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Coal mining in Australia: Understanding stakeholder knowledge of mining and mine rehabilitation

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ABSTRACT

Knowledge of mining is an important factor that can influence acceptance of activities conducted by the mining industry. However, understanding the objective knowledge of mining activities of the important stakeholder groups in mining is an issue that has been neglected. On the basis of an on-line survey focused on various target groups of stakeholders in Australia, we have examined a hypothesized model of factors that constitute knowledge of mining. The results show that knowledge of mining activities varies according to socio-demographic characteristics, experience of mining activities, and information sources about mining. Our findings highlight the key role of direct experience with mines and rehabilitation sites and the role of information in increasing knowledge of mining. In an effort to identify factors that frame acceptance of mining, the present study shows a new perspective by addressing objective knowledge of mining as an important asset that needs to be maintained and more widely spread.

1. Introduction

Protests against coal mining activities have frequently dominated newspaper headlines worldwide. The consequences of these protests have been not only financial losses for mining companies, but also societal unrest and decreasing acceptance of mining activities within society (Owen and Kemp, 2018). The relationship between the coal mining industry and society based on the acceptance of mining has been widely recognized as an essential component in successfully setting up and running mining businesses, their profitability and the minimization of business risks (Hendrychová and Kabrna, 2016; Lima et al., 2016; Que et al., 2015; Badera and Koceń, 2014; Franks et al., 2014; Moffat and Zhang, 2014). Management of the social and cultural impacts of coal mining is a subject of concern, not only to mining companies and local governments, but increasingly for researchers who are trying to understand the problem in order to suggest novel and effective policies and communication channels between the mining industry and society (Viveros, 2017; Litmanen et al., 2016; Barkemeyer et al., 2015; Hodge, 2014; Moran et al., 2014; Badera, 2013; Hilson, 2000). Researchers such as Haalboom (2016), Kemp et al. (2012), Preuss (2010) and Nijhof et al. (2006) have indicated the importance of knowledge for effective corporate social responsibility in mining.

Our research focuses on the coal mining industry in Australia, the world's largest exporter of black coal and the fourth largest producer (ITA, 2017). Although coal remains one of the leading global energy resources, its mining activities have multiple cumulative impacts (Wang et al., 2018; Franks et al., 2010). Addressing the theoretical conceptual model, the aim of this study is to conceptualize and analyse knowledge[1] of mining activities[2] possessed by various stakeholder groups in the framework of the Australian coal mining sector.

2. Theory

2.1. Influence of knowledge on cognitive and behavioural attitudes

The definition of knowledge as the amount of information stored in the memory places the focus on the individual (Pardi, 2011). Knowledge is influenced by a person's intellectual and socio-demographic background, beliefs, moods and experiences (Baharoon et al., 2016; Badera, 2013; Uggioni and Salay, 2012). As determined by Wijnhoven (1999), information sources can also significantly affect knowledge, and likewise representations of knowledge (Kraaijenbrink et al., 2005).

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[1] This research investigates a conceptual (declarative) type of knowledge (de Jong and Ferguson-Hessler, 1996).

[2] In this paper, we use the term 'mining activities' to cover both extraction and mine rehabilitation procedures of coal mining. Opencast and deep coal mining techniques are considered.

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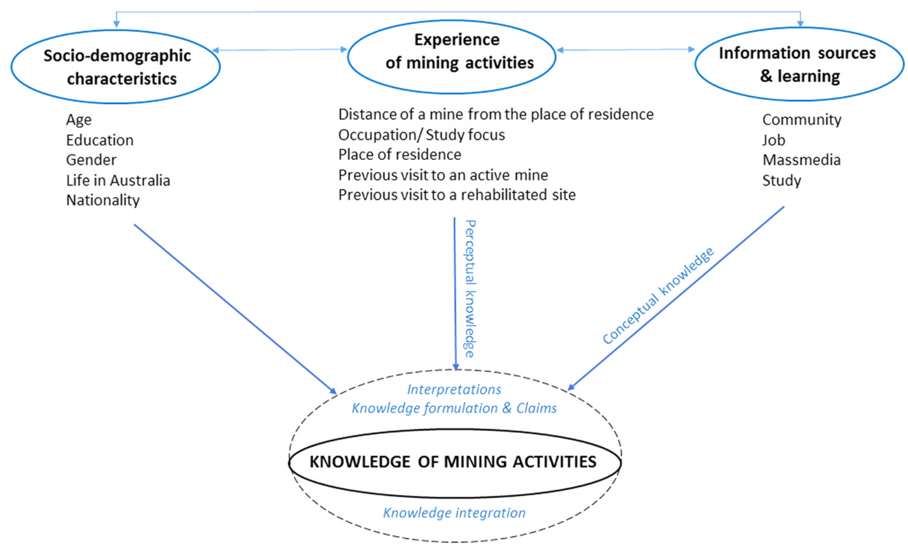

Fig. 1. The model of factors contributing to knowledge of mining activities. The model represents a scheme of hypothesized relationships between variables (see arrows).

It is widely recognized that the amount of knowledge has a crucial effect on how information is interpreted and accepted, especially information cues (Dagger and O'Brien, 2010). Selnes and Troye (1989) observed that people with a great amount of knowledge have more developed cognitive structures, comprising a broader range of relevant information that helps them to process information in a more detailed manner when making decisions. In contrast, people with less knowledge tend to perceive a higher level of risk, and be more critical of new technologies and products (Dagger and O'Brien, 2010; Webb, 2000). Similarly, Baharoon et al. (2016) pointed out that the amount of knowledge held by a community has a positive effect on the overall acceptance by the community of government plans and development decisions in its area. It is increasingly evident that to acquire and maintain a competitive advantage and acceptance by the various stakeholder groups including local communities, the cognitive source of knowledge must be explicitly managed (Haalboom, 2016; Schiuma, 2012).

Furthermore, knowledge has been recognized as behavioural potential. It is widely accepted that people behave in accordance with their knowledge and beliefs (Hunt, 2003; Miller, 1978; Ayer, 1958). Knowledge has also been described as a structural property of behavioural attitudes that is a function of beliefs and experiences (Fabrigar et al., 2006; Krosnick and Petty, 1995). Thus, a high level of knowledge is likely to lead to attitudes that are more stable over time (Eagly and Chaiken, 1993; Davidson et al., 1985).

2.2. Experimental studies on knowledge of mining: a critical overview

The importance of knowledge for activities with wide social and environmental impacts, such as mining industry operations, is well known (Basu et al., 2015). To date, however, there has been very limited research on knowledge of coal mining (Litmanen et al., 2016; Moffat et al., 2014; Badera, 2013). Moffat et al. (2014) measured self-reported knowledge of the CSG mining industry in Australia, and concluded that Australians evaluated their knowledge as low. Litmanen et al. (2016) measured knowledge of all types of mining in Finland based on self-assessed satisfaction with the level of information about mining and familiarity with local mines in local communities in two Finnish regions. The researchers found that familiarity with metal mine operations was strongly positively correlated with acceptance of mining for metals. However, the connection between familiarity and knowledge was not understood very well. Further details about knowledge of mining were presented by Badera (2013), who investigated self-assessed satisfaction with knowledge of surface lignite mining activities in Poland. The study found that over half of the members of the community considered their knowledge of mining to be satisfactory. This satisfaction with knowledge was significantly influenced by gender and by professional connection with the lignite mining industry. Although Badera (2013) investigated the influence of selected socio-demographic characteristics of participants on their satisfaction with their knowledge, he did not investigate the objective knowledge level and its determinants within any integrated framework.

