

Knowledge Beliefs and Problem-solving Capabilities among South African School Principals

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ABSTRACT A common thread in contemporary research on principal leadership refers to the ways in which principals go about solving complex problems. Research evidence implies that for effective problem-solving to take place, principals should also be aware of their own epistemological beliefs or knowledge assumptions. This concept leads to a model in which the respective link with a principal's ability to solve a complex problem is determined by his or her epistemological beliefs. Research done so far on principals' capabilities with regard to complex problem-solving has very seldom linked this construct with the construct of knowledge assumptions. The purpose of this current study, based on a qualitative exploratory study among a group of school principals in the Gauteng province of South Africa, was to examine the relationship between the two constructs of epistemological beliefs and the quality of thinking during problem-solving activities when participants first thought about a complex and uncertain (ill-structured) problem. An epistemological questionnaire, using a five-point Likert scale, was used as research instrument. Although the results showed that there was not a notable and systematic connection between epistemological beliefs and complex problem-solving among participants, the study provided substantial justification for looking at epistemological beliefs in the study of problem-solving capabilities among school principals world-wide.

INTRODUCTION

The majority of problems often confronting school principals in the workplace can mostly be defined as complex and uncertain, that is problems in which there is real uncertainty about how they can most effectively be solved. These problems are being referred to in the research literature as 'ill-structured' (Voss and Post 1988; Jonassen 1997; Bendixen and Schraw 2001). An ill-structured problem is a problem situation in which the existing state and the desired state of the problem are unclear and, hence, methods of reaching the desired state cannot be found. According to these authors, ill-structured problems are unique interpersonal activities and require people to express, inter alia, personal beliefs of knowledge. For this reason, cognitive processes alone are insufficient requirements for solving them, mainly because knowledge assumptions or epistemological beliefs affect the ways that people naturally tend to approach these problems (Mandler 1989; Jonassen 1997; Rogoff 1990, 2003; Oh and Jonassen 2007; Angeli and Valanides 2012).

Empirical research findings have indeed shown that a person's assumptions of knowledge do affect cognitive reasoning during problem-solving, specifically with regard to ill-structured problems (Schommer and Dunnell 1997;

Schraw 2001; Bendixen and Schraw 2001; Sinatra et al. 2003; Angeli and Valanides 2012). These research findings have, however, not considered the role of principals' epistemological beliefs on problem-solving capabilities in the school context.

Problem Statement and Purpose with the Study

The main purpose of this study was to examine epistemological beliefs during problem-solving activities among a number of secondary school principals in order to better understand how principals with different types of epistemological beliefs think about an ill-structured and controversial problem. With this in mind, the main problem statement for the study can now be phrased as follows: How do epistemological beliefs influence the way that school principals think about a problem? Before dealing with the research problem, the constructs of epistemological beliefs (EBs) and ill-structured problem-solving will first be conceptualised.

Conceptualising the Construct of 'Knowledge Assumptions'

To clarify the aim of this study, a brief discussion and summary of the construct of 'assumption of knowledge' follows. According to

Richardson (1994), the study of the assumption of knowledge is known as 'the epistemology', which means 'the theory or science of knowledge', and it is mainly concerned with the nature, scope and limitations of knowledge. This science considers topics such as the nature of knowledge and how it is acquired. In simpler terms, the science of knowledge explains 'how we know what we know.' Much of the debate in this field has focused on analysing the nature of knowledge and how it relates to connected notions such as truth, belief and justification (Brownlee et al. 2001).

According to the epistemology or theory or science of knowledge, people's assumptions of knowledge can be conceptualised in relation to Schommer's 1990s taxonomy. At that time Schommer (1990, 1994, 1998) challenged Perry's (1970) theoretical stance, submitting that beliefs are too complex to be captured in a single dimension, and proposed a multidimensional construct which she called 'epistemological beliefs' (EBs). Schommer (1990) sees EBs as a system of more or less independent beliefs. By 'system' Schommer (1993) means that there is more than one belief to consider, and by more or less independent she means that a person may hold some sophisticated beliefs about knowledge but may also have some less sophisticated views. With this in mind, Schommer (1993) identified the following four EBs as the most important independent beliefs about human knowledge:

- ♦ A belief in simple knowledge. Some people believe that knowledge is best characterised as isolated facts, which they perceive as separate and unrelated.
- ♦ A belief in absolute knowledge. Some people believe that knowledge is absolute, which means that they perceive knowledge as a certainty and argue that there is no error in scientific discoveries.
- ♦ A belief in innate knowledge. Some people hold that learning ability is fixed and that human ability is not the product of achievement and not subject to improvement.
- ♦ A belief in quick learning. This view holds that learning is not a gradual process but that when it happens, it happens quickly and instantly.

