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# TOWARD A MODEL OF EPISTEMIC COGNITION:

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TOWARD A MODEL OF EPISTEMIC COGNITION:
A MIXED METHOD STUDY

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For my wonderful Amanda

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**Abstract**

Both empirical and theoretical work in the field of personal epistemologies has indicated several epistemic factors that influence the way in which individuals approach information and knowledge formation. An organizational scheme is suggested for making sense of the various approaches to personal epistemologies and an integrative model of epistemic cognition that combines these elements along with contextual influences is proposed. Using a sample of 84 undergraduate and graduate students, 18 to 41 years of age, a mixed method approach was employed to begin investigations into the theoretical model. In an online information-seeking scenario on the, scientifically controversial but morally and politically neutral, topic of hand sanitizer, participants' initial thoughts on the topic were captured with Likert-type survey items and their online behaviors tracked using Internet logfile data. Follow-up open response survey items questioned participants on their approaches to the sources of information and for justification of the opinions they formed after having access to the information. Survey data were also collected on each of the proposed components at the individual level of the model: epistemic strategies, development, and motivations. Using regression and multiple mediation analyses the connections between contextual factors and individual and task-specific epistemic factors were explored. This indicated evidence of mediation of the relationship between epistemic development and the types of sources and time spent reading information by one of the proposed epistemic motivations, need for cognition. Regression analyses also revealed a lack of relationship between epistemic behaviors in the task and perceived sufficiency of information suggestive

of either an interaction between variables or influence by additional latent factors influencing standards for what counts as sufficient information as the basis of a justified opinion. Mixed method analyses indicated few significant differences in the types or amount of evidence that individuals provide as justification related to *epistemic development*, *motivation*, or *strategies*. However, mixed-methods analyses involving comparison of quantitative and qualitative measures revealed individual differences in the amount to which interest in the topic and risk perception influenced both the quantity and quality of the information accessed. This suggests the need to account for the influence of epistemic self-regulation and epistemic metacognition in an overall model of epistemic cognition.

## Chapter 1: Introduction

*Epistemic cognition*, the cognitive process through which individuals form knowledge, and the various influences on that process is an emerging topic within the field of educational psychology. Although the term has been in use for some time, up to this point epistemic cognition has largely been used to describe thoughts and reflections about the nature of, and criteria for, knowing (K. S. Kitchener, 1983). The term *personal epistemologies* (Hofer & Pintrich, 2002) has been used in a similar way, with the focus of the field largely on individual attitudes towards, and beliefs about the nature of knowledge and knowing. The construct definition of *personal epistemologies* has been highly contested (Hofer, 2002) and three distinct approaches can be found within the literature. The predominant approach centers on personal epistemologies as a developmental scheme that describes individuals as increasing in their view of knowledge as tentative and constructed (Baxter Magolda, 2001; Bromme, Kienhues, & Stahl, 2007; King & Kitchener, 1994; Perry, 1970; Schommer, 1990a). Another approach to personal epistemologies is one of describing the motivational traits that influence the way individuals approach knowledge formation (Cacioppo & Petty, 1982; DeBacker & Crowson, 2006; Kruglanski, 1990; Webster & Kruglanski, 1994). Researchers are also increasingly investigating the notion of personal epistemologies as specific knowledge-building strategies and modes of justification, although some researchers have also portrayed acquisition and application of strategies as a more fine-grained developmental scheme (Hammer & Elby, 2002; Louca, Elby, Hammer, & Kagey, 2004; Royce, 1978).

**Problem Statement**

Several different concepts, each broadly identified as *personal epistemologies* have been indicated as having influences on various aspects of learning and cognition. This includes the influence of *epistemic development* on standard setting in self-regulated learning (Bromme, Pieschl, & Stahl, 2010; Muis & Franco, 2009), comprehension tasks (Ryan, 1984; Schommer, 1990a) and metacognitive calibration (Stahl, Pieschl, & Bromme, 2006) and the influences of *epistemic motivations* on depth of processing, achievement, and learning goals (Cacioppo & Petty, 1982; DeBacker & Crowson, 2006; Kruglanski, 1990; Webster & Kruglanski, 1994). Initial investigations into *epistemic strategies* also indicate influences on learning, with Muis and Franco (2010) showing that individuals who report the use of a combination of rational and empirical strategies show higher rates of metacognitive strategy use, cognitive regulation, and problem solving achievement (Muis & Franco, 2010). A more recent study has also indicated that the match between the way knowledge is represented in instructional texts and the student's predominant epistemic strategy has implications for recall, processing strategies, and conceptual change (Franco, Muis, Kendeou, Ranellucci, & Sampasivam, 2012). However, while some studies have looked at how two of these three components might have a joint influence on individual approaches to knowledge construction and performance on ill-structured tasks (Kardash & Scholes, 1996; Nussbaum & Bendixen, 2003), as the proposed components have not previously been organized in this way studies have not sought to investigate how all three components might work together to influence behaviors during knowledge

construction. Given the links between the three components: epistemic strategies, development, and motivations, and strategy selection and standard setting it seems that there would be a combined effect on epistemic standard setting and epistemic behaviors in knowledge forming contexts that had not been investigated prior to the current study.

The need to investigate the influence within a context also relates to the problem raised in the literature of whether personal epistemologies are domain general or domain specific (Buehl, Alexander, & Murphy, 2002; Hofer, 2006a, 2006b; Muis, Bendixen, & Haerle, 2006; Schommer & Walker, 1995). Studies into the issue of domain specificity-generality indicate that there are differences in the way individuals express their beliefs about knowledge in specific domains (Buehl & Alexander, 2005; Hofer, 2000, 2001). While the idea that there are domain differences in expressed personal epistemologies is now widely accepted, the way in which they relate to one another or to domain general beliefs is not clear (Hofer, 2006b). This study attempted to address this by investigating whether there may be epistemic strategies, strategies specifically for attaining knowledge, that operate at both the general and specific levels.

This comparison of the way epistemic strategies are expressed at the domain general and context-specific levels is hampered by another problem in the personal epistemologies literature, the lack of investigation and clear definition of the precise nature of epistemic strategies. Richter and Schmid (2010) define epistemic strategies as "a special type of cognitive learning strategies that are aimed at validating the knowledge claims raised in expository or informational texts" (p. 49). However, the

current study defines epistemic strategies more broadly as different approaches individuals take to the justification of beliefs, which may include but are not limited to validation of knowledge claims in text based resources. Although the term is not widely used epistemic resources (Hammer & Elby, 2002; Louca et al., 2004), styles (Royce, 1978, 1983), beliefs (Hennessey, 2007), and strategies (Richter & Schmid, 2010) all seem to describe different aspects of epistemic strategy as defined in the current study. This study therefore further sought clarity on the nature of epistemic strategy, specifically by looking at the types of strategies individuals both use and report themselves as using in the online knowledge forming context, and how these specific strategies were related to strategies captured by the epistemic strategy instrument.

A common conceptual and methodological problem with many of the investigations into personal epistemologies is the inclusion of ontological beliefs, or beliefs about the nature of reality in conceptualizations of personal epistemologies. Examples of this include Kitchener's (1983) description of the epistemic assumption "that there is an objective reality" (p. 226), instrument items such as: "Scientists can ultimately get to the truth" and "If scientists try hard enough, they can find the truth to almost anything" (Schommer, 1990b) and "Experts in this field can ultimately get to the truth" (Hofer, 2000). Questions about ontological viewpoints have also been included as factors forming part of dimensional models of personal epistemologies (Greene, Azevedo, & Torney-Purta, 2010), for example "attainment of truth" (Hofer, 2000). Inclusion of ontological issues in the personal epistemologies literature are problematic on two counts, the first being the question

of whether or not individuals really reflect on the nature of reality (Hofer, 2002), and the second being the oversimplification of the realist stance as being necessarily dualist in nature (Greene et al., 2010).

A final methodological issue relates to the lack of accounting for the influence of context in many studies of personal epistemologies. This is particularly the case in those studies that combine two or more of the concepts from the personal epistemologies literature. One example of a study that does take into account some contextual factors is the Richter and Schmid (2010) study looking at the relationships between epistemic beliefs, attitudes, and strategies on self-regulated learning while reading an unfamiliar text. However this study focused only on the specific epistemic strategies students used as influenced by beliefs, attitudes, and processing goals and did not look at the learning outcome of the task and its relation to these contextual factors related to the topic. There is therefore a gap in the literature looking at the combined effect of the three broad areas of personal epistemologies (i.e., strategies, development, and motivations) that have so far been studied separately, on approaches to knowledge formation and the outcomes of knowledge formation tasks in specific contexts. Furthermore, there is a clear need to include contextual influences in any investigations into the effects of these components on epistemic standard setting, behaviors, and outcomes.

The main problems in the personal epistemologies literature that this study therefore sought to address was the gap in the literature regarding how these three disparate areas of the field are linked, and their combined influence on knowledge-forming behaviors in a context. Although the study was situated in an online

context on a scientifically controversial topic, the hope was that the study would begin to uncover links and influences of the three components on knowledge-forming standards and processes to facilitate a more thorough understanding of epistemic cognition. The focus of this study is on these links, influences, and the overall epistemic cognition process to shed some light on some of the construct definition issues, including the domain general versus domain specific nature of approaches to knowledge by investigating the influence of domain general, individual-level components, on a context-specific knowledge construction task. This study also began to uncover the nature of epistemic strategies actually possessed and utilized by individuals in knowledge formation situations. Finally, this study narrowed the focus of personal epistemologies by removing ontology dimensions (nature of truth) from the construct definition and shifting the focus purely onto notions of knowledge and knowing.

**Research Questions**

Given the problems identified in the literature as described above, the research questions focused on the links between the proposed components of epistemic cognition at both the domain general and context specific levels. There was also an additional focus on identifying the epistemic strategies used in context. The research questions were as follows:

1. How are domain-general epistemic strategies, development, and motivations related to the epistemic standards set and epistemic behaviors displayed in a

specific knowledge-forming context?

   a. Do epistemic motivations act as a mediator between epistemic development, strategies and the standards set in a knowledge-forming context?

   b. Which of the proposed epistemic motivations – need for closure or need for cognition – has the greatest impact on epistemic standard setting and epistemic behaviors displayed in an online knowledge-forming context?

   c. Which of the proposed contextual influences (i.e., interest, perceived personal risk, importance of understanding, and prior knowledge) has the greatest impact on epistemic standard setting and epistemic behaviors in a knowledge-forming context?

2. How are epistemic standards and behaviors related in a knowledge-forming context?

3. How is the repertoire of domain-general epistemic strategies and the epistemic strategies enacted in a knowledge-forming context related?

   a. What epistemic strategies emerge in a knowledge-forming context?

   b. Of the epistemic strategies that emerge in a knowledge-forming context, which of these are captured by the epistemic strategy instrument?

**Study Significance**

The study contributes to the field of personal epistemologies by providing some empirical support for the re-classification of previously studied components.

The study also opens important avenues for future research in standard setting, self-regulation, and problem definition as possible further components of a model of epistemic cognition. This study investigated how the suggested components might act together in context, particularly in relation to epistemic standard setting and selection of epistemic strategies.

## Chapter 2: Review of the Literature

The process through which individuals may attempt to distinguish true beliefs from false ones has been a heated topic in the fields of both philosophy and psychology. In philosophy, epistemology is the specific branch that seeks to conduct a "philosophical inquiry into the nature, conditions, and extent of human knowing" (Sosa & Kim, 2000, p. ix), while in psychology study the focus is more on individual "beliefs about knowledge and knowing" (Hofer, 2001, p. 354). Although it does seem to be the case that there are differences in the ways people treat knowledge and justification, including how they think about knowledge and knowing in more general terms, the idea that most individuals will have formed explicit personal theories of how knowledge is formed, acquired and justified does not seem to be supported by the literature (R. F. Kitchener, 2002; Muis & Franco, 2009).

Individual attitudes or beliefs about the nature of knowledge and knowing in the field of psychology are referred to variously in the literature as: *personal epistemologies* (Hofer, 2001), *epistemological reflection*, *epistemic transformation*, *epistemological assumptions* (Baxter Magolda, 2004), *epistemic assumptions*, *reflective judgment* (King & Kitchener, 1994), *epistemic beliefs* (Muis & Franco, 2009; Stahl & Bromme, 2007), *epistemic criteria* (Boldrin & Mason, 2009), *epistemological resources* (Louca et al., 2004) and *epistemic values* (Fallis & Whitcomb, 2009). The sheer volume of terminology applied to this field indicates the difficulties with construct definition and the divisions within the field. This study seeks to bring together these

varied approaches to defining personal epistemologies, by first conducting a thorough literature review into the various approaches to defining personal epistemologies, and subsequently carrying out an empirical investigation into the nature of the identified epistemic components, the relationships among them, and joint influences on behaviors in an online knowledge-forming context.

The following overview of the literature seeks firstly to investigate the different ways in which personal epistemologies have been described and studied. The review was initially based on a search of personal epistemologies articles that use terminology from philosophy to apply to the psychological constructs they describe. The focus of the review is on the way that philosophical terminology is used in the personal epistemologies literature, and in particular on the inconsistencies between the psychological application and philosophical theories that the terms or labels came from originally. Philosophy, and specifically epistemology, is then used as a lens for understanding and clarifying the differences between approaches within the field of personal epistemologies. A second function of the review is to examine the empirical findings about the relationship of the different constructs to learning and information processing. Based on the existing literature I have sought to make theoretically and empirically feasible connections between the different approaches to personal epistemologies as well as propose a model representing the combined and individual impacts of the various approaches to personal epistemologies on knowledge building.

Through an analysis of the literature, three major themes emerged in the way that researchers and theorists talk about personal epistemologies. These I have

labeled *epistemic strategies*, *epistemic development*, and *epistemic motivations*. From the initial finding, further key articles from the field of personal epistemologies were reviewed and found to be consistent with this coding approach. The distinction between these three components of the personal epistemologies research is used to organize the following literature review. Connections between the empirical findings and theoretical rationales for the three identified areas of the personal epistemologies literature are used to argue that there is strong justification for including each of these three approaches as a component of a hypothesized model of epistemic cognition. The final section of the literature review outlines the proposed model of how these three components might combine to influence epistemic standard setting and behaviors in a knowledge-forming context based on the influences on approaches to learning and knowledge formation indicated in the articles reviewed.

**Epistemological vs. Epistemic**

Both the terms epistemological and epistemic are used to describe beliefs, attitudes and approaches toward knowledge. However, it has been argued that researchers must be more careful to make the distinction between epistemological and epistemic (R. F. Kitchener, 2002). Given that epistemology means "theory of knowledge," R. Kitchener (2002) argues that actually what most researchers are referring to is epistemic rather than epistemological. In light of this, it is important for us as researchers to reflect on whether what we are describing and attempting to capture really reflects well formed individually held theories of knowledge.

Since it seems unlikely that most individuals do in fact have well-articulated theories of knowledge (R. F. Kitchener, 2002; Muis & Franco, 2009), I suggest that it is more likely that what we are really looking at are the basic understandings, representations, attitudes towards, and specific strategies individuals have for attaining knowledge. Therefore, as suggested by R. Kitchener (2002), I will be using the term *epistemic* rather than *epistemological* as the prefix for each of the proposed components of the hypothesized model, to indicate that these are intended to describe dispositions, strategies, or a developmental progression with the aim of attaining truth and avoiding error as their goal rather than a reflection of more explicit theories of knowledge.

**Justified True Beliefs**

Unlike models of more general information processing, the model of *epistemic cognition* described in this literature review and investigated in this study is intended to show the process by which individuals arrive at knowledge, with knowledge defined more closely in line with classical philosophical thinking as *justified true beliefs*. According to the proposed model, the knowledge arrived at can only be considered knowledge if the individual believes it and there is some form of justification, be that reasoning processes used, information referred to, or some other justification process. This is in line with the idea that "warranted knowledge is generally taken to be that sub-set of our individual beliefs that are effectively argued to be true" (Hallett, Chandler, & Krettenauer, 2002).

Despite this definition of knowledge as in line with "justified true beliefs," it is not within the scope of this study to attempt to define what truth is, or to provide a criterion for what constitutes adequate justification. As there is no agreed upon objective standard for justification, or standard provided by the current study, standards for justification are therefore taken as being set by the individual. In other words knowledge is, for the purposes of this study, the individual's justified beliefs, with adequate justification set at whatever level the individual feels to be adequate in the given context in order to make a decision. This shifting criterion for knowing is termed epistemic standards in the proposed model and is defined as the standard set by the individual for adequate justification of their beliefs in the specific knowledge forming context.

By removing any judgment of what constitutes truth from the model of epistemic cognition, I have sought to avoid some of the criticisms that there are confusions between epistemology and ontology in the personal epistemologies literature. Criticisms include questions about whether capturing individual ontologies are something we want to, or are even able to, accomplish due to the unlikelihood that the majority of individuals actually reflect on the nature of truth or reality (Hofer, 2002). Other criticisms include a question about use of the word "truth" in survey items to connote a naive realist perspective that is more reflective of the researchers' oversimplification of the realist stance as being necessarily dualist in nature (Greene et al., 2010).

## Three Approaches to Personal Epistemologies

As previously described, the field of personal epistemology may be thought of as being composed of three distinct approaches to thinking about the way that individuals approach knowledge construction as well as how they think about knowledge and knowing. These include: *epistemic strategies*, *epistemic development*, and *epistemic motivations*. All three components have been shown individually to predict individual approaches to learning and cognition, particularly in ill-structured domains (Cacioppo & Petty, 1982; DeBacker & Crowson, 2006; Kruglanski, 1989; Muis & Franco, 2009, 2010; Ryan, 1984; Schommer, 1990a; Stahl et al., 2006; Webster & Kruglanski, 1994). However, despite sharing similar influences on learning outcomes, these three different areas of personal epistemologies research have largely been seen as disparate conceptualizations. The following literature review seeks to firstly describe the three different approaches to personal epistemologies, and secondly show how these three approaches might be thought of as components of a model of epistemic cognition, which together influence epistemic standard setting and behaviors in information seeking and knowledge forming contexts.

**Epistemic development.** The predominant area of personal epistemologies focuses on the shift from an absolutist epistemic stance, the view that information is either right or wrong, towards a more evaluative or relativist stance, in which individuals recognize the constructed nature of knowledge and knowing, while still understanding that there are criteria by which information can be evaluated. This

idea of epistemic development as a move toward a view of knowledge as increasingly constructed, and a view of self as an increasingly active agent in the knowledge formation process (Kuhn, 1999; Perry, 1970) also describes the goal of development as arriving at a view of knowledge as a "coordination of the objective and subjective dimensions of knowing" (Kuhn, Cheney, & Weinstock, 2000, p. 309). The description of developing personal epistemologies from *absolutist* to *multiplist*, and finally to an *evaluative* stance (Kuhn, 1999) is similar to the pattern of cognitive development described by Piaget, or of Kohlberg's description of the course of moral development (Louca et al., 2004). First observed by Perry in his (1970) study, the nine stages he identified are more commonly simplified into the following four: dualism, multiplicity, relativism and commitment within relativism (Hofer & Pintrich, 1997); or to the three stages: absolutist, multiplist, and evaluative described by Kuhn (1999).

Perry's description of epistemic development remains the most widely referenced in the epistemic development branch of the personal epistemologies literature. Although he himself never used the term "epistemic development," the developmental scheme that he describes forms the basis of much of the research and theoretical pieces published in this field (Buehl & Alexander, 2001; Hofer & Pintrich, 1997). The scheme itself arose from a study reported in the book *Forms of Intellectual and Ethical Development in the College Years: A Scheme* (Perry, 1970). The qualitative four-year longitudinal study of male students at a prestigious university focused on the broader research question of how students respond to the relativism that Perry perceived as prevalent in the college environment. The study used

interviews conducted at the end of each academic year, and might be described as a phenomenological study given the lack of probes and the broad interview question that simply asked "what stood out" for them about the academic year. However the analysis would perhaps be more accurately described as a grounded theory approach, given the large number of participants and volume of data, as well as the generation of a new theory about intellectual development that arose from the analysis of that data. Although the study was not solely focused on how students view knowledge, the developmental scheme that Perry laid out incorporates many of the themes that are recognizable as the basis of the current field of personal epistemologies including conceptions of structure, nature, source and justification of knowledge (Buehl & Alexander, 2001).

One criticism that has been leveled at the study is the particularly homogenous nature of the participants. However, subsequent studies into individual epistemic development, including one study using only female participants (Belenky, Clinchy, Goldberger, & Tarule, 1986), have found a similar developmental trajectory (Baxter Magolda, 1992, 2001; Belenky et al., 1986) in different and more heterogeneous samples. As a grounded theory study, the Perry study was able to generate a scheme that emerged from the interview data, therefore providing strong evidence for the developmental scheme he laid out. Although there were clear limitations in the sample, the large amount of data as well as subsequent research that indicates a similar developmental trajectory show that this was an appropriate methodology, particularly at this point in the development of the new theory of epistemic development.

One such line of research that has indicated a similar path of development is that which has lead to the development of the *reflective judgment model* (King & Kitchener, 1994, 2002). Like the Perry scheme, this was also the result of a series of longitudinal studies. The findings are described in the book *Developing reflective judgment: Understanding and promoting intellectual growth and critical thinking in adolescents and adults.* However, unlike the Perry study, the King and Kitchener study was much more narrowly focused, and rather than focusing on general intellectual development, they focused specifically on ill-structured problem solving, which they describe as problems about which "reasonable people reasonably disagree" (King & Kitchener, 2002, p. 37). Due to this difference in the research question, the King and Kitchener study used a much more structured interview protocol called the *Reflective Judgment Interview* (RJI), which asked participants to respond to several ill-structured problems. Despite this difference in interview protocol, the analysis itself was similar to the grounded theory approach used by the Perry team, in that it again generated a developmental scheme from the interview data. The King and Kitchener (1994) book reports a series of studies based on administrations of the RJI to 1,500 student participants from high-school, undergraduate, and graduate populations. The resulting findings as described earlier, indicated a developmental model of increasingly sophisticated beliefs about the nature of knowledge, however unlike the hard-stage developmental sequence described in the Perry scheme, King and Kitchener's model of *reflective judgment* (King & Kitchener, 1994, 2002) outlines a "soft-stage model" of development. Like the Perry study, the King and Kitchener (1994) study was a large-scale interview-

based study, with a grounded theory approach to analysis. Similarly the resulting scheme is well-grounded in the data and provides a good basis for further study of epistemic development.

This depiction of a soft-stage model of development addresses a second criticism of Perry's scheme. As Kuhn (1997) describes, while these types of stage theories are useful for describing developmental "guideposts," they run into problems when trying to provide explanation for an individual's use of a range of strategies for knowledge formation at varying levels of sophistication, as well as the unevenness with which epistemic schemas are applied (Louca et al., 2004). To some extent King and Kitchener's model of *reflective judgment* (King & Kitchener, 1994, 2002) addresses this issue with their "soft-stage model" of development. Their developmental model closely reflects the neo-Kohlbergian approach to moral development put forward by Rest, Narvaez, Thoma, and Bebeau (2000), and depicts stages as overlapping waves. Rather than describing hard shifts from one stage to the next, this model describes individuals as employing reasoning schema in changing levels of *frequency*, rather than as moving universally from one stage to the next. In this way, although individuals may predominantly use a multiplist reasoning schema, depending on the context or support available they may also use a more dualist or evaluative approach. This model may go some way toward explaining why individuals of all ages can be found to display reasoning at each of the stages of epistemic development, as well as the variations in frequency according to reasoning domain (Kuhn et al., 2000; Kuhn & Park, 2005).

***Summary***. Despite some criticisms of taking a broad developmental approach to personal epistemologies (Hammer & Elby, 2002), there is strong evidence that there is a developmental trajectory to individual ways of thinking about knowledge and justification (King & Kitchener, 1994, 2002, 2004; Kuhn, 1999; Kuhn et al., 2000; Perry, 1970). Of the various developmental schemes described, King and Kitchener's reflective judgment model (1994), which characterizes developmental stages as overlapping waves rather than hard stages (King & Kitchener, 1994, 2002), provides the strongest rationale for why individuals of all ages can be found to be using epistemic reasoning at all levels of sophistication (Kuhn et al., 2000). Reference to context alongside these soft-stages may provide some explanation for findings that indicate both domain differences, and generality (Buehl et al., 2002; Hofer, 2006a; Muis et al., 2006). The conception of stages as reflecting the frequency of use of reasoning approaches rather than an absolute stage, makes this conception of epistemic development particularly appropriate for inclusion in the proposed model of epistemic cognition that includes contextual influences.

Though there are clear benefits to the King and Kitchener model of epistemic development, little explanation is provided for what the specific mechanisms of development are (Louca et al., 2004). Therefore, while this description of epistemic development has clear implications in terms of individual approaches to information and learning, and should be included in a model as an important influence on epistemic cognition, it seems necessary to include other components that might explain how development itself occurs. In addition,

although the soft-stage model goes some way to explain individual differences in approach in varying contexts, the reflective judgment model does not explain what type of contextual influences may account for the employment of varying reasoning schema in different judgment scenarios. While it is possible that context alone influences these differences in schema application, one possibility is that this is also related to the individual's available *epistemic strategies* within the particular domain of reasoning.

**Epistemic strategies.** Although not a clearly defined branch of the personal epistemologies field, using the lens of philosophy, many of the descriptions of epistemic beliefs and epistemic development seem to be better thought of as *epistemic strategies*. This includes frameworks characterizing types of reasoning put forward by Murphy, Alexander, Green, and Edwards (2007), Royce's ways of knowing (Royce, 1978, 1983), as well as the epistemic resources framework described by Hammer and Elby (2002). All of these frameworks: foundationalist, coherentist, reliabilist, rationalist, empiricist, as well as the more specific resources seem to be best described as strategies or tools that individuals can use to get at knowledge. This idea is supported by Richter and Schmid (2010) who describe epistemic strategies as a particular type of cognitive learning strategy "aimed at validating the knowledge claims raised in expository or informational texts" (p. 49).

While many of the frameworks for describing different approaches to reasoning take the philosophical literature as the foundation for their characterizations (Murphy, 2003; Murphy et al., 2007), the use of epistemological

theories as foundations for describing underlying individual epistemologies is problematic (Hammer & Elby, 2002). Moser (2002) notes that so far none of the epistemological theories has stood out as having "maximal effectiveness in getting truth and blocking error" (p. 14). Therefore, to try to categorize individuals as being foundationalists, reliabilists, or coherentists has questionable validity. Instead, by approaching these categorizations rather as representative of a range of epistemic strategies that individuals might use to attain knowledge seems both more likely, as well as more in line with current philosophical thinking, which describes epistemic strategies as having as their "fundamental goal the acquisition of truth and the avoidance of error" (p. 14). The following sections therefore examine some of these approaches from the personal epistemologies literature that might be thought of as belonging to the epistemic strategies component of the broader field.

***Foundationalism, coherentism, reliabilism, and social epistemology.*** This terminology for describing individual epistemic approaches came from a meta-analysis of conceptual change literature. Drawing from philosophy, Murphy et al initially identified "eight principle stances in epistemology" (Murphy et al., 2007, p. 107): foundationalism, coherentism, direct realism, probabilism, reliabilism, social epistemology, and virtue epistemology. Of these eight, they focused their analysis on the epistemic stances they found most represented in the conceptual change literature, specifically the foundationalism, coherentism, reliabilism, and social epistemology frameworks. I will discuss these four frameworks under the current section, while a discussion of the links between virtue epistemology and epistemic

motivations will be included in the epistemic motivation portion of the current chapter.

The main focus of the Murphy et al (2007, p. 107) chapter was how these epistemological frameworks might be used in order to identify the underlying epistemologies of conceptual change researchers. However, the authors also discuss the potential influence of instructional approaches on students' conceptual change as being somewhat dependent on the students' own underlying personal epistemologies. The foundationalism, reliabilism, coherentism terminology has also subsequently been applied to the study of individual teacher epistemic beliefs (Hennessey, 2007).

For the purpose of their analysis, Murphy et al. (2007, p. 107) categorize the epistemological frameworks using two dimensions: doxastic vs. non-doxastic, and normative (internalist) vs. naturalist (externalist). The doxastic—non-doxastic dimension refers to the role that beliefs play in justification. A doxastic epistemology is a theory of knowledge that asserts that justification for all knowledge rests *only* on the beliefs that are held, whereas non-doxastic epistemologies reject this assertion (Whitman, 1996). Non-doxastic epistemologies can therefore be distinguished by the additional forms of justification they permit; for example whether they allow purely internal, or also external sources of justification (Whitman, 1996). The internalist—externalist dimension here refers to whether the theory focuses on internal sources of justification (for example cognitive processes in itself) or externalist sources (for example how well cognitive processes create valid predictions) (Murphy et al., 2007). In their analysis Murphy

et al. (2007) characterize *foundationalism* and *coherentism* as doxastic—normative, and *reliabilism* and *social epistemology* as non-doxastic—naturalist. This method of categorizing epistemologies underscores one of the main issues in moves to apply philosophical terminology to psychology – the problem of oversimplification of philosophical theories. For example, there are both foundationalist and coherentist theories of justification that do allow for some external sources of justification or tethers (Fumerton, 2010; for examples see Elgin, 1996; Goodman, 2000). Just as many psychological theories of cognition are finely nuanced, so are philosophical theories of knowledge and over-simplification of the theories may ignore some of the aspects that could make them potentially useful to describe psychological constructs or cognitive processes.

*Foundationalism*. This "epistemic stance" is characterized by Murphy et al. (2007) as holding all knowledge as deriving "through ascent from basic beliefs internal to the knower" (p. 107). Sosa (2000), who emphasizes that both knowledge and beliefs are specific to a particular time, characterizes the foundationalist epistemology as having the structure of a pyramid, whereby "each piece of knowledge" (p.135) rests on a foundation of beliefs that are, at that moment, undeniable. While there are purely internalist foundationalist theories of knowledge, in more modern commentaries these are often referred to as radical foundationalism. Increasingly there are examples of contemporary theories of knowledge that incorporate external forms of justification while maintaining a foundational structure. One example of this is put forward by Fumerton (2010) who describes Goldman's (2000) reliabilist epistemology as an externalist theory of

justification that is built on a foundationalist structure. It may be the case that a focus on the general structure of knowledge described by foundationalist epistemologies, which describes knowledge as building on itself in some way, may be a useful concept to apply to the psychological literature.