Although previous studies have investigated knowledge of mining, they examined only subjective knowledge evaluated by the participants themselves. An investigation of subjective knowledge of mining raises difficulties and complexities. For example, Sitzmann et al. (2010) pointed out that the accuracy of self-assessments of the amount of knowledge is insufficient, and that people's self-perceptions appear to have only a tenuous relationship with reality. Dunning et al. (2004; p. 98) demonstrated that there is still "*a striking continuity in the errors that people make when they assess themselves*". While a high level of subjective knowledge increases reliance on previously stored information (Brucks, 1985), objective knowledge facilitates deliberation and the use of newly acquired information (Selnes and Gronhaug, 1986). Furthermore, objective knowledge positively affects the number of attributes considered by an individual when making a decision (Brucks, 1985). Selnes and Gronhaug (1986) propose that objective measures are preferable when research is focused on ability differences, whilst subjective measures should be used when concentrating on motivational aspects of product knowledge. Aertsens et al. (2011) who measured effect of both subjective and objective knowledge on attitudes towards organic food confirmed that higher level of objective and subjective knowledge were positively related to a more positive attitudes.

No complex research has yet been reported on factors influencing the objective knowledge of mining possessed by individuals from various stakeholder groups in the coal industry, and the topic has not been systematically investigated in the past. Our study targets to fill this gap.

2.3. The aim, the context and the contribution of the study

The aim of this study is to conceptualize and analyse knowledge of mining activities and the factors that constitute this knowledge. The study proposes the conceptual model presented in Fig. 1. The model includes variables identified by previous research as key determinants of the concept of knowledge (e.g., Haalboom, 2016; Laplonge, 2017; Litmanen et al., 2016; Moffat et al., 2014; Badera, 2013; Preuss, 2010; Fabrigar et al., 2006; Nijhof et al., 2006; Wijnhoven, 1999; Krosnick and Petty, 1995; Eagly and Chaiken, 1993; Davidson et al., 1985; Miller, 1978; Ayer, 1958). The present study aims to investigate the effect of three main groups of variables (socio-demographic characteristics, experience with mining activities, and sources of information about mining), and their interactions, on knowledge of mining activities held by individuals from four key stakeholder groups in the coal industry (see Fig. 1).

The hypothesized model has been developed and tested as a contribution to the theory of public knowledge of coal mining activities. Our study adopts a novel approach, while recognizing the importance of knowledge of mining activities as an aspect of the public image of coal mining industries. Knowledge is approached as a measurable intangible asset based on particular factors and their interactions, which are subjected to an analysis. This kind of complex analysis of factors and their mutual influences has been neglected by previous research. We suggest that a comprehensive investigation can provide a deeper insight into the issue.

The study is based in Australia, one of the world's top coal mining countries. Australia possesses vast amounts of energy resources, and is distinctive among industrialized countries with strong economies for its degree of dependence on mineral sector exports. The minerals industry is Australia's largest export industry, producing about 50% of Australia's total export earnings, which brings substantial economic benefits. Mining's share of the country's GDP has risen rapidly over the last decade. In 2017, the mining and mining equipment, technology and services sector contributed around 15% to Australia's gross domestic product (GDP), and supported 1.1 million jobs nationwide – around 10% of overall employment (Masige, 2017). Furthermore, mining has been one of the driving forces for much of the exploration of Australia's remote inland and for Australia's industrial development (Eklund, 2015). Although energy sector has been responsible for shaping Australian history, and continues to play a dominant role in Australia's economy, the relationship between the coal mining industry and society is not well understood. It remains a complex and sensitive topic (Owen and Kemp, 2018; Van der Plank et al., 2016). Coal mining production in Australia continue to increase, but mine rehabilitation is in its infancy (Campbell et al., 2017). It is crucial to undertake this study in such a puzzling environment, in order to gain a better understanding of the issues.

3. Data collection and analysis

Our study was designed using quantitative data collection activities, as discussed in Neuman (2006), after ethical approval had been given by Monash University. To analyse the proposed model, we developed an anonymous questionnaire targeting four groups of respondents: mining communities (i.e. members of the public living in the vicinity of coal mines), mining employees, industry regulators and local councils, university staff and students in the field of mining, particularly studying or working in Mining Engineering, Geology and Mine Closure.

3.1. Selection of respondents

Respondents were selected using stratified random selection and snowball sampling (Disman, 2008). The goal of the selection was to obtain a sample from four target groups, not a representative sample of the Australian population. These groups were a priori selected on the basis of their different experience with mining and their presumed different levels of knowledge of mining activities. Mining communities experience mining activities in their daily life in immediate vicinity of their homes. Their experience is therefore different from the experience of professionals in the mining industry. Industry regulators and local councils have institutional experience, and university staff and students possess higher level of knowledge in the field of mining. A total of 400 randomly selected respondents (100 from each group) were sent an e-mail invitation to complete the questionnaire. They were randomly selected from the initial list containing a total of 1 000 email addresses – 250 per target group. The members of the 'mining community' group were selected from various community groups and NGOs in different mining regions in Australia, using internet searching and/or a recommendation. The 'mining employees' members were selected from a list of all mining companies operating in Australia. Industry regulators and local councils were selected via their web pages on the basis of their affiliation to a mining region, and the university staff and students were selected from three Australian universities that offer courses in mining: Monash University, the University of Queensland, and Federation University Australia. The subsequent snowball sampling was carried out by the respondents themselves, who had the option to send invitations to other people who are relevant and might be interested in the survey. The survey was conducted on the website of Monash University and was carried out from August to December 2015.

3.2. Questionnaire design and distribution

The questionnaire was developed according to the standards for Internet-based quantitative studies (see Reips, 2002), and contained questions on participants' socio-demographic characteristics, their experience with mining activities (both generic and specific to coal mining) and their knowledge of mining and mine rehabilitation. To measure participants' knowledge of mining activities, we designed twenty statements about basic facts of the mining industry, both generic and specific to Australia and to the coal mining sector. For example, *"Mine rehabilitation means the establishment of a stable and self-sustaining ecosystem"* or the *"Coal mining industry is one of the primary industries in Australia and a significant contributor to Australia's Gross Domestic Product*. These statements were selected from an initial list of 50 statements via consensus in a group of senior researchers from Monash University and from the University of Life Sciences Prague, and were edited on the basis of the results of a pre-testing pilot study of the questionnaire (30 respondents; July 2015). Participants evaluated the statements as true or false, or if they did not know the correct answer they could choose the option 'Don't know'. Each participant obtained a total knowledge score composed of the sum of correct answers, as guided by methods used by Uggioni and Salay (2012). A correct answer was scored as 1, and wrong or 'Don't know' answers were scored as 0 for all 20 statements. The knowledge score of each participant was placed on a scale from 0 to 20.

A total of 330 residents of various parts of Australia participated in the survey. The overall response rate was 82.5%. All participants took part in the study on a voluntary basis, and their participation was therefore considered to be based on their interest in the issue of mining (similar to Zhang et al., 2015). Table 1 presents the structure of the survey sample according to socio-demographic information on the survey participants, their experience of mining activities and their main information sources about mining.