In the late 1980s, Schommer (1990) and others argued for an alternative approach to conceptualising people's EBs. She argued that epis-

temologies can be separated into a number of independent beliefs and consequently proposed three further beliefs, namely a belief in how 'complex' knowledge is (ranging from complex to simple), a belief in how 'certain' knowledge is (ranging from highly certain to highly uncertain) and a belief in the 'source' of knowledge (for example, knowledge coming from authority). According to Schommer (1990), these beliefs are more or less independent from one another. For instance, a school principal may believe in complex but certain knowledge, complex but uncertain knowledge, simple and certain knowledge or simple but uncertain knowledge.

Schommer (1990) went on to propose an influential way to measure EBs. In contrast to developmental work, which had relied principally on interviews and, to a lesser extent, on written, open-ended questions, she developed a questionnaire, widely referred to as the Epistemological Questionnaire (EQ), which is still regularly used today in studies on EBs. Other researchers in this field have since developed analogous scales tapping overlapping but not identical sets of EBs. Hofer (2000) has, for example, developed a questionnaire with items that also considered four similar beliefs. Hofer's (2000) questionnaire was designed so that the questions also referred to a specific field. In other words, in contrast to the questions developed by Schommer, his questions did not refer to knowledge in general but to knowledge in a specific field such as science or mathematics. The first two epistemological beliefs in Hofer's questionnaire, namely 'certainty' and 'simplicity', were about the nature of knowledge, while the third and fourth beliefs dealt with the issue of how a person comes to 'know' or 'learn' something, namely the 'source of and justification for knowledge'.

Beyond identifying these four dimensions in personal epistemology, Schommer also demonstrated "how these beliefs may influence comprehension and cognition of academic tasks and her work has been the most concerned with classroom learning" (Hofer and Pintrich 1997: 90). Several studies have examined the influence of EBs on academic performance, and results indicate that the former predict the latter. The less students believed in quick learning, fixed ability, simple knowledge and certain knowledge, the higher their academic performance (Schommer 1993, 1998; Schommer et al. 1997; Hofer 2001; Cano 2005).

In conclusion, while much has been theorised, researched and reported about epistemological beliefs over the past few decades, the author has selected and summarised a few additional and relevant conclusions about EBs that have been drawn by different researchers:

- ♦ There is a 'common sense theory of knowledge present in the average person' that develops as the person grows from childhood to adulthood (Kitchener 2002).
- ♦ Some EBs developed earlier than others. For example, EBs about institutional (socially or humanly constructed) facts developed earlier than those about brute (physical, or scientifically tested and proven) facts (Hallett et al. 2002).
- ♦ EBs is context-specific (Kitchener 2002).
- ♦ It appears that tertiary education has a major influence on the development of more sophisticated EBs (Kitchener 2002).
- ♦ Core beliefs about knowing influence other beliefs, knowledge and behaviour (Brownlee et al. 2001).

Since Schommer's 1990 questionnaire is, as already mentioned, still widely used today in various empirical research studies on EBs, it was decided to use an adapted version of this questionnaire to assess the participants' EBs. Having conceptualised the assumptions about knowledge in terms of the work of different scholars in the field, the concept of ill-structured problem-solving will now be dealt with.

Conceptualising the Construct of 'Ill-structured Problem-solving'

Jonassen (1997) distinguished well-structured from ill-structured problems, and articulated differences in cognitive processing engaged by each. More complex or ill-structured problem-solving often requires solvers to consider multiple perspectives and apply several criteria while evaluating problems or solutions. The ability to do so depends partially on problem-solvers' underlying beliefs about knowledge and how it develops. Since ill-structured problems have commonly divergent or alternative solutions, solvers must develop justification or an argument for supporting the rationale of their selection of a particular solution (Voss and Post 1988; Angeli and Valanides 2012).