*Coherentism.* Murphy et al. (2007) describe this epistemological framework as "that all of one's beliefs as mutually reinforcing and thereby justified as knowledge only in their mutual coherence" (p. 107). Sosa (2000) characterizes coherentism as a raft, free floating, unanchored, and although repairs can be made they "must be made afloat" (p.136) while standing on some other part of the raft. Again, both conceptions may be oversimplified, as there are some epistemologies, such as Elgin's *considered judgment* (1996), that might be characterized as coherentist with regards to the structure of knowledge, but is at the same time externalist in that there are tethers to the external world with which the system of beliefs is constantly compared.

*Reliabilism.* This epistemology is described by Murphy et al. (2007) as "the veracity of knowledge based on the cognitive mechanisms' reliability in producing true beliefs" (p. 107). In terms of applicability to psychology, reliabilist approaches tend to be the most explicit in their reference to the role of cognitive processes in attaining knowledge. Examples of this include Goldman's previously mentioned reliabilist epistemology (2000). Reliabilist epistemologies such as Goldman's focus on, at the most basic level, whether a cognitive process is capable of resulting in true beliefs most of the time. As this theory of knowledge focuses on cognitive processes this seems like a good fit for a model of epistemic cognition, though it

does not provide us with a depiction of which cognitive processes are best suited to the task, it may provide some guidance in terms of what epistemic strategies we want to encourage through instruction.

*Social epistemology.* According to the description given by Murphy et al. (2007) social epistemologies focus "on social practices and their influences on one's beliefs about knowledge" (p. 107). In education the "social dimensions of knowledge" (Schmitt, 1999, p. 354) are clearly an important area of epistemology to acknowledge as by its nature a curriculum often imposes to some extent what the "collective knowledge" (Schmitt, 1999, p. 354) of a population is, or at least the areas of knowledge that are important and should be given time in schools. However, it is not clear how this would fit into a model of epistemic cognition as a specific component, though it may be important to recognize the role of a social epistemology as the context in which epistemic cognition takes place.

*Summary.* While there is some evidence that individuals do use foundationalist, coherentist, and reliabilist approaches, and even socially constructed norms in order to justify their beliefs (Murphy et al., 2007), in individuals these frameworks seem to be better suited to describing strategies rather than underlying epistemologies. While individuals may be more inclined to use one strategy over another, it seems that these strategies might be taught as various methods of constructing knowledge, and in particular as means for evaluating existing knowledge, new information, and sources of information. This view is supported by the current moves towards instruction in information literacy, and is made explicit in the information literacy standards put forward by the American

Libraries Association (Association of College and Research Libraries, 2000) and reading informational texts standards of the common core curriculum (National Governors Association Center for Best Practices, 2010) both of which include checking the reliability of information, looking to the source, and checking the coherence with other information and existing knowledge all as means of evaluating the goodness of information, which cannot be denied as important steps in knowledge formation.

***Knowledge-based validation and consistency checking.*** In their study into the influence of epistemological beliefs and epistemic strategies on learning from text, Richter and Schmid (2010) introduce the notion of epistemic strategies. These they describe as "strategic cognitive activities that take the epistemic status of information into account" (p. 49). They then identify two such cognitive activities: knowledge-based validation and consistency checking as criteria by which individuals may judge information. Under their account, knowledge-based validation is described as focusing on "whether the information is true or plausible given what [the individuals] already know about a topic" (p. 50); a description that seems to be closely linked to the previously discussed foundationalist perspective (Murphy et al., 2007). The second criterion consistency checking, is described as "whether the information is consistent with and well justified by other information" (p. 50); this, similar to the previous knowledge-based validation criterion, seems closely linked to another of the perspectives discussed by Murphy et al. (2007), that of coherentism. The selection of these two criteria as well as the description of the benefits of employing both strategies as potentially leading "to a well organized and

tightly integrated knowledge representation" seems to closely align their approach with the process of reflective equilibrium described by Elgin (1996). Under Elgin's account internal coherence (consistency checking) is important, the coherent system is tethered to the external information by reference to initially tenable beliefs, much like the knowledge-based validation strategy.

The Richter and Schmid (2010) study lends some strong support to the idea that these approaches to knowledge formation, previously described in the literature as epistemic stances, may be better thought of as epistemic strategies. Unlike previous theoretical discussions of epistemological stances or styles, the Richter and Schmid approach to cognitive strategies does not attempt to classify individuals, but looks at these approaches to knowledge formation as being specifically epistemic sorts of cognitive strategy. While the study does provide evidence that the employment of epistemic strategies is being strongly influenced by contextual factors including area of study, and text genre, the conception of epistemic strategies does not preclude the possibility of an individual using multiple strategies to attain knowledge. In fact, as previously described, Richter and Schmid argue that the use of both strategies together would result in a more coherent knowledge representation.

***Ways of knowing.*** Rationalism, empiricism and metaphorism were introduced into the psychology literature by Royce (1978) as "three ways of knowing." Conceived as "epistemic styles" (p. 153) the three ways of knowing are described as psychological patterns that could be used alone or combined by an individual, perhaps in a hierarchical order of preference (Muis & Franco, 2010). In

other words, an individual might be more likely to use rationalism as a way of attaining knowledge but may also use empirical means as a second choice, if it is more fitting to the situation. These ways of knowing are termed "basic" by Royce as he argues that they have a direct connection to cognitive processes (Muis & Franco, 2010; Royce, 1978). The three epistemic styles are described in terms of being the particular cognitive processes an individual employs for "getting at" knowledge. Rationalism is therefore described as attaining knowledge through looking for logical consistency; empiricism as accepting as knowledge that which we "perceive correctly" (p. 149); the third "way of knowing", metaphorism, asserts that "knowledge is dependent upon the degree to which symbolic cognitions lead to universal rather than idiosyncratic awareness" (p. 149).

These three ways of knowing may be particularly attractive to personal epistemologies researchers as they were specifically identified due to the way in which these processes "and the corresponding truth criterion involved are both specifiable and primary" (Royce, 1983, p. 167). This means that not only are ways of knowing clearly defined and explained as to why they should be included in a psychological analysis of epistemology, but also that it is clear what should *not* be included in this analysis and why:

> Such epistemologies as authoritarianism and intuitionism cannot qualify. Intuitionism, for example, fails to qualify because it does not have a valid truth criterion, whereas authoritarianism fails because both its psychological processes and its truth criterion are based on some other (i.e., an authority) epistemic approach – i.e., authoritarianism is a *derived* way of knowing.

(Royce, 1983, p. 167)

Researchers using epistemic styles as a component of their study argue that an additional benefit of this approach is that the three ways of knowing are clearly linked to observable cognitive processes (Muis & Franco, 2010; Royce, 1978). However, the exclusion of epistemologies such as authoritarianism and intuitionism may be problematic. While it does seem to be the case that either the lack of a valid truth criterion, or a truth criterion based on an external source make these excluded epistemic approaches different from the psychological approaches allowed by Royce's scheme, it is not clear that these are not valid or even in some cases legitimate epistemic strategies, particularly where, for example, personal expertise is low and an appropriate expert or authority figure can be found. In these cases, a derived way of knowing may be more adaptive than the high cognitive effort required by the primary styles Royce suggests.

There is evidence that individuals do exhibit these ways of knowing. Most recently, Muis and Franco (2010) used a mixed-methods approach to investigate the relation of these epistemic profiles to metacognition, problem solving, and achievement. In this study of 231 undergraduate educational psychology students, Muis and Franco (2010) were able to capture individuals reporting a use of rationalism, empiricism, or a combination of rationalism and empiricism as their means of attaining knowledge. In the qualitative portion of the study 78 students took part in a problem-solving task that was recorded using a think-aloud protocol. Analysis of the data revealed that students who were identified using the Royce measure as having a mixed rational and empirical epistemic profile were more

likely to use metacognitive strategies and had higher levels of problem solving achievement. These findings indicate that individuals who fit both profiles were better at problem solving and may provide some evidence that these "profiles" may be better thought of as strategies given the ability of students to use both strategies at once as well as the positive influence multiple strategy use had on their problem solving ability. This mixed methods approach lends more validity to the underlying construct as well as the instrument used as it is correlated in the expected directions with the constructs investigated.

***Epistemic resources.*** In response to the idea that developmental models reflect individuals' underlying theories or approaches to knowledge, Hammer and Elby (2002) put forward the idea of epistemic resources. According to their theoretical model, these epistemic resources can be used by an individual to understand several different aspects of knowledge including: the "nature and sources of knowledge" (p. 177), "epistemological activities" (p. 179), "epistemological forms" (p. 180), and "epistemic stances" (p. 181). They suggest that individuals of all ages have these resources and can understand each of these components of knowledge and knowing in several different ways. While they view these epistemic resources as finer grained building blocks in the construction of broader epistemic understandings, Hammer and Elby (2002) also suggest that shifting towards thinking about "finer-grained resources" (p. 183) can help us to think about the sorts of components that go into the construction of a more sophisticated epistemology.

The epistemic resources approach (Hammer & Elby, 2002) is closely aligned with the idea of epistemic development, though it describes a much more

incremental approach, than the more general stage models. However, it seems that a greater distinction between the kinds of strategies or resources an individual uses to try to attain knowledge, and their more general beliefs about the nature of knowledge is necessary. There is reason to believe that for individuals, a greater proficiency with a wider range of epistemic resources might enable overall epistemic development, it seems that the number and type of epistemic resources available and the ability to apply them should be thought of as separate from the developmental schemes, which seem to more closely describe the way individuals approach and think about knowledge in more general terms. Due to this distinction, Hammer and Elby's epistemic resources approach to personal epistemologies, is incorporated here under the broader umbrella of *epistemic strategies.*

***Summary of epistemic strategies in the literature.*** While there is support for individual use of differing epistemic strategies (Franco et al., 2012; Muis & Franco, 2010; Murphy et al., 2007; Richter & Schmid, 2010), the conception of epistemic resources as being finer grained components of a more general epistemic developmental trend has little empirical support (Hammer & Elby, 2002). Furthermore, the characterization of epistemic strategies as tools for validating knowledge claims (Richter & Schmid, 2010) is so conceptually different to the description of epistemic development as attitudes and beliefs about the nature of knowledge, that it seems important to maintain separation between epistemic development and learning and being able to apply epistemic strategies. The importance of maintaining conceptual clarity between development and strategies,

as well as the empirical and theoretical support for the influence of epistemic strategies on learning provides the rationale for the inclusion of epistemic strategies as distinct from epistemic development in a model of epistemic cognition in context.

It seems clear that epistemic strategies and epistemic development do not describe the same thing, however, it does seem that there must be a relationship between the two, though the nature of this is not clear. As previously described, Hammer and Elby (2002) suggest a fine grained approach of specific building blocks in four different areas that go into the construction of epistemic understandings. This idea of building understandings through acquiring more resources, together with empirical evidence that using a mixed strategies approach to validate knowledge claims leads to greater use of metacognitive strategies and higher levels of problem solving achievement (Muis & Franco, 2010), suggests that developing more *epistemic strategies* may enable overall *epistemic development*. In terms of how epistemic strategies could be learned, the literature on metacognition provides some suggestions. Studies into methods for teaching metacognitive skills indicate that this might be done through embedding the skills within taught content, emphasizing the importance of these skills, and making provisions for continued instruction and emphasis on these skills over time (Veenman, Van Hout-Wolters, & Afflerbach, 2006). If epistemic strategies are learned in a similar way, then this may partially explain domain differences. Teaching within the different domains is likely to carry implicit and sometimes explicit messages about appropriate ways of attaining knowledge within the field (Hofer, 2000, 2006a). Depending on the

instruction students have received, they may therefore have more knowledge and experience with epistemic strategies in certain fields and therefore their epistemic behaviors are likely to be different in different domains. In this way, the mechanism of development lacking from the King and Kitchener (1994) reflective judgment model, used here for the *epistemic development* component of the model is explained, and cautions that epistemic development is not due solely to maturation (Alexander & Sinatra, 2007; Hofer, 2001) are met.

As has been demonstrated by this portion of the literature review over epistemic strategies, this is by no means a clear component of a model of epistemic cognition. Several suggestions have been put forward here as comprising epistemic strategies including *foundationalism*, *coherentism*, *direct realism*, *probabilism*, *reliabilism*, *social epistemology*, and *virtue epistemology* (Murphy et al., 2007); *knowledge-based validation* and *consistency checking* (Richter & Schmid, 2010); *rationalism*, *empiricism*, and *metaphorism* (Royce, 1978); and knowledge of *nature and sources of knowledge, epistemological activities, epistemological forms*, and *epistemic stances* (Hammer & Elby, 2002). This does not even begin to scratch the surface of the full range of epistemological theories from the field of philosophy that would be considered by Moser (2002) as strategies. However, it does seem that beginning to understand this component of the model may shed some light on understanding the mechanisms of epistemic development, as well as potential approaches for both improving epistemic cognition within specific context and supporting development at the more general level. Therefore, the proposed study will use *foundationalism*, *coherentism*, and *reliabilism* (Hennessey, 2007; Murphy et al., 2007) for this component of the

model in order to "get started" in the investigation, but will also allow for open responses to begin a more exploratory investigation of this component and its influences.

**Epistemic motivations**. The third theme that emerged from the personal epistemologies literature is that of epistemic motivation. Here epistemic motivation is used to indicate motivations that specifically impact the process of belief formation (Chinn, Buckland, & Samarapungavan, 2011; Fairweather, 2001). Unlike epistemic strategies and epistemic development, which are somewhat intertwined in the literature, epistemic motivations tend to be treated as a distinct field. In terms of the philosophical roots, this seems to be an area of personal epistemologies that may be closely related to virtue epistemology. In philosophy, moral virtue theories focus on the virtuous character of the individual, however epistemic virtue theories focus specifically on intellectual virtues (Zagzebski, 2000). These, Zagzebski explains, are differentiated from moral virtues by the particular motivations underlying the behavior, which, in the case of intellectual virtues are "based in the motivation for knowledge" (Zagzebski, 2000, p. 458).

Of the sources reviewed, the only mention of virtue epistemology in the psychological literature is by Murphy et al. (2007), who briefly characterize virtue epistemology as focusing "on the character of the knower rather than individuals' beliefs or collections of beliefs" (2007, p. 107). The lack of focus in the psychology literature is particularly surprising given that most models of epistemic development

carry a judgment about the type of personal epistemologies that are more sophisticated, and by association more valuable (Hofer & Pintrich, 1997). In one of the few articles to bridge philosophy and this area of psychology Chinn, Buckland, and Samarapungavan (2011) argue that both *epistemic virtues* and *vices* ought to be included in conceptions of epistemic cognition. The authors suggest two components of *need for closure*: *closed-mindedness* and *discomfort with ambiguity* (Kruglanski, 1990) as potential candidates for epistemic vice. Based in Lay Epistemic Theory (Kruglanski, 1990), need for closure, is described as an individual's "motivational tendency or proclivity" to seek a definite answer (Kruglanski & Webster, 1996, p. 264). Research findings indicate that individuals with a high need for closure show tendencies to seize and freeze on information rather than engaging in the hypothesis generation – validation process as an ongoing practice (Kruglanski & Webster, 1996). A high dispositional need for closure may also affect both the way in which an individual processes information in trying to find answers to questions (DeBacker & Crowson, 2006) as well as a reduction in the amount of information individuals process before committing to a conclusion (Kossowska, 2007). These tendencies seem in active opposition to the "motivation for knowledge" (p. 458) described as the grounds for epistemic virtue by Zagzebski (2000).

In another of the rare articles to address epistemic virtue in psychology, Lahroodi (2007) discusses the potential of *need for cognition* (Cacioppo & Petty, 1982; Cacioppo, Petty, Feinstein, & Jarvis, 1996) as a naturally grounded example of an epistemic virtue. Lahroodi's focus on cognitive traits describes those as

epistemically valuable which "stand in a suitable relation to epistemically desirable ends such as true belief, knowledge and justification" (2007, p. 228) and notes that need for cognition, the motivational tendency to "engage in and enjoy thinking" (Cacioppo & Petty, 1982, p. 116) would seem to fit this description. This argument for need for cognition as an epistemic virtue is further strengthened by research findings indicating that the trait has an effect on individual enjoyment and engagement with arguments; in particular the type of controversial arguments that may require high levels cognitive engagement (Kardash & Scholes, 1996; Nussbaum & Bendixen, 2003).

***Summary.*** There is some evidence that both *need for closure*, and *need for cognition* operate at trait-level as epistemic motivations. This evidence of their influence on cognitive engagement (Kardash & Scholes, 1996; Nussbaum & Bendixen, 2003) and level and amount of processing (DeBacker & Crowson, 2006; Kossowska, 2007) indicates their importance in a model of epistemic cognition, together with the strong theoretical rationales for the inclusion of epistemic virtues and vices in a model of epistemic cognition, due to the way they orient the individual towards epistemic aims (Chinn et al., 2011) indicates an important role in a model of individual approaches to knowledge. As well as having a clear influence on learning and engagement, epistemic motivations may also influence engagement in learning and applying epistemic strategies and therefore possibly impact epistemic development. The current study provides an initial investigation into how the three components may be linked and lays the groundwork for future study.

While several other epistemic virtues and vices have been suggested by both psychologists and philosophers, the proposed study will focus on *need for closure* and *need for cognition* as two different *epistemic motivations*. Both constructs have evidence of operating at trait-level and are well-established approaches to epistemic motivations with empirical evidence for their effect on learning. By using both need for closure and need for cognition, the proposed study will also seek to capture both an epistemic virtue and an epistemic vice.

**Domain Generality and Specificity**

Much of the earlier research in epistemic development focused on the development of individuals' general beliefs about knowledge. As the field has developed, several studies into the issue of domain specificity-generality have been carried out (Buehl & Alexander, 2001; Buehl et al., 2002; Hofer, 2000). These studies indicate that there are differences in the way individuals express their beliefs about knowledge in specific domains, and also that level of expertise and familiarity with the epistemic norms of the field seem to be the most important factor in predicting the level of development of personal epistemologies (Hofer & Pintrich, 1997), with more in-depth knowledge of a subject predicting greater sophistication of personal epistemologies within that domain. While the idea that there are domain differences in expressed personal epistemologies is now widely accepted, the way in which these domain specific beliefs relate to one another or to domain general beliefs is not clear (Hofer, 2006a).

Hofer (2006a) has suggested that the issue may be more a case of how domain general beliefs are enacted differently dependent on the particular knowledge domain. In other words, personal epistemologies interact with the context to give the appearance of domain specific beliefs (Hofer, 2006a). It is this idea of the influence of *context* rather than domain dependence that informs the current study. In the proposed model, domain forms part of the more specific context that may influence the individual's approaches to knowledge construction via the individual's knowledge of epistemic norms of the field in which they are operating (Hofer & Pintrich, 1997) and the epistemic strategies which are appropriate for that field.

This also supports Hofer's (2006a) suggestion that education may have a greater influence on beliefs about knowledge than simply effects on domain specific beliefs. Under this understanding of the domain specificity-generality issue, education becomes not only about teaching the epistemological assumptions of a certain subject, but also an education in how to evaluate new information; that is, "learning how to learn" (p. 73) both within that domain but also, through exposure to domain differences in epistemologies, at the domain general level.

**Blurring the Lines: Epistemology and Ontology**

Several of the depictions of *personal epistemologies* described in the literature include reference to the nature of reality. Examples include Kitchener's (1983) description of the epistemic assumption "that there is an objective reality" (p. 226)

that may underlie an individuals' epistemic cognition. Examples of items on instruments that include this notion include: "Scientists can ultimately get to the truth" and "If scientists try hard enough, they can find the truth to almost anything" that form part of the Schommer's Epistemological Questionnaire (1990b). However, the concept of reality and the relation of truth to that reality are really more *ontological* questions than *epistemological*. This confusion is further complicated by items that attempt to capture individual beliefs about knowledge, truth, and the nature of reality while using words such as "truth" and "knowledge" in the questions themselves. This is problematic as one individual may respond to the question "Scientists can ultimately get to the truth" with a strongly agree, based on the belief that scientific "truth" is subjective and negotiated; while another may respond in the same manner based on a view of "truth" as reflective of an objective reality. The argument is not that an individual's views about the nature of reality and the relation of knowing and truth to reality (however that is defined) do not have an impact on how an they might approach knowledge construction or acquisition, but that it is important to maintain a separation between the concepts in order to not confound personal epistemologies with ontological beliefs.

A second argument against the introduction of ontological issues into conceptualizations of personal epistemologies is the question of whether most individuals really spend time reflecting on the nature of reality. While many individuals may have at least thought about what they consider themselves as knowing, and the best ways to go about finding and evaluating information to achieve knowledge, I question how many individuals have truly reflected on the

nature of reality. If the answer to this question is "not the vast majority", the question of how meaningful these types of items are must be addressed. If most individuals are likely to respond to these types of question on a "gut instinct," responses to these items are unlikely to indicate either a well-formed and articulated belief, or anything about their approach to knowledge formation.

Keeping these issues in mind, care has been taken in selecting instruments for this study, in some cases re-wording instrument items to remove words such as "truth," "knowledge," and "reality" from survey items. This is so that we do not confuse the issues, or label an individual with "unsophisticated" personal epistemologies, on the basis of an ontological distinction. This is also reflected in the proposed analysis of outcomes, standards, and behaviors to focus only on justification and belief.

**Proposed Model of Epistemic Cognition**

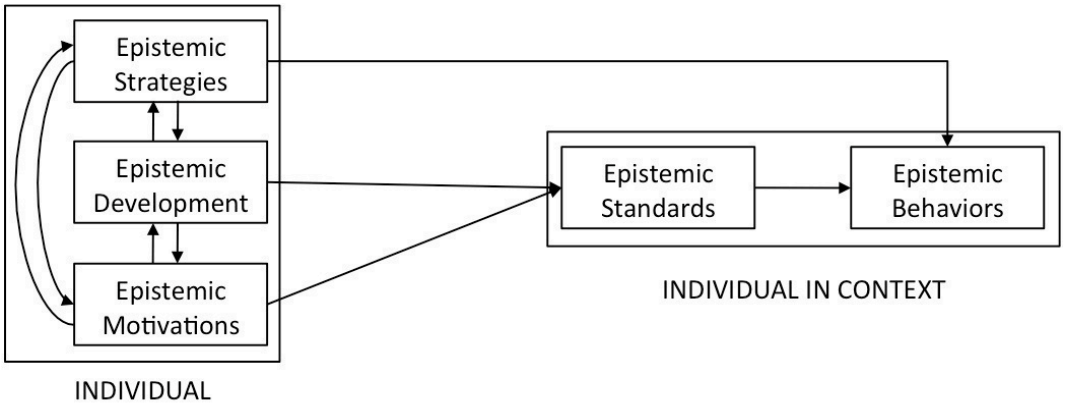


*Figure 1.* General model of individual influences on context-driven approaches to knowledge formation.

The model of *epistemic cognition* proposed here is an attempt to bring together the three approaches of personal epistemologies described and investigated in the current literature into a model that describes the process through which individuals form knowledge. The model is not only an effort to integrate the constructs put forward by each of the respective branches of the field, but also to make sense of the findings with regards to the impact on epistemic behaviors in a knowledge-forming context. The model also seeks to make sense of the findings regarding the problem of domain specificity and generality by separating individual strategies, development, and motivations at the general level from those specific standards and behaviors enacted in specific contexts. As throughout the previous review of the field of personal epistemology, I have also used the lens of philosophy to try to make sense of both the current terminology and findings.

The hypothesized model shows the three identified branches of personal epistemologies research: *epistemic strategies*, *epistemic development*, and *epistemic motivations* as jointly influencing the setting of *epistemic standards* and, through the standards set, the application of *epistemic strategies* in context. *Epistemic standards* are described as the standards an individual has in a specific context for how much processing and information they deem necessary in order to be comfortable forming an opinion. *Epistemic behavior* here describes individual approaches to knowledge formation in a specific context, including enacted *epistemic strategies*, and the amount of processing both in terms of time spent and information assessed, before coming to a conclusion. This means that effectively *epistemic strategies* appears twice in the model, both at the individual and individual-in-context levels. This reflects the idea of epistemic strategies as a specific type of cognitive strategy with knowledge formation as the goal (Richter & Schmid, 2010).

In the proposed model I hypothesize reciprocal effects between all three individual components: *epistemic strategies*, *epistemic development* and *epistemic motivation*. First I will look at the nature of the relationship between epistemic development and epistemic strategies. Although several researchers have discussed concepts that I have here categorized as *epistemic strategies* (Murphy et al., 2007; Royce, 1978, 1983) these particular researchers have focused on these as underlying personal epistemologies that drive individual approaches to knowledge formation. While Richter and Schmid (2010) focus on epistemic strategies as a specific type of cognitive strategy, it is Hammer and Elby's account (2002) of epistemic resources as finer grained blocks in the construction of broader epistemic understandings, that

most closely relates to the position of epistemic strategies within the proposed model. Rather than strategies being a finer grained approach than the broad stages of development (Hammer & Elby, 2002) it seems to me that epistemic strategies are related to, but not component parts of, *epistemic development*. I hypothesize that this relationship operates in two specific ways. Firstly, learning epistemic strategies, in much the same way as learning metacognitive strategies supports metacognitive development (Schraw, 1998; Veenman et al., 2006), may support epistemic development. Secondly, that the current level of epistemic development may influence the types of strategies that an individual seeks out or is taught, as well as the fluency in their application. For example, if an individual views knowledge as a "coordination of the objective and subjective" (Kuhn et al., 2000) she may be more likely to augment a broader range of epistemic strategies in order to construct knowledge that fits that description. Similarly, she may also then be more likely to use strategies that correspond with this view of knowledge, thereby, through practice, enabling their skill in applying them.

The second hypothesized reciprocal relationship is between epistemic development and epistemic motivation. Here I will focus on the two epistemic motivations discussed in the literature review: *need for closure* (Kruglanski, 1990; Webster & Kruglanski, 1994) and *need for cognition* (Cacioppo & Petty, 1982). Though there is only a low negative correlation ($r$ = -.28) between need for closure and need for cognition (Webster & Kruglanski, 1994), studies into both of these proposed epistemic motivations show relationships with epistemic development. In these studies, need for cognition is correlated with more sophisticated views on

some dimensions of epistemic development (Kardash & Scholes, 1996), while need for closure is correlated with more naive views on dimensions of epistemic development (DeBacker & Crowson, 2006). Both need for closure and need for cognition are described as dispositions (Cacioppo & Petty, 1982; Cacioppo et al., 1996; Kruglanski, 1990; Webster & Kruglanski, 1994), given this, it seems reasonable to hypothesize that epistemic motivations may impact epistemic development through the types of interaction with information and approaches to knowledge formation and learning preferred by the individuals. Pintrich, Marx, and Boyle (1993) suggest in regards to need for closure, that it may develop over time through experience, this supports the hypothesis that epistemic development may also influence epistemic motivations through the way the individual views knowledge and knowing.

The third reciprocal relationship hypothesized in the model is between epistemic strategies and epistemic motivations. Similar to the proposed relationship between epistemic development and epistemic motivations, it is hypothesized that epistemic motivation may impact the degree to which the individual is likely to learn and develop aptitudes for using epistemic strategies. This hypothesis is supported by research findings indicating relationships between need for cognition and deep cognitive engagement and use of multiple cognitive strategies (Cacioppo, Petty, Kao, & Rodriguez, 1986; Cacioppo, Petty, & Morris, 1983; Furlong, 1993). Similar studies into need for closure show a relationship with more surface learning strategies, which due to their nature are more likely to be non-epistemic as these strategies do not seek to integrate new information with existing knowledge, and do

not foster a deep understanding of the material (Franco et al., 2012). The suggestion of an influence of epistemic strategies on epistemic motivation relates to Pintrich et al.'s (1993) observation that experience may influence need for closure, a trait that they suggest may develop over time. If this were the case, it would seem that exposure to and learning new epistemic strategies would be a strong candidate for influencing both need for closure, as well as possibly need for cognition, given that enjoyment of thinking might be more likely to be greater when the individual has more strategies available to them.

Embedded within the broader umbrella of *epistemic behaviors*, e*pistemic strategies* appears twice in the hypothesized model, both at the individual and individual in context levels. This reflects the idea of epistemic strategies as a specific type of cognitive strategy with knowledge formation as the goal (Richter & Schmid, 2010). In this way, enacted epistemic strategies are not in any way proxies for underlying personal epistemologies, but represent the epistemic strategies that the individual has selected from their "tool box" as appropriate for the knowledge-seeking task. I hypothesize that the selection of epistemic strategies used in the knowledge-forming context is influenced by the demands of the context itself as well as the epistemic standards set by this particular individual in the specific knowledge-forming context. Research into the domain specificity of personal epistemologies indicates that personal epistemologies are expressed differently in different domains. Hofer (2006a) has suggested that this is due to domain general beliefs being enacted differently and that it is the way that personal epistemologies interact with the context that gives the appearance of domain specific beliefs.

The hypothesized model is general in the sense that it shows both *epistemic motivation* as well as *epistemic behaviors* as single entities, whereas in the models tested these components will be operationalized as specific factors and constructs. The general model also suggests that epistemic strategies, development, and motivation together influence epistemic standard setting that mediates the relationship between the three components and epistemic behaviors within specific contexts. However, it is unclear from the current research and theory how this might occur. Contextual factors that may influence epistemic behaviors in knowledge-forming contexts might include: perceived personal risks of making the wrong decision, interest in the topic itself, as well as prior knowledge of the subject. Given the importance of individual perception in some of the contextual factors it is conceivable that these factors may mediate the interaction between individual epistemic factors and behaviors; however, it may also be the case that these factors instead moderate the relationship. Therefore one goal of the proposed study will be to test competing models with contextual factors both as mediators and moderators of the relationship between individual epistemic factors and epistemic behaviors in context.