3.3. Statistical analyses

The effect of respondents' demographic characteristics, their experience with mining, and their sources of information about mining activities (Table 1) on their knowledge score (dependent variable) was analysed by Generalized Linear Models (GLMs). As a quantitative response variable, the knowledge score was converted into a variable with binomial distribution comprising two vectors – the actual number of points for correct answers and the number of points not scored (incorrect answers and Don't knows). For example, if the number of points scored by a certain respondent was 14, the number of points not scored was 6. The value 14 represents the respondent's successful responses, and is a measure of the respondent's range of knowledge, while the 6

Table 1
Information about participants: their demographics, experience with mining activities, and their main sources of information about mining. The percentage in brackets in the right column shows the structure of the survey sample in each category of a variable.

Socio-demographic characteristics	Categories (%)
Age	18–29 years (17.0%); 30–49 years (39.7%); 50–64 years (33.3%); over 65 years (10.0%)
Education	University degree (83.9%); Lower than university level (16.1%)
Gender	Male (57.0%); Female (43.0%)
Life in Australia (i.e. how long the participant has been living in Australia)	Whole life (65.8%); Others (34.2%)
Nationality	Australian (87.3%); Others (12.7%)
Place of residence (i.e. character of the region where the respondent currently lives)	Mining region (18.2%); Non-mining region (18.2%); Metropolitan area (63.6%)
Experience of mining activities	**Categories (%)**
Distance of an open pit mine from the respondent's place of residence	Less than 50 km (33.6%); More than 50 km (44.5%); Don't know (21.8%)
Distance of an underground mine from the respondent's place of residence	Less than 50 km (17.6%); More than 50 km (49.1%); Don't know (33.3%)
Occupation / study focus	Mining and/or rehabilitation (33.9%); Others (66.1%)
Place of residence (i.e. character of region where respondent currently lives)	Mining region (18.2%); Non-mining region (18.2%); Metropolitan area (63.6%)
Previous visit to an active mine (i.e. the participant was inside an open pit or underground mine with various purpose of the visit such as work or excursion)	Yes (77.6%); No (22.4%)
Previous visit to a rehabilitated site (i.e. the participant was on a rehabilitated site with various purpose of the visit such as work, trip or excursion)	Yes (64.8%); No (35.2%)
Information source & learning (i.e. the main source of information about mining activities)	**Categories (%)**
Information source – community	Yes (25.5%); No (74.5%)
Information source – job	Yes (44.2%); No (55.8%)
Information source – mass media	Yes (51.5%); No (48.5%)
Information source – study	Yes (32.1%); No (67.9%)

points not scored are a measure of the respondent's lack of knowledge (the higher this value, the lower the level of knowledge). Following the standard rules in modelling with binomial errors (Crawley, 2007), we used the *cbind* function and bound together two vectors of the response variable into a single object 'y', which comprises both vectors. This single object 'y' was used in further analyses as the response variable, instead of using the original number of points gained. Subsequently, the significance of each explanatory variable was analysed within a separate model using GLM, in order to sort these variables in descending order according to their particular significance in the full model (i.e., the most significant variable was placed first in the full model). Apart from these main variables, all double interactions between the variables were included in the full model. The full model was then simplified, i.e. all non-significant variables ($p > 0.05$) in the last position in the model were excluded step-by-step, using the backward selection procedure (Crawley, 2007). The final model, consisting only of significant variables, was checked using standard statistical diagnostics. All analyses were performed using R statistical freeware, version 3.0.2 (R Core Team, 2013).

4. Results

Data analysis showed that the knowledge score varied according to all three groups of variables from the tested model – demographic characteristics, experience with mining activities, and information sources about mining. The particular factors and their interactions that significantly affected respondents' knowledge of mining activities are presented in the following sections, and also in Table 2, Table 3 and Fig. 2. Their effect sizes (coefficients of determination, R^2) are presented in Tables 2 and 3. The influence of the predictor variables in the following sections is described in terms of their effects (i.e. regression coefficients) and their significance (p-values).

4.1. Demographic characteristics

The respondents' knowledge was affected by gender ($p < 10^{-6}$; $R^2 = 0.020$) with men showing higher levels of knowledge than women. The second significant demographic variable was the level of the respondents' education ($p = 0.04$; $R^2 = 0.007$). Respondents with university degrees showed slightly higher levels of knowledge than respondents with lower education (Table 2). Other demographic parameters: nationality, whether the respondent was born in Australia, and age, did not influence the respondents' knowledge of mining activities

Table 2
Factors with a significant influence on knowledge of mining activities. The factors are listed in order according to their significance (p-value), from the highest to the lowest, in each of the three surveyed groups (df – degree of freedom; dev. – the amount of variability explained by the variable in the model; R^2 – the proportion of variability explained by the variable in the model).

Factors and their categories **Socio-demographic characteristics**	Average knowledge score	df	dev.	R^2	p
Gender		1	26.51	0.020	$< 10^{-6}$
Male	14.80				
Female	12.17				
Education		1	9.27	0.007	0.04
University degree	13.91				
Lower than university	12.38				
Experience of mining activities					
Previous visit to an active mine		1	47.88	0.037	$< 10^{-6}$
Yes	14.61				
No	10.42				
Previous visit to a rehabilitation site		1	27.63	0.021	$< 10^{-6}$
Yes	14.79				
No	11.60				
Occupation / study focus		1	16.38	0.013	$< 10^{-4}$
Mining and/or rehabilitation	15.79				
Others	12.58				
Information source & learning					
Information source – job		1	5.36	0.004	0.02
Yes	15.43				
No	12.27				
Information source – study		1	4.06	0.003	0.04
Yes	14.87				
No	12.65				

Table 3
Significant interactions between factors influencing the respondents' knowledge of mining. The factors are listed in their order of significance (p-value), from the highest values to the lowest values (df – degrees of freedom; dev. – the amount of variability explained by the interaction in the model; R^2 – the proportion of variability explained by the interaction in the model).

