

Exploring the Role Learners' Understanding of Simplicity of Knowledge has on Online Search  
Behavior When Solving Ill-Structured Problems

Aric Gaunt

Michigan State University

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The current proposal is interested in investigating how an open source such as the internet mediates the relationship between student epistemic beliefs, particularly the dimension of simplicity of knowledge (knowledge is isolated and simple versus interrelated and complex) (Schommer, 1990) and learning strategies, particularly online search behavior when solving ill-structured problems. Within these problems, this study is interested in how learner epistemic beliefs may predict strategies used while learning on the internet compared.

It is thought that multiple representations provide opportunities for extensions of thought, thus promoting the potential for access to what may have been inaccessible perspectives (Hannafin, Hill, Land, & Lee, 2014). The internet is an example of a technological medium that can afford access to many pieces of information and perspectives on virtually any topic in any discipline. It has also been described as an environment conducive to complex learning (Jacobson, 2008). Previous work has examined the role of epistemological beliefs on achievement and learning behaviors, but there exists less work that addresses whether or not and how these beliefs influence these behaviors in an open-source, online environment.

Ill-structured problems are characterized by having multiple solutions- they have no single, clear-cut answer, and may draw knowledge and perspective from multiple disciplines (Ulyshen, Koehler, & Gao, 2015) and it has been thought that the internet, containing an incomprehensible amount of information and holding this information interconnectedly, may be a powerful tool to approach these types of problems (DeSchryver & Spiro, 2009). Previous work suggests that more constructivist epistemological beliefs (knowledge is complex and tentative as

opposed to simple and certain) may be predictive of deep-processing strategies (Schommer et al, 1992).

Information on the internet can be thought of as presented in an unstructured manner as learners experience mechanisms such as hyperlinks, hypertext, and hypermedia, affording opportunities for nonlinear learning- constructing knowledge from a multitude of sources to fit contexts of unique problems (Spiro, Coulson, Feltovich, & Anderson, 2004). Contrary to this notion, some research has suggested that students use the internet to find quick answers instead of to gather information to elaborate and justify ideas (Mansourian & Ford, 2007). Schommer (1990) found that for students who read a passage in which the concluding paragraph was removed, belief in quick learning was related to the writing of oversimplified conclusions, poor performance on a comprehension test, and overconfidence in test performance. This notion is further supported by work by Bråten and Strømsø (2006), which suggested that quick learning was associated with a decrease in awareness the difficulty of managing the breadth of knowledge within the internet. Hofer (2004) reported similar findings by suggesting that students reporting simple and certain epistemological beliefs were likely to perform searches in a brief manner, not seeking additional sources. This prompts inquiry as to why, despite its affordances for complex learning, the internet may be used to collect information quickly to form quick answers and whether or not epistemic beliefs may mediate the type of learning strategies students use while solving ill-structured problems- problems not characterized by a simple answer.

Previous work has examined the role of learner epistemic beliefs on achievement goals, learning goals, and achievement (Muis & Franco, 2009), but less work has focused on the possible differences between general and internet specific epistemological beliefs (Bråten, Strømsø, & Samuelstuen, 2005) and how these beliefs may influence strategies used to learn on

the internet. This relationship is worth investigating as the internet becomes increasingly relied on as a knowledge acquisition tool in schools. Better understanding how the internet affects learner beliefs and learning behaviors has implications towards better preparing students to use the internet to solve problems that are not well-structured (characterized by a single correct answer). The purpose of this study is to examine learner beliefs regarding the simplicity of knowledge (simple versus interrelated) and how these beliefs influence learning strategies and are influenced by the internet.

### **Theoretical Framework and Literature Review**

This proposal's framework draws from *Cognitive Flexibility Theory* (CFT) (Spiro, Feltovich, Jacobson, & Coulson, 1992). CFT offers a framework of which to think about knowledge acquisition in a constructivist perspective regarding ill-structured domains. This perspective emphasises complex, nonlinear, and ill-structured learning. The internet, affording ill-structured organization of information, is a technological tool that can foster this type of learning. Containing search engines and hyperlinks, the internet can allow users to learn about complex topics and approach ill-structured problems through searching for multiple perspectives, specific cases, and personal opinions (DeSchryver & Spiro, 2009). Through the eyes of this perspective, this proposal is interested in learners' abilities to capitalize on the construction and affordances of ill-structured learning that the internet provides, that is, what actions and strategies do learners use that reflect CFT when on the internet? What actions and strategies do they use that do not reflect CFT? What influences learners' decisions to perform certain actions or employ certain strategies on the internet when approaching an ill-structured task?