## Chapter 3: Methodology

The study uses an online knowledge formation task containing multiple texts of opposing positions on the topic of "Should the use of hand sanitizer be promoted in universities?" Participants were given time to select and read as many of the pieces as they felt necessary to form an opinion on the topic at which point they responded to open-ended reflection questions both about the topic itself, as well as their justification processes. Quantitative data about the pages visited and Likert-scale items on the contextual factors interest, perceived personal risk, and prior knowledge were also collected. This together with the previously described qualitative data was used to assess the *epistemic standards* and *epistemic behaviors* components of the model. The topic of hand sanitizer use was chosen both because of students' acquaintance with hand sanitizer as a product, of which dispensers are positioned in numerous places around the campus, but also their likely lack of familiarity with the public health issues involved in its usage. The topic is also currently fairly contentious with opposing texts easily sourced at multiple levels of authoritativeness including scientific literature. Quantitative data on participants' individual levels of *epistemic development* as well as their *epistemic motivations* and *strategies* were collected using online survey instruments.

This mixed method approach enabled investigation of the model as a whole, as well as more specific aspects of the hypothesized model. Using a mixed methods approach allowed for investigation of aspects of the model that have more defined construct definitions such as *epistemic development* and *motivations*, as well as those that are as yet less well defined such as *epistemic strategies*. Epistemic development

and some epistemic motivations have available instruments, and could therefore be quantified. However, epistemic strategies are less well defined, therefore a more qualitative approach enabled investigation of these components of the model in a more exploratory manner, and also made it possible to assess the appropriateness of the hypothesized model as a whole. As the proposed study is cross-sectional the reciprocal influences between the proposed individual components of the model were not investigated. However, correlations between epistemic motivations, development, and strategies were obtained.

This chapter will first outline my underlying theoretical framework, or epistemological beliefs underlying the present study. I will then go on to further explain the theoretical rationale for using a mixed method approach and lay out the research design. The rest of the chapter describes the participants, materials, instruments, and data collection procedures, as well as the data preparation that took place prior to the analysis.

## Theoretical Framework

My ontological view is that there is a single external reality. However, I also believe the nature of this reality can never be objectively known, and may be very different to that which we perceive. Many philosophers have discussed this disconnect between our perception and the external reality. This "veil of perception" can be described as the gap between perception and reality, and is due to the existence of the external reality as independent of our sensation of it. Locke

(1979) describes a type of representational realism whereby our perceptions are somehow representative of the external reality. How close these representations are to the external reality is not clear and, like many philosophers, I agree that there is no objective way of knowing how close these representations are. Due to this underlying assumption, in terms of our knowledge of the external reality, I believe that the status of the truth condition (under the classical conception of knowledge as "justified true belief") of knowledge can never be ascertained. Although some statements are true with regards to their correspondence to the external reality and others are not, I do not think that there will ever be a way of knowing whether the truth condition has been satisfied. This inability to know for certain whether something is true or not is due to the previously described disconnect between the external reality and our perception of it.

In terms of knowledge and the knower, I therefore believe that rather than knowledge, we can instead only strive for understanding, through making sense of the perceived connections between assertions, and justified beliefs. What I suggest for justification and understanding is a type of internal coherentism and external reliabilism similar to that suggested by Elgin (1996). Under her description of *Considered Judgment*, justification is gained through reflecting on whether a proposition has initial tenability with regards to the coherence with the individual's overall system of beliefs. While I believe that Elgin's conception of considered judgment has some problems with regards to the agency of the individual in making those judgments about a proposition's initial tenability and subsequent incorporation in their greater system of beliefs, I do think this idea of initial

tenability could be expanded to include standards for justification that would recognize individual cognitive capabilities. In this way, judgments about the plausibility of an assertion could be made with reference to multiple sources of both internal and external evidence in the form of both perceptions of reality as well as prior beliefs. This addition of standards for justification may provide us with a stronger rationale for believing that may get us somewhat closer to an accurate reflection of the external reality. However, this description of considered judgment does mean that what constitutes justified beliefs is highly subjective and highly dependent upon both individual's perceptions of reality and their pre-existing schema.

This epistemological and ontological viewpoint has led me to position myself as a critical pragmatist (Crotty, 1998) in terms of my underlying assumptions about the nature of reality and also of inquiry. Like James (1981) I am interested in conducting inquiry and interpreting the results in terms of the "respective practical consequences" (p. 26). This epistemological standpoint is in line with the epistemological framework at the root of mixed method inquiry where methods are selected based on their usefulness as tools in answering the research questions (Schutz, Chambless, & DeCuir, 2004).

**Rationale and Evidence for a Mixed Method Approach**

The main rationales for employing a mixed-method approach for the study were to investigate the *process* and for *completeness* in describing and investigating the

model (Bryman, 2006, p. 106). The study sought to investigate the hypothesized model of epistemic cognition as a potential explanation for the interaction of domain-general epistemic strategies, development, and motivation and their combined influence on epistemic standards and behaviors in a knowledge-forming context. Given that the study sought not only to ascertain the relationships between components, but also to understand the underlying mechanisms through which the components may influence standard setting and strategy selection, a mixed-methods approach was deemed necessary.

The argument for the necessity of a mixed-methods approach is best approached by looking at the research questions individually. The first set of research questions focused on the relationships between the proposed components of the model:

1. How are domain-general epistemic strategies, development, and motivations related to the epistemic standards set and epistemic behaviors displayed in a specific knowledge-forming context?
    a. Do epistemic motivations act as a mediator between epistemic development, strategies and the standards set in a knowledge-forming context?
    b. Which of the proposed epistemic motivations: need for closure or need for cognition has the greatest impact on epistemic standard setting and epistemic behaviors displayed in a knowledge-forming context?
    c. Which of the proposed contextual influences (i.e., interest, perceived personal risk, importance of understanding, and prior knowledge) has the

greatest impact on epistemic standard setting and epistemic behaviors in a knowledge-forming context?

The focus of these questions on relationships, and specifically sub-questions on possible mediation effects of motivations, and the level of impact of contextual influences and epistemic motivations clearly required a primarily quantitative approach. However, epistemic behaviors and the nature of the relationship between standards and behaviors could not be captured purely quantitatively. Therefore in order to address the broader question of the nature of the relationships between context independent epistemic components and context dependent components necessitated the incorporation of a qualitative approach. In other words, quantitative methods alone would not have been adequate to look more closely at the *process* behind the relationships or provide *completeness* in the descriptions of the influences of the various components in the model. In other words, quantitative analysis would not have been able to fully investigate the processes involved or to provide a "comprehensive account" (Bryman, 2006, p. 106) of epistemic cognition. On the other hand, while qualitative analyses enabled an analysis of the processes and participant thinking in terms of their selection of strategies and means of justification in the knowledge-forming context, they cannot investigate the nature of the relationships in terms of mediation or magnitude of effects.

The second and third questions both focused on epistemic behaviors within the knowledge-forming context:

2. How are epistemic standards and behaviors related in a knowledge-forming context?

3. How is the repertoire of domain-general epistemic strategies and the epistemic strategies enacted in a knowledge-forming context related?
    a. What epistemic strategies emerge in a knowledge-forming context?
    b. Of the epistemic strategies that emerge in a knowledge forming context, which of these are captured by the epistemic strategy instrument?

While quantitative data covering some aspects of epistemic standards and behaviors were collected, not all aspects of epistemic behaviors are quantifiable. One primary example of this is epistemic strategies, as there is no single instrument that captures all of the epistemic strategies proposed in the literature review. The instrument used was therefore unlikely to capture all possible strategies exhibited by students during the task. Due to this limitation, the study only collected quantitative data on epistemic strategies at the domain general level and did not ask participants to repeat an epistemic strategies instrument for their strategy use in the knowledge-forming context. Instead of a quantitative measure, qualitative questions about strategies participants used during the knowledge-forming context were necessary for *completeness*. Participant open-ended responses to questions about the strategies used to select materials in addition to their general responses to the topic prompt were analyzed inductively for specific strategies employed during the task and compared with their quantitative responses. A final consideration was that the qualitative data collected on epistemic strategies employed in context led to greater understanding of the construct with potential applications for further *instrument development*, another of the mixing rationales found by Bryman (2006).

The use of mixed methods for this study was also better aligned with my own pragmatist epistemological framework than a single method approach, and was hoped to be more successful in capturing the multi-layered nature of the assumed external reality. By using a combination of methodological approaches the potential for understanding "different aspects of the phenomena under study" (Schutz, Nichols, & Rodgers, 2008, p. 278) was increased. Schutz et al's description of ontology as that of a richly layered and complex reality, with an epistemology of never quite knowing whether we had attained "the truth" aligns closely with my own and provides a strong rationale for utilizing multiple approaches to try to make sense of phenomena from multiple angles and lenses.

**Research Design**

The study employed concurrent implementation (Onwuegbuzie & Collins, 2007), meaning that the qualitative and quantitative data were collected at the same time as each other. The task-based data collection resulted in both quantitative and qualitative data; while the remaining survey instruments resulted only in quantitative data. The sequence of the surveys and online search task were determined by priming considerations, with the surveys given following the problem solving task so as not to cue participants into the focus of the study, and in particular the types of strategies they might have used in the knowledge forming task to approach the information provided.

In terms of the dominance, different approaches were used to study each set

of research questions. For the first group of research questions, an embedded correlational design (Creswell & Plano Clark, 2007) was used. This is a quantitative dominant approach with a focus on the correlations, in this case the path models. Qualitative data were used to investigate the underlying processes. Interpretation was therefore primarily quantitatively driven, with qualitative descriptions. For this set of research questions:

1. How are domain-general epistemic strategies, development, and motivations related to the epistemic standards set and epistemic behaviors displayed in a specific knowledge-forming context?
    a. Do epistemic motivations act as a mediator between epistemic development, strategies and the standards set in a knowledge-forming context?
    b. Which of the proposed epistemic motivations: need for closure or need for cognition has the greatest impact on epistemic standard setting and epistemic behaviors displayed in a knowledge-forming context?
    c. Which of the proposed contextual influences (i.e., interest, perceived personal risk, importance of understanding, and prior knowledge) has the greatest impact on epistemic standard setting and epistemic behaviors in a knowledge-forming context?

the quantitative data were used to investigate correlations between the individual epistemic strategies, development and motivations, and the epistemic standards and behaviors employed during the task. Qualitative data were used to investigate the underlying processes behind any correlations found, particularly those relating to

the epistemic behaviors displayed in the knowledge-forming context.

The second research question focused heavily on the epistemic behaviors:

2. How are epistemic standards set, and epistemic behaviors displayed in a knowledge-forming context related?

Due to the limitations of the epistemic strategies instrument, dominance for this question will again take an embedded correlational approach. Correlations between the quantitative data on individuals' epistemic standards for the task, and data from the internet logs on the number of pages visited and amount of time spent were analyzed. Qualitative data from student reflections and descriptions of strategies employed while reading and reflecting on the information were used to investigate the processes. These were then compared with the data from the quantitative instrument in order to illuminate similarities and differences between strategies captured by the instrument and those that the participants themselves described using during the task.

The third set of research questions was investigated using a more exploratory design (Creswell & Plano Clark, 2007):

3. How is the repertoire of domain-general epistemic strategies and the epistemic strategies enacted in a knowledge-forming context related?
    a. What epistemic strategies emerge in a knowledge-forming context?
    b. Of the epistemic strategies that emerge in a knowledge forming context, which of these are captured by the epistemic strategy instrument?
    c. In order to answer these questions, comparisons between the quantitative and

qualitative data were made in order to more deeply understand the phenomenon under study.

The implementation and dominance described above may be illustrated by the following figure. The illustration shows the task-based components including context on the right, and the individual components on the left as in the original proposed model (*Figure 2*). Variables that were investigated quantitatively are shown as white boxes. Epistemic behaviors and standards, which were investigated with both quantitative and qualitative data, are shown as a shaded box to indicate the inclusion of qualitative data. The relationship between individual epistemic strategies and those that emerged as part of the epistemic behaviors in context were investigated purely qualitatively, and are therefore indicated in the figure by dashed connectors. This inclusion in the figure of epistemic behaviors as being investigated both qualitatively and quantitatively indicates the embedded aspect of the embedded correlational design used to address questions one and two; while the dotted line between individual epistemic strategies and task-based epistemic behaviors indicates the more exploratory approach to the third question. As this study employed cross-sectional data collection, the relationships between epistemic strategies, development, and motivations were investigated through correlations. However, correlations between these components provide some support for conducting a longitudinal cross-lagged investigation of the reciprocal influences between domain general epistemic strategies, development, and motivations.

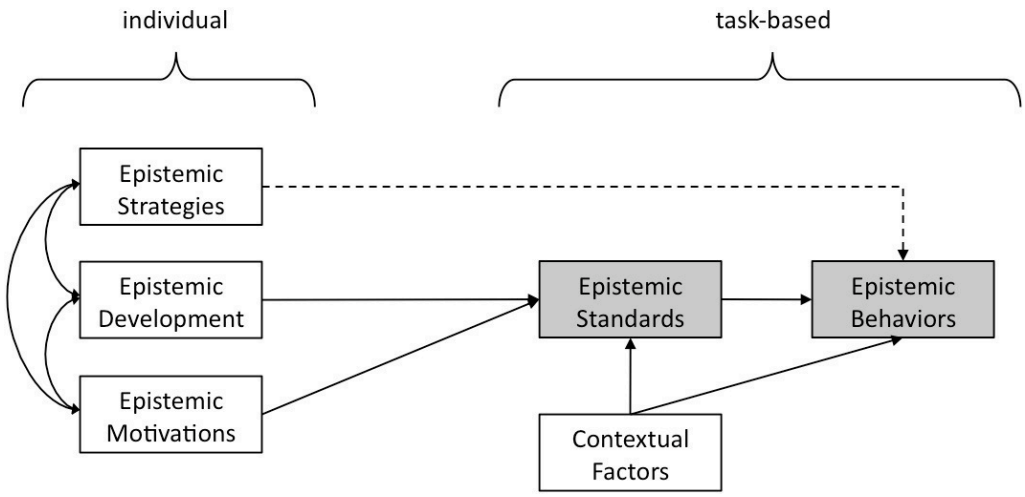


*Figure 2.* Illustration of the study design implementation and dominance.

## Participants

The participants for this study were undergraduate and graduate students enrolled in philosophy and education classes at a large state University in the Southwest United States. There was a total of 84 participants, 13.10% of which were male, and 86.90% were female. The ages of the participants were between 18 and 41 ($M$ = 21.04, $SD$ = 3.13). Of the participants, 85.70% identified as White, 2.40% as African American, 2.40% as American Indian, 1.20% as Hispanic, 3.60% as Asian, 1.20% as Pacific Islander, 3.60% identified as mixed-ethnicity (2.40% identified as Hispanic and White, and 1.20% as Native American and White). The total number of semesters in college reported by participants was between 2 and 18 ($M$ = 5.57, $SD$ = 2.71). The GPA of participants was between 2.75 and 4.0 ($M$ = 3.42, $SD$ = 0.35).

## Materials

**Search task topic**. Hand sanitizer is commonly seen on college campuses and public spaces and is therefore a product that most students are aware of. However, the use of hand sanitizer remains scientifically controversial with the CDC going back and forth on its recommendations for hand sanitizer use (Boyce & Pittet, 2002; Hall et al., 2011) but, in contrast with some other scientifically controversial topics such as the HPV vaccine (Hilpert, Brem, Carrion, & Husman, In Press) the use of hand sanitizer is not morally controversial, nor is it a topic that seems to be closely tied to political or religious affiliation such as global warming (Bråten & Strømsø, 2010; Bråten, Strømsø, & Samuelstuen, 2008; Strømsø, Bråten, & Samuelstuen, 2008) or evolution (Sinatra, Southerland, McConaughy, & Demastes, 2003). Although the other topics are good at obtaining participant engagement, underlying moral beliefs seem to moderate the relationship between the epistemic factors studied and the behaviors and resulting opinions from participant encounters with the instruction or text (Hilpert et al., In Press).

A second reason for selecting hand sanitizer as the basis for the online task was the availability of Internet resources of varying quality on both sides of the argument, including both pro and con hand sanitizer use articles from authoritative sources. The use of controversial, argumentative, and dual-positioned texts is a commonly used approach to investigating the role of epistemic beliefs in processing of information (for examples see: Bråten et al., 2008; Kardash & Howell, 2000; Mason, Boldrin, & Ariasi, 2010). The main benefit of this approach for this study was that the articles were restricted allowing for easy coding of the materials

accessed by the participants. This approach also ensured that all participants had access to the same articles regardless of their Internet search abilities, as the study was intended to look at individual uses of available information rather than their ability to search and find information on the Internet.

**Search task environment**. In order to find Internet resources on the topic of hand sanitizer Google searches were conducted using the search terms "hand sanitizer," "hand sanitizer dangers," "hand sanitizer benefits," "hand sanitizer pros," and "hand sanitizer cons" the search results were investigated and the text from 16 different pages at various levels of authority were copied and pasted into Word files. Although several peer reviewed journal articles were found on the topic of hand sanitizer, these were rejected for the purposes of this study due to length and the amount of subject specific terminology. The researcher sorted the 16 articles into different levels of authority using the *trustworthiness* and *expertise* dimensions described by information science (Danielson, 2006). According to this framework *trustworthiness* encompasses ideas such as accuracy of information and lack of bias, while *expertise* includes concepts such as the ability of the source to provide accurate and valid information (Danielson, 2006). Word counts, Flesch-Kinkaid Reading Ease, and Flesch Grade Level equivalents were then obtained for the main text contained on the Web pages. Subsequently four pairs of articles emerged has having equivalent authority, approximately equivalent word counts, and levels of reading difficulty. For the purposes of maintaining equivalency of word count and reading difficulty across pro and con sets, as well as keeping each text more cleanly on one side of the argument some content was cut from the

Infection Control Today article "CDC's endorsement of alcohol hand rubs launches in hand hygiene" (Dix, 2002) and the term "nosocomial transmission" was translated to "hospital-acquired infection" to improve readability and comprehension. A summary of the word count and readability scores for each text and means for both pro and con groups can be viewed in Tables 1 and 2.

Web pages at the fourth and highest level of authority were, therefore, those that referenced empirical peer reviewed articles but showed a lack of bias. Both articles at this level were from the website infectioncontroltoday.com (Dix, 2002; Vogel, 2011), a healthcare focused publication that provides summaries of research and studies, as well as reports and guidelines from public health agencies and professional organizations. At the first and lowest level of authority were pages from thisispublichealthusf.blogspot.com "Hand Sanitizer: Killing Germs on the Go!" (Nunzio, 2011) and www.whiteowlconspiracy.com "Think hand sanitizers protect you against germs? Think again…" (WhiteOwlConspiracy.com, 2010). Both were low on trustworthiness and expertise with the "This is public health" blog referencing no external sources, and the "White Owl Conspiracy" article showing clear signs of bias in the language used as well as the approach of the website as a whole. At the second level of authority, the Livestrong.com articles (Hampton, 2011; Hanes, 2011) were also low on *expertise* due to a lack of accuracy in reporting as well as a lack of reference to external sources for their claims. While at the third level the article from the Washingtonpost.com (Cohn, 2011) was higher on *trustworthiness* and *expertise* due to the reference to and description of an empirical study, however there was some detail missing due to the style of reporting

and potentially the expertise of the reporter in this subject area. The second third-level article was from LiveScience.com (LiveScience Staff, 2010) and showed higher levels of *trustworthiness* and *expertise*, and described an empirical study in detail. However, it is noted in the article that one of the researchers of the study reported in the article was employed by a hand sanitizer manufacturer, which raises questions of potential bias.

Table 1

*Summary of word counts and readability for pro-hand sanitizer articles*

| Level | URL | Word Total | Flesch-Kinkaid Reading Ease | Flesch Grade Level |
|---|---|---|---|---|
| 1 | http://thisispublichealthusf.blogspot.com/2011_05_01_archive.html | 290 | 52.1 | 10.7 |
| 2 | http://www.livestrong.com/article/86149-advantages-alcohol-hand-sanitizer/ | 333 | 35.9 | 12.0 |
| 3 | http://www.livescience.com/11138-hand-sanitizer-work-number-sick-days.html | 382 | 29.4 | 12.0 |
| 4* | http://www.infectioncontroltoday.com/articles/2002/12/cdc-s-endorsement-of-alcohol-hand-rubs-launches-n.aspx | 1067 | 51.5 | 10.7 |
| | Total Words | 2072 | - | - |
| | Readability Scores *M* | - | 42.2 | 11.4 |

*Notes:* * indicates that words were cut and some wording changed to improve readability and equivalency of word count. See description of materials for further details.

Table 2

*Summary of word counts and readability for con-hand sanitizer articles*

| | URL | Word Total | Flesch-Kinkaid Reading Ease | Flesch Grade Level |
|---|---|---|---|---|
| 1 | http://www.whiteowlconspiracy.com/uncategorized/think-hand-sanitizers-protect-you-against-germs-think-again/ | 318 | 37.6 | 12.0 |
| 2 | http://www.livestrong.com/article/101880-risks-hand-sanitizers/ | 503 | 38.4 | 12.0 |
| 3 | http://www.washingtonpost.com/local/handing-out-diplomas-with-a-side-of-a-clean/2011/05/23/AFn3d79G_story.html | 431 | 42.3 | 11.6 |
| 4 | http://www.infectioncontroltoday.com/news/2011/08/researchers-study-hand-sanitizers-and-norovirus-risk.aspx | 771 | 14.2 | 12.0 |
| | Total Words | 2023 | - | - |
| | Readability Scores *M* | - | 39.4 | 11.9 |

Following the selection of Internet resources used for the information use task, replica web pages were created. Due to the closed nature of the search task for analysis purposes, it was important that none of the resources linked out to the wider Internet; therefore, all links were removed from text and images in the final web pages available to participants. In order to present the information in a realistic environment a web page identical to a Google search results page was created with links to each of the pages above a brief portion of the text from each linked resource and date posted. To counteract any possible effect of the top hit being perceived as most relevant, two versions of the Google search results pages were produced with differently sequenced results. The first version displayed the LiveScience.com pro hand sanitizer article "Hand Sanitizer at Work May Lower the Number of Sick Days..." as the top hit, while the second version showed the anti-hand sanitizer article "Think hand sanitizers protect you against germs? Think again..." from the whiteowlconspiracy.com site first in the list of results. Both the web pages and both versions of the Google results pages are available in Appendix C.

## Instruments

**Pre-task survey.** The pre-task survey focused on four of the contextual factors from the model. There were three questions for *epistemic standards* (e.g., It is important that I understand the issues of this topic before forming an opinion), *interest* (e.g., I think this is an interesting topic), and *personal risk* (e.g., Making the

wrong decision on this issue could impact me negatively). Perception of *prior knowledge* was addressed by the single item: "I have already encountered a great deal of information on this subject." All contextual factor questions were measured using 7-point Likert scales, with 1 being strongly disagree, 4 neutral, and 7 strongly agree. A final question asked for participants' *existing opinion* on the topic "Indicate the extent to which you agree or disagree with the statement "OU should be purchasing and promoting the use of hand sanitizer on campus." This question was also measured using a 7-point Likert scale (see Appendix B for the full instrument).

**Epistemic behaviors.** Quantitative information from the task came from the Internet log files. The Internet log files provided numerical data on the number of pages accessed, the amount of time spent on each page visited, information about which specific pages were visited. Due to the structure of the information presented, log file data also provided the level of authority of each of the pages accessed and the number of pages on each side of the issue accessed. The sequence in which the pages were visited was also provided.

**Post-task survey.** The post-task survey began with a fourth Likert-type *epistemic standards* question, which aimed to capture how confident individuals felt in their decision: "I feel I have read enough information to form an opinion on the subject." Participants noted their agreement using the same 1-7 scale described previously. The remainder of the post-task survey focused on their thoughts on the issue after reading the information and how they reached the decision. These were assessed using mainly open-ended questions as well as one quantitative question

which asked participants to rate the helpfulness of the available sources (see Appendix D).

**Epistemic motivations**. Two different traits were measured for the epistemic motivations component of the hypothesized model: *Need for Closure* (Kruglanski, 1999; Kruglanski & Webster, 1996; Webster & Kruglanski, 1994) and *Need for Cognition* (Cacioppo & Petty, 1982; Cacioppo et al., 1996). Although other epistemic motivations have been suggested including dogmatism, open-mindedness, and intellectual curiosity among many others (Chinn et al., 2011) the current study focuses on need for closure and need for cognition as two traits that are already well established in the personal epistemologies literature and which also capture both an epistemic virtue and vice.

***Attitudes, Beliefs and Experiences Scale.*** *Need for closure* will be measured using a 16 Likert-item short-form of the Attitudes, Beliefs, and Experiences scale (ABE) (Kruglanski & Webster, 1996). This version comprises only the following two subscales: discomfort with ambiguity and closed-mindedness. Only these two subscales are used as they most clearly impede "the attainment of an epistemic aim" (Chinn et al., 2011, p. 158). Cronbach alpha's for each scale range from high .60s to low .80s for discomfort with ambiguity, and .61 for closed-mindedness (Webster & Kruglanski, 1994). Items include: "In most social conflicts, I can easily see which side is right and which is wrong" (discomfort with ambiguity) and "I do not usually consult many different opinions before forming my own view" (closed-mindedness). (See Appendix E for full instrument).

***Need for Cognition Scale.*** *Need for cognition* was measured using the short form 18 Likert-item Need for Cognition Scale (NCS) (Cacioppo, Petty, & Kao, 1984). The 18 item scale is highly correlated with the original 34 item scale ($r = .95$, $p < .001$) and has high internal consistency ($\alpha = .90$) (Cacioppo et al., 1996). Items include: "I would prefer complex to simple problems" and "I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought." (See Appendix F for full instrument).

**Adapted Epistemic Beliefs Scale.** Due to a lack of empirical investigation into the nature and variety of epistemic strategies and instrument to capture the full range of possible strategies, only three of the proposed epistemic strategies were be measured: foundationalism, coherentism, and reliabilism. The 30 Likert-item Epistemic Belief Scale (Hennessey, 2007) was originally designed to capture teacher epistemic beliefs about approaches to teaching science. For a sample of pre-service teachers the instrument has reported Cronbach's alphas from .67 to .81 for the foundationalist items, from .82 to .89 for coherentist items, and from .77 to .87 for reliabilist items. The instrument has also been adapted to assess student beliefs about appropriate teaching practices for biology and educational psychology (Hennessey, in preparation). For the purposes of the proposed study, the original instrument was used as the basis for new items re-written to focus on individual approaches to learning about a new topic. Example items include foundationalism: "I think about how new information builds on what I already understand," coherentism: "I look for explanations that show how new information is related to

numerous concepts," and reliabilism: "I reflect on whether my thinking aligns with the available evidence." (For full instrument see Appendix G).

**Reasoning about Current Issues Test.** Epistemic development was measured using the Reflection on Current Issues Test (RCI) (Wood, Kitchener, & Jensen, 2002). The instrument is comprised of three ill-structured problems accompanied by 10 statements about justification that map on to different levels of reasoning in the Reflective Judgment Model (King, 2000; King & Kitchener, 1994) (see Appendix H for a sample problem). As previously discussed, the Reflective Judgment Model is a soft-stage model, therefore the use of three ill-structured problems is intended to indicate the predominant stage of the participant. In keeping with this perspective, the authors of the instrument warn that the stage given by participants' scores can only indicate functional reasoning ability, rather than optimal level (King & Kitchener, 2004). However, as the proposed study looks at epistemic cognition as a process by which individuals construct justified beliefs and the individual factors that influence that process, functional rather than optimal reasoning ability is more relevant to the proposed model. Participants are asked to rate how similar each of the statements are to their own thinking using Likert-scale responses. Participants are then asked to rank the top three statements that most resemble their thinking, this ranking is used to assign a score of 2-7, which corresponds to the stage on the Reflective Judgment Model. Included in the responses is the option to mark an item as meaningless, meaningless statements are present for each ill-structured problem and participants are made aware of this, which may result in some higher level approaches to reasoning being indicated as

meaningless, and some meaningless items being treated as meaningful. These meaningless items act as a control and help refine the scoring of the instrument. Cronbach's alphas for the RCI range from low to mid .70s (King & Kitchener, 2004). (See Appendix H for sample item).

**Procedures**

The experimental task was administered to groups of up to 15 at a time and data were collected at single session using Firefox web browser on both PC and Mac laptops. Prior to data collection the researcher installed Sqlite Manager, a Firefox add-on onto each computer, set the Firefox preferences to "Remember History," and hid the URL from the navigation toolbar. Following data collection from the first group, it became apparent that the log files did not record pages arrived at via the back button, meaning that the return to Google and the end time points page visits were not recorded. For subsequent data collection sessions a new version of the web pages was created with dummy back buttons that were links to the Google page. DisableBackspaceNavigation 0.6 (Fuchlocher, 2011), a Firefox add-on was subsequently also installed as part of the set-up process to prevent participants using keystrokes to return to the Google page, thus circumventing the links.

On entering the data collection location, participants were assigned a participant ID number. This number was in the survey and also in the file name for the log file data and was used to link the survey responses and downloaded Internet log file data. Surveys were administered using SurveyMonkey, a web-based survey solution. This eliminated the need for data input from pencil and paper surveys,

and also allowed for integration with the online search task including random assignment of the Google search page version A or B (see Appendix C). They were first asked to provide demographic information (see Appendix A) and then introduced to the task with the prompt “Should OU spend any of its budget on purchasing and promoting the use of hand sanitizer on campus?” Students were then asked to respond to the pre-task survey (see Appendix B).

Following the pre-task survey items participants were given the following instructions:

> Thinking about the question "Should OU spend any of its budget on purchasing and promoting hand sanitizer on campus?" look at the information available on the following web page. You may look at and use as much or as little of the information as you like. Use the links and browser "back button" to navigate. When you have finished browsing and reading the information close the tab to return to this survey.

Participants were then shown a link to the information, which was presented in a Google-type web page with eight “search results” on the topic of hand sanitizer. SurveyMonkey randomly assigned the version of Google available to each participant, 49% of participants had access to version A, and 51% to version B. The online format was used due to both the prevalence of the use of online information in problem solving, as well as ease of using Internet log files to collection data about the number and name of sources accessed, the amount of time spent on each page, as well as the sequence in which the sources were accessed.