Interactions between factors	Average knowledge score		df	dev.	R^2	p
Life in Australia: Information source – community	Community	Others	1	33.64	0.026	$< 10^{-6}$
Living since birth in Australia	14.27	13.22				
Others	11.27	14.59				
Previous visit to a rehabilitated site: Information source – study	Study	Others	1	17.11	0.013	$< 10^{-4}$
Mine visit	15.45	14.37				
No visit	12.88	11.27				
Previous visit to an active mine: Information source – study	Study	Others	1	13.36	0.010	$< 10^{-3}$
Mine visit	15.12	14.31				
No visit	12.92	9.94				
Information source – study: Information source – community	Community	Others	1	13.01	0.010	$< 10^{-3}$
Study	14.59	15.00				
Others	12.74	13.20				
Distance from an open pit mine: Education	University degree	Lower than university	1	11.18	0.009	$< 10^{-3}$
50 km and less	14.56	14.30				
More than 50 km	14.47	11.52				
Don't know	11.86	10.50				
Distance from an open pit mine: Information source – community	Community	Others	1	9.53	0.007	0.002
50 km and less	13.50	15.09				
More than 50 km	13.45	14.16				
Don't know	13.54	11.25				
Distance from an open pit mine: Previous visit to an active mine	Visit	No visit	1	8.55	0.007	0.003
50 km and less	15.19	9.39				
More than 50 km	14.42	11.92				
Don't know	13.63	9.81				
Age: Information source – study	Study	Others	1	8.35	0.006	0.004
18–29 years	14.63	10.42				
30–49 years	14.98	13.81				
50–64 years	14.70	12.86				
over 65 years	16.00	13.96				
Distance from an open pit mine: Nationality	Australian	Others	1	7.74	0.006	0.005
50 km and less	14.55	14.11				
More than 50 km	13.88	15.06				
Don't know	11.24	13.06				
Previous visit to an active mine: Previous visit to a rehabilitated site	Rehabilitation visit	No visit	1	6.91	0.005	0.009
Mine visit	15.11	13.14				
No visit	12.13	9.65				
Previous visit to an active mine: Information source – community	Community	Others	1	6.44	0.005	0.010
Mine visit	13.69	14.96				
No visit	12.25	10.07				
Age: Education	University degree	Lower than university	1	5.90	0.005	0.015
18–29 years	13.39	10.75				
30–49 years	14.38	12.46				
50–64 years	13.34	12.92				
over 65 years	14.56	13.33				
Education: Information source – mass media	Mass media	Others	1	5.38	0.004	0.020
University degree	13.12	14.81				
Lower than university	12.09	12.60				
Nationality: Information source – mass media	Mass media	Others	1	5.03	0.004	0.020
Australian	12.92	14.40				
Others	13.59	14.36				
Distance from an underground mine: Nationality	Australian	Others	1	4.92	0.004	0.020
50 km and less	14.22	14.33				
More than 50 km	14.52	15.12				
Don't know	11.74	13.59				
Life in Australia: Education	University degree	Lower than university	1	4.51	0.003	0.030
Living in Australia since birth	13.75	12.55				
Others	14.19	11.73				
Previous visit to an active mine: Education	University degree	Lower than university	1	3.99	0.003	0.045
Visit	14.94	12.88				
No visit	10.37	10.67				

(see Table 1).

4.2. Experience with mining activities

A significant connection was found between the effects of respondents' experience with mining and their level of knowledge. The factor with the strongest effect on knowledge of mining activities was a participant's previous visit to an active mine ($p < 10^{-6}$; $R^2 = 0.037$). Respondents who had visited an active mine obtained higher knowledge scores than respondents without this experience, and the difference in knowledge scores between mine visitors and others was the highest among all assessed factors (Table 2). Similarly, a previous visit to a rehabilitated area had a highly significant positive influence on participants' knowledge ($p < 10^{-6}$; $R^2 = 0.021$). However, the average knowledge of visitors to a rehabilitated area was lower than the knowledge of visitors to an active mine. As regards the occupation or the study focus of the respondents, employees and students in the field of mining showed greater knowledge than participants from other fields

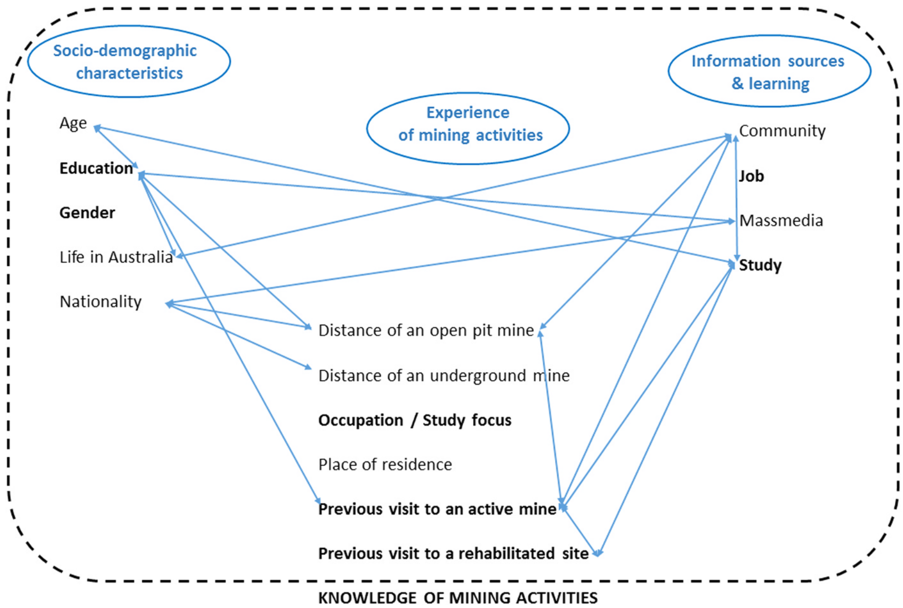

Fig. 2. A scheme of factors affecting knowledge of mining activities. The three surveyed groups of factors are represented in circles. Significant single factors are shown in bold. Significant interactions between factors are shown by arrows.

($p < 10^{-4}$; $R^2 = 0.013$). Their average knowledge score was the highest among all groups of respondents (Table 2). Other variables represented experience with mining as place of residence, distance from an open pit mine / underground mine from the respondent's place of residence (see Table 1) did not influence the respondents' knowledge of mining activities.

4.3. Information sources on mining

Two of the four analysed information sources were indicated as significant factors influencing the knowledge score: job ($p = 0.02$; $R^2 = 0.004$) and study ($p = 0.04$; $R^2 = 0.003$; Table 2). Participants who indicated their job or their studies as their main information source about mining achieved higher knowledge scores than other respondents. By contrast, the use of mass media and the community as the main information sources about mining (see Table 1) did not influence the respondents' knowledge of mining activities.

4.4. Interactions between factors

Data analyses showed that 17 out of a total of 45 analysed interactions between factors had a significant influence on the participants' knowledge of mining activities. All significant interactions are listed in Table 3, and are shown in Fig. 2. A previous visit to an active mine, education, as well as information sources from their community or from their studies, and the distance of an open pit mine from the respondent's residence were the interactions that had the greatest influence on the respondents' knowledge.

5. Discussion

Although knowledge has been described as an abstract construct (Hunt, 2003), our research has demonstrated that it can be a qualitatively measured variable with predictors analysed using methods and analytical techniques taken from the social sciences. Our findings support our hypothesized model (Fig. 1), and have shown that socio-demographic characteristics, experience with mining and mine rehabilitation, and sources of information about mining, together with their mutual interactions, significantly affect respondents' knowledge of mining activities of the coal mining sector. The influence of the predictor variables in the following sections is described in terms of their effects (i.e. regression coefficients) and their significance (p-values). Several notable lessons can be learned from this survey: (1) the complexity of the model is essential – knowledge is built on the coexistence of factors and on interactions between them, (2) direct experience has a crucial effect on knowledge, (3) sources of information shape knowledge, but some sources have more impact than others, (4) socio-demographics affects knowledge, but at varying levels of significance.

The complexity of the model

The clearest finding that emerged from our study is that the complexity of the proposed model plays a key role in shaping the knowledge of coal mining activities. We determined that all three surveyed groups of variables, and their interactions, were equally significant factors influencing knowledge. Furthermore, as shown in Fig. 2, the significant interactions identify the existence of linkages between factors inside a group (e.g. between study and community as the main information sources) and also between factors from different groups through the entire hypothesized model (e.g. between previous visit to an active mine and education). These linkages suggest mutual connections between factors, and how they are influenced by each other. For example, some factors have a significant position in a model exclusively as a part of interactions influenced by other factors, but their impact on knowledge of mining by themselves – as single factors – was not recognized (e.g. variables such as distance between a participant's place of living and an open pit mine; community as a major information source about mining). Our findings demonstrate that the complexity of the model is based on 7 strong individual factors that independently affect knowledge of mining, and 17 significant interactions between factors that affect knowledge through the whole hypothesized model.

