00	38.05	7.56
T3HO47Pos	46.10	45.12	2.06	60.00	57.94	9.50
T3HO48Neg_R	39.32	40.00	6.10	60.00	53.90	12.89
T3HO49Pos	43.42	40.93	1.28	60.00	58.72	10.26
T3HO50Pos	37.68	40.00	12.30	60.00	47.70	9.77
T3HO51Pos	44.55	42.82	20.47	60.00	39.53	8.53
T3HO Sub-scale	41.51	40.41	29.04	59.83	30.79	6.54

SI unit of measurement: mm

Appendix J: Comparative mean graphs – HCQ sub-scales 2, 3, 4 and 5

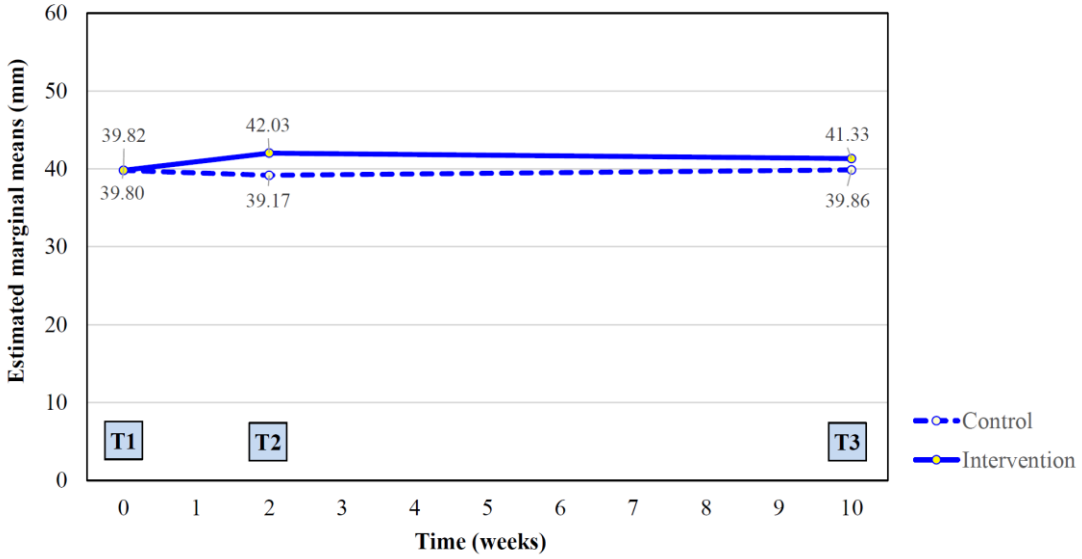