Once participants finished reading as much or as little of the information as

they felt was necessary to answer the question prompt, they were asked to complete a second Likert-type epistemic standards question on whether they saw the amount of information they read as sufficient. Following this, participants responded to the following prompt with a short essay: "What is your opinion on the use of hand sanitizer in university settings?" as well as open-ended survey items about how they reached the decision, including how they decided which pages to look at, and how they made decisions about how valuable the information provided was. (See Appendix D)

Following the collection of task related data, participants were presented with quantitative surveys aimed at capturing epistemic motivations (need for closure and need for cognition), epistemic strategies, and epistemic development at the individual level. The epistemic development instrument, the Reasoning about Current Issues Test (RCI) is a copyrighted assessment tool and is administered by Reflective Judgment Model researchers, therefore this instrument was completed on an external website (http://www.reflectivejudgment.org) which participants accessed via a link on the final page of the SurveyMonkey surveys. Although the model depicts epistemic components at the individual level as influencing those at the task specific level, the sequence of data collection with these components collected after the task was selected to avoid any possible prompting about the nature of the study. As the individual components epistemic motivations, strategies, and development have been shown to operate at trait level, the sequence of data collection is not seen as a threat to the validity of the study.

Once participants had completed the final survey, the researcher used Sqlite

manager, a FireFox add-on to open the sqlite.places database and the following syntax from forensicswiki.org (2011) to pull the URLs visited and time data together into a single table:

> SELECT datetime(moz_historyvisits.visit_date/1000000,'unixepoch', 'localtime'), moz_places.url, moz_places.title, moz_places.visit_count
>
> FROM moz_places, moz_historyvisits
>
> WHERE moz_places.id = moz_historyvisits.place_id (Forensics Wiki, 2011)

Tables were then exported as .csv files and saved to a password protected USB drive under the participant ID number. Csv file data were later merged into a single xls file using Microsoft Excel for analysis.

**Data Preparation: Quantitative**

Following each data collection session, data from the individual Internet log files saved at the data collection were analyzed and time spent at each of the resources accessed were calculated for each participant by subtracting the time the source was accessed from the subsequent return to the emulated Google page. These data were copied into a single Excel file, which included the version of the Google search page the participant had access to, the web pages visited, the sequence they were visited in, and the time spent at each web page. Due to unforeseen difficulties with the Internet logging data on the amount of time spent at

each page were only accurate for 66 of the 84 participants. These 18 missing data included the initial ten participants prior to the addition of a dummy back button, as well as the four participants who used backspace navigation before the DisableBackspaceNavigation (Fuchlocher, 2011) was instituted as part of the data collection procedure. A further four participants did not follow the instructions to return to Google at the conclusion of their search so the duration recorded for the time spent at the final page visited was inaccurate.

At the conclusion of all data collection sessions an aggregate score of time spent, combined with the level of authority, was created (VisitScore) for the 66 participants with complete time information by assigning four points to the most authoritative source, three for sources at the third level of authority, two for the second level, and one for the least authoritative and multiplying the points assigned to each source by the amount of time spent on the page: ∑(time spent x level of authority). A balance score was also created to reflect epistemic behaviors. This was calculated by subtracting the number of con pages visited from the number of pro pages visited. As the focus was on balance between pages visited rather than the particular viewpoint the individual focused on, the valance of the score was then removed. The scores were reverse coded so that a score of 4 reflected the greatest level of balance between pro and con articles, and scores of 1 the least. Participants who visited no pages were assigned a value of 0.

At the conclusion of all data collection sessions the survey data were downloaded from SurveyMonkey, were sorted by participant ID number and saved as a new file. Open responses from the post-task survey as well as the item asking

participants to note the sources they visited were then removed from this resaved version of the data. Many of the participants failed to note "did not read" for the question "Which sources did you think were the most helpful?" Zeros (the value assigned to the response "did not read") were therefore entered for sources with no participant responses so that the analyses would not be affected by list-wise or pairwise deletion. The two scores described above VisitScore, and Balance, as well as the sites visited were copied into the data file. Data were then imported into SPSS and the "recode into same variable" function was used to reverse code items in the Need for Cognition Scale (items 3, 4, 5, 7, 8, 9, 12, 16, and 17) and the Attitudes, Beliefs, and Experiences Scales (items 1, 8, 9, 12, and 14).

**Adapted Epistemic Belief Scale.** PRELIS (Jöreskog & Sörbom, 2006) was used to assess univariate normality epistemic strategy items from the AEBS. After assessing that the item distributions did not significantly differ from the normal curve a CFA was conducted LISREL (Jöreskog & Sörbom, 2006). Although comparative model fit indicated acceptable model fit (CFI=.97), the goodness of fit index (GFI=.65) indicated that the model was a poor fit. Additionally, there were very high correlations between the three factors. Between the latent variables coherence and foundationalism the correlation was .99, between coherence and empiricism .87, and between foundationalism and empiricism .84. This indicates that the items lacked discriminant validity and may have been measuring the same latent trait (Kline, 2011). Therefore, given the lack of theoretical rationale for adjusting the factor structure, it was decided to conduct an EFA using SPSS to investigate the factor structure empirically. A principal components approach was used, with no

rotation and the SPSS default eigenvalue cut-off of 1. Kline (1994) suggests that using the SPSS default eigenvalue of 1 as the cut-off for factors typically produces too many factors, with later factors explaining little additional variance. In this case although SPSS produced a five-factor solution, the scree-plot indicated either a two or one factor solution, as there was a sharp change in slope at the second factor (See Figure 3). Kline suggests that the point at which the line of the scree plot changes slope is a good indication of the number of factors which should be rotated (Kline, 1994, p. 75).

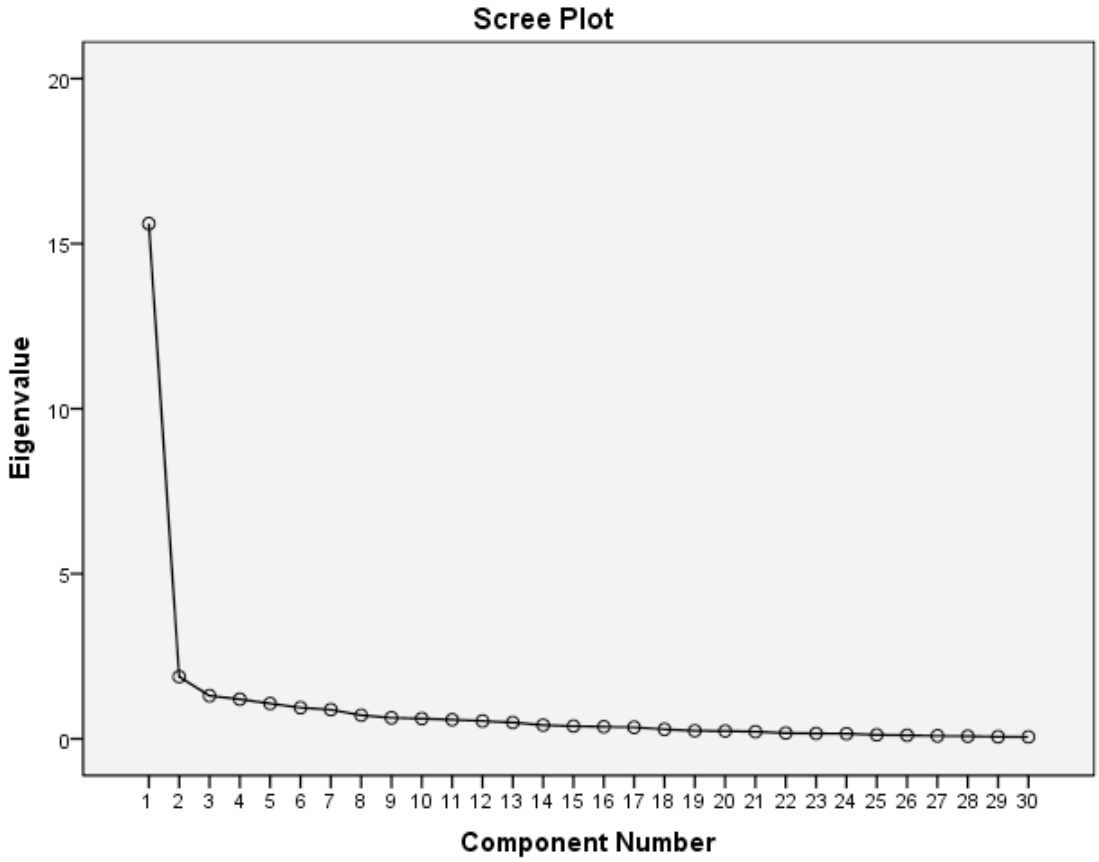


*Figure 3.* Scree plot showing eigenvalues for each component of the Adapted Epistemic Beliefs Scale.

A second EFA was therefore run, this time using varimax rotation and specifying a two-factor solution. According to Kline (1994) varimax rotation is a good method when an orthogonal simple structure is desired. For the purposes of instrument development simple structure is desirable as they are both replicable and simple to interpret. The single factor solution explained 52.82% of the variance, while the rotated two-factor solution explained 59.08%, with factor 1 explaining 35.98% and factor 2 explaining 23.10% of the variance. Item loadings for the two

factor solution were then inspected and seemed to fall into two theoretically distinct epistemic strategies: looking for connections between new and existing understandings (internalist) and reference to evidence (externalist). Items that loaded within .15 of each other on both factors were eliminated (items 6, 8, 13, 12, and 24). Scale reliabilities were obtained for each scale, and means scores created. Analysis of the scale reliability for *internalist* indicated a Cronbach's alpha of .96 for 16 items. Analysis of the scale reliability for *externalist* indicated a Cronbach's alpha of .87 for 7 items. Composite scores for each scale were created by computing the mean across items for each participant.

Table 3

*Factor Loadings for Exploratory Factor Analysis of the Adapted Epistemic Belief Scale with Varimax Rotation*

| Scale | internalist | externalist |
|---|---|---|
| 22. I look for explanations of the topic that build on basic understandings | **.81** | .24 |
| 25. I examine the links between concepts | **.81** | .33 |
| 5. I think about how new information builds on what I already understand | **.78** | .23 |
| 28. I look for examples that show how concepts are related | **.77** | .29 |
| 19. I reflect on how new information connects with my existing understandings | **.77** | **.42** |
| 20 I think about whether information is consistent with what I already understand | **.75** | .38 |
| 12. I think about whether examples reinforce my basic understanding | **.75** | .27 |
| 26. I look for information that shows how concepts are related | **.74** | **.43** |
| 16. I think about how new information could be explained using information that everyone already understands | **.73** | .26 |
| 11. I think about whether new information aligns with my current understanding | **.73** | .20 |
| 2. I make connections between the topic and other concepts I already understand | **.72** | .35 |
| 3. I look for examples that make sense given my current understanding | **.67** | .37 |
| 30. I try to see what conclusions about the topic I would arrive at given my existing understandings. | **.66** | .31 |
| 29. I begin building my understanding of a topic by looking at the underlying ideas. | **.63** | **.41** |
| 1. I look at the links between as many concepts as possible | **.62** | .34 |
| 15. I look for explanations that show how new information is related to numerous concepts | **.60** | **.44** |
| 24.*I reflect on the evidence for my thinking | **.59** | **.53** |
| 21.*I justify my understandings by looking at the available evidence | **.56** | **.53** |
| 14. I focus on understanding a few core concepts | **.51** | .09 |
| 8.* I relate my understanding of new information to my direct observations | **.45** | **.43** |
| 10. I make judgments based on whether or not explanations are based on observable evidence | .08 | **.73** |
| 18. I inform my understandings by looking for more evidence | .33 | **.73** |
| 27. I make sure that my reasoning is based on evidence | .30 | **.72** |
| 9. I focus on information that is based on evidence rather than opinion | .26 | **.71** |
| 23. I check my conclusions by referring to evidence | .39 | **.70** |
| 17. I reflect on whether the conclusion would be evident to everyone | .10 | **.64** |
| 7. I look for examples that provide observable evidence | .39 | **.62** |
| 4. I look for examples that show how reasoning can be confirmed by evidence | **.40** | **.60** |
| 13.*I reflect on whether my thinking aligns with the available evidence | **.51** | **.57** |
| 6.* I verify new information by looking at more evidence | **.52** | **.55** |

*Note.* Items adapted from the Epistemic Belief Scale (Hennessey, 2007).Factor loadings > .40 are in boldface. *indicates items eliminated from the final scales.

**Attitudes, Beliefs, and Experiences Scale.** A CFA was also conducted on the Attitudes, Beliefs, and Experiences scale (ABES). The chi square minimum fit function indicated a statistically significant result, which in the case of model test statistics represents a failure to reject the null hypothesis that the model implied covariance matrix is a good fit to that of the data (Kline, 2011). Therefore an EFA was conducted, this time although the Scree plot indicated a three-factor solution, the component items suggested by the loadings resulting from a varimax rotation and requesting a three-factor solution could not be theoretically justified. Therefore a third EFA was conducted requesting a two-factor solution. The resulting loadings indicated items loading on the expected factor with the exception of items 5 and 3, which loaded on both factors, and items 12, 10, and 11, which had loadings of lower than .4 (see Table 4). Items 5 and 3, which loaded on both factors, were assigned to the expected *closed mindedness* factor, this raised the internal reliability from .66 with neither, to .73 when both were included. Internal reliability for six items on the *discomfort with ambiguity* scale was .73. Composite scores for each scale were created by computing the mean across items for each participant.

Table 4

*Factor Loadings for Exploratory Factor Analysis With Varimax Rotation of Need for Closure Items*

| Scale | | ambiguity | closed |
|---|---|---|---|
| 6. | When I am confused about an important issue, I feel very upset. | **.78** | -.11 |
| 13. | I feel uncomfortable when someone's meaning or intention is unclear to me. | **.69** | .09 |
| 4. | I feel uncomfortable when I don't understand the reason why an event occurred in my life. | **.67** | .24 |
| 2. | I don't like situations that are uncertain. | **.60** | .25 |
| 15. | I'd rather know bad news than stay in a state of uncertainty. | **.48** | .00 |
| 7. | In most social conflicts, I can easily see which side is right and which is wrong. | **.46** | -.01 |
| 5. | I feel irritated when one person disagrees with what everyone else in a group believes. | **.46** | **.44** |
| 12* | I prefer interacting with people whose opinions are very different from my own. | .40 | .21 |
| 10* | I like to know what people are thinking all the time. | .39 | -.28 |
| 11* | It's annoying to listen to someone who cannot seem to make up his or her mind. | .37 | .24 |
| 9. | When thinking about a problem, I consider as many different opinions on the issue as possible. | .12 | **.70** |
| 14. | I always see many possible solutions to problems I face. | -.19 | **.69** |
| 1. | Even after I've made up my mind about something, I am always eager to consider a different opinion. | .28 | **.64** |
| 8. | When considering most conflict situations, I can usually see how both sides could be right. | .05 | **.55** |
| 16. | I do not usually consult many different opinions before forming my own view. | .04 | **.55** |
| 3. | I dislike questions which could be answered in many different ways. | **.42** | **.47** |

*Note.* Factor loadings > .40 are in boldface. Items 5 and 3 were both assigned to the *closed mindedness factor*. *indicates items eliminated from the final scales.

Internal reliability coefficients were then obtained for the pre-task 3-item scales for interest, personal risk, and importance of understanding, as well as the *Need for Cognition Scale*. There was no indication that removing any of the items

would significantly raise the internal reliabilities of these scales therefore composite scores computed by calculating the mean across all items for each scale. Descriptive statistics including reliability coefficients for scale scores are available in Table 7. Of the 66 participants whose data are included in the quantitative analyses of the model two participants did not answer the question asking whether they felt they had sufficient information on the topic to form an opinion, and one did not answer the question about the amount of prior knowledge they had on the question. Given the already reduced number of participants, and the small amount of missing data, mean imputation was deemed an appropriate approach in order to avoid loss of data resulting from listwise deletion in the path models (Kline, 2011).

Results from the *Reasoning about Current Issues Test* were received from the Reflective Judgment Model researchers and the mean score derived from the three scenarios was incorporated into the quantitative data. Composite scores and single-item scores, which included prior knowledge, initial opinion, as well as task-based epistemic behavior scores VisitScore and Balance, were then screened for univariate normality in PRELIS (Jöreskog & Sörbom, 2006). The screening indicated that skewness and kurtosis for Perception of Personal Risk, Prior Knowledge, Initial Opinion, Information Sufficiency, VisitScore, Balance, and the RCI and Discomfort with Ambiguity composite scores violated the assumption of normality (see Table 5), therefore these scores underwent normal transformation in PRELIS prior to further analyses.

Table 5

*PRELIS Tests of Skewness and Kurtosis Significance Values*

| | Skewness | | Kurtosis | | Skewness and Kurtosis | |
|---|---|---|---|---|---|---|
| Variable | Z-Score | P-Value | Z-Score | P-Value | Chi-Square | P-Value |
| Perceived Risk | 0.71 | .48 | -2.54 | .01 | 6.96 | .03 |
| Prior Knowledge | 2.23 | .03 | -1.23 | .22 | 6.50 | .04 |
| Initial Opinion | -3.34 | .00 | 2.10 | .04 | 15.58 | .00 |
| Visit Score | 4.02 | .00 | 1.76 | .08 | 19.24 | .00 |
| Balance | -4.60 | .00 | 2.52 | .01 | 27.47 | .00 |
| Sufficiency of Information | -4.34 | .00 | 3.43 | .00 | 30.55 | .00 |
| RCI | -2.41 | .02 | 1.72 | .09 | 8.79 | .01 |
| Discomfort w/ambiguity | -2.20 | .03 | 1.12 | .27 | 6.08 | .05 |

Table 6

*PRELIS Tests of Skewness and Kurtosis Significance Values Following Normal Score Transformation*

| | Skewness | | Kurtosis | | Skewness and Kurtosis | |
|---|---|---|---|---|---|---|
| Variable | Z-Score | P-Value | Z-Score | P-Value | Chi-Square | P-Value |
| Perceived Risk | 0.06 | .95 | -0.40 | .69 | 0.16 | .92 |
| Prior Knowledge | 0.66 | .51 | -0.82 | .41 | 1.10 | .58 |
| Initial Opinion | -0.48 | .63 | -0.68 | .50 | 0.68 | .71 |
| Visit Score | 0.34 | .73 | -0.46 | .64 | 0.33 | .85 |
| Balance | -1.22 | .22 | -2.09 | .04 | 5.86 | .05 |
| Sufficiency of Information | -0.41 | .68 | 0.08 | .93 | 0.18 | .92 |
| RCI | 0.00 | 1.00 | 0.13 | .89 | 0.02 | .99 |
| Discomfort w/ambiguity | 0.01 | .99 | 0.12 | .91 | 0.01 | .99 |

**Data Preparation: Qualitative**

Following each data collection session survey responses were downloaded from SurveyMonkey. Responses to the following open and closed response items were copied into an individual text file for each participant along with the questions themselves to provide structure:

- Do you think that OU should be purchasing and promoting the use of hand sanitizer on campus?
- I feel I have read enough information to form an opinion on the subject
- Having looked at some of the available information, what is your opinion on whether the use of hand sanitizer should be promoted in universities?
- Do you think your opinion could change in the future?
- Sources chosen:
  - thisispublichealthusf.blogspot.com: Hand Sanitizer: Killing Germs on the Go!
  - www.whiteowlconspiracy.com: Think hand sanitizers protect you against germs? Think again...
  - www.livestrong.com: Risks Of Hand Sanitizers
  - www.livestrong.com: Advantages Of Alcohol Hand Sanitizer
  - www.washingtonpost.com: Handing out diplomas with a side of a clean - The Washington Post
  - www.livescience.com: Hand Sanitizer at Work May Lower the Number of

Sick Days...

> www.infectioncontroltoday.com: Researchers Study Hand Sanitizers and Norovirus Risk

> www.infectioncontroltoday.com: CDC's Endorsement of Alcohol Hand Rubs Launches New Era in Hand Hygiene

> Why did you choose those sources?

> Helpful Sources

> Why did you find these the most helpful?

The information was then saved as .txt files under the participant ID number to allow for easy reference and creation of file sets based on the quantitative analysis.

Files were then imported into TAMS Analyzer (Text Analysis Markup System) for analysis (Weinstein, 2012). TAMS Analyzer is an open source computer program designed to help researchers code, recode, and group codes into broader themes in documents using text tagging. The program can then be used to analyze codes including providing code frequency counts and graphics based on the data and relationships between codes. Given the relatively large number of individual qualitative responses TAMS Analyzer was selected as an appropriate method of storing and organizing the text-based data. Given the features of the program, which allow for the creation of sets within the imported files, TAMS Analyzer was also seen as an ideal method for creating sets based on responses to quantitative items and being able to compare common themes emerging from the

data within each set as well as making comparisons between sets.

In addition to downloading the data, creating individual files for participants, and importing the data files following each data collection session, an additional file was also created for memoing the data analysis process. Memoing is an integral part of the qualitative analysis process and for this study formed an important part of both the analysis, write-up and peer debriefing process (Creswell, 2007; Ezzy, 2002; Miles & Huberman, 1994). Memoing, in addition to allowing the researcher to note emerging thoughts about connection between themes, also enhances the auditability (Miles & Huberman, 1994) of the research and lays open the phases of analysis for peer review (Ezzy, 2002). Memoing can take many forms. My own memos contain both an overview of the steps taken during the analysis process, but also my emerging thoughts about how codes may be grouped into themes, and how these may be related, as well as initial thoughts on how the data related to the research questions. Although memoing is possible within TAMS Analyzer, I opted to conduct my memoing separately in a Word document in order to both reduce my dependence on TAMS Analyzer, as well as to allow my own thinking about the connections between codes and themes to be free of the constraints of the program itself and my own expertise in its use (Ezzy, 2002).

Inductive analysis of the qualitative data also began following the first data collection session. This began by classifying (Strauss & Corbin, 1998) the different components of the data. These classifications were largely determined by responses to specific questions in the survey. However, some participant responses to questions fit better in other classifications than would have otherwise been

determined by the question it was responding to alone.

The second step in the analysis was abstracting (Strauss & Corbin, 1998) from the data. For this I used "in vivo codes" with the labels based on the words of the respondents themselves. Whereas Miles and Huberman (1994) suggest an approach based on seeing how the data fits to an existing theoretical framework, I decided to use a more grounded theory approach as described by Strauss and Corbin (1998). This allows for the codes and themes to emerge from the data and was seen as a more appropriate approach to the data as the theoretical framework for the strategy components in particular is not yet established. Therefore trying to make the data fit a theoretical framework would have been impossible. In vivo coding was conducted on the open responses until the coding reached saturation. Throughout this in vivo coding process memoing continued focusing largely on the possible links between the in vivo codes and on possible categories to emerge from them.

Following in vivo coding of the first 20 participants the importance of including access sequence from the Internet logfiles was realized so a ninth classification "Source Sequence" was added to the text files along with the sequence information and version of the Google simulation was available to the participant. After analyzing data from 40 participants saturation seemed to have been reached. Saturation is the point at which no new information seems to be emerging from the coding process (Strauss & Corbin, 1998), and at this stage, there were over 400 "in vivo" codes (a negative side effect of the ease with which qualitative software enables the user to create new codes) many of which were very

similar in the wording of the "in vivo" code and equivalent in meaning. The process of examining these codes and condensing them into more specific codes that captured the meaning of the participants' own words began. A list was generated of all of the codes generated so far and the search and recode functions were used to examine codes within the participant responses and check for correspondence of meaning between participants. Similar chunks of text were recoded using a more uniform coding system. This resulted in 237 codes across the eight open response questions and logfile data, which includes 67 codes to describe access sequence, and source preference, which were used for analysis of access patterns of participants falling into different groups based on the quantitative data. Through this recoding process the following categories were constructed: *forms of justification*, *openness to change*, *source selection rationale*, and *source helpfulness rationale*. Although these largely fell along lines of the classifications described above there was a lot of overlap in the way that individuals talked about the justification for their opinions, the sources they used and why they used them across all four open response questions.

Axial coding was then conducted (Strauss & Corbin, 1998) in order to find relations between codes and categories to sub-categories by looking at the properties of the ways that the participants wrote about their opinion forming process through the four questions. Sub-categories are able to explain more than categories as they breakdown the concept into greater detail, but also illuminate connections between the more fine-grained codes (Strauss & Corbin, 1998). These sub-categories emerged following the initial distilling of "in vivo" codes into codes, and used the

same functions of TAMS Analyzer to search for codes within the text and re-read sections of coded text within their original context to look for meanings and connections. The recode function then allowed for the addition of subcategories to the original codes in order to allow the connections between codes emerge within their broader categories. Due to the brief nature of many of the participant responses a full, grounded theory approach was not possible. However, results of the axial coding as well as comparisons between logfile data, quantitative responses, and the qualitative data are presented in the findings section.

# Chapter 4: Findings

The current study was conducted with the aim of empirically investigating the relationship between the three approaches to personal epistemologies and positioning them within a model of epistemic cognition. Quantitative data was collected both at the general level and within an online knowledge-forming task. These data were then used to investigate how domain general epistemic strategies, development, and motivations were related to the epistemic standards set and the behaviors displayed in an online knowledge forming setting. This included investigation into the potential role of epistemic motivations as mediators between epistemic development and strategies and the epistemic behaviors exhibited in the specific context, as well as the relative influence of each of the proposed epistemic motivations and contextual factors on information approach behaviors. Quantitative data were also used in combination with the qualitative data collected in order to look at the relationship between standards and behaviors in a knowledge-forming context.

## Quantitative Findings

**Descriptive statistics.** Prior to composite score construction as described in the methodology section, the Cronbach alphas for all composite study variables were computed. These together with the descriptive statistics for both the epistemic and task variables are presented in Table 7.

Table 7

*Descriptive Statistics for Epistemic and Task Variables*

| Variable | *n* | *M* | *SD* | α | Range | | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| | | | | | Potential | Actual | | |
| Pre-task | | | | | | | | |
| Interest | 66 | 4.35 | 1.45 | .98 | 1 – 7 | 1.00 – 7.00 | -0.47 | -0.10 |
| Risk* | 66 | 3.44 | 1.35 | .85 | (1 – 7) | .75 – 6.29 | 0.18 | -0.29 |
| Understanding | 66 | 4.95 | 1.21 | .87 | 1 – 7 | 2.00 – 7.00 | -0.30 | -0.30 |
| Prior Knowledge* | 66 | 3.00 | 1.58 | | (1 – 7) | .64 – 7.09 | 0.19 | -0.58 |
| Initial Opinion* | 66 | 1.12 | 1.39 | | (1 – 7) | -1.92 – 3.22 | -0.14 | -0.41 |
| Task | | | | | | | | |
| Information Sufficiency* | 66 | 5.41 | 1.02 | | (1 – 7) | 2.72 – 7.25 | -0.12 | -0.07 |
| VisitScore* | 66 | 418.10 | 431.01 | | | -328.19 – 1507.56 | 0.10 | -0.32 |
| Balance* | 66 | 2.93 | 1.22 | | (0 – 4) | .63 – 4.30 | -0.35 | -0.83 |
| Epistemic Strategies | | | | | | | | |
| Internalism | 66 | 4.86 | 0.97 | .96 | 1 – 7 | 2.65 – 7.00 | -0.07 | -0.46 |
| Externalism* | 66 | 4.56 | 0.87 | .87 | (1 – 7) | 2.33 – 6.67 | -0.16 | 0.04 |
| Epistemic Development | | | | | | | | |
| RCI* | 66 | 4.70 | 0.78 | .63 | (2 – 7) | 2.76 – 6.65 | 0.00 | -0.04 |
| Epistemic Motivations | | | | | | | | |
| Discomfort w/Ambiguity* | 66 | 4.84 | 0.86 | .73 | (1 – 7) | 2.67 – 7.00 | 0.00 | -0.05 |
| Closed Mindedness | 66 | 3.30 | 0.84 | .73 | 1 - 7 | 1.29 – 4.86 | -0.28 | -0.43 |
| Need for Cognition | 66 | 4.44 | 1.02 | .93 | 1 – 7 | 1.61 – 6.72 | -0.12 | 0.37 |

*Notes:* Items indicated with a * show the descriptive statistics for the variable after normal score transformation. The original scales for these variables are shown in parentheses.

Cronbach's alphas were deemed acceptable for scale variables, with the lower reliability for the Reasoning about Current Issues Questionnaire (RCI) variable reflective of the small number of items and particular structure of the instrument. The RCI instrument consists of three scenarios to which participants respond by rating reasoning approaches in terms of how similar they are to their own thinking, and then ranking these approaches. However, because each scenario results in a single score the internal reliability is calculated on the basis of only three scores. Additionally, the RCI instrument and the theory on which it is based reflects a soft stage model, therefore it is consistent with the theory and proposed model that participants would respond differently depending on the content and context of the different scenarios, as it is the functional level of reflective judgment that is assessed by the instrument as an average across topics.

**Correlations between variables.** A correlation matrix was then obtained in order to investigate the relationships between epistemic strategy, development, and motivations as well as their relationships to the task variables (see Table 6). The variable *Semester*, to indicate the total number of semesters in college, was also included in the correlation matrix as this has been indicated in the literature as related to the level of epistemic development (Perry, 1970). The correlation matrix indicated that there were significant correlations in the expected directions between the *epistemic strategy* dimensions: internalist and externalist, the *epistemic motivations*: discomfort with ambiguity and need for cognition, and VisitScore. While, surprisingly, the level of balance in website selection was not significantly

correlated with any of the epistemic variables, it was related to the number of semesters of college attended and the VisitScore. Both of the *epistemic strategies* correlated significantly with a feeling of having sufficient information following the search task to justify their opinion. Information sufficiency was also related to interest in the topic. Although the RCI, the variable intended to capture *epistemic development*, was not correlated with any of the task variables, it was positively correlated with the both the internalist epistemic strategy dimension and the epistemic motivation need for cognition, and negatively correlated with closed mindedness. The high correlation between internalist and externalist epistemic strategies indicates that, despite the indications of the EFA, that the two scales may be indicative of a single latent trait rather than two different epistemic strategy approaches.

Given the relationships indicated by the correlation matrix, a series of regressions was performed in order to address research question 1. As the main outcome variable for mediation and regression analyses was VisitScore, the 18 participants who did not have accurate visit time data due to problems with Internet logging were eliminated from the quantitative analyses. Therefore, mediation and regression analyses were conducted only the 66 participants with accurate VisitScore data.