For ill-structured problems, the process of justification requires identifying as many as pos-

sible of the various perspectives, supporting arguments and evidence on opposing perspectives, evaluating information, and developing and arguing for the best possible solution (Voss and Means 1991). According to Churchman (1971), reconciling different interpretations of phenomena based on goals or perceptions about the nature of the problem is a critical process in developing justification. Thus, the problem-solver's epistemic cognition is an important component in order to develop justification for ill-structured problems (Kitchener 2013). For developing justification, individuals need epistemic cognition in order to understand that ill-structured problems do not always have a correct solution, and how to choose between alternative solutions (Jonassen 1997).

However, the process of developing justification for well-structured problems is quite different and focuses mostly on the development of a logical argument in support of the correct solution. Overall, research findings have consistently shown that performance in the solving of well-structured problems is independent of performance on ill-structured tasks, with ill-structured problems engaging a different set of epistemological beliefs, and thus a different process for developing justification about the problem at hand (Schraw et al. 1995; Bendixen and Schraw 2001; Hong and Jonassen et al. 2003; Jonassen and Kwon 2001; Angeli and Valanides 2012; Kitchener 2013).

The Possible Link between Epistemological Beliefs and Ill-structured Problems

Research findings have indeed established a positive relationship between epistemological beliefs and reasoning in ill-structured problem-solving among participants in a variety of studies (Bendixen and Dunkle et al. 1994; Schommer and Dunnell 1997; Bendixen et al. 1998; Bendixen and Schraw 2001; Sinatra et al. 2003). For example, research by Bendixen et al. (1994) showed that people who view ability as innate and thus fixed may be less inclined to develop and use advanced reasoning skills when thinking about ill-structured issues. Also research by the same authors (1995) found that well-structured and ill-structured problems engaged different epistemological beliefs. Schommer and Dunnell (1997) found that the more students believe that the ability to learn is fixed at birth, that learning

is quick or not-at-all, and that knowledge is unchanging, the more likely they are to write particularly simplistic solutions to problems.

Having conceptualized the two main constructs of the study as well as the possible link between them, the methodology of the study will now be discussed.

METHODOLOGY

Ten school principals (P1 to P10) from the Gauteng province of South Africa were randomly selected to participate in this small-scale exploratory study, based on an earlier and similar study by Angeli and Valanides (2012). Of the ten principals selected for the study, six were males and four were females; their average age was 41.5 years. Since Schommer's 1990 Epistemological Questionnaire (EQ), as already mentioned, is still widely used today in various empirical research studies on EBs, it was decided to use an adapted version of this questionnaire for data collection to assess the participants' EBs as all of the items in the original questionnaire were not applicable in the school context.

The adapted EQ consisted of five items measuring participants' perceived importance of an ill-structured issue (item 1) and their EBs with regard to this problem (items 2-5). The five items (interview questions) on the EQ were adapted from King and Kitchener's (1994) model. The five items on the quantitative research instrument were accompanied by a five-point Likert scale that varies between a rating of 5 (extremely important) and a rating of 1 (not important at all).

After ethical clearance was obtained, data were collected during a workshop presented for school principals in Pretoria during August 2012. The session lasted one hour. During the first 20 minutes, participants completed the EQ. After completion they were allocated 20 minutes to read an article with a controversial (socially sensitive) nature that culminates in a complex and uncertain (ill-structured) problem. Subsequently, for the next 20 minutes, participants had to work individually in order to write on their personal view with regard to this problem. Participants' views and position on the problem were saved for analysis purposes. Written instructions asked the participants to analyze the issue broadly from different perspectives, while supporting their position with reasons and evidence.

As in the study of Angeli and Valanides (2012), item 1 on the questionnaire requests the

participant to rate the importance of a complex or ill-structured social problem, while items 2 to 5 were more in-depth and touched on disagreements and knowledge assumptions during problem-solving. Item 2 prompted the participants to state whether it was indeed possible to express different points of views on the same issue and to explain furthermore how this sort of disagreement among problem-solvers was possible. Items 3 and 4 dealt with how beliefs on knowledge could be justified. Specifically, item 3 prompted the participants to explain how two problem-solvers could arrive at and justify their different views on the same issue, while item 4 asked the participants to explain and justify their point of view on the issue. Item 5 raised the issue of whether it could be known for sure that an individual's position on a specific issue at hand was correct. In all instances participants were asked to explain their answers accordingly.