This proposal also draws upon Schommer's (1990) *dimensional view* of personal epistemology, specifically, the dimension of "simplicity of knowledge" which deals with

whether an individual tends to view knowledge as isolated and simple or interrelated and complex. Hofer & Pintrich (1997) posited that the dimensions outlined by Schommer should be operationalized into 2 dimensions consisting of the nature of knowledge (what knowledge is) and the process of knowing (how one comes to know). The nature of knowledge dimension of this model corresponds to the dimension of simplicity as described by Schommer (1990). Muis & Franco (2009) continued to build upon this work by constructing a model to test how epistemic beliefs influence achievement goals, learning goals, and achievement whose results support the idea that each component influences its direct consequent (epistemic belief-achievement goals-learning goals-achievement).

This proposal seeks to expand upon this work by examining epistemic beliefs as well as examining learning strategies in terms of online behavior. Previous research has examined learning behaviors on the internet in relation to internet epistemic beliefs regarding correctness. Work by Kammerer & Gerjets (2012) sought to test how learners' belief that correct knowledge exists on the internet (not to be mistaken with the notion that all knowledge on the internet is correct) influences source evaluations on a search engine and found the more individuals believed the internet contains correct knowledge, the better evaluative tendencies they displayed. Work by Pieschl, Stahl, & Bromme (2008) examined if learners with different epistemological beliefs and varying levels of prior knowledge were more or less flexible in the learning process for learning materials with different levels of complexity and how epistemological beliefs and prior knowledge influence learning outcomes. Results of this study indicated that there is evidence to support that students calibrate learning to different levels of difficulty and that this calibration may be influenced by epistemological beliefs and prior knowledge.

Consistent with the idea that ill-structured problems are not characterized by simple solutions, Lin et al. (2011) argued that research regarding multi-document literacy appears to be more important than ever before; this provides opportunities for both access to breadth of knowledge, argumentation, and reflection. Strømsø & Bråten (2010) indicated that helping students develop more adaptive beliefs about Internet-based knowledge and knowing may better prepare them to take advantage of the numerous opportunities existing within Internet.

This study seeks fill a gap and explore how learner epistemic beliefs are related to learning behaviors when learning occurs on the internet. Think alouds have been used previously to examine individuals' epistemological thinking during computer searches (Ericsson & Simon, 1993). Hofer (2004) employed this methodology to assess epistemological thinking and examine how students engage in this thinking during online searching and argued that the dimension of simplicity is activated during knowledge construction. Additionally, retrospective questioning will be employed in order to address the need for triangulation when using think aloud methods (Charters, 2003).

Since this study is interested in how epistemic beliefs function during internet tasks, we would employ the *Internet-Specific Epistemological Questionnaire* (ISEQ) (Bråten & Weinstein, 2004) to measure students' internet specific epistemic beliefs about the simplicity of knowledge. This questionnaire was designed to model Hofer & Pintrich's (1997) model of personal epistemology and measures the dimensions of the nature of knowledge (what knowledge is) and the process of knowing (how one comes to know). Specifically, 9 items on the ISEQ measure the simplicity of internet based knowledge. These items focused on the extent to which students understood the internet as an culmination of specific facts or complex concepts (sample items: On the Internet, it is the richness of detail about what I am studying that is most prominent; The

most important aspect of the Internet is that it contains so many specific facts about what I am studying in my classes) (Bråten, et al., 2005).