Table 8

*Correlation matrix for all individual epistemic and task level variables*

| | | Sem | GPA | ES1 | ES2 | ED | EM1 | EM2 | EM3 | Int | Und | Ris | PK | IO | VS | SI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sem | Semester | - | | | | | | | | | | | | | | |
| GPA | GPA | -.10 | - | | | | | | | | | | | | | |
| ES1 | Internalist | .16 | .27* | - | | | | | | | | | | | | |
| ES2 | Externalist | -.04 | .11 | .75** | - | | | | | | | | | | | |
| ED | RCI | -.17 | .28* | .24* | .18 | - | | | | | | | | | | |
| EM1 | Discomfort w/Ambiguity | -.09 | -.16 | .01 | .10 | -.08 | - | | | | | | | | | |
| EM2 | Closed Mindedness | -.09 | -.13 | -.41** | -.28** | -.31** | .25* | - | | | | | | | | |
| EM3 | Need for Cognition | .18 | .24* | .67** | .45** | .25* | -.22* | -.54** | - | | | | | | | |
| Int | Interest | .20 | -.07 | .18 | .09 | -.02 | -.07 | .03 | .19 | - | | | | | | |
| Und | Understanding | .05 | .03 | .36** | .35** | .09 | .16 | .04 | .21* | .26* | - | | | | | |
| Ris | Risk | -.10 | -.10 | -.19 | -.18 | .08 | .10 | .24* | -.07 | .36** | .22* | - | | | | |
| PK | Prior Knowledge | -.10 | -.07 | .04 | .01 | .00 | .05 | .05 | .03 | .27* | -.03 | .04 | - | | | |
| IO | Initial Opinion | -.06 | -.15 | .07 | .10 | .21 | .08 | .08 | .10 | .66** | .04 | .36** | .29** | - | | |
| VS | VisitScore | .28** | .22* | .32** | .21* | .12 | -.33** | -.18 | .33** | .14 | .16 | .02 | -.13 | -.06 | - | |
| IS | Information Sufficiency | -.10 | -.07 | .44** | .47** | .04 | .16 | -.19 | .12 | .29** | .16 | -.17 | .06 | .30 | .00 | - |
| Bal | Balance | .34** | -.05 | .11 | .00 | .00 | -.12 | -.05 | .15 | -.01 | -.08 | -.18 | -.06 | -.09 | .38** | -.05 |

Notes: n = 66; *p<.05; **p<.01one-tailed

**Regression Analyses.** Due to the small sample size and the large number of potential variables in the model, a series of regressions analyses was conducted in order to answer the research questions rather than constructing a larger path model. Research question 1(b) asked: Which of the proposed epistemic motivations, need for closure or need for cognition, has the greatest impact on epistemic standard setting and epistemic behaviors displayed in a knowledge-forming context? A multiple regression was conducted in SPSS in order to investigate the extent to which each of the variables *discomfort with ambiguity*, *closed mindedness*, and *need for cognition* predicted *VisitScore*. Variables were entered into the analysis simultaneously; the results are shown in Table 9.

The results indicated that closed mindedness did not significantly predict VisitScore. A separate regression analysis was conducted with discomfort with ambiguity and need for cognition, which together predicted 17.9% ($p < .05$) of the variance, with discomfort with ambiguity negatively related to VisitScore ($\beta = -.27$, $p < .01$) and need for cognition positively related ($\beta = .27$, $p < .05$). In answer to question 1(b) need for cognition and discomfort with ambiguity appear to account for similar amounts of the variance in opposing valences.

Table 9

*Regression coefficients of epistemic motivations on VisitScore*

| | | | | 95% CI for *B* | |
|---|---|---|---|---|---|
| | *B* | *S.E.* | β | Lower | Upper |
| Discomfort with Ambiguity | -141.00 | 59.76 | -.28* | -260.447 | -21.55 |
| Closed Mindedness | 28.46 | 70.61 | .06 | -112.69 | 169.60 |
| Need for Cognition | 125.619 | 57.83 | .30* | 10.01 | 241.23 |

*Notes:* $R^2 = .18$ ($p < .01$), * $p < .05$

Question 1(a) asks whether the relationships between epistemic development and strategies and the epistemic standards enacted during the task are mediated by epistemic motivations. Baron and Kenny (1986) lay out four steps for testing mediation. These are test that: (1) the initial variable predicts the dependent variable, (2) the initial variable predicts variations in the proposed mediator, (3) the proposed mediator predicts variations in the dependent variable, (4) when controlling for the mediator, the effect of the initial variable on the dependent variable is zero. It has subsequently been argued that not all four steps are necessary (Kenny, Kashy, & Bolger, 1998). This is because the path from the initial variable to the dependent variable can be implied if steps 2 and 3 are met, and that step 4 only applies in the case of complete mediation, which is unlikely in the social sciences (Kenny et al., 1998). As the previous analysis of the comparative influences of the epistemic motivation variables on VisitScore indicates that only discomfort and need for cognition predict significant variations in the dependent variable, only these two variables were used as mediators in the regression analyses carried out to address this question.

Three multiple-mediation models were tested using INDIRECT (Preacher &

Hayes, 2008) a macro for SPSS. This macro allows the researcher to test multiple mediator models using both the Sobel test and bootstrapping. In addition to the total, direct, and indirect effects, INDIRECT is also able to assess the comparative significance of individual indirect effects using bootstrapping to provide confidence intervals. This method eliminates the need to conduct separate regressions of the independent variable on the mediators and dependent variable. The three models tested therefore were (1) epistemic development, the epistemic strategies (2) internalist, and (3) externalist, each with discomfort with ambiguity and need for cognition as mediators, and VisitScore as the dependent variable. The number of number of bootstrap samples recommended has increased as computing power has increased (Preacher & Hayes, 2008), therefore 5,000 bootstrap samples were requested to provide bias corrected and accelerated (BCa) CIs of 95% for each of the three models, results are presented in Table 10.

Table 10

*Mediation of the Effect of Epistemic Development and Strategies on VisitScore Through Discomfort with Ambiguity, and Need for Cognition*

| | Sobel Tests | | | Bootstrapping | |
|---|---|---|---|---|---|
| | Point Estimate | Product of Coefficients | | BCa 95% CI | |
| | | SE | Z | Lower | Upper |
| (1) Epistemic Development | | | | | |
| | | | Indirect effects | | |
| Discomfort w/Ambiguity | 11.81 | 19.37 | 0.61 | -15.92 | 58.92 |
| NFCog | 36.55 | 24.03 | 1.52 | 1.51 | 114.53 |
| TOTAL | 48.36 | 32.43 | 1.49 | -0.01 | 135.54 |
| | | | Contrasts | | |
| Ambig. vs. NFC | -24.74 | 29.25 | -.85 | -96.94 | 29.85 |
| (2) Internalist | | | | | |
| | | | Indirect effects | | |
| Discomfort w/Ambiguity | -.93 | 17.53 | 0.43 | -58.76 | 39.83 |
| NFCog | 22.40 | 46.06 | 0.49 | -84.73 | 127.33 |
| TOTAL | 21.47 | 49.70 | 0.43 | -109.72 | 142.09 |
| | | | Contrasts | | |
| Ambig. vs. NFC | -23.33 | 48.86 | -.48 | -120.16 | 88.90 |
| (3) Externalist | | | | | |
| | | | Indirect effects | | |
| Discomfort w/Ambiguity | -15.26 | 19.55 | -0.78 | -83.32 | 32.82 |
| NFCog | 43.07 | 30.95 | 1.39 | -17.99 | 145.34 |
| TOTAL | 27.81 | 39.46 | 0.70 | -73.59 | 145.83 |
| | | | Contrasts | | |
| Ambig. vs. NFC | -58.33 | 33.46 | -1.74 | -139.09 | 12.48 |

The bootstrap results indicate that only the relationship of epistemic development (as indicated by the RCI) and VisitScore is mediated by one of the proposed epistemic motivations: need for cognition. However, the bootstrap contrast between discomfort with ambiguity and need for cognition indicates that there is no statistically significant difference between the indirect effect when the RCI variable is mediated by discomfort with ambiguity and the indirect effect when the variable is mediated by need for cognition. Additionally the Sobel test for the relationship between development and VisitScore mediated by need for cognition indicates non-

significance (absolute scores of $Z > 1.96$ are significant at $p < .05$). Although the Sobel test is known to be very conservative, this result taken together with the contrast of the mediated effects through discomfort with ambiguity and need for cognition, indicate a need for caution when interpreting the 95% confidence interval for the indirect effect of development through need for cognition on VisitScore.

In order to further investigate the influence of the individual epistemic factors on epistemic standard setting and behaviors a step-wise regression was performed of all of the components: development, strategies, and motivations on Information Sufficiency. Information Sufficiency was used as a second proxy for standards in addition to VisitScore, which captured the actual amount and type of information the participants accessed. The results of the regression analysis indicated that use of externalist epistemic strategies ($\beta = .47$, $t(64) = 4.87$, $p < .01$) was the strongest predictor of perceptions of information sufficiency. All other variables were excluded. Externalist epistemic strategies explained 22% of the variance in Information Sufficiency Perceptions, $R^2 = .22$, $F(1, 64) = 17.81$, $p < .01$. A second step-wise procedure was conducted from the three epistemic components on balance, which represented the extent to which the articles were balanced or one sided. None of the individual level variables emerged as predictors.

Question 1(c) focused on the contextual influences (interest, perceived personal risk, importance of understanding, and prior knowledge) on epistemic standard setting and epistemic behaviors. In order to assess the impact of these four contextual factors on epistemic standard setting and behaviors, a step-wise

regression was performed with all four contextual influences on VisitScore, balance, and Information Sufficiency. None of the variables emerged as significant predictors of VisitScore or Balance. However, both interest, $\beta = .41$, $t(64) = 3.32$, $p < .01$ and risk, $\beta = -.32$, $t(64) = -2.63$, $p < .001$ emerged as predictors of Information Sufficiency. Together, interest and risk accounted for 17.5% of the variance, $R^2 = .18$, $F(1, 64) = 6.90$, $p < .05$.

**Mixed-Method Findings**

Following the creation of composite scores, the 84 participants in the study were sorted from highest to lowest on the six epistemic development, motivation, and strategy variables. Individuals with the 10 highest scores, and 10 lowest scores on each variable were selected for further qualitative analysis. Due to the overlap between participants' scores across the six variables, the selection process resulted in a total of 60 participants whose responses were used in the subsequent analyses. The open response short essays were analyzed "blind" without reference to their scores on the variables. File sets based on scores were only created after the open coding process was complete in order to prevent the possibility of bias in coding by the researcher on the basis of expected responses. Axial coding was then conducted with reference to participants' scores on the variables in order to look for patterns among similar participants. Due to the large amount of data, this was conducted using the search function of TAMS Analyzer. TAMS Analyzer allows the researcher to search for a specific code set and generate reports based on that code and organized by another variable encoded in the data. For the purposes of the present analysis the coded portions of the data were organized into columns

representing each of the twelve high-low groups on the six variables. These also linked back to the original documents so that codes could be analyzed both individually and in context.

As previously described, the coding process resulted in four broad categories largely embedded in the open response questions themselves. These were: *forms of justification*, *openness to change*, *source selection rationale*, and *source helpfulness rationale*. Within each of these categories were several sub-categories, which I will describe in the following sections beginning with forms of justification. Throughout the following description of the mixed method findings the high/low group on the each of the six variables that the participant quoted belongs to are reported in parentheses. Where the participant belongs to more than one group all groups are reported.

**Forms of Justification.** There were three main approaches to justification used by participants. These were: providing evidence, asserting beliefs, and expressing preferences. Within each of these broad categories were several sub-categories that appeared in the data.

***Evidence***. Several sub-categories emerged as common forms of evidence given by participants in support of their opinions. These were: *personal experiences*: "I have even seen recently that people will put a large bottle of hand sanitizer next to sinks which encourages people to actually use that because it is readily available and faster" (development – low), information from the *online sources*:

> as an article I read stated, the use of hand sanitizers in work places and public environments have minimized the number of sick days that people are taking and the amount of coughing, flu and other viruses that circulate around work places (discomfort with ambiguity and closed mindedness – high)

*prior knowledge*: "I can't help but think about stuff I have heard about hand sanitizer and the affects on your hands. For example, I have heard that if hand sanitizer is used too much then it will dry out your hands and make them a bit rough" (discomfort with ambiguity – low), and *example situations*: "I think this mostly because of publicly shared areas like for example; computer labs, door handles, or classroom desks etc" (discomfort with ambiguity – low).

There seemed to be very little difference in comparing participants at the high and low ends of any of the epistemic motivation, development, or strategy variables in terms of their general frequency of evidence use. However, participants high in internalist and externalist strategies and need for cognition, and low in closed mindedness and discomfort with ambiguity, did offer more evidence based on the specific sources provided than their counterparts. Individuals low in discomfort with ambiguity and closed mindedness also offered more examples of specific situations where hand sanitizer might be useful than those high on those measures.

***Asserting beliefs.*** The sub-category of *asserting beliefs* emerged as statements that were not explicitly tied either to the available resources, prior knowledge, experiences, or to specific examples. Several types of beliefs emerged that formed

part of the participants' statements in support of their opinions following the search task. These were: *beliefs about cleanliness and hygiene*: "Since college students are always so busy and in a rush, hand sanitizer is a great way to promote clean hands which will lead to healthier students and faculty" (closed mindedness – high), *convenience*: "Yes, it does not kill as many germs as soap and water, but the convenience of it is great and it is better to use something than nothing at all" (closed mindedness, discomfort with ambiguity, and development – high), *germs* and the spread of germs and their relation to health and illness: "Germs spread so quickly and easily" (closed mindedness and discomfort with ambiguity – high), the *general effectiveness* of sanitizer: "Considering that it is easier, more tie [*sic*] efficient, and more likely to kill bacteria it seems that hand sanitizer is an easy choice over soap" (closed mindedness – low, development and need for cognition – high), *implementation*: "Hand sanitizer would also be something that would be easy to install in college campuses. It could easily be put in places such as gyms, bathrooms, classrooms, and hallways" (internalist strategies and development – low), *financial* aspects of promoting and purchasing sanitizer:

> I think, OU should wait until there is a consensus on the topic before investing any large amount into the promotion of hand sanitizers. Students and taxpayers would be very upset if they knew their university was spending money on hand sanitizer and then it turned out it was not effective (closed mindedness – high, development – low)

; the *role of universities* in health promotion: "I also believe that it is not the job of a university to promote the use of hand sanitizer, it should be an individuals choice"

(development – high), and *beliefs about other people* including other's perceptions and knowledge of sanitizer, their ability to use sanitizer responsibly, and their laziness in hand hygiene: "I believe that people often use hand sanitizer as a replacement for hand washing, which I would think that wouldn't be as affective" (discomfort with ambiguity – low). Across beliefs as a broad category there were no clear differences in the frequencies that beliefs were asserted as a form of justification between high and low scores on the epistemic variables.

***Expressing Preferences.*** These were assertions that were neither beliefs nor evidence, but purely statements of preference without reference to any evidence or reasoning for the preference. These included preferences both about the *use* of hand sanitizer, as well as the *type of promotion* that should be employed by the university. There was a marked difference in the use of this approach for justification across participants scoring high and low on these variables. Across epistemic development, strategy, and motivation variables, the preferences as justification approach was used far more by individuals who were high on closed mindedness: "I personally am a fan of this product and use it every change [*sic*] I can get" (closed mindedness – high, need for cognition – low) with eight instances as opposed to only two put forward by those low on closed mindedness; low on externalist strategies: "If they were to put tiny signs up all over campus I don't know if I would like that" (internalist and externalist strategies – low), 10 compared to only one instance for those ranking high on the externalist scale; low on internalist strategies: "I feel that it is very important that hand sanitizer be distributed in universities" (internalist strategies – low), six compared to three; low need for cognition: "In my

opinion hand sanitizer should be provided around the university even if research shows that it may not be as affective as people think it really is" (need for cognition, development, and externalist strategies – low), seven to two; and low on the RCI: "But, at the end of the day everyone should just wash their hands. That works just as well if you take the time to do it" (need for cognition, development, and internalist strategies – low), five to three. The only variable that did not show a difference in frequency was the discomfort with ambiguity scale. Four of the participants who used expressing preferences as a component of their opinion justification were also participants that did not access any of the information available to them.

**Openness to change.** Codes and subcategories within this broader category were largely taken from responses to the question "Do you think your opinion could change in the future?" While some of the participants' responses were a short "yes" or "no" many of the participants provided more detail into the possibility of change and what they perceived as necessary to prompt a change of their beliefs. There were four subcategories: *change as contingent* on something else (such as more information, research, or "proof"), *change unlikely*, *change possible*, and *no*. There were clear differences between groups in the type of response to given to this question.

Across epistemic development, strategy, and motivation variables the individuals who described the possibility of change as contingent on some other factors were more often low on closed mindedness:

> I do think my opinion could change in the future and the first thing that comes to mind that might change it is context. Seeing as public schools are receiving less and less funding, I don't think that hand sanitizer should be very high on the priority list. If not having hand sanitizer, meant more funding for something more important, than [*sic*] my answer would be no. (discomfort with ambiguity and closed mindedness – low)

six instances as opposed to three by those high on closed mindedness; low on discomfort with ambiguity: "Depending upon the research that is done and presented in the future, my opinion could possibly change" (discomfort with ambiguity – low, need for cognition – high), 10 compared to only four instances for those ranking high on the discomfort with ambiguity scale; high on externalist strategies: "In my view, all personal opinions should be dynamic, allowing for a more complex or accurate opinion based on reliable and recent information" (closed mindedness – low, development and internalist and externalist strategies – high), seven to four; high on internalist strategies: "My opinion could change if new information is presented or if the formula for hand sanitizer changes." (internalist strategies and need for cognition – high, closed mindedness – low), seven to four; high need for cognition: "I think my opinion could change in the future if there were some study done that produced some strong evidence either for or against the use of hand sanitizer" (need for cognition – high), seven to five; and high on the development: "If more concrete, scientific proof was provided to me that said conclusively whether or not sanitizer is worth it I might change my mind"(development – high) nine to five. Caution does need to be taken, however,

although participants in these groups' responses were more likely to discuss change as contingent, some of the participants did talk about contingencies that could have been satisfied by information that they had actually already accessed. For example one participant stated that their opinion may change if "test results come back and hand sanitizers are having detrimental results to its users, or they find out that hand sanitizers actually have no benefits, then I may change my mind" (development – high). However, they had already accessed two of the con articles about the risks of sanitizers including the article from infectioncontroltoday.com that linked sanitizer use to increased risks of norovirus. This seemed to be a pattern across participants on all four variables at both high and low ends of the scales, that they would state an openness to change and describe it as contingent on a certain type of information that the internet logs indicated that they had accessed, but which they either did not refer to in their responses or were dismissive of:

> Yes my opinion could change in the future if there were strong evidence that contradicts what we now know about the use of hand sanitizers. The information regarding how it does not protect against all viruses and that it could cause other ailments from overuse is not enough damaging evidence to suggest that the risks outweigh the benefits of promoting the use of hand sanitizers on University campuses. (internalist strategies - high)

Individuals high on discomfort with ambiguity and closed mindedness and low on need for cognition, more frequently responded "no" or "unlikely" in answer to the question. However, this did not extend to individuals low on the development variable, and epistemic strategies variables, although these individuals were more

likely to indicate the problem as unimportant: "in my opinion, this is not a huge issue that is really important."

**Source selection rationale.** These rationales were mostly provided in response to the question "Why did you choose those sources?" Several different approaches to source selection emerged, these were: *appearing first*, *balance*, *context*, *curiosity and interest*, *aspects of information anticipated*, *capturing attention*, *personal relevance*, *confirming beliefs*, and *perceived credibility of sources*.

***Appearing first.*** First appearance in the Google page was a common reason for choosing specific websites, with frequency of this rationale being fairly even across categories. Some participants included in their responses some reference to previous experience of Google searches, for example: "I choose the first few sources presented within the google results page mainly because when I conduct my own google searches, I find that the first few articles are generally the most relative to the topic in question" (discomfort with ambiguity and closed mindedness – high). Although not all participants cited this as a reason for their selection, between six and eight participants out of ten in all of the groups opened the first source that appeared in their Google page first in their access sequence. Comparing the data on need for cognition, which was indicated in the quantitative results as having significant influence over VisitScore, the 20 participants highest and lowest on the variable did not differ $\chi^2(1, N = 40) = .125$, $p = .73$. Again, comparing the 20 individuals highest and lowest on interest, there was no statistically significant difference $\chi^2(1, N = 40) = 2.133$, $p = .144$.

The frequency of opening the first link first in an individual's access sequence did not appear to be impacted by the actual source that appeared first in Google. The difference between individuals who accessed the first link on GoogleA (22 out of 29) and those who accessed the first link on GoogleB (23 out of 31) was non-significant $c^2(1, N = 60) = .022$, $p = .881$. This indicates that there was no difference between the first link being pro or con, as on GoogleA the first page was a pro sanitizer article and GoogleB was anti sanitizer. It also indicates that authority of the first source did not make individuals more or less likely to select the first link, as the first link from GoogleA was to livescience.com a reputable science website, while GoogleB was from whiteowlconspiracy.com a conspiracy blog.

***Capturing attention.*** Some variation of "Their titles jumped out at me" (discomfort with ambiguity - high, externalist and internalist – low) and "The Advantages of Alcohol Hand Sanitizer article as well as the Hand Sanitizer at Work May Lower the Number of Sick Days article stood out the most to me" (closed mindedness – high, development – low) were common explanation for source selection, particularly among high closed mindedness and discomfort with ambiguity; low need for cognition, low epistemic strategies, and low development groups. Although individuals in high need for cognition, strategy, and development groups, and low closed mindedness and discomfort with ambiguity groups, also used terms like "stood out" they tended to elaborate more "I also read these because the description sounded interesting or caught my attention," (externalist strategies and development – high) whereas for the contrasting groups this was often the only explanation they provided.

***Balance.*** Wanting "to see both sides of the argument" (development – high) was a common rationale for choosing sources on both sides of the argument. Participants who offered this reasoning were in all groups, although the highest frequencies (nine of ten participants) were in the low discomfort with ambiguity, and high externalist strategies (seven of ten) group. Lowest on this strategy were the low epistemic development and high discomfort with ambiguity groups, both with only two instances among the ten participants in each group.

The next step from wanting to see both sides, was the desire to see all the available resources. This was not common among participants, with only three of the 60 qualitative participants choosing to do so (compared to six who chose to look at none at all). All of the participants who claimed to have looked at all of the sources, and who actually did, fell into the low groups on closed mindedness and discomfort with ambiguity, the high groups on need for cognition, development, and internalist epistemic strategies variables. Common across these participants in their rationales was a desire to "make the most informed choice."

***Curiosity and interest.*** Both interest and curiosity played a role in selection for some participants "I was curious to know if others believed that hand sanitizer could eliminate sick days in students and faculty" (discomfort with ambiguity - low), " wondered what their getting the diploma had to do with sanitizer" (need for cognition – high, development – low). For one participant, their interest in the topic increased as they read more articles: "Each site intrigued me to read the next one. At first, I didn't think I needed to know that much information because I trusted hand sanitizers but after the negative reports, I wanted to keep reading" (internalist

– low). For some participants their interest in a particular article seemed to be less about an openness to new information, but more about being interested in articles that confirmed their pre-existing opinions "I chose this source because it looked the most interesting to me and I thought that it would have good information about being in public places and *using hand sanitizers often* [emphasis added]."

***Aspects of information anticipated.*** Eight participants talked about the information they thought they could get from the sources they selected. Some of this was more general "I decided that those sources seemed like they would give me the most information" (internalist and externalist – low). While others' responses focused more on the specific information that they perceived the source could provide: "I also chose the "lowering the number of sick days" because that is extremely important as a student and a worker" (development – low). This sub category was not repeated enough to draw conclusions about frequencies between groups.

***Personal relevance.*** Three of the participants cited personal relevance as a reason they choose particular links to access. Although this wasn't a common approach across participants, for the three participants that used this rationale, this was a key component of their explanations for choosing the sources they did. For example: "I chose those sources because the titles of them were the most interesting and related to my life" (closed mindedness – high, development – low). The personal relevance seemed to be tied to pro-sanitizer beliefs, and mention of health and hygiene in other open responses:

I also chose the "lowering the number of sick days" because that is extremely

> important as a student and a worker. I am a full time student balancing two jobs, and with most of my classes and my rent depending on my paycheck, I cannot miss school or work because of being sick. It was interesting to see, even though small, how the study affected the number of sick days taken and can even stop the smallest head cold or cough. (closed mindedness – high, development – low)

***Perceived credibility of sources.*** Although citing credibility of sources was a common selection rationale for individuals in the low discomfort with ambiguity, closed mindedness, and high need for cognition, epistemic strategies, and development groups, only one individual in the high discomfort with ambiguity group cited source credibility as a rationale for site selection: "They seemed to be somewhat more reliable than the others listed" (closed mindedness – low, discomfort with ambiguity, externalist and internalist strategies, need for cognition, and development – high). In the low need for closure, high development, strategy, and need for cognition groups judgments about the credibility of sources were frequently stated as selection rationales. These were stated both generally "And I used the livescience sourced [*sic*] because it appeared reputable in regards to the information I was seeking" (development, need for cognition, and externalist strategies – high) and more specifically, drawing on knowledge or inferences about the sites themselves:

> Blogs are often very opinionated, so I chose to avoid those as well as any site with "conspiracy" in its title. The Washington Post and Live Science are both reputable sources that are more likely to be scientific and objective.

> Livestrong has been enshrined in controversy lately, so I avoided it as well. (closed mindedness – low; need for cognition, epistemic development, and internalist strategies – high).

Other individuals talked about their usual approaches to determining credibility and their lack of ability to do that with this particular set of sites "Normally, when I do research for stuff I would like to know about I look at sources with .org addresses or from expert resources" (discomfort with ambiguity – low, need for cognition – high).

***Confirming beliefs.*** In contrast, individuals in the high discomfort with ambiguity and closed mindedness, low need for cognition, strategies, and development were much more likely to provide a confirming belief rationale for selecting sources: "I had hears [*sic*] about this information before and chose the link to confirm what I had heard" (discomfort with ambiguity – high, internalist and externalist strategies – high). Although not explicit in her response to the question, this participant, who only accessed pro websites, also appeared to be confirming beliefs: "My parents as well as teachers growing up really encouraged the use of hand sanitizer so I was more prone to read the article about the advantages rather than the disadvantages" (closed mindedness – high, development – low).

**Source helpfulness rationale.** These codes emerged largely from the last question, participants were first asked to indicate on a scale of 1-4 and 0 for "did not read" how helpful they found the sources. In the open response questions they

were then asked to explain why the sites they had ranked most highly were the most helpful. Some of the responses to the previous question about site selection fell more into this category than in selection rationales, those responses were coded and are included in this section. Several of the source selection rationale sub-categories reappear in this category. The distinction was made between similar phrases that if the participant talked about the title, domain name, or snippet of information contained on the Google page this was an example of a *source selection rationale*. If participants talked about the actual content, or information that could only be found from reading the article and not from the search page this would count as an example of *source helpfulness rationale*.

***Balance.*** There were eleven different instances of discussions of balance in the data. This seemed to be used in two different ways, the primary use of balance was to talk about the *range* of sites available and the two or more sites that they indicated as being most helpful as representing two sides of the arguments: "These sources gave useful information about the risks and benefits of using hand sanitizer" (closed mindedness - low, need for cognition and externalist strategies – high) and seeing both opinions on the subject "although some articles which is not support my opinion but i still would like to follow my thoughts, but it is nice to know different opinions [*sic*]" (discomfort with ambiguity - low). A second way in which balance was expressed was to talk about breadth of information *within* particular articles: "I believed these were most helpful because they were very broad and did not have opinion based facts" (internalist strategies - high). There seemed to be no clear differences between groups in how often this was provided as a

rationale for the highest ranking of the most helpful sources.

***Relevance.*** This encompasses both *personal relevance of the information to their lives*: "They intrigued me with the titles and wanted me to read more into it because of its value to my daily lifestyle" (discomfort with ambiguity - high) and *relevance to the question*: "I found this the most helpful because people would not want to lose days of school because of them being sick" (development – low). In many cases these two rationales greatly overlapped. This approach to justification of the sources used, seemed to be most often tied to the "hand sanitizer at work may lower the number of sick days" livescience.com article and occurred only in the high discomfort with ambiguity and closed mindedness, and low development and internalist strategies groups.

***Aspects of the information provided.*** There were 23 instances of general discussion about the information that the sources they selected contained using words such as *enou*gh: "I did not read all of the articles because I felt that I was educated enough on this topic after reading the articles that I had" (discomfort with ambiguity – low), *new*: "The white owl conspiracy page was also interesting because it presented information I had not heard before" (closed mindedness – high, development – low), *good*: "They gave good information" (closed mindedness - high), and *accurate*: "I thought they gave accurate information" (need for cognition – high). There were no frequency differences on this sub-category; although at a finer grain of coding comparing those responses that talked about the information giving them better understanding of the subject: "I felt that they provided enough information to help me understand the research that has been done on the topic"

(closed mindedness – low) versus just "good information" or a focus more on the clarity "I found them being short and to the point, while still giving the important information to me" (closed mindedness – high) seem to reveal more differences between participant approaches.

***Interest.*** This sub-category occurred three times in the data. The three instances were: "It was the most interesting out of the ones I read" (internalist, externalist, need for cognition, development – low), "I found the work place article interesting and thought it had given me a good amount of information to answer more questions" (ambiguity, closure – high, need for cognition – high), and "I found those sources most helpful because I agreed with what they had to say and their points were interesting" (closed mindedness - high, need for cognition – low).

***Confirming beliefs.*** As in the source selection rationale category, responses here focused on the alignment between the information provided in the source and their own beliefs. For example: "I found these two most helpful because they presented me with information that I already find to be true in regards to hand sanitizers" (need for cognition, development, externalist strategies - high). This approach was most common among high closed-mindedness, however, the example provided is from an individual scoring highly on need for cognition, the RCI, and the externalist strategy instrument.