Direct experience is crucial

Our study indicates that direct experience of an active mine or a rehabilitated site is the strongest predictor of knowledge of mining activities, both in its significance (p-values) and the effect size (R^2). This is supported by our further findings that the average knowledge scores of respondents who had not previously visited a mine or a rehabilitated site were very low in all interactions with other factors.

Even more importantly, respondents who had not visited either a mine or a rehabilitated site showed the lowest knowledge of mining activities of all evaluated groups of respondents. In addition, there is evidently a synergistic effect of both types of direct experience, from a mining site and from a rehabilitated site. This strongly supports observations made by Fuller et al. (2006), who considered field visits to be a deeper form of learning, and also the findings of Boyle et al. (2007) that direct experience makes understanding more enjoyable and thus more effective. Greater knowledge supported by direct experience with mining activities can be connected with higher interest and motivation, which have been described as the “engine of learning” (Paris and Turner, 1994, p. 217), either as a reason for a visit or as a consequence of a visit (see e.g. Schunk and Usher, 2012; Brophy, 2010). Similarly, respondents working or studying in the field of mining showed greater knowledge of mining activities than others. This is in accordance with Uggioni and Salay (2012), who found that a related field of study or occupation have increasing effects on knowledge. There can be a synergistic effect of direct experience with mining and work in mining that can influence the level of knowledge. Higher knowledge can be also connected with employee's benefits such as continuing education courses in mining, participation in scientific conferences, workshops and the like. Furthermore, Luchinskaya (2014) pointed out that graduates from technical disciplines (i.e. science, technology, engineering) use a greater amount of knowledge in their work than other groups of graduates, and apply the knowledge and skills gained during their university studies in their current job to a greater extent than other graduates. Our results also demonstrate that direct experience via a mine visit has an even stronger effect on the knowledge of university educated respondents than on participants with lower education. However, ‘non visitors’ obtained similar knowledge scores irrespective of their education.

Sources of information about mining shape knowledge in various ways

Our research supports previous findings that some sources of information play a more important role in shaping knowledge of mining activities than others (e.g., Wijnhoven, 1999), both as single factors and in interaction with other variables. However the effect sizes (R^2) were not high. More specifically, respondents’ main information source for their job and for their studies were recognized as significant single factors increasing their knowledge of mining activities. This is consistent with the findings of Uggioni and Salay (2012). Although *study* as an information source was found to be involved in four significant interactions with other factors, the factor *job* was not influenced by any other factor. The interactions indicate that the effect on their knowledge of respondents’ studies as their main information source was stronger among younger participants than among older participants. In addition, information acquired from respondents’ studies had a stronger impact on their knowledge when combined with a previous visit by the respondent to an active mine or to a rehabilitated site than when there was no previous direct experience. These findings of ours are in accordance with findings reported by Fuller et al. (2006) and Boyle et al. (2007).

However, community and mass media as respondents’ main sources of information about mining were indicated as important exclusively in their interactions with other factors in the model. Participants who used other information sources than their community showed the greatest knowledge of mining activities. As regards information from their community, we found that the most significant interaction in the model was the linkage between the community and the length of the respondents’ residence in Australia. While the effect of the information from the community was greater for participants who had lived in Australia for their whole life, the effect of information from the community on other participants was absolutely different. This may suggest that Australian-born citizens and immigrants are surrounded by different communities (see e.g. Thomas et al., 2016), and this can significantly affect the knowledge of the respondents. University graduates who indicated that the mass media was their main source of information showed significantly lower knowledge than university graduates who used other information sources. However the knowledge of respondents with lower education was unaffected by their source of information. This suggests a synergistic effect of education and the use of major information sources other than the mass media. These findings support the observation that information obtained from the community and from the mass media can contain gossip and rumours, and can thus be manipulated and shaped to a greater extent by personal attitudes than by factors that can generally lead to improved knowledge (Bhattacharya, 2016; Beersma and Van Kleef, 2012). Rumours have been described as a window into people's uncertainties and anxieties (Kelley, 2004). Considering that we live in an age of a serious lack of certainty (Doyle, 2010), rumours can seriously influence our perceptions, our judgements and our learning (DiFonzo and Bordia, 2002), and thus our overall knowledge. By contrast, information sources such as jobs and studies are based on facts, academic education and professional skills, and their impact on knowledge is more effective (Guskey and Huberman, 1995).

Socio-demographics affect knowledge with diverse significance

Our study indicates that particular demographic parameters affect knowledge of mining activities in various ways and more or less strongly. The most significant single factors were the respondent's gender and education. Education formed important links with five other factors in the model, while gender did not interact significantly with any other factors (see Fig. 2). These linkages illustrate that education has a stable position in the model. It is fundamentally connected with other factors in its effect on knowledge, whereas gender affects knowledge only as a solid single factor.

We have confirmed that men showed greater knowledge of mining activities than women. This is consistent with other studies, which have suggested that males outperform females in general knowledge (e.g. Steinmayr et al., 2015). However, Schroeders et al. (2016) pointed out that while women performed better in health-related topics (e.g. medicine, ageing), men showed better knowledge in the natural sciences (e.g. engineering, physics). These gender differences in knowledge may be related to differences in interests between the genders. Males tend to be more interested in engineering and science, while females tend to show greater interest in social and artistic domains (Wang and Degol, 2017). These observations account for our finding that mining, as a technical discipline, is generally more interesting for men than for women, and this higher level of interest may lead to greater knowledge of mining among men (Rotgans and Schmidt, 2014).

Our results also demonstrate that higher education supports higher knowledge. Respondents with a university degree generally had a greater amount of knowledge than respondents with lower education. This is in accordance with Uggioni and Salay (2012), who reported that a higher level of education correlates positively with a higher level of knowledge. A University of Oxford study (University of Oxford, 2001, p. 4) states that “*some advocates of accountability and educational efficiency tend to represent higher education as a knowledge assembly line*”. We have confirmed that participants with university education showed greater knowledge than others in four out of five significant interactions. Only the effect of the mass media as the main information source on mining was stronger than the effect of education, as discussed above. We have also shown that the effect of education is strong through all age groups of respondents, though it is strongest among younger participants. This can be connected with experience and professional knowledge, which is more closely related to age than to education level, as has been observed by Peterson et al. (2017). Education has been shown to have a strong effect on respondents’ knowledge, both for the group of respondents living in proximity to an open pit and for the group of respondents living over 50 km from a pit. However, there was evidently a smaller difference in knowledge between less educated and more highly-educated people living in the proximity of a pit. This may be connected with the greater direct experience with mining activities of respondents living close to a pit. This experience shapes their knowledge more strongly than their education, as has been observed by Marzano (2004).

5.1. Implications and recommendations

As the agendas of sustainable mining development continue to advance, it will be necessary to place increasing importance on non-material assets, such as knowledge (Prno and Slocombe, 2014). Our study suggests important ramifications for the coal mining industry, for policy makers and for scientists. Coal mining companies often focus their interest strictly on directly mitigating the negative impacts caused by mining operations. They provide local employment, they invest in housing and local infrastructure, and they remediate landslides and other destructive consequences of mining activities, rather than focusing on cognitive assets (Lyytimäki and Peltonen, 2016; Van der Plank et al., 2016; Barkemeyer et al., 2015; Moffat and Zhang, 2014). However, Schiuma (2012) has pointed out that the way to be successful is by putting more emphases on cognitive sources. As Hunt (2003) has highlighted, knowledge is an important intangible asset of a company that should not be neglected. This is particularly necessary in mining, where stakeholders' acceptance of mining operations needs to be gained and maintained, in order to avoid financial losses in mining development (Owen and Kemp, 2018; Moffat and Zhang, 2014; Prno, 2013).