The proposed study seeks to address the relationship between epistemic beliefs regarding simplicity of knowledge (measured by the ISEQ) and online searching behaviors (elaborated by think-alouds). The study will ask students to acquire knowledge on a complex topic. There will be 3 conditions. All conditions will instruct participants to seek out knowledge in order to answer the question: *Should genetically modified (GMO) foods be served in schools*. The first condition will not be instructed to seek out information from any particular source nor to use any particular strategy when doing so. The second condition will be instructed similarly to the first, differing in that participants will be informed of the nature of deep open learning. The third condition will be instructed similarly to the second, differing in that participants will receive additional instruction to employ deep searches for information.

The research question for this study is:

Are learning strategies predicted by epistemic beliefs regarding the simplicity of knowledge observed on the internet?

## **Method**

### **Study Design**

This study's design will consist of 3 conditions: A control condition where participants will be asked to acquire knowledge in order to inform their answer to the online searching task question via internet; A condition where participants will be asked to acquire knowledge to inform their answer to the question and in which they will also be informed about the possibility of deep searching; and a condition where participants will be asked to acquire knowledge to inform their answer to question additionally will be informed about the possibility of deep

searching as well as instructed to perform such actions. Participants will be randomly assigned a condition. Participants will be observed in a research laboratory setting.

All participants will have access to computers to complete the questionnaire and will have access to the computer and internet during internet search task-this will be the only accessible material for them for the duration of the study. Participants will possess freedom to acquire knowledge using any strategy they wish. All conditions will be presented with the same task which has been adapted from Cui (2016):

*“The University Food Services will be discussing whether genetically modified foods should be served in school at the next meeting. Suppose you are one of the student representatives at University Food Services, and you are delegated as responsible for presenting the multiple perspectives on this controversial issue for further discussion and then stating your own point of view. Make sure to include specific supports for your statements.”*

This topic has been chosen as we believe it fits well with the criteria proposed by Deschryver (2012):

1. It needs to be an ill-structured problem with no pre-existing, definite solutions.
2. It needs to be of general interest to the participants.
3. It cannot be too broad or too narrow. If it is too broad, the participants will not be able to get sufficient information within the limited time duration. If it is too narrow, the participants will not be able to experience the complexity of the topic.
4. It needs to have two sides to explore and extensive resources available for both.

A pilot study will be conducted in order to determine time needed, interest level, and prior knowledge.



All conditions will be asked to complete the same set of questions regarding epistemic beliefs. The procedure will be as follows: Consent form presented, description of the task given, , participant completes questionnaire, participant participates in knowledge acquisition task, retrospective interview conducted, and participant is debriefed.

### **Participants**

This study will consist of participants at large midwestern university. Participants will be of the undergraduate level coming from various academic majors. This proposal is interested in college-level students as academic expectations of these learners often coincides with abilities to synthesize and engage in complex problem solving. At this educational level, a common expectation is for students to independently seek out information in order to complete tasks. We will exclude biology/chemistry majors as they may hold competencies in more advanced ways than the average person of this age-their abilities and attitudes may be unrepresentative of the population examined.

Since this study will employ both quantitative (ISEQ) and qualitative (think alouds) measures of data collection and analyses, we believe 30 participants will provide an adequate quantity of data of both personal reasoning (think-aloud) and epistemic beliefs (questionnaire). Sample size was chosen as a small number of participants would afford an in depth analysis to recognize patterns and common strategies for searching for information across learners. It will seek to balance academic major background and gender between the experimental and control conditions.

Subject recruitment will occur through a psychology subject-pool. Because of this, it is implied that participants will be incentivised to participate through course credit. Data collection will be occur on the university's premises, in a research laboratory setting. Screening of

participants will be employed to exclude computer science majors and persons suffering from blindness.

### **Materials and Measures**

Participants will be asked to gather information regarding the use of GMOs in schools. This is the suggested topic because 1) from the sampling procedure (biology and chemistry majors excluded), it is assumed participants do not have extensive knowledge of this topic and 2) the search task topic is a complex issue and whose answer(s) is/are not generalizable to a single definition. There is no objectively simple answer, and the focus of the study is not to evaluate how correct participants are in their choice of operating system, rather, it is interested in the reasoning behind gathering information on the topic and that reasoning's possible association with the student's understanding of the simplicity of knowledge on the internet. Think alouds will be used to verbalize learning behaviors with reasoning. To ensure engagement in think alouds, participants will be instructed to verbalize their thoughts for performing actions before beginning the study. Think alouds will be recorded and coded for themes of knowledge simplicity. Coding will consist of frequency counts (how many times was this theme mentioned) for both think alouds and retrospective questioning. Interrater-reliability will be used to reinforce measure reliability.