***Credibility.*** There were twelve instances of students referring to credibility in some form including *reliability* of the information, *objectivity*, and *legitimacy*. Examples for *reliability* include: "They sounded reliable, and seemed to be telling the truth" (externalist strategies and development – high). For *objectivity*:

"Objectivity, scientific data, and examples made this site the most helpful" (development, internalist and externalist strategies – high; closed mindedness - low) and "The study was sponsored by a University, not one of the hand sanitizers company. It is of my understanding that the study was unbiased, which is essential when forming an opinion" (discomfort with ambiguity and externalist strategies – high). Legitimacy: "The sites that I thought were most helpful seemed to provide valid information that seemed legitimate" (discomfort with ambiguity, closed mindedness, need for cognition, development – low). As is evident from the examples, use of this justification cut across groups in somewhat unexpected ways particularly in individuals who were high in the proposed "epistemic vices" of discomfort with ambiguity and closed mindedness, but also high in the proposed "virtue" need for cognition as well as epistemic development.

***Facts and truth.*** Use of the word "truth" was applied in two ways. Firstly as *equated with data*: "I thought that the white owl site was very informative and brought legitimate sources such as doctors perspectives and scientific information to show how important and true the use of hand sanitizer is" (development – low; closed mindedness - high) and "They revolved mostly around facts, research and data" (discomfort with ambiguity – low; externalist and internalist strategies - high). Secondly as a more *general intuition*: "I believe that the new information was enlightening with a lot of truth to them" (development, internalist strategies, need for cognition – high; discomfort with ambiguity and closed mindedness – low) and "They sounded reliable, and seemed to be telling the truth" (externalist strategies and development – high). Another example about intuitions or beliefs about the

truth of the information is this: "Also, I did not think that the information about hand sanitizer lowering the number of sick days was that helpful because after reading the first article about it not being affective, I did not find the information to be true" (closed mindedness – high). This participant was high on closed mindedness and, similar to the first example in this category that was also given by an individual high in closed mindedness, both participants began with positive view of sanitizer but opened the first link on their GoogleB webpages – "Think hand sanitizers protect you against germs? Think again…" from whiteowlconspiracy.com – and in their responses seem to have stuck, (or have seized and frozen (Kruglanski & Webster, 1996)) on this material. The participant from the first example read only the first article, while the participant whose response was just provided accessed several sources on both sides of the argument, but did not discuss any other sources in their responses except for in this section, where they dismissed the resources as untruthful.

***Research and data.*** Although there was significant overlap with other sub-categories, the focus on research and data, and also the process of reliable research did emerge as a separate category containing coded phrases not captured elsewhere. This differed from the "facts and truth" category in that the responses focused more on the scientific process and research as a source of information rather than data and truth as a property of the data. Examples include: "The lowering of sicks days by using the hand sanitizer was a good article to read. It had a long period of time that several individuals were followed in order to see if the experiment was effective or not" (internalist, externalist strategies - high) and "I found the hand sanitizer

article relating to lowering sick days the most helpful because it presented information I believed to be well researched" (closed, discomfort with ambiguity - high). Again, there was no evidence of great differences in the frequency of this approach between groups.

***Clarity and conciseness.*** Issues of clarity and conciseness both in information, but also the actual layout of the webpage itself emerged as one of the more common sub-categories within the broader category of source helpfulness rationales. Examples include: "It was easy to glance and see what the website thought about hand sanitizer, I didn't really have to work to find the information" (need for cognition, internalist, externalist – low; discomfort with ambiguity - high) and "I thought the livestrong [*sic*] advantages article was the most clear and concise in making its points about how hand sanitizer can help" (development – low, closed - high). Frequency was similar across groups.

***Read.*** This sub category reflected the very literal response of "They were the only ones I looked at" to the question of why the individual rated the sources they did most highly on helpfulness. Three participants provided this response in the high discomfort with ambiguity, high closed mindedness, and low closed mindedness groups.

***Prompting reflection.*** In contrast with "I read these" as a response, this sub-category captures sources that individuals described as "just made me think" (discomfort with ambiguity - low; need for cognition – high). Participants using the approach, or preference for particular sources talked about how the sites facilitated reflection "Even though they had different opinions about hand sanitizer, they

made me think about what I believe on the subject" (need for cognition – high). Overall frequency was too low to discern differences between groups.

***Anti-rationales.*** The final category of anti-rationales, captures those justifications that focus more on the negatives of the sources they rated as unhelpful, rather than the positives of the sources they rated more highly. There were only three instances of this, with the participants falling in the Development - high, internalist and externalist strategies – low groups. An example of this approach: "I found them all equally unhelpful. Most of them didn't rely on sources that I could see and made broad generalizations" (development – high).

**Strategies and context: secondary analysis.** As the third group of research questions focused on the links between the *epistemic strategies* reported at the domain general level and those exhibited during the online search task, and question 1(c) focused on the influence of context, four additional file sets were created by sorting the data by the epistemic strategies variables and looking for the two individuals with the highest and lowest levels of interest in the topic. Interest was selected as a key variable following the quantitative analysis, which revealed interest as having an influence over perceptions of information sufficiency. The demographic information of these participants, as well as their scores on the epistemic strategy, development, and motivation variables; task variables: interest, risk, initial opinion, and information sufficiency; and the specific pages visited along with the sequence in which they were accessed and how this relates to the sequence on the page are provided in tables 11 and 12.

Table 11

*Demographic Information for High/Low Epistemic Strategy with High/Low Interest Participants*

| | Interest | | Age | Gender | Ethnicity | Semesters |
|---|---|---|---|---|---|---|
| Internalist High | High | HI-HI-A | 29 | Male | African American | 13 |
| | | HI-HI-B | 20 | Female | Caucasian | 4 |
| | Low | HI-LI-A | 19 | Female | Caucasian | 3 |
| | | HI-LI-B | 19 | Female | Caucasian | 4 |
| Internalist Low | High | LI-HI-A | 21 | Female | Caucasian | 6 |
| | | LI-HI-B | 20 | Female | African American | 7 |
| | Low | LI-LI-A | 20 | Female | Caucasian | 4 |
| | | LI-LI-B | 20 | Female | Hispanic | 4 |
| Externalist High | High | HE-HI-A | 21 | Female | Caucasian | 8 |
| | | HE-HI-B | 20 | Female | Caucasian | 5 |
| | Low | HE-LI-A | 20 | Female | Caucasian | 4 |
| | | HE-LI-B | 20 | Female | Caucasian | 4 |
| Externalist Low | High | HE-HI-A | 23 | Female | Caucasian | 10 |
| | | LE-HI-B | 20 | Female | Caucasian | 4 |
| | Low | LE-LI-A | 19 | Female | Caucasian | 4 |
| | | LE-LI-B | 19 | Female | Caucasian | 4 |

Table 12

*Epistemic Development, Strategy, and Motivation Scores and Task Variable Scores for High/Low Epistemic Strategy with High/Low Interest Participants*

| | Interest | | ES1 | ES2 | ED | EM1 | EM2 | EM3 | Int | Ris | IO | SI | Website Access Sequence | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Internalist High | High | A | 6.65 | 5.13 | 4.73 | 3.86 | 2.13 | 6.72 | 7.00 | 1.00 | 2 | 7 | con4 | pro4 | pro4 | con2 | pro3 |
| | | B | 7.00 | 5.75 | 4.70 | 3.00 | 2.50 | 5.39 | 5.67 | 2.67 | 3 | 7 | pro3* | con2* | pro2 | con3 | con4 |
| | Low | A | 6.53 | 7.00 | 4.90 | 6.50 | 3.50 | 5.11 | 1.00 | 1.67 | -1 | 7 | con1* | | | | |
| | | B | 6.59 | 5.75 | 5.62 | 6.29 | 2.00 | 5.94 | 2.00 | 1.67 | 1 | 6 | con1* | pro1 | con4 | | |
| Internalist Low | High | A | 2.65 | 3.38 | 4.73 | 5.86 | 3.25 | 2.28 | 5.33 | 4.00 | 2 | 6 | | | | | |
| | | B | 3.35 | 3.63 | 3.00 | 5.00 | 4.00 | 4.28 | 6.00 | 6.00 | 3 | 4 | pro3* | | | | |
| | Low | A | 3.24 | 3.00 | 3.50 | 5.43 | 3.88 | 1.61 | 1.00 | 2.67 | -1 | 4 | | | | | |
| | | B | 3.47 | 3.29 | 4.70 | 5.00 | 4.00 | 3.72 | 3.00 | 4.00 | 1 | 5 | con1* | pro2 | | | |
| Externalist High | High | A | 6.00 | 5.88 | 5.37 | 4.29 | 3.63 | 4.00 | 6.67 | 3.67 | 3 | 6 | pro3* | con2* | | | |
| | | B | 5.76 | 6.25 | 5.87 | 5.29 | 2.50 | 6.44 | 5.33 | 2.00 | 3 | 6 | con1* | pro3 | con2 | | |
| | Low | A | 5.76 | 6.13 | 4.48 | 6.29 | 3.88 | 5.00 | 3.00 | 3.67 | 1 | 6 | con1* | | | | |
| | | B | 5.29 | 5.75 | 5.90 | 4.29 | 3.75 | 4.44 | 3.00 | 3.00 | 1 | 6 | pro3* | con2* | con4* | pro1* | |
| Externalist Low | High | A | 4.29 | 3.13 | 5.53 | 6.00 | 5.00 | 3.28 | 6.67 | 2.67 | 3 | 6 | con1* | con4* | pro2 | pro1 | |
| | | B | 4.59 | 3.25 | 1.83 | 5.43 | 4.25 | 2.78 | 5.33 | 3.33 | 2 | 5 | con1* | | | | |
| | Low | A | 3.59 | 3.25 | 4.63 | 5.00 | 3.00 | 4.28 | 3.00 | 2.67 | 1 | 5 | con2 | con1 | con2 | pro2 | |
| | | B | 3.65 | 3.13 | 3.83 | 4.71 | 3.63 | 3.22 | 2.00 | 1.00 | 0 | 5 | con1* | pro3 | | | |

*Notes:* * indicates that the page was accessed in the sequence shown on the version of. Google available to the participant.

For the *source selection rationale* and the *source helpfulness rationale* there were numerous subcategories and responses were often quite short such that there was much less overlap between participants making frequency counts between groupings largely uninformative. Therefore, the mixed-method analysis of influences of interest on individuals scoring high and low on the internalist and externalist epistemic strategy variables will focus only on *forms of justification* and *openness to change*. In terms of *source selection rationale* the sequences for these individuals can be viewed in Table 12, and show no apparent difference in the frequency of first source selection, with seven of the eight participants high on either strategy accessing the first link first in their search sequence (see Table 12).

***Forms of Justification.*** As found in the main analysis the three main approaches to justification used by participants were also found in the internalist and externalist epistemic strategy sub-groups. These were: *providing evidence*, *asserting beliefs*, and *expressing preferences*.

*Evidence.* When sorting the information for high and low interest combined with high internalist and externalist scores there did seem to be some differences in the amount of justification provided for beliefs. These differences on interest were not as clear for those with low scores on the epistemic strategy variables. The differences were, however, confounded by the strength and valence of the participants' original opinions. Individuals who were interested in the topic tended to have strongly favorable pre-existing opinions of hand sanitizer, whereas individuals who had low interest in the topic tended to have neutral or only slightly positive or negative views of hand sanitizer. In terms of their patterns of

justification, that meant that individuals high on interest focused more on the pro-hand sanitizer sources and providing more pro-hand sanitizer examples, for instance: "There can be no 100% replacement of old fashioned soap and water hand washing procedures, but the use of alcohol based hand sanitizers is effective enough to prevent most medicine resistant bacteria and virus" (HE-HI-A). Whereas their disinterested counterparts who began with slightly negative initial views focused on the inefficacy of hand sanitizer and sources that supported that stance "Hand sanitizer fails to exterminate all germs and the effects only last for a maximum of two minutes before it is necessary to re-apply" (HI-LI-A). As is reflective of the sources accessed (see Table 11), the pairs of individuals higher on internalism and externalism referenced the more authoritative sources, particularly those individuals who were higher in interest. Individuals with low interest who were also low on either epistemic strategy largely maintained their original stance and either accessed no sources at all, or were dismissive in their justifications of sources opposing their initial views on the topic. For example, this participant had a neutral view on the topic and, despite reading both a pro and con source, did not reference the pro source beyond this statement in their justification of opinion: "I do feel that promotion of the product may not change the number of students who take sick days" (LE-LI-B).

*Asserting beliefs.* Comparing these pairs of individuals with high and low scores on the two epistemic strategy variables combined with high and low interest, there were differences in the frequency of belief assertion as justification. Pairs of individuals with high levels of externalist and internalist strategies and high interest

provided more support in the form of beliefs than their disinterested counterparts. Similar to use of evidence, the differences in frequency comparing those of low and high interest were not as clear for those with low scores on the epistemic strategy variables. The pair of individuals high on the internalist measure at both high and low ends of the interest continuum expressed more beliefs as justification than those low on this measure whether highly interested or disinterested. The same problem occurred in this analysis with interest being associated with strength and valence of beliefs. For example those who began with neutral or only slightly positive opinions tended to focus more on financial arguments to dismiss the promotion and purchase of hand sanitizer: "Wasting taxpayers and students money on hand sanitizer would be wrong. Money should be put towards more worthwhile projects" (HE-LI-A).

*Expressing preferences.* Looking to the high and low epistemic strategy pairs with high and low interest, the statement of preference approach for justification was only used by individuals low on the externalist and internalist strategies. High interest with low externalist participants used the strategy the most with four instances to only two in the low interest pair. There was only one instance of this strategy in the low internalist/low interest pair.

***Openness to change.*** Subcategories and codes for the openness to change category largely came from the responses to the question "Do you think your opinion could change in the future?" Focusing on the *change as contingent* subcategory and comparing these subgroups organized by high and low interest, high and low externalist and internalist epistemic strategies, the differences are less

clear than on the broader groups based only on the variables, without including interest as an organizer. Many of those individuals who had high interest at both high and low epistemic strategy levels already had strong pre-existing opinions on the issue, which may have been a factor in them being less likely to change opinions, or to only change opinion based on strong counter-evidence such as "If there were to be new research that comes up that is harmful and a health risk, then this would be the only reason to change my mind about placing hand sanitizer on university campuses" (HE-HI-A). Of the pairs who were low on interest those individuals who were high on epistemic strategy remained fairly neutral and due to the lack of importance could not foresee their opinion changing:

> I do not think my opinion on this subject will change in the future. Unless test results come back and hand sanitizers are having detrimental results to its users, or they find out that hand sanitizers actually have no benefits, then I may change my mind. But in my opinion, this is not a huge issue that is really important. I think it would be fine if universities decide to promote the use, but in reality I don't think they would really be loosing [*sic*] much if they decide against the promotion. Students are going to do what they want, no one can force them to do something. If they want to use it they will, if not, they won't. (HE-LI-B)

Those individuals low in interest and low on epistemic strategy were split between two individuals open to change:

> Yes I think my opinion could change in the future. With more information about the topic, such as how the universities would promote the use of the

hand sanitizer I might be more inclined to lean one way over the other. (LE-LI-A)

and two who were adamantly unlikely to change: "I highly doubt it... I am not and never will be a germ freak" (HI-LI-B).

**Access sequence.** The final portion of the qualitative results focus not on the written responses but on an analysis of the sequence of link access via the Internet logfiles. As noted earlier in the qualitative analysis, accessing the first link first in an individual's access sequence was very common with 41 of the 60 participants whose responses were analyzed quantitatively following this pattern. In order to further investigate this phenomenon I selected out the two individuals scoring highest, and lowest on the RCI who had also access to GoogleA to compare their approach to the information. In looking at the t-test no statistically significant difference was found in whether individuals began with the first link as dependent on whether they had access to GoogleA or GoogleB. Therefore A was selected as first in alphabetical order, as the sequence of links in the browser did not appear to have an impact on the access sequence used by participants.

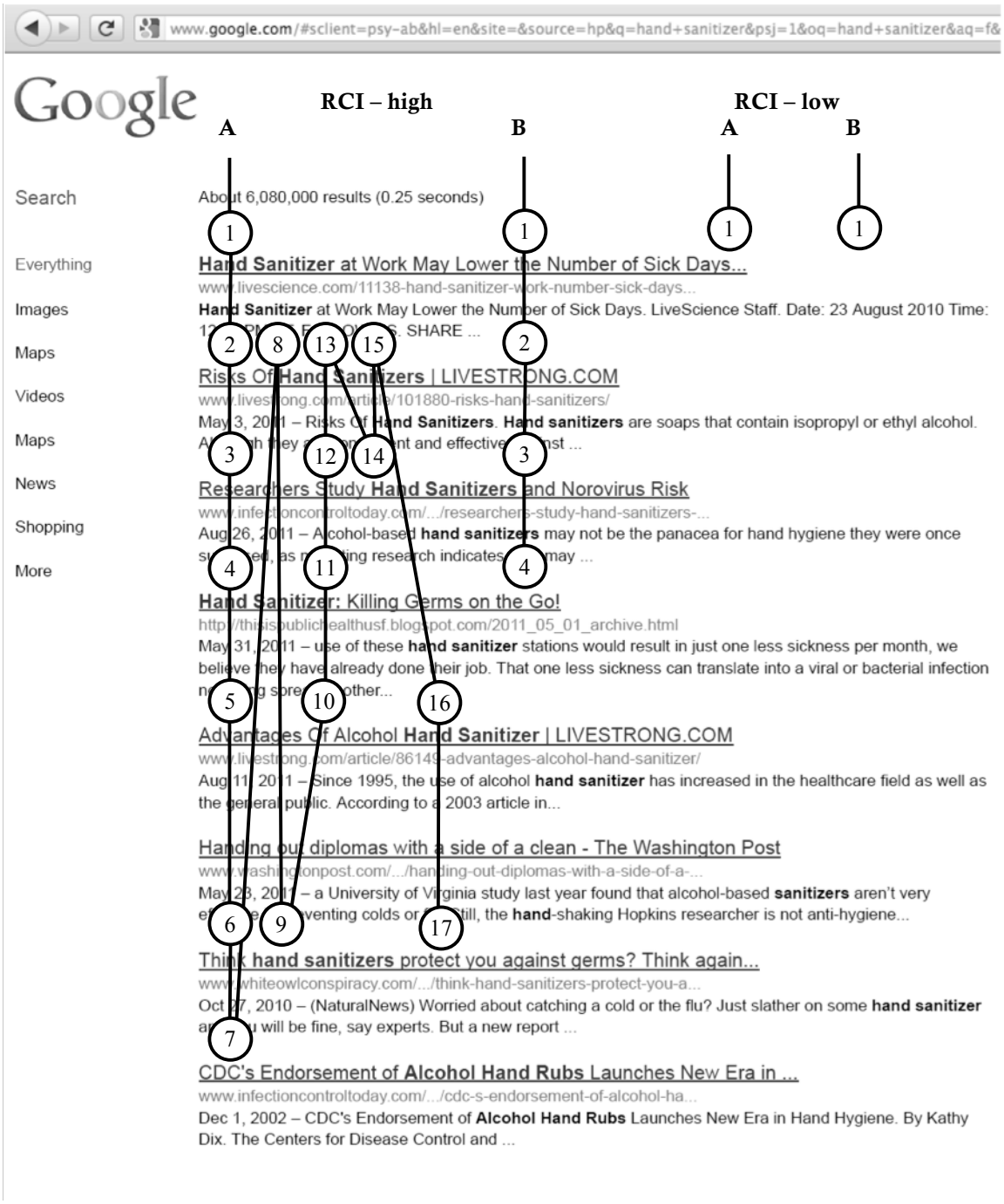


*Figure 4.* Image showing the sequence of visits by participants assigned to Google version A who scored highest and lowest on the RCI Questionnaire.

All four of the participants were female Education majors. Both LOW-A and B were 20 years old, while HIGH-A was 41, and HIGH-B was 18, the upper

and lower limits of the range. Table 13 shows their scores on pre and post task questions as well as their scores on epistemic strategies, development, and motivation scores.

As shown in Table 13, although HIGH-A and HIGH-B were the highest development scores for those participants assigned to Google version A, they differed on epistemic motivation by more than one standard deviation on all three of the scores, with HIGH-A scoring lower on both closed mindedness and discomfort with ambiguity (need for closure), and higher on need for cognition. Although HIGH-A scored lower on the evidence scale of the epistemic strategies instrument than HIGH-B, she scored higher on the concept scale. The concept scale focuses on links between information and understanding, so the many jumps back and forth between pages and multiple visits to some of the available sources is interesting and reflects the connections described by many of the items on the scale. HIGH-A's rationale for selecting all of the sources also echoes ideas of understanding that underlie the concept scale "I chose to read them all because I wanted to hear all the opinions that were available to me to make the most informed choice about the topic and issues" Additional factors that may have influenced their approaches to the available sources were the difference in their interest, perception of risk, and importance of understanding to the topic. HIGH-A's scores on risk, interest, understanding were higher than that of HIGH-B's, and may also have influenced her greater engagement with the materials. Whereas HIGH-B was very clear about the lack of importance she placed on the topic in her own defense of why her opinion was unlikely to change in the future:

Table 13

*Epistemic and Task scores for participants shown in Figure 4.*

| Participant | | INT | RIS | UND | PK | IO | SI | ED | ES1 | ES2 | EM1 | EM2 | EM3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOW | A | 5.67 | 5.33 | 5.33 | 6 | 2 | 6 | 1.83 | 4.35 | 4.75 | 5.71 | 3.63 | 4.83 |
| | B | 6.00 | 6.00 | 6.00 | 6 | 3 | 4 | 3.00 | 3.35 | 3.63 | 5.00 | 4.00 | 4.28 |
| HIGH | A | 5.00 | 4.00 | 5.00 | 4 | 2 | 7 | 5.83 | 6.24 | 4.88 | 2.29 | 1.38 | 5.78 |
| | B | 3.00 | 3.00 | 3.67 | 3 | 1 | 6 | 5.90 | 5.29 | 5.75 | 4.29 | 3.75 | 4.44 |

*Note.* INT = Topic interest, RIS = Perceived personal risk, UND = Importance of understanding, PK = Prior knowledge, IO = Initial opinion, SI = Sufficiency of information; ED = RCI, ES1 = Concept, ES2 = Evidence, EM1 = Discomfort with ambiguity, EM2 = Closed mindedness, EM3 = Need for cognition.

> "I do not think my opinion on this subject will change in the future. Unless test results come back and hand sanitizers are having detrimental results to its users, or they find out that hand sanitizers actually have no benefits, then I may change my mind. But in my opinion, this is not a huge issue that is really important. I think it would be fine if universities decide to promote the use, but in reality I don't think they would really be loosing much if they decide against the promotion. Students are going to do what they want, no one can force them to do something. If they want to use it they will, if not, they won't"

Although LOW-A and LOW-B were the lowest scores for participants who saw version A of the Google page, their RCI scores were more than one standard deviation apart with LOW-B having the higher of the two scores. All three epistemic motivation scores were within one standard deviation of one another,

however, LOW-A had higher scores on both the concept and evidence scales of the epistemic strategies scale. Her rationale for the source selection she made focused on relevance "I felt that it was relevant to me. I work in a restaurant and am an education major. If there is something that I can do to keep myself from missing work and school now or missing work once I become a teacher, I am going to do all I can" while LOW-B's rationale for the selection was that "it was the first one that really drew my attention" Although HIGH-B's rationale also focused on the resources being first, her rationale also included some reflection on past experiences with the search engine and the sequence of resources provided on the page "these were the first sources to pop up. Usually in my opinion, those are the most relevant to the topic and the most popular" She also talks about interest and wanting to read both sides of the argument "I also read these because the description sounded interesting or caught my attention. I also wanted to read both the positive and negative opinions" This idea of balance, was an aspect clearly missing from the approach of both LOW-A and B to the information, both of whom accessed only the first article on the page, an article that happened to agree with their opinions on the topic prior to viewing any information.

LOW-A had the highest score on discomfort with ambiguity of all four of the participants shown in the illustration, and in line with previous findings from studies using the need for closure scale (Kruglanski & Webster, 1996), showed signs of seizing and freezing on the information she accessed. Student sickness and attendance at work and school were mentioned as the sole piece of evidence for her opinion on hand sanitizer following her access to the information. In addition, it

was also the only justification for why her opinion was unlikely to change in the future: "Attendance is so important and sickness is not something that sound [*sic*] interfere when schools can take action to prevent it"

Another interesting difference between approaches to and perceptions of information occurs between HIGH-B and LOW-A. Despite HIGH-B's lack of interest and perceived risk involved with the introduction of hand sanitizer, she still read four articles representing both sides of the topic. LOW-A had higher scores on all three contextual aspects: interest, perceived risk, and importance of understanding and yet only read one article, which was in agreement with her original position. Despite this difference in the number of sources accessed, both HIGH-B and LOW-A indicated "agree" in response to the statement "I feel I have read enough information to form an opinion on the subject" This gives us some insight into epistemic standard setting in information contexts.

## Chapter 5: Discussion

The current study put forward a model of epistemic cognition whereby the three different approaches to personal epistemologies, epistemic development, strategies, and motivations, were integrated. Data were collected on participants' epistemic behaviors in an online context and follow up questions asked them to reflect on their processes of justification to arrive at their opinions. Survey data on the three epistemic components were also collected and both quantitative and mixed methods analyses were conducted in order to investigate the three research questions.

In terms of finding out how the domain-general epistemic strategies, development, and motivations are related to the epistemic standards set and epistemic behaviors displayed in a specific knowledge-forming context, some information about the possible relationships were discovered. Moderate correlations among all six of the epistemic development, motivation, and strategies variables indicate that they are related, though not measuring the same thing. Correlations of both internalist and externalist epistemic strategies, discomfort with ambiguity, and need for cognition with the aggregate VisitTime score, which represents both the level of authority of the sources accessed and the time spent reading, indicates that the proposed components: epistemic strategies and motivations do have some influence over epistemic behaviors in online knowledge-forming contexts. A multiple regression of the three proposed epistemic motivation variables on VisitScore indicated that both need for cognition and discomfort with ambiguity explaining significant variance in VisitScore.

Interestingly the level of epistemic development did not directly correlate with any of the epistemic behavior indicators. It was, however, negatively correlated with closed mindedness, and positively correlated with need for cognition; indicating that there may be a mediated role for development in a model of epistemic cognition. Mediation analysis provided some evidence of this, as multiple mediation analyses indicated need for cognition as a potential mediator (CI 95%[1.51, 114.53]) of the indirect effect from epistemic development to VisitScore. However, there is reason to proceed with caution, as a contrast analysis between the discomfort with ambiguity and need for cognition indirect paths indicated that the difference between the indirect effect through discomfort with ambiguity and that through need for cognition is non-significant (CI 95%[-96.94, 29.85]). It may be the case that the instrument for epistemic development is not sufficiently reliable (Cronbach's alpha = .63) despite the structure of the task and the model. It may be the case that only three scenarios are not sufficient to capture the level of epistemic development particularly given the possible variation of application within the soft stage model. Further investigation, including longitudinal studies, into the relationships between epistemic development, motivations, and strategies is necessary to understand the directionality of the influences on epistemic behaviors both in knowledge forming context as well as over the course of learning and development.

The finding that Balance was not correlated with any of the proposed individual level components of the model was surprising. This may have been due to the scale of measurement, although the range and standard deviation appear to

be sufficiently large following the normal score transformation. It may also be due to the nature of the task itself, and the set-up of the Google pages. Perhaps some individuals who may not otherwise have been motivated to look for information on both sides of an argument did look at both sides because they were included in the first few "hits" and because they knew their online activities were being logged. Similarly, the trivial nature of the task as perceived by other participants may have influenced individuals who may usually be more highly motivated to explore both sides of an argument to just read the first couple of pages and stop the search process. Alternatively, this may be an indication that there are other mediating, or perhaps moderating variables influencing the relationship between epistemic development, motivation, and strategies and Balance such that there are only relative small direct influences.

The finding that Sufficiency of Information and VisitScore were not significantly correlated was also interesting. The Sufficiency of Information question asked participants, after they had had time to look at the information, whether they felt they had enough information to form a justified opinion. While it was not directly related to VisitScore, there was some evidence that sufficiency was related to some degree to context. Although contextual factors did not directly influence VisitScore or Balance, they did relate to the Sufficiency of Information item. Both interest and risk accounted for variance in Sufficiency of Information, with higher risk predicting lower scores on Sufficiency of Information and higher interest predicting higher scores. In addition, the externalist strategies variable was also indicated in a multiple regression as predicting some of the variance in the

Sufficiency of Information score. The lack of a direct effect of interest and risk on the VisitScore measure of epistemic behaviors may be indicative of the influence of some other factor. It may also be the case that there is some moderated mediation occurring whereby some interest and risk perception influence individuals differently depending on the level of some other factor (Preacher, Rucker, & Hayes, 2007). Particularly in light of the qualitative analysis indicating a difference in the impact of interest depending on levels of epistemic strategies and development. Investigation of the possibility of moderated mediation was beyond the scope of the current study and sample size. However, the qualitative data does indicate that this is an avenue worthy of future investigation.

The apparent link between interest, the strength of pre-existing opinions (particularly pro-sanitizer opinions), and epistemic strategy use was also informative. Interest seemed to influence participants at the higher end of strategy use to access more information and use more evidence-based strategies for justification. Those scoring lower on epistemic strategy use with high interest did not seem to be as strongly influenced to look at more information. These individuals also tended to supply more belief based sources of justification. This differential influence of interest may relate to the previously hypothesized latent factor, possibly of self-regulation, but also to an interaction between problem definition and epistemic motivations. High epistemic strategy use was correlated with lower scores on the two need for closure scales: discomfort with ambiguity, and closed mindedness and high in need for cognition. It is therefore possible that interest may be related to the problem definition. Perhaps those higher in need for

closure and high in interest, define the problem as unambiguous and therefore more aligned with their epistemic motivations. Those with high interest and a high need for cognition may be more interested because their definition of the problem is as more complex. This possibility has implications for the study of epistemic cognition and designing studies that look at contextual influences on individuals both in terms of the type of model that would capture these complexities, but also in designing studies that would capture the differences in contextual influence in meaningful ways. While hand sanitizer as a topic did avoid many of the issues associated with more morally controversial topics, such that the differences in justification strategies were not "washed out" by religious or political beliefs. The perception of the level of complexity of the problem may not have been as high. One suggestion for overcoming these difficulties may be to use more authentic situations, perhaps tied to class assignment, so that participants may be more likely to be engaged in the topic in a way that many likely were not in this scenario.