Existing research shows that a higher level of knowledge can have a positive effect on attitudes and on acceptance (Baharoon et al., 2016; Badera, 2013), and can also shape people's behaviour (Aertsens et al., 2011). We therefore recommend that the coal mining industry take steps to increase knowledge and understanding of their operations including all environmental, legal and social aspects to ensure greater acceptance by key stakeholder groups. Our study has demonstrated that direct experience with mining and mine rehabilitation is the most important factor affecting knowledge of mining activities of the coal mining sector. Mining companies, councils and other relevant organizations focused on corporate social responsibility are recommended to include direct experience with mining and mine rehabilitation in their strategies to support social capital and to increase public awareness and understanding on mining operations and their impacts and benefits. The ways to strengthen direct experience with mining could be for instance to involve field trips to mining and rehabilitated areas in school and community education, mining and rehabilitation planning and community involvement programs (Basu et al., 2015). Our study also shows that knowledge decreases with increasing distance between a participant's place of residence and an open pit mine, irrespective of the participant's level of education. On the basis of this finding, we recommend to policy makers to work on raising the knowledge of mining particularly in non-mining regions. Community engagement and collaborative approaches that lead to greater knowledge should be included in the development strategies of mining operations of the mining sector (in accordance with Owen and Kemp, 2018; Haalboom, 2016; Frantál, 2016). This is likely to create greater community trust and acceptance of mining activities in the long run.

5.2. Limitations of the study, and future research

The investigation of the present model provides an insight into the concept of stakeholder knowledge of mining activities in the framework of the coal mining sector. The value of our study lies in its analytical approach to knowledge of mining activities, while regarding this knowledge as a measurable concept based on three main groups of predictors and their interactions. The study addresses a knowledge gap by focusing on objective knowledge of mining activities possessed by various stakeholder groups involved in coal industry. Although theoretical frameworks focused on the concepts of attitudes towards mining have already been presented e.g. by Viveros (2017), Zhang et al. (2015), Prno and Slocombe (2014), and Moffat and Zhang (2014), knowledge was a neglected factor in these works.

Although the findings of our study make a significant contribution to understanding what constitutes objective knowledge of coal mining activities, we are aware of some limitations in the study. For instance, the participants were selected from four stakeholder groups involved in coal mining industry. Future research should consider to test the conceptual model on a representative sample and to include the general public as a key group of participants (e.g. Joyce and Thomson, 2000). Further, our respondents were recruited on-line via email invitations. Although the use of the Internet as a communication medium in our study was consistent with the work of Bishop (1997) and Wherett (1999), it has to be recognized that Internet-based surveys have disadvantages as well as disadvantages, as identified by Wright (2005), and by Fricker and Schonlau (2002). Future research may consider the use of via face-to-face interviews, or a combination of face-to-face interview, as shown by e.g., Zhang et al. (2015), and the method used in our study here.

Our study research assessed the objective knowledge of participants via an assessment of statements as true, false or don't know. Future research may explore how sure respondents are about their answers when they evaluate a statement as true or false (see Hunt, 2003). Attention should be also paid to the difference between objective and subjective knowledge of mining activities as already suggested by Klerck and Sweeney (2007). Our study also investigated the main sources of information about mining that respondents used - future research might focus on respondents' trust in the information sources that they use (see Kiousis, 2001).

Our study showed that there is a lack of understanding of the role of stakeholder knowledge of mining activities. There is an evident need for additional future research on the direct connection between knowledge of mining activities, public attitudes to mining and public acceptance of mining operations of the energy sector.

6. Conclusion

People's opinion based on objective knowledge is an important social notion, and is particularly crucial in democratic societies. This is the case when considering the perception of mining, an industry that provides significant social and economic benefits, but also has negative impacts.

In an effort to identify factors that establish community and stakeholder acceptance of coal mining, this paper presents a novel perspective. Our research articulates the importance of stakeholder knowledge of mining and the main factors that constitute that knowledge in the framework of the coal industry. While direct experience, represented by visits to mines and mine rehabilitation sites, conclusively increased knowledge of mining, the effect of particular information sources on knowledge of mining varied. Information obtained from participants' jobs and from their studies always increased their knowledge of mining, but information about mining from the mass media and from the community showed mostly the opposite effect. More importantly, the present research has demonstrated the conceptual model of how various knowledge determinants are related to each other and their effect on knowledge of mining.

We suggest that understanding the factors affecting knowledge of mining activities can help to build effective communication channels and collaboration between various stakeholder groups, the coal mining industry and policy makers. Better knowledge of mining, together with better communication, can minimize conflicts around coal mining operations. The well-informed relevant stakeholders will be able to contribute more fruitfully to discussions about mining projects, and will be able to offer informed suggestions about how best to carry out mining operations. If stakeholders important in decisions on mining development has good knowledge of mining, it will of course continue to oppose poorly conceived mining projects. However, it will also be quicker to support well-planned projects, and access to the benefits of resource development will not be needlessly obstructed.