The study will measure epistemic beliefs regarding simplicity of knowledge via questionnaire. Questions will be taken from the Internet-Specific Epistemological Questionnaire (Bråten & Weinstein, 2004) which has been used previously (Bråten, Strømsø, & Samuelstuen, 2005; Strømsø & Bråten, 2010) to measure the dimension of *simplicity of internet-based knowledge* and measured on a 10-point Likert scale (1 = strongly disagree, 10 = strongly agree) The questionnaire will be completed on a computer.

Total time of the study will be roughly 1 hour with 10 minutes dedicated to completing the items from the ISEQ, 30 to the internet search process, 10 for the retrospective questioning process, and 10 for the debriefing process.

### **Limitations and Delimitations**

There are foreseen limitations to this study. First, the population of which the sample will be drawn raises issues of generalizability as external validity of the results will be constrained to populations of similar educational attainment, regional affiliation, and age characteristics of the study's sample. Another limitation of the study is its place of location; awareness of being in a study may alter participant behavior compared to a more naturalistic setting. Finally, motivational variability to participate may influence the validity of the quantitative measure (questionnaire). The study attempts to mitigate this effect by drawing from a population incentivized by similar compensation as well as employing qualitative measures that leave less ambiguity to the analyses of the data they produce.

As discussed by Ericsson and Simon (1980), think alouds may be incomplete and exclude thought processes that are not held in working memory long enough to be expressed verbally. This limitation is addressed by the addition of retrospective questioning which is thought to construct triangulation among methods of data collection.

A major delimitation of the study is the conscious choice not to include a quantitative measure to examine learning behaviors during the task. It was decided that using the qualitative methodologies of coding think alouds would best represent the values for searching behaviors. Additionally, these methodologies impose no expectations on to the participant regarding which searching behaviors to employ. Since this study was focused on the relationship between learning on the internet and learner epistemic beliefs about the simplicity of knowledge, it was

decided that a qualitative approach to examining this aspect of the study would impose fewer constraints on the types of learning behaviors examined.

### **Summary and Significance of Study**

This proposal outlines a study that seeks to better understand how learner beliefs about how simple or complex the nature of knowledge exists on the internet may be predictive of behaviors while solving ill-structured problems. Learning behavior may reflect such beliefs as suggested by previous work (Hofer, 2004; Muis & Franco, 2009; Strømsø & Bråten, 2010). The internet can be thought of as a tool that affords opportunities for nonlinear learning conducive to solving in ill-structured domains (Spiro, Coulson, Feltovich, & Anderson 2004) yet previous work has indicated that it is not always used in this way, often being used for quick searches and to find simple answers (Bråten and Strømsø, 2006; Hofer, 2004; Mansourian & Ford, 2007).

Implications for this study may inform future research interested in investigating both how the internet can be used as a tool to promote learning characterized by the ability to draw from multiple perspectives and disciplines spontaneously in order to meet the demands of a diverse range of problems (Spiro and Jehng, 1990) and how beliefs regarding the simplicity of knowledge may influence internet search behavior. Ultimately, this study hopes to build upon a body of research that seeks to improve educators' abilities to recognize how students build knowledge which has implications towards informing interventions that allow for students who are better prepared to solve problems they may face in the real world which often exist in ill-structured domains