Questions about the relation between standards and behavior were not adequately answered by the current study. Two items were designed to capture standards – *importance of understanding* and *Sufficiency of Information*. Importance of understanding behaved more like a contextual factor, and even in that framework only correlated with interest and risk, and with epistemic strategies and need for closure, not with the hypothesized VisitScore variable. Surprisingly, sufficiency of information, which asked participants whether they felt they had enough information in order to form a justified opinion, was also not significantly correlated with VisitScore, although perceptions of risk, interest, and externalist

epistemic strategies were shown in regression analyses to be related. Both items were perhaps more reflective of different participant conceptions of what constitutes "understanding" and "justification" and therefore not useful as indicative of a direct relationship with VisitScore. Rather, the sufficiency of information might better be thought of as a proportion out of 7, with for instance a 6 out of 7 representing that I have 6/7ths of the information I need to form a justified opinion so that it is scaled by the amount of information that the individual actually accessed. The "importance of understanding" scale, was correlated with internalist epistemic strategies, $r = .36$, $p < .01$, and with externalist epistemic strategies, $r = .35$, $p < .01$, and therefore somewhat consistent with the idea that it is conceptions of understanding rather than a standard that is being captured by this item.

This difficulty in capturing epistemic standards may also be reflective of shifting standards. As described by one of the participants as part of their source selection rationale: "Each site intrigued me to read the next one. At first, I didn't think I needed to know that much information because I trusted hand sanitizers but after the negative reports, I wanted to keep reading." Although this idea of changing standards and redefinition of the task was only articulated by one of the participants whose responses were analyzed qualitatively, it may be the case that several of the participants began with different standards than those that emerged during the information search part of the task. For some, this may have been a pre-existing opinion that was challenged, as for this participant, or it may have been the case that some participants began with a low risk perception that changed upon reading about potential risks, or participants who had high risk and interest

perceptions but whose beliefs were confirmed with the first site and therefore felt no need to search any further. It may also be the case that there is some other factor not accounted for by the variables included in the current study. One potential avenue for investigation might be the role of self-regulation in the model of epistemic cognition.

The mixed-method evidence does seem to suggest that standards as shifting and dynamic may be a more reasonable approach to depicting what happens during epistemic cognition. This lends significant support for the need to conduct more qualitative and mixed-method studies into epistemic cognition across a variety of contexts. In online settings, think aloud procedures, screen capturing, and even eye-tracking studies may be useful in order to really investigate what information individuals are looking at in order to form opinions and to get some insight via think alouds for the processes behind link selection. Repeated measures over time during a knowledge forming task may be another more quantitative approach; however, unless very carefully structured, this may have the potential, even more than a think aloud, for participants to be prompted to report processes for justification, or even to use them, than they otherwise might have in a more authentic situation.

Questions related to the specific relationship between epistemic strategies enacted in the task and those captured at the domain general level. The mixed method analysis comparing individuals with the highest and lowest scores on the epistemic strategies instrument on their qualitative responses did provide some insight into this relationship, however the small sample did not allow for enough in

context strategy data to be collected for quantitization (Onwuegbuzie & Collins, 2007) and statistical analysis. However comparison of frequencies did indicate, for instance that those individuals higher on externalist strategies were more likely to provide evidence from sources rather than provide beliefs, and more likely to express an openness to change based on evidence, which is consistent with the rationale behind the scale. Further investigation into the relationships on a much larger scale are necessary to determine both the validity of the instrument, as well as the relationship between domain general and task specific strategy use.

There were some difficulties with the open response items. Not all participants provided full responses to the questions, meaning that they may not have been describing all of the strategies they used. There was a certain amount of overlap in responses to the open response question and consequently between the third and fourth categories that emerged in the qualitative analysis: *source selection rationale* and *source helpfulness rationale*. This made it difficult to tease apart the actual reason why individuals looking at the Google pages chose to access the sources they did from those they did not, versus why the sources they selected were good sources to have chosen. This was possibly due to individuals not remembering in retrospect why they chose to click on a particular link, or what information was available to them prior to accessing the page, whereas remembering the information from the page itself and being able to rationalize the decision for why that page was a good selection would have been far easier to recall. Therefore, the responses and codes that arose from this section are perhaps not as informative as they might have been had this information been collected in another manner. Despite this, the

Internet logs do provide some insight into the selection rationale, in many cases more so than the open responses, particularly for those participants whose access sequence works through the web links in the order that they appeared on the Google simulation. Because selection of materials is such an important part of epistemic cognition, and knowledge formation, this limitation of the current study provides another strong case for using a think-aloud protocol in order to try to capture that decision making process in the moment it is actually made, rather than asking participants recall their reasoning in retrospect. This is particularly important, as selecting appropriate sources and being able to provide a rationale for that source selection are both key components of information literacy standards across a range of subjects (American Association for the Advancement of Science, 1993; Association of College and Research Libraries, 2000; National Governors Association Center for Best Practices, 2010).

Related to this is the finding that a large proportion of participants selected the first source that appeared in their Google page, across groups. Of course, as the Google pages were propagated with resources, they were all relevant to the topic. However, an authentic search task is necessary in order to ascertain whether this is a common strategy, or if the relevance of all of the available pages to the topic skewed the likelihood of first page being selected. Evidence of *seizing* in formation contained in the first page accessed, and *freezing* that opinion (Kruglanski & Webster, 1996) either by being dismissive of findings in contradictory articles, or by only accessing article in support of that view in individuals with high need for closure was interesting. This indicates that further analysis of the data with regards

to changes of opinion from before the task to after the information has been access may be a fruitful avenue for investigation.

**Limitations and Suggestions for Further Study**

Although both purely quantitative as well as mixed method investigations into the relationships between scores on the epistemic strategies scales indicated that the two epistemic strategy dimensions measured by the items were related both to other general level epistemic variables and the epistemic behaviors enacted in the online knowledge-forming task, caution must be taken. Confirmatory factor analysis was unable to confirm the theoretical factor structure of the Adapted Epistemic Beliefs Scale (Hennessey, 2007). However, an EFA indicated a two-factor structure with externalist strategies – those based on evidence external to the knower, and internalist strategies – those based on connections between evidence and existing knowledge, and connections between existing understandings, which was theoretically defensible. The differences between the factor structure of the new instrument as indicated by the exploratory factor analysis, and that of the instrument on which it was originally based (Hennessey, 2007) calls into question the adapted instrument's validity. The current study did not include a thorough validity study of the instrument and thus only has evidence for the internal reliability of the scale items, and the results of the exploratory factor analysis. No further evidence is available as to whether the reliability of the items holds over time, or if the factor structure can be replicated in a different sample. Correlations in the expected directions with measures of epistemic motivations and epistemic

development offer some concurrent validity for the scales. Additionally, the focus in the qualitative portion of the study on a selected group of individuals falling high and low on the two proposed epistemic strategies dimensions also provides some construct validity evidence. However, in order to validate the construct, as well as to more thoroughly investigate the relationships between strategies in context and those captured by the instrument, a much larger study of the relationship would need to be conducted including both belief justification and information selection components of epistemic behaviors in context.

Responses to the "possibility of change" question raise some doubts about the validity of self-report measures. Here many participants reported that they were open to change, however, did not actually take on board information that fit the criteria they stated for change to occur. For example this participant described a change of opinion as contingent on if "test results come back and hand sanitizers are having detrimental results to its users, or they find out that hand sanitizers actually have no benefits, then I may change my mind" (development – high.) However, as described the participant had already accessed an article that linked sanitizer use to increased risks of norovirus. Although statements of contingent change occurred more often in participants scoring low on the need for closure instrument, both the survey instrument and the open response items are self-reports and do not seem to be reflected in the observations via logs and other open response questions of what they actually did in the task with regards to their actual openness to change. This further strengthens the call for more qualitative, and mixed method observation studies in a variety of contexts in order to observe participants and

what they actually do in knowledge formation.

## Conclusions

The current study provides some evidence for the proposed model of epistemic cognition. Quantitatively all three components at the domain general level: epistemic development, motivations, and strategies, were shown to be linked to some aspect of epistemic behaviors in context. Contextual influences were also shown to influence perceptions of sufficiency of information in forming opinions in the given context. However, mixed method analyses provided evidence that there are differences in individual approaches to justification that vary with individuals who fall high or low on the proposed components. Additionally, the mixed method analysis provided indication that interest in a topic may differentially influence individuals high and low in epistemic strategy use, providing some explanation of the quantitative results that indicated no direct influence of context on epistemic behaviors and suggesting a role in the model of epistemic cognition for a latent variable not depicted in the current theoretical model. Therefore, although some aspects of the proposed model are supported, it is clear that there are factors unaccounted for by the current model and which were not captured by the research design and instruments used in this study. The findings also indicate the need to add to the model a depiction of the ongoing influence of context on standard setting beyond the initial standards set when faced with the problem.

It is clear from these findings that further data needs to be collected and

different types of studies pursued with more authentic observations of individuals in knowledge forming contexts. Continued used of qualitative and mixed method design will allow for in-depth investigations of the possible influences on epistemic cognition. Quantitative cross-lagged designs also need to be conducted in order to investigate possible reciprocal influences between epistemic development, strategies, and motivations over time in order to see whether it might be possible to support development through, strategy instruction or cueing different epistemic motivations. Further instrument development for this purpose would be necessary, it is clear that the RCI has some problems of reliability with so few items to capture the soft-stage model, and this problem would likely be exacerbated over the course of a longitudinal study. For epistemic strategies, the instrument adapted from Hennessey (2007) shows some promise. However, further validation of the significant adaptations is necessary. It is also clear from the mixed-method portion of the analysis that there are other latent variables at work in the influences of the three proposed individual components of the epistemic cognition model. The next step in investigation may be to go back to the methods employed by Perry (1970) and conduct more qualitative grounded-theory designs in order to deeply investigate the factors involved in setting and changing standards in epistemic cognition.

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## Appendix A: Demographic Information

Subject ID:

_____

Age:

_____

Gender:
☐ Male
☐ Female
Other (please specify): _____

Ethnicity:
☐ African-American
☐ Asian-American
☐ American Indian
☐ Caucasian, not of Hispanic Origin
☐ Hispanic
Other (please specify): _____

How many semesters have you been enrolled in college?

_____

Major:

_____

Cumulative GPA:

_____

## Appendix B: Pre-Task Survey

Thinking about the question **"Should OU spend any of its budget on purchasing and promoting the use of hand sanitizer on campus?"** please respond to the following survey items.

Indicate the extent to which you agree or disagree with the statement below:

| Strongly disagree | Moderately disagree | Slightly disagree | Neutral | Slightly agree | Moderately agree | Strongly disagree |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

1. I find this topic interesting ..... 1 2 3 4 5 6 7
2. It is important that I understand the issues of this topic before forming an opinion ..... 1 2 3 4 5 6 7
3. Making the wrong decision on this issue could impact me negatively ..... 1 2 3 4 5 6 7
4. Reading about the issues before I make a decision on this question is important ..... 1 2 3 4 5 6 7
5. This topic is interesting to me ..... 1 2 3 4 5 6 7
6. It is important to me that I read about the issues before answering this question ..... 1 2 3 4 5 6 7
7. Forming the wrong opinion on this issue could impact my health or that of my family members and close friends ..... 1 2 3 4 5 6 7
8. I think this is an interesting topic ..... 1 2 3 4 5 6 7
9. There is a personal risk to me of making the wrong decision ..... 1 2 3 4 5 6 7
10. I have already encountered a great deal of information on this subject ..... 1 2 3 4 5 6 7

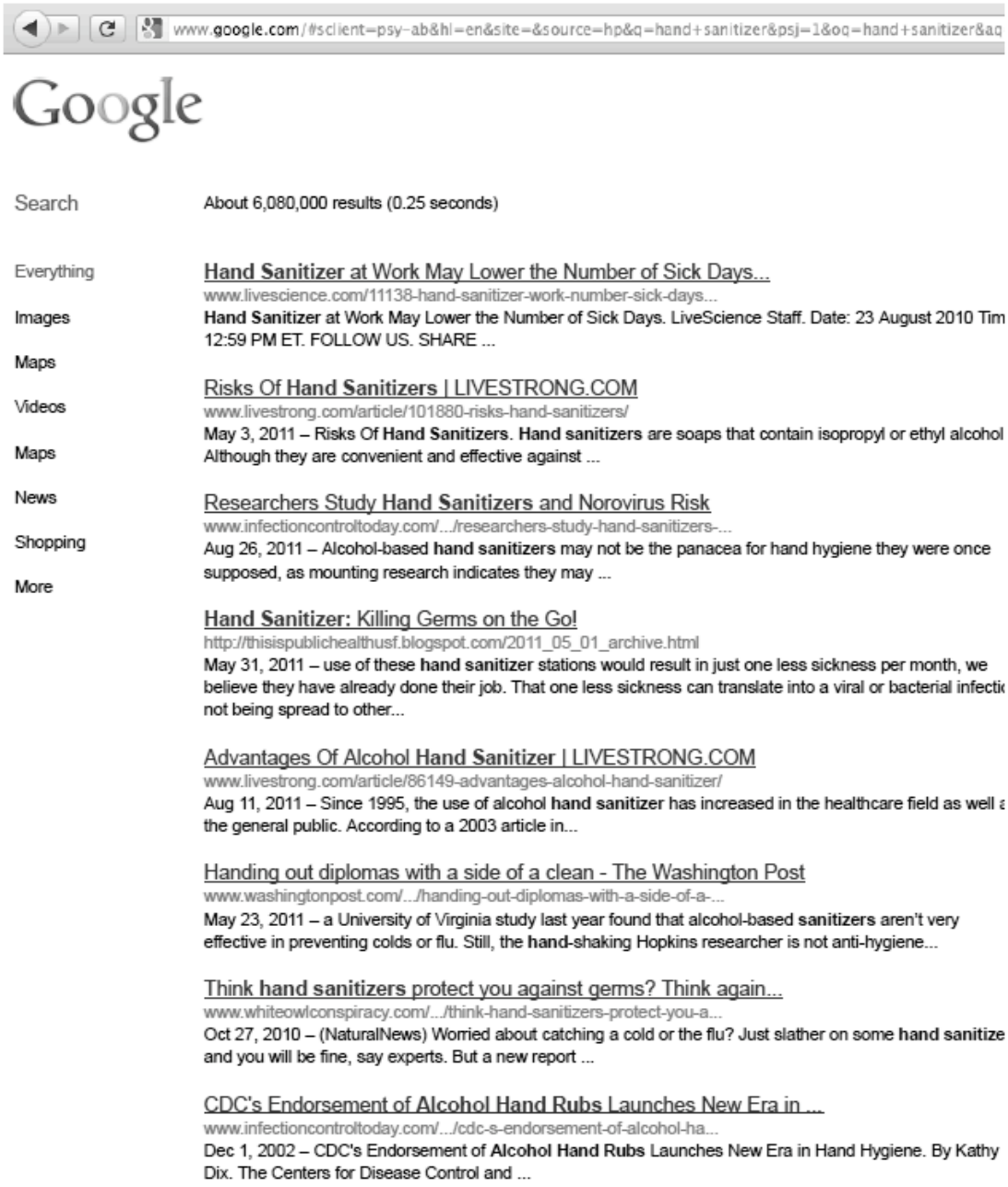
Indicate the extent to which you agree or disagree with the statement below:

**"OU should be purchasing and promoting the use of hand sanitizer on campus"**

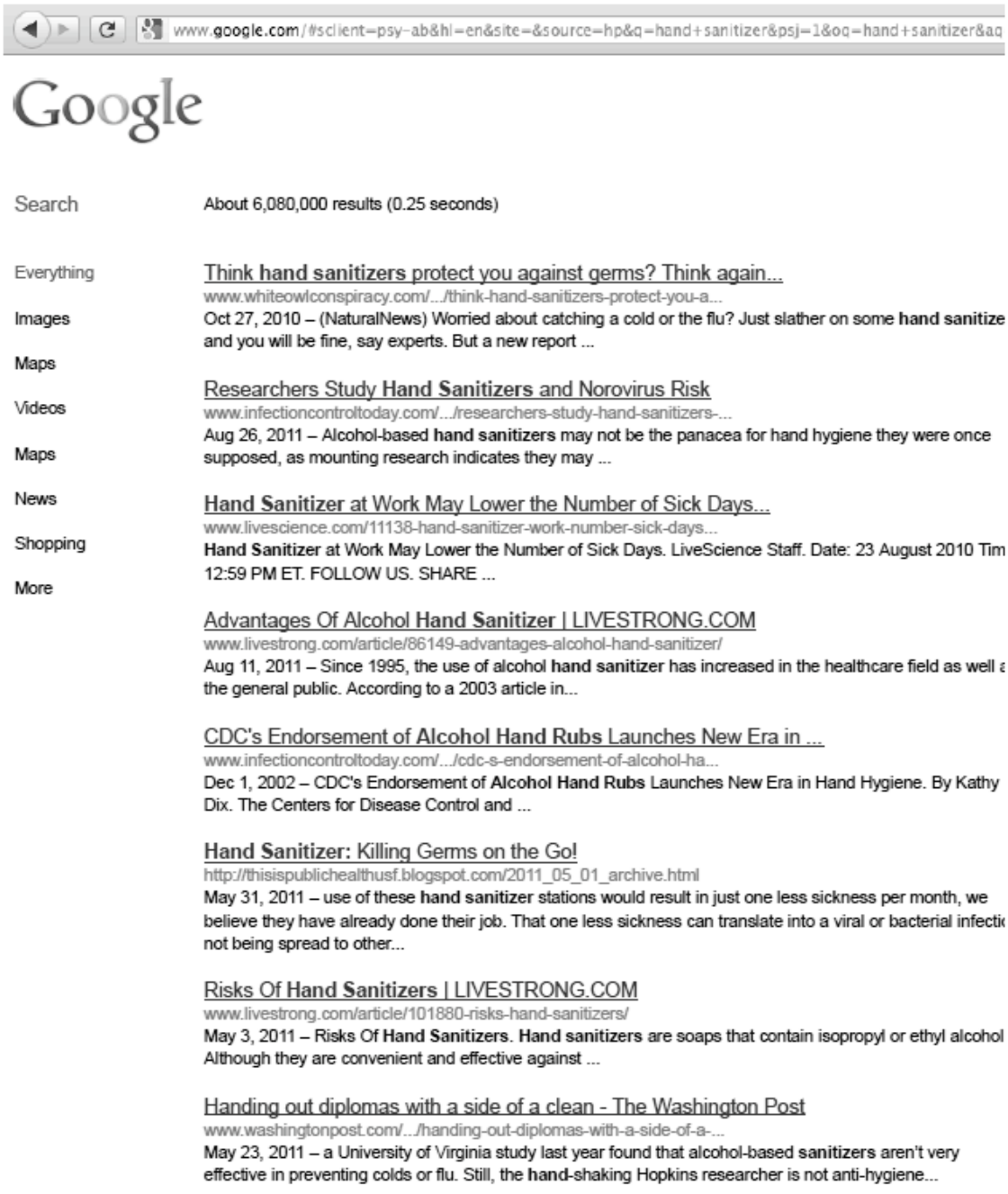
| Strongly disagree | Moderately disagree | Slightly disagree | Neutral | Slightly agree | Moderately agree | Strongly disagree |
|---|---|---|---|---|---|---|
| -3 | -2 | -1 | 0 | 1 | 2 | 3 |

# Appendix C: Task Web Pages

## Google Search – Version A



**Google Search – Version B.**



**Pro – Authority Level 1**

thisispublichealthusf.blogspot.com/2011_05_01_archive.html

# This is Public Health!

What *is* public health? Wanna find out? Students in the USF *Intro to Public Health* class have chosen strategic areas in the Tampa Bay community that they feel represent public health in action. This blog is dedicated to explaining, understanding, and discussing what their interpretations of exactly what the heck is.... public health?!

TUESDAY, MAY 31, 2011

## Killing Germs on the Go!


Our world is a fast paced one, and that requires us to be on the go. This tends to mean we take for granted important tasks; such as washing our hands on a regular basis. In the past year, USF administrators have made a concerted effort to give students and faculty means in which they can help prevent the spread of germs and bacteria by placing hand sanitizing stations throughout the USF campus. For our group picture we chose one of the many hand sanitizer stations that are placed all over campus, the one featured is actually right outside our classroom in the Public Health building on the second floor! According to the CDC, "Hand sanitizers were effective in reducing gastrointestinal illnesses in households, in curbing absentee rates in elementary schools, and in reducing illnesses in university dormitories." (Reynolds SA, Levy F, Walker ES. Hand sanitizer alert [letter]. Emerg Infect Dis [serial on the Internet]. 2006 Mar)

If student and faculty use of these hand sanitizer stations would result in just one less sickness per month, we believe they have already done their job. That one less sickness can translate into a viral or bacterial infection not being spread to others, which in turn results in less use of medical care in treating a potential sickness in the public health arena on a secondary or tertiary level. Hand sanitizers show the importance of primary prevention in public health.

This by no means implies that hand sanitizers should take the place of normal hand washing. Hand sanitizers should be used as an additional method to fight the spread of germs and help us keep up with our fast paced society.

### Blog Archive

2011 (63)
- ► September (21)
- ► June (7)
- ▼ May (13)
  - + Killing germs on the go!
  - + Pedal for Public Health
  - + Who's in your clothes ?
  - + Handrails are Public Health
  - + Public Health in the Park
  - + A taste of public health
- ► February (21)
- ► January (1)

2010 (11)
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# THINK HAND SANITIZERS PROTECT YOU AGAINST GERMS? THINK AGAIN

(NaturalNews) Worried about catching a cold or the flu? Just slather on some hand sanitizer and you will be fine, say experts. But a new report has some different things to say. According to "germ experts", alcohol-based hand sanitizers only kill certain germs for up to two minutes before drying up and becoming useless. And a recent study out of the University of Virginia (UV) revealed that alcohol-based hand sanitizers do not reduce the overall number of cold and flu cases, either, suggesting they are ineffective.

NaturalNews covered the UV study back in September but a new survey conducted by Healthpoint found that most Americans still believe hand sanitizers are effective anyway, and that they work for long periods of time than they actually do.

"Alcohol sanitizers last only a minute or two and must be reapplied when recontamination occurs," explained Dr. Philip Tierno Jr., Ph.D., director of clinical microbiology and immunology at NYU Langone Medical Center. But more than 50 percent of Americans think hand sanitizers last about 30 times longer than this in a single application.

Even the U.S. Centers for Disease Control and Prevention (CDC) admits that that hand sanitizers "will not kill all germs", but the agency still recommends that people use them. But in the UV study, there was little difference in the number of rhinovirus and influenza infections between people who use hand sanitizers and people that do not.

Many hand sanitizers are also loaded with toxic chemicals that get absorbed in the skin and cause other health problems. And they ultimately will not protect you from getting sick. So a more preferable way to stay healthy and avoid viral and bacterial infections is to take plenty of natural vitamin C and vitamin D, eat powerful superfoods like garlic and astragalus, and drink plenty of clean water.

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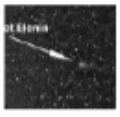
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Home / Skincare & Beauty / Skincare Treatments / Hand Sanitizers / Advantages of Hand Sanitizers

# ADVANTAGES OF ALCOHOL HAND SANI

Aug 11, 2011 | By Julie Hampton

Since 1995, the use of alcohol hand sanitizer has increased in the healthcare field as well as the general public. According to a 2003 article in "Infection Control Today," most alcohol hand sanitizers contain approximately 60 to 95 percent ethanol or isopropanol alcohol. Gels, rinses and foams are different types of alcohol hand sanitizer available. A variety of advantages exist for alcohol hand sanitizers over regular hand washing; yet, you should always was grossly soiled hands with water and antimicrobial soap, according to the Centers for Disease Control's hand hygiene guidelines.

## CONVENIENCE

Use of an alcohol sanitizer is convenient. You can transport bottles in your pocket, purse, car or simply keep a small amount at a workstation or desk. Water and a sink are not always immediately available--including in a classroom setting or at a public sporting event. Avoid the trouble of finding a sink and washing hands or waiting in long lines in the restroom by simply carrying a small portion of sanitizer with you. The CDC recommends cleaning hands before and after eating, when preparing food or when hands are potentially contaminated with bodily fluids.

## LESS TIME

Applying hand sanitizer takes less time than washing with antimicrobial soap. Using a hand sanitizer takes about 15 seconds, according to the website Dr. Green. Washing hands takes much longer--you must scrub your hands with water and soap for a minimum of 20 seconds and then dry them.

## BETTER AT KILLING GERMS

Using an alcohol-based sanitizer is more effective in reducing the spread of rotavirus, adenovirus and rhinovirus compared with medicated and non-medicated hand soaps according to studies cited by the CDC. Sanitizers studied included those with 70 percent alcohol. Pathogens, such as gram-negative bacilli, were less likely to transfer from patients when healthcare workers used hand sanitizers instead of regular hand washing.

## REFERENCES


- Infection Control Today: Choosing an Alcohol Hand Sanitizer
- CDC: Guideline for Hand Hygiene in Health-Care Settings
- Dr. Green: Soap and Water or Alcohol-Based Hand Sanitizers?


*Article reviewed by Matt Olberding Last updated on: Aug 11, 2011*



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# RISKS OF HAND SANITIZERS

May 3, 2011 | By Tracii Hanes

Hand sanitizers are soaps that contain isopropyl or ethyl alcohol. Although they are convenient and effective against a number of bacteria and viruses, hand sanitizers carry some potential risks, such as skin or eye irritation, risk of fire, alcohol poisoning upon ingestion. Fortunately, it is possible to obtain the benefits of hand sanitizers while decreasing the risks by following some basic precautionary measures.

## ALCOHOL POISONING

Most effective hand sanitizers contain between 60 and 90 percent alcohol, which is sufficient to cause alcohol poisoning upon ingestion. Children are at especially high risk, because they are more likely to put their hands in their mouths or handle food before the product evaporates. According to CNN Health, a 2 ounce bottle of hand sanitizer may contain as much alcohol as four shots of vodka.

Symptoms of alcohol poisoning may include intoxication, dizziness, slurred speech, blurry vision, vomiting and coma. To help prevent alcohol poisoning from hand sanitizers, use a dime-sized amount and supervise children when using hand sanitizers containing alcohol. Wait until the product has dried before handling food, and avoid hand-to-mouth contact directly after use.

## FIRE

Because of the high alcohol content, some hand sanitizers may carry a mild risk of flammability. According to the New York City Department of Health, alcohol-based hand sanitizers should not be used near heat or flame, as they may pose a fire hazard.

To avoid the risk of fire, store alcohol-based hand sanitizers in a cool, dry area away from direct heat sources and open flames. Avoid smoking or using a lighter directly after applying hand sanitizer, and wait for the product to dry thoroughly before striking matches or handling other fire-producing materials.

## BACTERIAL RESISTANCE

According to the Mayo Clinic, frequent use of hand sanitizer may lead to an increased risk for developing treatment-resistant bacteria. The same is true of oral antibiotics like penicillin, which should be used sparingly in order to maintain their effectiveness against various strains of bacteria.

Using hand sanitizers only when soap and water is not readily available may help reduce the risk for developing and spreading treatment-resistant bacteria. It is not effective when dirt and food particles are present under the nails and may give a false sense of cleanliness, allowing germs to spread. Soap and water are needed to remove dirt and buildup and should be the first line of defense against bacteria and other germs whenever possible.

## SKIN AND EYE IRRITATION

The alcohol in hand sanitizers can cause a stinging or burning sensation when applied to cuts, scrapes and sensitive skin. Alcohol has a drying effect and may cause a worsening of dry skin and certain skin conditions like eczema. When it comes into contact with the eyes, severe irritation, tearing and redness may occur.

People with dry or sensitive skin should apply moisturizing lotions or creams frequently when using hand sanitizer. Avoid contact with eyes, and flush thoroughly with cool water if contact occurs. It may be necessary to contact a physician if eye irritation is severe.

## REFERENCES


- CNN: Hand Sanitizer Risks
- New York City Department of Health and Mental Hygiene: Alcohol-Based Hand Sanitizer Fact Sheet
- Mayo Clinic: Hand-Washing: Dos and Don'ts


*Article reviewed by Ecliptic Extremes Last updated on: May 3, 2011*

**Pro – Authority Level 3**

www.livescience.com/11138-hand-sanitizer-work-number-sick-days.html

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Article:

# Hand Sanitizer at Work May Lower the Number of Sick Days

LiveScience Staff
Date: 23 August 2010 Time: 12:59 PM ET

Employers looking to ward off illness in the office might consider investing in some hand sanitizer dispensers.

Alcohol-based hand disinfectants seem to reduce the number of cases of the common cold, fever and coughing in an office environment, and decrease the number of sick days employees take due to these illnesses, according to a new German study.

The number of participants in the study was quite small, but if future research confirms the findings, hand sanitizers may prove to be a cost-effective way of maintaining employee health, the researchers said.

## Good Hand Hygiene

Researchers recruited 129 administrative employees from a university in Greifswald, a town in northeastern Germany, and from other public administration offices in the country, for the 13-month study. While previous studies had looked at the benefit of hand sanitizers in medical facilities, day care centers and universities, the effect of these disinfectants in workplaces such as public administration offices had not been examined.

About half of the administrative employees were told to maintain normal hand-washing behavior, while the other half were supplied with hand disinfectant and instructed to try to use it at least five times during each workday.

The participants were followed from March 2005 to April 2006. At the end of every month, they filled out surveys saying whether they had experienced symptoms of the common cold, sinusitis, sore throat, fever, cough, bronchitis, pneumonia, influenza or diarrhea, and whether the illness had forced them to take time off from work.

Using hand sanitizers significantly decreased the odds of being absent with a cold, cough, fever or diarrhea, the researchers found.

## Coming in sick

The study also found a reduction in symptoms of illness at work, suggesting that using hand disinfectant can reduce productivity losses from workers who come in when they're sick.