Figure AJ.1. Baseline, impact and follow-up means – HCQ sub-scale 2-DH

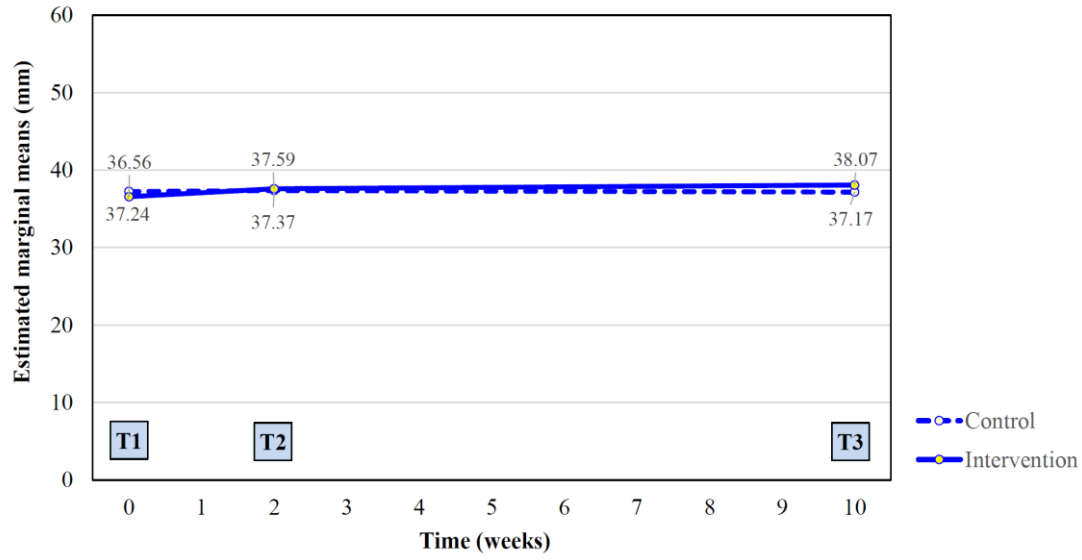

Figure AJ.2. Baseline, impact and follow-up means – HCQ sub-scale 3-SHI

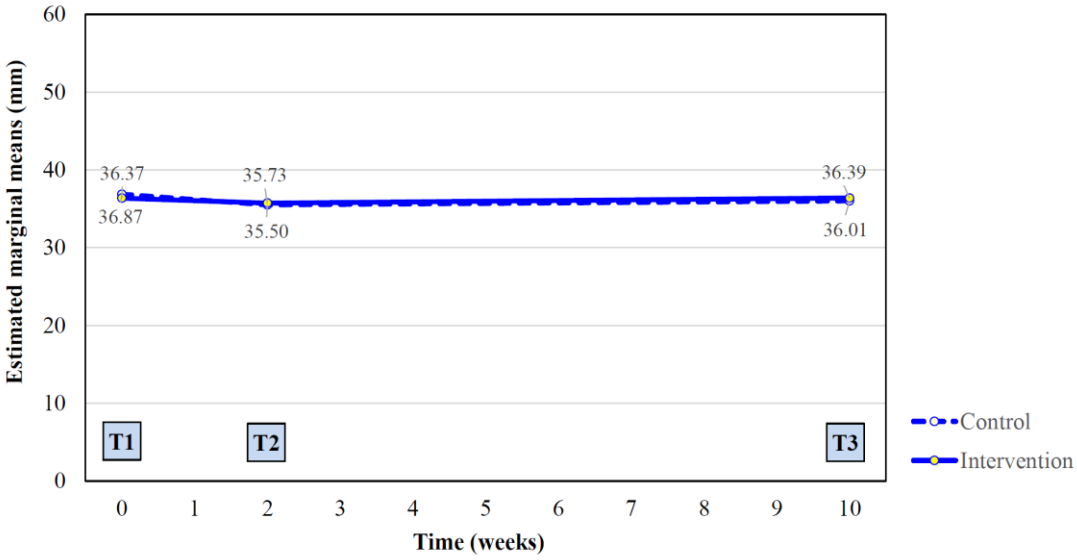

Figure AJ.3. Baseline, impact and follow-up – HCQ sub-scale 4-ACP

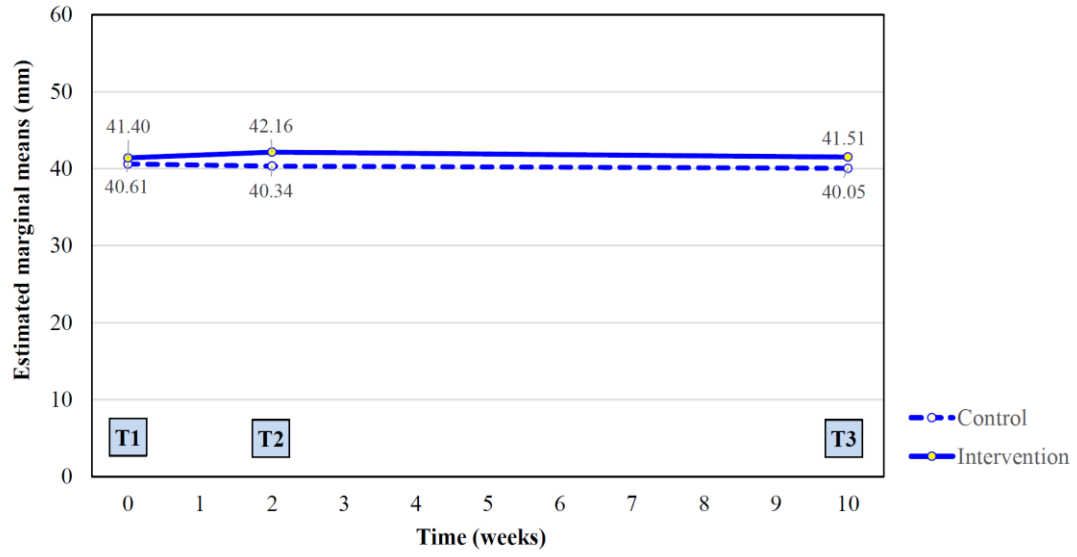

Figure AJ.4. Baseline, impact and follow-up means – HCQ sub-scale 5-HO

Appendix K: Test of Within-Subjects Effects (HCQ Sub-scales)