## References

- Bråten, I., Strømsø, H. I., & Samuelstuen, M. S. (2005). The relationship between Internet-specific epistemological beliefs and learning within Internet technologies. *Journal of Educational Computing Research*, 33, 141–171. doi:10.2190/E763-X0LN-6NMF-CB86.
- Bråten, I., & Strømsø, H. I. (2006). Epistemological beliefs, interest, and gender as predictors of Internet-based learning activities. *Computers in Human Behavior*, 22, 1027-1042.
- Bråten, I., & Weinstein, C. E. (2004). Internet-Specific Epistemological Questionnaire (ISEQ). Austin, TX: Department of Educational Psychology, University of Texas at Austin
- Charters, E., (2003). The Use of Think-aloud Methods in Qualitative Research An Introduction to Think-aloud Methods, *Broke Education*, 12(2), 68-82
- Cheng, C. (2016). Exploring Skilled Web Learners' Planning Process in Online Reading and Learning for Solving Ill-structured Problems, *unpublished manuscript*, Michigan State University
- DeSchryver, M. , & Spiro, R. J. (2009). New forms of deep learning on the web:Meeting the challenge of cognitive load in conditions of unfettered exploration in online multimedia environments. In R. Z. Zheng (Ed.), *Cognitive effects of multimedia learning* (pp. 134–152). Hershey, PA: Information Science Reference/IGI Global Publishing.
- Ericsson, K. A.,&Simon, H. A. (1993). *Protocol analysis:Verbal reports as data*. Cambridge, MA: MIT Press.
- Hannafin, M. J., Hill, J. R., Land, S. M., & Lee, E., (2014), Student-Centered Open Learning Environments: Research, Theory, and Practice, *Handbook of research on educational communications and technology*, 641-651.

Hofer, B. K. (2004). Epistemological understanding as a metacognitive process: Thinking aloud during online searching. *Educational Psychologist*, 39, 43-55.

Kammerer, Y., & Gerjets, P., (2012) Effects of search interface and Internet-specific epistemic beliefs on source evaluations during Web search for medical information: an eye-tracking study, *Behaviour & Information Technology*, 31:1, 83-97

Lin, J-W., Lai, Y. C., Chang, L. C., (2011) Fostering self-regulated learning in a blended environment using group awareness and peer assistance as external scaffolds *Journal of Computer Assisted Learning*, 21, 137-151

Mansourian, Y., & Ford, N. (2007). Search persistence and failure on the web: A “bounded rationality” and “satisficing analysis. *Journal of Documentation*, 63, 680–701

Muis, K. R., Franco, G. M., (2009), Epistemic beliefs: Setting the standards for self-regulated learning, *Contemporary Educational Psychology*, 304, 306-318

Pieschl, S., Stahl, E., & Bromme, R. (2008). Epistemological beliefs and self-regulated learning with hypertext. *Metacognition Learning*, 3, 17–37. doi:10.1007/s11409-007- 9008-7

Strømsø, H. I, & Bråten, I, (2010), The role of personal epistemology in the self-regulation of learning, *Metacognition Learning*, 5, 91-11

Schommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology*, 82, 498–504. doi:10.1037/0022- 0663.82.3.498

Schommer, M., Crouse, A., & Rhodes, N. (1992). Epistemological beliefs and mathematical text comprehension: Believing it is simple does not make it so. *Journal of Educational Psychology*, 84, 435–443.

Schunk, D. H. (2001). Social cognitive theory and self-regulated learning. In B. J. Zimmerman &

- D. H. Schunk (Eds.). Self-regulated learning and academic achievement: Theoretical perspectives (Vol. 2, pp. 125–152)
- Spiro, R. J., Coulson, R. L., Feltovich, P. J., & Anderson, D. K. (2004). Cognitive flexibility theory: Advanced knowledge acquisition in ill-structured domains. In R. B. Ruddell & N. Unrau (Eds.), *Theoretical models and processes of reading* (5th ed., pp. 640–653). Newark, DE: International Reading Association
- Spiro, R. J., Feltovich, P. J., Jacobson, M. J., & Coulson, R. L. (1992). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains. In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 57–75). Hillsdale, NJ: Lawrence Erlbaum.
- Spiro, R. J., & Jehng, J. C. (1990). Cognitive flexibility and hypertext: Theory and technology for the nonlinear and multidimensional traversal of complex subject matter. In D. Nix & R. J. Spiro (Eds.), *Cognition, education, and multimedia: Explorations in high technology* (pp. 163–205). Hillsdale, NJ: Lawrence Erlbaum.
- Ulyshen, T. Z., Koehler, M. J., and Gao, F., (2015) Understanding the Connection Between Epistemic Beliefs and Internet Searching, *Journal of Educational Computing Research* 0(0) 1–39