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References

Aertsens, J., Mondelaers, K., Verbeke, W., Buysse, J., Van Huylenbroeck, G., 2011. The influence of subjective and objective knowledge on attitude, motivations and consumption of organic food. Br. Food J. 113 (11), 1353–1378.
Ayer, A.J., 1958. The Problem of Knowledge. Macmillan and Company, London.
Badera, J., 2013. Local communities' knowledge of lignite surface mining – sources and level of satisfaction: examples from central Poland. Environ. Socio-Econ. Stud. 2, 29–35.
Badera, J., Kocoń, P., 2014. Local community opinions regarding the socio-environmental aspects of lignite surface mining: experiences from central Poland. Energ. Policy 66, 507–516.
Baharoon, D.A., Rahman, H.A., Fadhl, S.O., 2016. Publics' knowledge, attitudes and behavioural toward the use of solar energy in Yemen power sector. Renew. Sust. Energ. Rev. 60, 498–515.
Basu, P.K., Hicks, J., Krivokapic-Skoko, B., Sherley, C., 2015. Mining operations and corporate social responsibility: a case study of a large gold mine in regional Australia. Extr. Ind. Soc. 2, 531–539.
Barkemeyer, R., Stringer, L.C., Hollins, J.A., Josephi, F., 2015. Corporate reporting on solutions to wicked problems: sustainable land management in the mining sector. Environ. Sci. Policy 48, 196–209.
Beersma, B., Van Kleef, G.A., 2012. Why people gossip: an empirical analysis of social motives, antecedents, and consequences. J. Appl. Soc. Psychol. 42 (11), 2640–2670.
Bhattacharya, H., 2016. Mass media exposure and attitude towards spousal violence in India. Soc. Sci. J. 53, 398–416.
Bishop, I.D., 1997. Testing perceived landscape colour difference using the Internet. Landsc. Urban Plan. 37, 187–196.
Boyle, A., Maguire, S., Martin, A., Milsom, C., Nash, R., Rawlison, S., Turner, A., Wurthman, S., Conchie, S., 2007. Fieldwork is good: the student perception and the affective domain. J. Geogr. High. Educ. 31 (2), 299–317.
Brophy, J., 2010. Motivating Students to Learn, 3rd ed. Routledge, New York.
Brucks, M., 1985. The effects of product class knowledge on information search behavior. J. Consum. Res. 12, 1–16.
Campbell, R., Linqvist, J., Browne, B., Swann, T., Grudnoff, M., 2017. Dark Side of the Boom What we do and Don't Know About Mines, Closures and Rehabilitation. The Australia Institute. 〈http://www.tai.org.au/sites/default/files/P192%20Dark%20side%20of%20the%20boom%20FINAL_0.pdf〉 (accessed 10.9.2018).
Crawley, M.J., 2007. The R Book. Wiley & Sons, Chichester.
Dagger, T.S., O'Brien, T.K., 2010. Does experience matter? Differences in relationship benefits, satisfaction, trust, commitment and loyalty for novice and experienced service users. Eur. J. Mark. 44 (9/10), 1528–1552.
Davidson, A.R., Yantis, S., Norwood, M., Montano, D.E., 1985. Amount of information about the attitude object and attitude–behaviour consistency. J. Pers. Soc. Psychol. 49, 1184–1198.
de Jong, T., Ferguson-Hessler, M.G.M., 1996. Types and qualities of knowledge. Educ. Psychol. 31 (2), 105–113.
DiFonzo, N., Bordia, P., 2002. Rumor and stable-cause attribution in prediction and behaviour. Organ. Behav. Hum. Dec. 88, 329–353.
Disman, M., 2008. How to Produce Sociological Knowledge. User Guide. Karolinum, Prague.
Doyle, C., 2010. The Illusion of Certainty. Faculty of Education, Memorial University of Newfoundland. 〈http://www.mun.ca/educ/faculty/mwatch/Doyle%20-%20The%20Illusion%20of%20CertaintyApril%204.pdf〉 (accessed 20 February 2017).
Dunning, D., Heath, C., Suls, J., 2004. Flawed self-assessment: implications for health, education, and the workplace. Psychol. Sci. Public Interest 5, 69–106.
Eklund, E., 2015. Mining in Australia: an historical survey of industry–community relationships. Extr. Ind. Soc. 2, 177–188.
Eagly, A.H., Chaiken, S., 1993. The Psychology of Attitudes. Harcourt, Brace, & Janovich, Fort Worth.
Fabrigar, L.R., Petty, R.E., Smith, S.M., Crites, S.L., 2006. Understanding knowledge effects on attitude-behavior consistency: the role of relevance, complexity, and amount of knowledge. J. Pers. Soc. Psychol. 90, 556–577.
Franks, D.M., Davis, R., Bebbington, A.J., Ali, S.H., Kemp, D., Scurrah, M., 2014. Conflict translates environmental and social risk into business costs. Proc. Natl. Acad. Sci. USA 111 (21), 7576–7581.
Franks, D.M., Brereton, D., Sarker, T., Cohen, T., 2010. Cumulative Impacts: A good Practice Guide for the Australian Coal Mining Industry. Brisbane: Centre for Social Responsibility in Mining and Centre for Water in the Minerals Industry, Sustainable Minerals Institute, The University of Queensland and Australian Coal Association Research Program.
Frantál, B., 2016. Living on coal: mined-out identity, community displacement and forming of anti-coal resistance in the Most region, Czech Republic. Res. Policy 49, 385–393.
Fricker, R.D., Schonlau, M., 2002. Advantages and disadvantages of internet research surveys: evidence from the literature. Field Methods 14, 347–367.
Fuller, I., Edmondson, S., France, D., Higgitt, D., Ratinen, I., 2006. International perspectives on the effectiveness of geography fieldwork for learning. J. Geogr. High. Educ. 30, 89–101.
Guskey, T.R., Huberman, M., 1995. Professional Development in Education: New Paradigms and Practices. Teachers College Press, New York.
Haalboom, B., 2016. Pursuing openings and navigating closures for aboriginal knowledges in environmental governance of uranium mining, Saskatchewan, Canada. Extr. Ind. Soc. 3, 1010–1017.
Hendrychová, M., Kabrna, M., 2016. An analysis of 200-year-long changes in a landscape affected by large-scale surface coal mining: history, present and future. Appl. Geogr. 74, 151–159.
Hilson, G., 2000. Sustainable development policies in Canada's mining sector: an overview of government and industry efforts. Environ. Sci. Policy 3, 201–211.
Hodge, R.A., 2014. Mining company performance and community conflict: moving beyond a seeming paradox. J. Clean. Prod. 84, 27–33.
Hunt, P.D., 2003. The concept of knowledge and how to measure it. J. Intellect. Capital 4 (1), 100–113.
ITA, 2017. International Trade Administration. Australia – Mining. 〈https://www.export.gov/article?Id=Australia-Mining〉 (accessed 20.1.2018).
Joyce, S., Thomson, I., 2000. Earning a social license to operate: Social acceptability and resource development in Latin America. CIM (Can. Min. Metall.) Bull. 93 (1037), 49–53.
Kelley, S.R., 2004. Rumors in Iraq: A Guide to Winning Hearts and Minds (Master's thesis). Naval Postgraduate School, Monterey.
Kemp, D., Owen, J.R., Van de Graaff, S., 2012. Corporate social responsibility, mining and "audit culture". J. Clean. Prod. 24, 1–10.
Kiousis, S., 2001. Public trust or mistrust? Perceptions of media credibility in the information age. Mass Commun. Soc. 4, 381–403.
Klerck, D., Sweeney, J.C., 2007. The effect of knowledge types on consumer-perceived risk and adoption of genetically modified foods. Psychol. Mark. 24, 171–193.
Kraaijenbrink, J., Wijnhoven, F., Groen, A., 2005. Do Knowledge Sources Matter? Exploring the Effect of Knowledge Sources on Knowledge Integration Processes, OKLC 2005, 17-19 March, Boston. 〈http://www2.warwick.ac.uk/fac/soc/wbs/conf/olkc/archive/oklc6/papers/kraaijenbrinkwijnhoven_groen.pdf〉 (accessed 20 February 2017).
Krosnick, J.A., Petty, R.E., 1995. Attitude strength: an overview. In: Petty, R.E., Krosnick, J.A. (Eds.), Attitude Strength: Antecedents and Consequences. Erlbaum, Mahwah, pp. 1–24.
Laplonge, D., 2017. The "un-womanly" attitudes of women in mining towards the environment. Extr. Ind. Soc. 4 (2), 304–309.
Lima, A.T., Mitchell, K., O'Connell, D., Verhoeven, J., Van Cappellen, P., 2016. The legacy of surface mining: remediation, restoration, reclamation and rehabilitation. Environ. Sci. Policy 66, 227–233.
Litmanen, T., Jartti, T., Rantala, E., 2016. Refining the preconditions of a social licence to operate (SLO): reflections on citizens' attitudes towards mining in two Finnish regions. Extr. Ind. Soc. 3 (3), 782–792.
Luchinskaya, D., 2014. Do graduates use the skills and knowledge gained from their degrees? GMT e-newsletter. GMT winter 2013/2014. 〈https://www2.warwick.ac.uk/fac/soc/ier/publications/2014/luchinskaya_2014_graduate_trends.pdf〉 (accessed 20 February 2017).
Lyytimäki, J., Peltonen, L., 2016. Mining through controversies: public perceptions and the legitimacy of a planned gold mine near a tourist destination. Land Use Policy 54, 479–486.
Marzano, Robert J., 2004. Building Background Knowledge for Academic Achievement: Research on What Works in Schools. ASCD.
Masige, S., 2017. Mining sector accounts for 15 per cent of Australia's economy: Deloitte. Australian Mining. 〈https://www.australianmining.com.au/news/mining-sector-accounts-15-per-cent-australias-economy-deloitte/〉 (accessed 10.9.2018).
Miller, J.G., 1978. Living Systems. McGraw-Hill, New York.
Moffat, K., Zhang, A., 2014. The paths to social licence to operate: an integrative model explaining community acceptance of mining. Res. Policy 39, 61–70.
Moffat, K., Zhang, A., Boughen, N., 2014. Australian attitudes toward mining. Citizen Survey – 2014 results. CSIRO, Australia (EP 146276).
Moran, C.J., Lodhia, S., Kunz, N.C., Huisingh, D., 2014. Sustainability in mining, minerals and energy: new processes, pathways and human interactions for a cautiously optimistic future. J. Clean. Prod. 84, 1–15.
Neuman, W.L., 2006. Social Research Methods: Qualitative and Quantitative Approaches. Pearson/A&B, Boston.
Nijhof, A., de Bruijn, T., Fisscher, O., Jonker, J., Karssing, E., Schoemaker, M., 2006. Learning to be responsible: developing competences for organization-wide CSR. In: Jonker, J., de Witte, M. (Eds.), The Challenge of Organizing and Implementing