Source	Measure		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power[a]
Time	1-RHI	Sphericity Assumed	2081.494	2	1040.747	18.146	.000	.169	1.000
		Greenhouse-Geisser	2081.494	1.988	1047.265	18.146	.000	.169	1.000
		Huynh-Feldt	2081.494	2.000	1040.747	18.146	.000	.169	1.000
		Lower-bound	2081.494	1.000	2081.494	18.146	.000	.169	.988
	2-DH	Sphericity Assumed	12.104	2	6.052	.111	.895	.001	.067
		Greenhouse-Geisser	12.104	1.961	6.171	.111	.891	.001	.067
		Huynh-Feldt	12.104	2.000	6.052	.111	.895	.001	.067
		Lower-bound	12.104	1.000	12.104	.111	.740	.001	.063
	3-SHI	Sphericity Assumed	27.428	2	13.714	.394	.675	.004	.113
		Greenhouse-Geisser	27.428	1.970	13.919	.394	.672	.004	.113
		Huynh-Feldt	27.428	2.000	13.714	.394	.675	.004	.113
		Lower-bound	27.428	1.000	27.428	.394	.532	.004	.095
	4-ACP	Sphericity Assumed	39.569	2	19.784	.332	.718	.004	.102
		Greenhouse-Geisser	39.569	1.948	20.308	.332	.712	.004	.102
		Huynh-Feldt	39.569	2.000	19.784	.332	.718	.004	.102

		Lower-bound	39.569	1.000	39.569	.332	.566	.004	.088
	5-HO	Sphericity Assumed	6.494	2	3.247	.091	.913	.001	.064
		Greenhouse-Geisser	6.494	1.916	3.390	.091	.905	.001	.064
		Huynh-Feldt	6.494	1.979	3.282	.091	.911	.001	.064
		Lower-bound	6.494	1.000	6.494	.091	.763	.001	.060
Time * Group	1-RHI	Sphericity Assumed	1069.373	2	534.687	9.322	.000	.095	.977
		Greenhouse-Geisser	1069.373	1.988	538.035	9.322	.000	.095	.976
		Huynh-Feldt	1069.373	2.000	534.687	9.322	.000	.095	.977
		Lower-bound	1069.373	1.000	1069.373	9.322	.003	.095	.855
	2-DH	Sphericity Assumed	57.106	2	28.553	.524	.593	.006	.135
		Greenhouse-Geisser	57.106	1.961	29.114	.524	.589	.006	.135
		Huynh-Feldt	57.106	2.000	28.553	.524	.593	.006	.135
		Lower-bound	57.106	1.000	57.106	.524	.471	.006	.111
	3-SHI	Sphericity Assumed	60.645	2	30.322	.872	.420	.010	.199
		Greenhouse-Geisser	60.645	1.970	30.777	.872	.418	.010	.197
		Huynh-Feldt	60.645	2.000	30.322	.872	.420	.010	.199
		Lower-bound	60.645	1.000	60.645	.872	.353	.010	.152
	4-ACP	Sphericity Assumed	36.711	2	18.355	.308	.735	.003	.098
		Greenhouse-Geisser	36.711	1.948	18.841	.308	.729	.003	.098
		Huynh-Feldt	36.711	2.000	18.355	.308	.735	.003	.098

		Lower-bound	36.711	1.000	36.711	.308	.580	.003	.085
	5-HO	Sphericity Assumed	12.135	2	6.068	.171	.843	.002	.076
		Greenhouse-Geisser	12.135	1.916	6.335	.171	.834	.002	.076
		Huynh-Feldt	12.135	1.979	6.133	.171	.841	.002	.076
		Lower-bound	12.135	1.000	12.135	.171	.680	.002	.069
Error (Time)	1-RHI	Sphericity Assumed	10209.242	178	57.355				
		Greenhouse-Geisser	10209.242	176.892	57.715				
		Huynh-Feldt	10209.242	178.000	57.355				
		Lower-bound	10209.242	89.000	114.711				
	2-DH	Sphericity Assumed	9696.476	178	54.475				
		Greenhouse-Geisser	9696.476	174.569	55.545				
		Huynh-Feldt	9696.476	178.000	54.475				
		Lower-bound	9696.476	89.000	108.949				
	3-SHI	Sphericity Assumed	6188.633	178	34.768				
		Greenhouse-Geisser	6188.633	175.374	35.288				
		Huynh-Feldt	6188.633	178.000	34.768				
		Lower-bound	6188.633	89.000	69.535				
	4-ACP	Sphericity Assumed	10601.663	178	59.560				
		Greenhouse-Geisser	10601.663	173.412	61.136				

	Huynh-Feldt	10601.663	178.000	59.560
	Lower-bound	10601.663	89.000	119.120
5-HO	Sphericity Assumed	6324.839	178	35.533
	Greenhouse-Geisser	6324.839	170.490	37.098
	Huynh-Feldt	6324.839	176.112	35.914
	Lower-bound	6324.839	89.000	71.066

[a]*Computed using alpha = .05*