"We were able to demonstrate that hand disinfection can easily be introduced and maintained outside clinical settings as a part of the daily hand hygiene," the researchers wrote for an upcoming issue of the journal BMC Infectious Diseases. "Therefore it appears as an interesting and probably cost-efficient method within the scope of company health support programs."

The researchers noted a potential conflict of interest in their study: One of the authors is employed by Bode Chemie, a German company that manufactures hand sanitizer products.

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www.washingtonpost.com/local/handing-out-diplomas-with-a-side-of-a-clean/2011/05/23/AFn3d79G_story.

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# Handing out diplomas with a side of a clean

Text Size Print E-mail Reprints

By Meredith Cohn, Published: May 23

Before the Johns Hopkins University president gives 1,300 graduating students their congratulatory handshake Thursday, volunteers will give them a cautionary dollop of hand sanitizer.

"What can I say? We're a health-conscious university," said Dennis O'Shea, spokesman for Hopkins.

Since the influenza epidemic of 2009, gel disinfectant has been spreading around schools like strep on throats. Yet there's little scientific evidence that harmful bacteria are passed through a casual squeeze of the hands during commencement. One of the first studies to put the handshake under the microscope comes from Hopkins's School of Public Health, and it shows little danger from dangerous pathogens.

And other, more general research may make deans, presidents and principals question why they ever bother to wash.

Another Hopkins researcher recently found that the automatic faucets common in public bathrooms are harboring excess bacteria, such as legionella. A study led by an Ohio researcher found refillable soap dispensers so prone to contamination that users' hands may be more bacteria-laden than before they were washed. And a University of Virginia study last year found that alcohol-based sanitizers aren't very effective in preventing colds or flu.

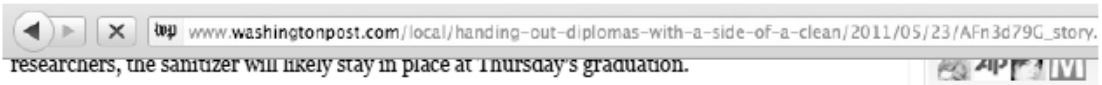
Still, the hand-shaking Hopkins researcher is not anti-hygiene. Dr. David Bishai is a professor in the School of Public Health, after all.

Watching graduation after graduation, he said, the scary pathogens stuck to the dean's hands "was all I could think about." For his study, more than a dozen deans agreed to be swabbed before and after their 2008 ceremonies — though some had to be disqualified for sneaking sanitizer every 10 or 20 students.

Turns out that palms, unless extra moist from stress, just aren't good receptors for pathogens.

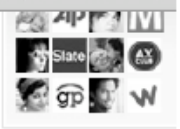
Bishai insists that hand-washing is still a good idea. There's still bad stuff out there, such as antibiotic-resistant Staphylococcus aureus, or MRSA. But his study, published in the June issue of Journal of School Nursing, found only one dangerous bacterial pathogen per every 5,209 on someone's hand.

"I thought I'd get a big grant from Purell to study more graduations," he said. "But no. The level of bacteria at graduations is probably smaller than you thought it was. So chill out: A graduate's hand is probably not the dirtiest thing you are going to touch on graduation day."




researchers, the sanitizer will likely stay in place at Thursday's graduation.

He added, "We are a research university, committed to evidence-based best practices, so we might take another look later on. On the other hand, a little hand sanitizer never hurt anybody."

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# CDC's Endorsement of Alcohol Hand Rubs Launches New Era in Hand Hygiene

December 1, 2002
Posted in Articles, Hygiene, Hand Hygiene, Environmental Hygiene, Gloves, Personal Protective Equipment (PPE), Centers For Disease Control And Prevention (CDC), Public Health, Handwashing, Hand Antisepsis, Infections, Bacteria, Bacterial Infections, Guidelines & Regulations, Research & Studies, Patient/Worker Safety, PPE & Standard Precautions

## CDC's Endorsement of Alcohol Hand Rubs Launches New Era in Hand Hygiene

*By Kathy Dix*



The Centers for Disease Control and Prevention (CDC) recently released its long-awaited hand-hygiene guidelines. *Infection Control Today* spoke with the guidelines' co-author, Didier Pittet, about the root of some of the revised recommendations.

There is a core group of people who are considered global authorities on hand hygiene. Didier Pittet is one of them, renowned for his experience with this fundamental element of infection control.

Traditional soap-and-water handwashing is going the way of the dodo bird, implied Pittet, at least in terms of between-patient hygiene when there is no visible soil on the hands. "In most situations, conventional handwashing with soap and water will always be relatively inconvenient compared to alcohol-based hand rubs," he noted. In some situations, when healthcare workers (HCWs) are less rushed, there is time for old-fashioned handwashing. But typically, the one- to two-minute handwash is too time-consuming, especially in intensive care units or other sectors that may have up to 35 opportunities for handwashing each hour.

One impetus behind the new guidelines was the inability of HCWs to wash their hands so many times an hour. "People are very busy," Pittet stressed. "There is a shortage of nurses and there are always many things to do. I don't think it would be easy to promote old-fashioned handwashing."

Thus the alcohol-based hand rub. The hand rub is more efficacious than soap-and-water, is more accessible than sinks (it can be carried in a pocket), and is effective against many microorganisms, even multi-drug resistant pathogens. This has been documented in multiple studies, including one by Pittet published in 1999.1

**RESISTANCE: BACTERIAL AND HUMAN**

Must we concern ourselves about microbial resistance to alcohol? No, Pittet says. "Nowadays there is no resistance to alcohol; resistance in bacteria has not been demonstrated at all, in contrast to resistance to medicated soaps that have been used for handwashing. There is no mechanism for resistance to alcohol that has been described in bacteria."

However, he says that is a separate issue from some HCWs' resistance to change -- and to the alcohol content of the hand rub. "Some HCWs are reluctant to use alcohol for many reasons, one being that alcohol is alcohol, because people have the impression that they may become alcohol addicts!" said Pittet. "It's completely wrong, but what is in the minds of some people is sometimes difficult to control."

He adds that many HCWs fear developing dry skin from frequent hand rub use. "The problem is that if you ask HCWs to apply in a similar frequency, alcohol vs. soap, the skin is killed a lot more by the soap than by the alcohol," said Pittet. "People will tell you, 'Since using alcohol, my skin is drier than it was before.' But what you need to realize is that people didn't wash their hands before. They were compliant at 10 or 15 percent. With alcohol, they are compliant at 40, 50, 60 even 80 percent." Alcohol-based hand rubs, he added, do less harm to skin than medicated soap in the long run.

A study published by John Boyce and colleagues demonstrated that hands did not tolerate soap as well as they tolerate alcohol rubs.2 "There will be some reluctance by very old-fashioned doctors and nurses who will not accept that alcohol is more efficacious than medicated soap, just because they learned at medical school or nursing school that medicated soap is the way to go," noted Pittet. In the future, students will be trained in the use of hand rubs rather than just soap and water, but for now, some

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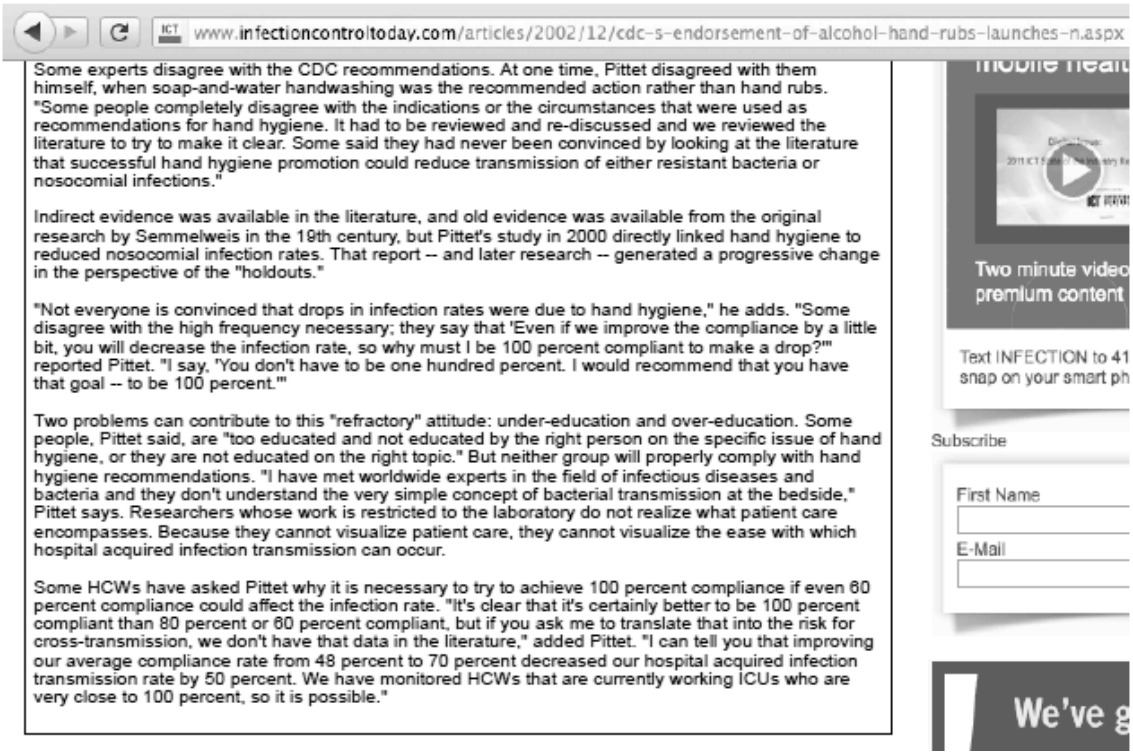
www.infectioncontroltoday.com/articles/2002/12/cdc-s-endorsement-of-alcohol-hand-rubs-launches-n.aspx
Some experts disagree with the CDC recommendations. At one time, Pittet disagreed with them himself, when soap-and-water handwashing was the recommended action rather than hand rubs. "Some people completely disagree with the indications or the circumstances that were used as recommendations for hand hygiene. It had to be reviewed and re-discussed and we reviewed the literature to try to make it clear. Some said they had never been convinced by looking at the literature that successful hand hygiene promotion could reduce transmission of either resistant bacteria or nosocomial infections."
Indirect evidence was available in the literature, and old evidence was available from the original research by Semmelweis in the 19th century, but Pittet's study in 2000 directly linked hand hygiene to reduced nosocomial infection rates. That report -- and later research -- generated a progressive change in the perspective of the "holdouts."
"Not everyone is convinced that drops in infection rates were due to hand hygiene," he adds. "Some disagree with the high frequency necessary; they say that 'Even if we improve the compliance by a little bit, you will decrease the infection rate, so why must I be 100 percent compliant to make a drop?'" reported Pittet. "I say, 'You don't have to be one hundred percent. I would recommend that you have that goal -- to be 100 percent.'"
Two problems can contribute to this "refractory" attitude: under-education and over-education. Some people, Pittet said, are "too educated and not educated by the right person on the specific issue of hand hygiene, or they are not educated on the right topic." But neither group will properly comply with hand hygiene recommendations. "I have met worldwide experts in the field of infectious diseases and bacteria and they don't understand the very simple concept of bacterial transmission at the bedside," Pittet says. Researchers whose work is restricted to the laboratory do not realize what patient care encompasses. Because they cannot visualize patient care, they cannot visualize the ease with which hospital acquired infection transmission can occur.
Some HCWs have asked Pittet why it is necessary to try to achieve 100 percent compliance if even 60 percent compliance could affect the infection rate. "It's clear that it's certainly better to be 100 percent compliant than 80 percent or 60 percent compliant, but if you ask me to translate that into the risk for cross-transmission, we don't have that data in the literature," added Pittet. "I can tell you that improving our average compliance rate from 48 percent to 70 percent decreased our hospital acquired infection transmission rate by 50 percent. We have monitored HCWs that are currently working ICUs who are very close to 100 percent, so it is possible."
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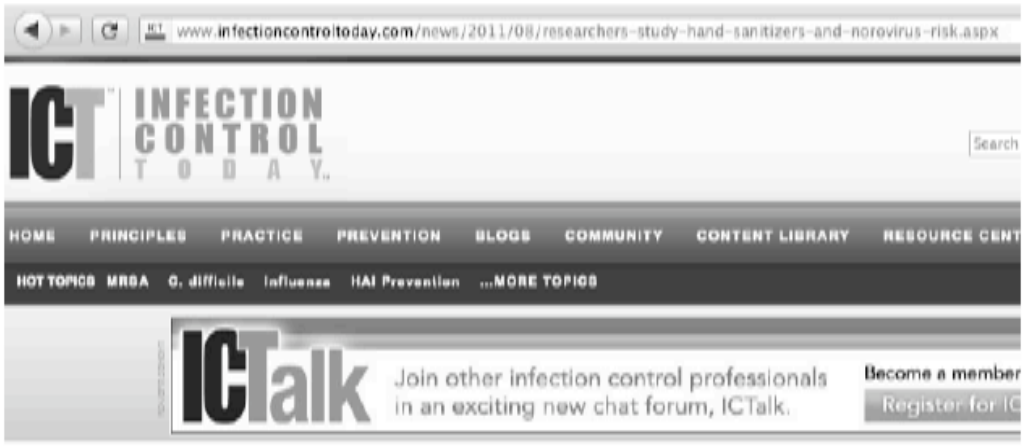


# Researchers Study Hand Sanitizers and Norovirus Risk

August 26, 2011
Posted in News, Hand Sanitizer, Hand Hygiene, Norovirus, Research, Research & Studies

Alcohol-based hand sanitizers may not be the panacea for hand hygiene they were once supposed, as mounting research indicates they may not be effective substitutes for soap and water, and in some cases may actually increase the risk for outbreaks of highly contagious viruses in healthcare settings.

Public health experts, however, say more rigorous investigations will be necessary to trump the convenience of using hand sanitizers, among other benefits, or substantially alter existing recommendations that strongly encourage their use by healthcare professionals.

It's widely recognized that improper use of antibiotics contributes greatly to the development and spread of super bugs in healthcare settings, but the link between hand sanitizers and bacterial resistance is less clear.

A survey of 161 long-term care facilities in the United States presented at an American College of Preventive Medicine meeting in February revealed an association between the preferential use of alcohol-based hand sanitizers for routine hand hygiene with an increased risk for outbreaks of norovirus, the highly infectious virus that causes most cases of acute gastroenteritis.

Staff in facilities that experienced norovirus outbreaks were six times more likely to use hand sanitizers equally or more than soap and water for routine hand hygiene, according to the study (Am J Infect Control 2011;39:296-301). Of 45 facilities that reported preferential use of alcohol-based hand sanitizers, 53 percent experienced a confirmed outbreak of norovirus, compared with 18 percent of 17 facilities that used hand sanitizers less often than soap and water.

Moreover, three facilities with multiple norovirus outbreaks reported that staff were more likely or much more likely to use hand sanitizers than soap and water, both routinely and during an outbreak.

While these findings indicate that alcohol-based hand sanitizers might be "suboptimal in controlling the spread of noroviruses," the retrospective design of the survey precludes any causal link between hand sanitizer use and norovirus outbreaks, says author Dr. David Blaney of the Epidemic Intelligence Service at the US Centers for Disease Control and Prevention (CDC).

Care homes that reported preferential use of hand sanitizers might simply have more robust infection control programs and therefore might be more likely to recognize and report norovirus outbreaks, he explains. "That being said, this study shows there's a need to look at more organism-specific outbreaks prospectively."

If the findings are confirmed in prospective studies, Blaney says changes to recommended policies regarding routine hand hygiene practices should be considered to place increased emphasis on hand washing using soap and water, as well as the use of disposable gloves during outbreaks.

Other studies have demonstrated that alcohol-based hand sanitizers are often ineffective against nonenveloped viruses, including norovirus, suggesting their use may not be appropriate in settings that frequently experience outbreaks, such as long-term care facilities (Appl Environ Microbiol 2010; 76:394-399 and Appl Environ Microbiol 2008;74:5047-52).

Two studies looking at the effectiveness of alcohol-based hand sanitizers against Clostridium difficile have also indicated that overreliance on the sanitizers may leave viable spoors on the hands of health care workers (Infect Control Hosp Epidemiol 2010; 31:565-70 and Infect Control Hosp Epidemiol 2009; 30:239-44).

The CDC has since released updated guidelines for the prevention and control of norovirus that recommend against using hand sanitizer as a substitute for soap and water hand washing.

But while "the efficacy of alcohol-based and other hand sanitizers against norovirus remains controversial," the CDC's Updated Norovirus Outbreak Management and Disease Prevention Guidelines suggests that the evidence is by no means conclusive.

"The findings of these studies also have to be taken in context of the benefits afforded by alcohol-based hand sanitizers and the uncertainty in their designs," explains Aron Hall, an epidemiologist with the

## Appendix D: Post-Task Survey

Thinking about the question "Should OU spend any of its budget on purchasing and promoting the use of hand sanitizer on campus?" please respond to the following survey items.

**Indicate the extent to which you agree or disagree with the statement: "I feel I have read enough information to form an opinion on the subject"**

| Strongly disagree | Moderately disagree | Slightly disagree | Neutral | Slightly agree | Moderately agree | Strongly disagree |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

**Having looked at some of the available information, what is your opinion on whether hand sanitizer should be purchased and promoted in universities?**

**Do you think your opinion could change in the future?**

**Which sources did you choose to read?**

- ☐ thisispublichealthusf.blogspot.com: Hand Sanitizer: Killing Germs on the Go!
- ☐ www.whiteowlconspiracy.com: Think hand sanitizers protect you against germs? Think again...
- ☐ www.livestrong.com: Risks Of Hand Sanitizers
- ☐ www.livestrong.com: Advantages Of Alcohol Hand Sanitizer
- ☐ www.washingtonpost.com: Handing out diplomas with a side of a clean - The Washington Post
- ☐ www.livescience.com: Hand Sanitizer at Work May Lower the Number of Sick Days...
- ☐ www.infectioncontroltoday.com: Researchers Study Hand Sanitizers and Norovirus Risk
- ☐ www.infectioncontroltoday.com: CDC's Endorsement of Alcohol Hand Rubs Launches New Era in Hand Hygiene

**Why did you choose those sources?**

| |
|---|
| |

**Which sources did you think were the most helpful?**

| | Not at all helpful | Slightly helpful | Moderately helpful | Very helpful | Did not read |
|---|---|---|---|---|---|
| thisispublichealthusf.blogspot.com: Hand Sanitizer: Killing Germs on the Go! | 1 | 2 | 3 | 4 | 0 |
| www.whiteowlconspiracy.com: Think hand sanitizers protect you against germs? Think again... | 1 | 2 | 3 | 4 | 0 |
| www.livestrong.com: Risks Of Hand Sanitizers | 1 | 2 | 3 | 4 | 0 |
| www.livestrong.com: Advantages Of Alcohol Hand Sanitizer | 1 | 2 | 3 | 4 | 0 |
| www.washingtonpost.com: Handing out diplomas with a side of a clean - The Washington Post | 1 | 2 | 3 | 4 | 0 |
| www.livescience.com: Hand Sanitizer at Work May Lower the Number of Sick Days... | 1 | 2 | 3 | 4 | 0 |
| www.infectioncontroltoday.com: Researchers Study Hand Sanitizers and Norovirus Risk | 1 | 2 | 3 | 4 | 0 |
| www.infectioncontroltoday.com: CDC's Endorsement of Alcohol Hand Rubs Launches New Era in Hand Hygiene | 1 | 2 | 3 | 4 | 0 |

**Why did you find these the most helpful?**

| |
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| |

## Appendix E: Attitudes, Beliefs, and Experiences Scale – Short Form

Directions: Read each of the following statements and decide how much you agree with each according to your attitudes, beliefs, and experiences. It is important for you to realize that there are no "right" or "wrong" answers to these questions. People are different, and we are interested in how you feel. Please respond according to the following 6-point scale by marking the proper number in the space provided after each item. Please check that you have completed each item once you have finished.

| Strongly disagree | Moderately disagree | Slightly disagree | Neutral | Slightly agree | Moderately agree | Strongly agree |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

1. Even after I've made up my mind about something, I am always eager to consider a different opinion.....1 2 3 4 5 6 7
2. I don't like situations that are uncertain. .....1 2 3 4 5 6 7
3. I dislike questions which could be answered in many different ways.....1 2 3 4 5 6 7
4. I feel uncomfortable when I don't understand the reason why an event occurred in my life.....1 2 3 4 5 6 7
5. I feel irritated when one person disagrees with what everyone else in a group believes.....1 2 3 4 5 6 7
6. When I am confused about an important issue, I feel very upset.....1 2 3 4 5 6 7
7. In most social conflicts, I can easily see which side is right and which is wrong. .....1 2 3 4 5 6 7
8. When considering most conflict situations, I can usually see how both sides could be right.....1 2 3 4 5 6 7
9. When thinking about a problem, I consider as many different opinions on the issue as possible.....1 2 3 4 5 6 7
10. I like to know what people are thinking all the time. .....1 2 3 4 5 6 7

11. It's annoying to listen to someone who cannot seem to make up his or her mind. .....1 2 3 4 5 6 7

12. I prefer interacting with people whose opinions are very different from my own. .....1 2 3 4 5 6 7

13. I feel uncomfortable when someone's meaning or intention is unclear to me. .....1 2 3 4 5 6 7

14. I always see many possible solutions to problems I face. .....1 2 3 4 5 6 7

15. I'd rather know bad news than stay in a state of uncertainty. .....1 2 3 4 5 6 7

16. I do not usually consult many different opinions before forming my own view. .....1 2 3 4 5 6 7

**Scoring:**

Reverse Coded: 1, 8, 9, 12, 14

Discomfort with ambiguity: 2, 4, 6, 7, 10, 11, 13, 15

Closed-mindedness 1, 3, 5, 8, 9, 12, 14, 16

## Appendix F: Need For Cognition Scale

Directions: The following statements represent how students may feel about thinking and reasoning. Read each statement and indicate the extent to which it is true of you, using the scale below.

| Strongly disagree | Moderately disagree | Slightly disagree | Neutral | Slightly agree | Moderately agree | Strongly agree |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

1. I would prefer complex to simple problems. .....1 2 3 4 5 6 7
2. I like to have the responsibility of handling a situation that requires a lot of thinking. .....1 2 3 4 5 6 7
3. Thinking is not my idea of fun. .....1 2 3 4 5 6 7
4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities. .....1 2 3 4 5 6 7
5. I try to anticipate and avoid situations where there is likely chance I will have to think in depth about something. .....1 2 3 4 5 6 7
6. I find satisfaction in deliberating hard and long for hours. .....1 2 3 4 5 6 7
7. I only think as hard as I have to. .....1 2 3 4 5 6 7
8. I prefer to think about small, daily projects to long-term ones. .....1 2 3 4 5 6 7
9. I like tasks that require little thought once I've learned them. .....1 2 3 4 5 6 7
10. The idea of relying on thought to make my way to the top appeals to me. .....1 2 3 4 5 6 7
11. I really enjoy a task that involves coming up with new solutions to problems. .....1 2 3 4 5 6 7
12. Learning new ways to think doesn't excite me very much. .....1 2 3 4 5 6 7

13. I prefer my life to be filled with puzzles that I must solve. .....1 2 3 4 5 6 7

14. The notion of thinking abstractly is appealing to me. .....1 2 3 4 5 6 7

15. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.....1 2 3 4 5 6 7

16. I feel relief rather than satisfaction after completing a task that required a lot of mental effort. .....1 2 3 4 5 6 7

17. It's enough for me that something gets the job done; I don't care how or why it works.....1 2 3 4 5 6 7

18. I usually end up deliberating about issues even when they do not affect me personally.....1 2 3 4 5 6 7

## Appendix G: Adapted Epistemic Belief Scale

Instructions: Think about how you approach learning about a new topic across a variety of different areas and subjects. Use the following scale to indicate how often you use each of the following strategies to try to make sense of information and form an opinion.

Try to think as generally as possible. There are no right or wrong answers.

| **Never** | **Rarely** About 10% of the time | **Occasionally** About 30% of the time | **Sometimes** About 50% of the time | **Frequently** About 70% of the time | **Usually** About 90% of the time | **Every time** |
|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** |

1. I look at the links between as many concepts as possible .....1 2 3 4 5 6 7
2. I make connections between the topic and other concepts I already understand .....1 2 3 4 5 6 7
3. I look for examples that make sense given my current understanding .....1 2 3 4 5 6 7
4. I look for examples that show how reasoning can be confirmed by evidence .....1 2 3 4 5 6 7
5. I think about how new information builds on what I already understand .....1 2 3 4 5 6 7
6. I verify new information by looking at more evidence.....1 2 3 4 5 6 7
7. I look for examples that provide observable evidence.....1 2 3 4 5 6 7
8. I relate my understanding of new information to my direct observations .....1 2 3 4 5 6 7
9. I focus on information that is based on evidence rather than opinion.....1 2 3 4 5 6 7
10. I make judgments based on whether or not explanations are based on observable evidence. .....1 2 3 4 5 6 7
11. I think about whether new information aligns with my current understanding.....1 2 3 4 5 6 7
12. I think about whether examples reinforce my basic understanding .....1 2 3 4 5 6 7
13. I reflect on whether my thinking aligns with the available evidence.....1 2 3 4 5 6 7
14. I focus on understanding a few core concepts .....1 2 3 4 5 6 7

15. I look for explanations that show how new information is related to numerous concepts.....1 2 3 4 5 6 7
16. I think about how new information could be explained using information that everyone already understands.....1 2 3 4 5 6 7
17. I reflect on whether the conclusion would be evident to everyone .....1 2 3 4 5 6 7
18. I inform my understandings by looking for more evidence .....1 2 3 4 5 6 7
19. I reflect on how new information connects with my existing understandings .....1 2 3 4 5 6 7
20. I think about whether information is consistent with what I already understand.....1 2 3 4 5 6 7
21. I justify my understandings by looking at the available evidence.....1 2 3 4 5 6 7
22. I look for explanations of the topic that build on basic understandings .....1 2 3 4 5 6 7
23. I check my conclusions by referring to evidence.....1 2 3 4 5 6 7
24. I reflect on the evidence for my thinking.....1 2 3 4 5 6 7
25. I examine the links between concepts .....1 2 3 4 5 6 7
26. I look for information that shows how concepts are related.....1 2 3 4 5 6 7
27. I make sure that my reasoning is based on evidence.....1 2 3 4 5 6 7
28. I look for examples that show how concepts are related. .....1 2 3 4 5 6 7
29. I begin building my understanding of a topic by looking at the underlying ideas. .....1 2 3 4 5 6 7
30. I try to see what conclusions about the topic I would arrive at given my existing understandings. .....1 2 3 4 5 6 7

foundationalism: 5, 12, 14, 16, 17, 22, 29, 30

coherentism: 1, 2, 3, 11, 15, 19, 20, 25, 26, 28

reliabilism: 4, 6, 7, 8, 9, 10, 13, 18, 21, 23, 24, 27

# Appendix H: Sample RCI Item

**Artificial Sweeteners**

**People often have to make decisions that may affect their health such as deciding whether to eat foods or drink beverages that contain artificial sweeteners. There have been conflicting reports about the safety of these additives. For example, some studies have indicated that even in small amounts, artificial sweeteners (such as Nutrasweet) can cause health problems, making foods containing them unsafe to eat. Other studies, however, have indicated that even in large amounts, artificial sweeteners do not cause health problems, and that the foods containing them are safe to eat.**

1. Please indicate your personal opinion on this issue: I think that artificial sweeteners:

| Are not safe for people to eat | | I do not know/cannot decide | | Are safe for people to eat |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

2. How is it possible that researchers in the same field disagree about whether a particular artificial sweetener is harmful? (Please write your answer on the lines provided.)

3. Many people have heard about disagreements among researchers about this, and they suggest different reasons why that might happen. How similar is each of the following reasons to your own understanding of why researchers disagree? (Darken the Appropriate Cirde.)

***VS= Very Similar, S= Similar, D= Dissimilar, VD= Very Dissimilar, M= Meaningless***

(VS) (S) (D) (VD) (M) A. Researchers who are honest will not disagree about whether a particular artificial sweetener is harmful.

(VS) (S) (D) (VD) (M) B. Researchers disagree about this issue because, like everyone else, they are confused about the safety of artificial sweeteners. Therefore it is my perspective that what they conclude is just their opinion.

(VS) (S) (D) (VD) (M) C. Researchers disagree whether enough studies have been done that show artificial sweeteners are safe or that these chemicals are not safe.

(VS) (S) (D) (VD) (M) D. Researchers disagree because of the different ways they were brought up and/or the different schools they attended.

(VS) (S) (D) (VD) (M) E. Researchers disagree because they approach the issue with different opinions already in mind about whether additives are safe. As a result, they conduct studies to support their view.

(VS) (S) (D) (VD) (M) F. Researchers arrive at different conclusions because the evidence itself is complex and they examine it from several perspectives. They arrive at a decision by synthesizing their knowledge, experiences, and expert opinions.

(VS) (S) (D) (VD) (M) G. Researchers might say that one view about the safety of a sweetener was better, but they would also say that this viewpoint is relative to a particular way of understanding this issue.

(VS) (S) (D) (VD) (M) H. Researchers disagree because the premeditated hard evidence is synthesized into available belief systems about different comprehensive factual analyses.

(VS) (S) (D) (VD) (M) I. Researchers disagree because they are really studying different facets of the issue and the best ways to address one facet of the issue are different than the best ways to address other facets.

(VS) (S) (D) (VD) (M) J. Researchers disagree because their evaluation of the evidence leads them to defend different conclusions. Some researchers conclusions are more reasonable, however, and reflect a more comprehensive synthesis of the available information.

4. Please rank the statements above (A, B, C., etc.) that are most similar to your thinking. Please check only one statement per line. If no statement beyond one or two is at all like your thinking, check the box labeled "None of These" on the appropriate line(s).

Statement (A) (B) (C) (D) (E) (F) (G) (H) (I) (J) is most like how I think.

Statement (A) (B) (C) (D) (E) (F) (G) (H) (I) (J) [None of These] is second most like how I think.

Statement (A) (B) (C) (D) (E) (F) (G) (H) (I) (J) [None of These] is third most like how I think.