The data collected from the ten participants with the EQ were analyzed with a three-stage rubric, shown in Table 1, which constituted an adaptation of King and Kitchener's (1994) model into a simpler version. The rationale behind the original seven-stage model adaptation into a three-stage rubric was that "models of epistemological development postulate three broad stages characterized first by absolutist beliefs, followed by the advent of relativist beliefs, followed by the advent of pluralist beliefs in which beliefs are viewed as relative" (Schraw 2001: 456). In addition, there is also agreement in the literature that, regardless of the number of EBs, there are fundamentally two different types corresponding to 'view of knowledge' and 'justification of beliefs' (Hofer and Pintrich 1997; Angeli and Valanides 2012).

In recording the responses of the participants on the EQ, the researcher independently recorded the answers to items 2 to 5 of the EQ. Each of the three-stage rubric consisted of two sub-sections, namely the two different types of EBs referred to above ('view of knowledge' and 'justification of beliefs'). Responses to each one of the items were rated by referring to one of the sub-sections of each stage. For example, the responses to items 2 and 5 were rated based on their fit with the section on 'view of knowledge' of each stage, whereas the responses to items 3 and 4 were rated based on their fit with the section on 'justification of beliefs' at each of the stages.

Table 1: Epistemological beliefs rubric

<i>Stage</i>	<i>View of knowledge Knowledge is:</i>	<i>Concept of justification</i>
<i>A: Absolutist Thinking</i>	is assumed to be either right/wrong; is not absolutely certain; is temporarily uncertain; and will soon be determined.	Beliefs need no justification; Beliefs are justified through an authority figure; Most questions are assumed to have a right answer; There is little or no conflict in making decisions about disputed issues.
<i>B: Relativist Thinking</i>	is uncertain (there is no right or wrong); is idiosyncratic to the individual; is seen as subjective and contextual.	Beliefs are justified by giving reasons and evidence; Beliefs are filtered through a person's experiences and criteria for judgment.
<i>C: Reflective Thinking</i>	is constructed by comparing evidence and opinion on different sides of an issue; is the outcome of the process of reasonable inquiry leading to a well-informed understanding.	Beliefs are justified by comparing evidence and opinion from different perspectives. Conclusions are defended as representing the most complete, plausible understanding of an issue on the basis of the available evidence.

Each item on the EQ was analyzed and scored using a scale from A to C. These symbols corresponded to the three stages of the simplified three-stage rubric of EBs shown in Table 1. A score of A, B and C indicated performance at the level of absolutist thinking (A), the level of relativist thinking (B) and the level of reflective thinking (C), respectively. Scores were then summarized into a four-symbol code indicating the respective scores from each of the four items 2 to 5. For example, AABA indicated performance at the level of absolutist thinking for items 2, 3 and 5, and at the relativist thinking level for item 4.

DATA ANALYSIS AND DISCUSSION OF RESULTS

After the session the responses were analyzed. Responses were coded and 15 elements were identified and used to simplify the recording of data. The elements included criteria important to good quality thinking such as emotion, value judgments, the extent to which there was a point of view that was clearly supported, explanations and opposing arguments, as well as a discussion of an alternative point of view and reasons for supporting it. An inductive approach was used to create different categorizations of the quality of thinking and to classify each response in one of these categories. Observed disagreements among the participants were also noted and resolved. The 15 elements were furthermore categorized into three groups, namely cognitive, cultural and emotional. Cognitive elements are directly related to reasoning,

cultural elements are related to cultural identity and emotional elements are related to participants' feelings.

According to the EQ scores, four participants (P1, P2, P4, P8) were found to be reflective thinkers (on stage C of epistemological development) and the remaining six (P3, P5, P6, P7, P9, P10) relativist thinkers (on stage B of epistemological development). None of the participants was found to be at stage A of epistemological development. Those who scored at stage C (P1, P2, P4, P8) were classified as "High EBs" or "High/Low EBs" and those who scored at stage B (P3, P5, P6, P7, P9, P10) were classified as "Low EBs". Table 2 describes the respective recording codes, epistemological stages and type of thinking levels of the 10 participants.