Corporate Social Responsibility. Palgrave Macmillan, New York, pp. 148–172.
Owen, J., Kemp, D., 2018. Mine Closure and Social Performance: An Industry Discussion Paper. Centre for Social Responsibility in Mining, Sustainable Minerals Institute, The University of Queensland, Brisbane.
Pardi, P., 2011. What is Knowledge? 〈http://www.philosophynews.com/author/paulp.aspx〉 (accessed 20 February 2017).
Paris, S.G., Turner, J.C., 1994. Situated motivation. In: Pintrich, P.R., Brown, D.R., Weinstein, C.E. (Eds.), Student Motivation, Cognition, and Learning: Essays in Honor of Wilbert J. McKeachie. Lawrence Erlbaum, Hillsdale, pp. 213–237.
Peterson, D.J., Gargya, S., Kopeikin, K.S., Naveh-Benjamin, M., 2017. The impact of level of education on age-related deficits in associative memory: behavioral and neuropsychological perspectives. Cortex 91, 9–24.
Preuss, L., 2010. Barriers to innovative CSR: the impacts of organisational learning, organisational structure and the social embeddedness of the firm. In: Louche, C., Idowu, S.O., Filho, W.L. (Eds.), Innovative CSR: From Risk Management to Value Creation. Greenleaf, Sheffield, pp. 331–351.
Prno, J., Slocombe, D.S., 2014. A systems-based conceptual framework for assessing the determinants of a social license to operate in the mining industry. Environ. Manag. 53, 672–689.
Prno, J., 2013. An analysis of factors leading to the establishment of a social licence to operate in the mining industry. Res. Policy 38, 577–590.
Que, S., Awuah-Offei, K., Samaranayake, V.A., 2015. Classifying critical factors that influence community acceptance of mining projects for discrete choice experiments in the United States. J. Clean. Prod. 87, 489–500.
R Core Team, 2013. R: A language and environment for statistical computing. R Foundation for Statistical Computing. 〈http://www.R-project.org/〉 (accessed 20 February 2017).
Reips, U.D., 2002. Standards for Internet-based experimenting. Exp. Psychol. 49, 243–256.
Rotgans, J.I., Schmidt, H.G., 2014. Situational interest and learning: thirst for knowledge. Learn. Instr. 32, 37–50.
Schiuma, G., 2012. Managing knowledge for business performance improvement. J. Knowl. Manag. 16 (4), 515–522.
Schroeders, U., Wilhelm, O., Olaru, G., 2016. The influence of item sampling on sex differences in knowledge tests. Intelligence 58, 22–32.
Schunk, D.H., Usher, E.L., 2012. Social cognitive theory and motivation. In: Ryan, R.M. (Ed.), The Oxford Handbook of Human Motivation. Oxford University Press, Oxford, pp. 13–27.
Selnes, F., Troye, S.V., 1989. Buying expertise, information search, and problem solving. J. Econ. Psychol. 10 (3), 411–428.
Selnes, F., Gronhaug, K., 1986. Subjective and objective measures of product knowledge contrasted. Adv. Consum. Res. 13, 67–71.
Sitzmann, T., Ely, K., Brown, K.G., Bauer, K., 2010. Self-assessment of knowledge: a cognitive learning or affective measure? Acad. Manag. Learn. Edu. 9, 169–191.
Steinmayr, R., Bergold, S., Margraf-Stiksrud, J., Freund, P.A., 2015. Gender differences on general knowledge tests: are they due to differential item functioning? Intelligence 50, 164–174.
Thomas, R.L., Chiarelli-Helminiak, C.M., Ferraj, B., Barretter, K., 2016. Building relationships and facilitating immigrant community integration: an evaluation of a cultural navigator program. Eval. Program Plann. 55, 77–84.
Uggioni, P.L., Salay, E., 2012. Consumer knowledge concerning safe handling practices to prevent microbiological contamination in commercial restaurants and socio-demographic characteristics, Campinas/SP/Brazil. Food Control 26, 331–336.
University of Oxford, 2001. Paper 1: Higher education and higher learning. University of Oxford, Institute for the Advancement of University Learning. 〈https://www.learning.ox.ac.uk/media/global/wwwadminoxacuk/localsites/oxfordlearninginstitute/documents/supportresources/lecturersteachingstaff/resources/resources/Higher_Education_and_Higher_Learning.pdf〉 (accessed 20 February 2017).
Van der Plank, S., Walsh, B., Behrens, P., 2016. The expected impacts of mining: stakeholder perceptions of a proposed mineral sands mine in rural Australia. Res. Policy 48, 129–136.
Viveros, H., 2017. Unpacking stakeholder mechanisms to influence corporate social responsibility in the mining sector. Res. Policy 51, 1–12.
Wang, Z., Lechner, A.M., Baumgartl, T., 2018. Mapping cumulative impacts of mining on sediment retention ecosystem service in an Australian mining region. Int. J. Sust. Dev. World 25 (1), 69–80.
Wang, M.T., Degol, J.L., 2017. Gender gap in science, technology, engineering, and mathematics (STEM): current knowledge, implications for practice, policy, and future directions. Educ. Psychol. Rev. 29, 119–140.
Webb, D., 2000. Understanding customer role and its importance in the formation of service quality expectations. Serv. Ind. J. 20, 1–21.
Wherett, J.R., 1999. Issues in using the Internet as a medium for landscape preference research. Landsc. Urban Plan. 45, 209–217.
Wijnhoven, F., 1999. Managing Dynamic Organizational Memories: Instruments for Knowledge Management. Twente University Press, Enschede.
Wright, K.B., 2005. Researching internet-based populations: advantages and disadvantages of online survey research, online questionnaire authoring software packages, and web survey services. J. Comput.-Mediat. Comm. 10, 1–15.
Zhang, A., Moffat, K., Lacey, J., Wang, J., González, R., Uribe, K., Cui, L., Dai, Y., 2015. Understanding the social licence to operate of mining at the national scale: a comparative study of Australia, China and Chile. J. Clean. Prod. 108 (Part A), 1063–1072.