Participants' transcripts were consequently analyzed using a scheme to visualize the flow of participants' reasoning as it appeared in the transcripts. Four types of problem-solvers, namely types I, II, III and IV, emerged from this analysis.

Type I problem-solvers show low-level thinking depicting failure to think about the problem systematically. Instead, several points of view are expressed in a disconnected way without any consistent flow of logic. Of the participants, two (P9, P10) fell into this category. Type II problem-solvers show thinking that is reasoned within a stated point of view supported by a number of reasons. The flow of logic in their thinking is well-organized and systematic. There is reason in thinking but the arguments presented are not elaborated adequately. Their thinking appears to be what Paul (1995: 15) refers to as monological, meaning "thinking that hardly ever con-

Table 2: Epistemological stages, scoring codes and types of thinking

<i>Participant's ID</i>	<i>Epistemological stage</i>	<i>Scoring codes</i>	<i>Thinking type</i>
P 1	Stage C (High)	CBCC	Reflective (III)
P 2	Stage C (High)	BCCC	Reflective (III)
P 3	Stage B (Low)	ABBB	Relativist (II)
P 4	Stage C (High)	CCCB	Reflective (II)
P 5	Stage B (High/Low)	BABB	Relativist (II)
P 6	Stage B (Low)	BBBC	Relativist (II)
P 7	Stage B (High/Low)	AABB	Relativist (II)
P 8	Stage C (High)	CCCC	Reflective (IV)
P 9	Stage B (Very Low)	ABBA	Relativist (I)
P10	Stage B (Very Low)	BBBB	Relativist (I)

siders major alternative points of view, or hardly ever responds to objections framed by opposing views". Forty percent of the participants (P3, P5, P6, P7) fell into this category. Of these participants, two (P3, P6) scored low on the EQ and the remaining two (P5, P7) scored high/low. Type III problem-solvers show thinking associated with depth. However, as with type II problem-solvers, their thinking appears to be mono-logical as different points of view or opposing arguments are not examined. Three participants (P1, P2, P4) exhibited thinking in this category, while all three scored high on the EQ. Type IV problem-solvers' reveal critical (multi-logical) thinking capabilities. Multi-logical thinking is the opposite of mono-logical thinking, namely thinking that considers opposite points of view and examines both supporting and opposing arguments for each view (Paul 1995). Only one participant (P8) fell into this category and scored high on the EQ.

The results showed that there were two participants (P3, P6) who performed low on the EQ but well on the problem-solving task, and also one participant (P5) who performed high on the EQ but poorly on the problem-solving task. Based on these results, it seems that other context-dependent factors affected participants' performance on the ill-structured issue.

CONCLUSION

This study reports on the results of an exploratory study among Gauteng school principals that sought to better understand how participants with different personal EBs reasoned about a complex and ill-structured problem. According to the qualitative results of this study there was not a systematic connection between EBs and ill-structured problem-solving capabilities between participants. For example, there were participants who scored low on the EBs

questionnaire but achieved high individual performance for the ill-structured problem, while other participants scored high on the EBs test, but achieved low individual problem-solving performance. Similarly, participants with low EBs scores achieved high group performance, and participants with high EBs scores achieved low group performance. Thus, according to the results of this study, it seems that ill-structured problem-solving entails some unique characteristics that influence one's reasoning about the problem. Thus, the fact that the problem was ill-structured and complex influenced the way participants thought about it.

RECOMMENDATIONS

Based on the results, it seems that the relationship between personal epistemology and problem-solving can be better understood if it is conducted in such a way that the details of the specific context are considered carefully. All things considered, this is an exploratory study with one small localized sample; obviously, therefore, no generalizations can be drawn at this point. It would be valuable if future studies with larger samples were to examine the issues discussed further, so that ultimately a theory about social epistemology can be derived. In addition, this study only examined one type of problem, namely a complex and emotionally ill-structured social problem; therefore future experimental designs with different kinds of problems could provide valuable insights about the extent to which different problem types require different sets of epistemological beliefs.

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