Computers in Human Behavior 60 (2016) 384–397

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

The effects of source representation and goal instructions on college students' information evaluation behavior change

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ARTICLE INFO

Article history:
Received 25 December 2014
Received in revised form
5 February 2016
Accepted 10 February 2016
Available online 1 March 2016

Keywords:
Online inquiry
Information evaluation behavior
Source representation scaffolds
Goal instructions

ABSTRACT

We investigated ways of scaffolding information evaluation behavior (IEB) in online inquiry contexts. Previous instructional support simplified IEB and rarely critically addressed the cognitive load that accompanies multiple representations or naïve task perception that hinders critical evaluation. We conducted a longitudinal, 2 × 2 quasi-experimental study in an introductory college biology course, varying (A) Source Representation Scaffolds to address limited cue awareness and cognitive load and (B) Goal Instructions to address task perception. For treatment A, students were given an annotation tool in addition to a checklist (Control A). For treatment B, instead of persuasion goal instructions (Control B), written task directions prompted student to consider alternative ideas (balanced reasoning goals). We measured students' IEB four times. We also measured individual task perception and cognitive capacity. Multilevel analyses identified the specific nature of changes in IEB. On average, IEB did not improve much in the baseline group while task perception and cognitive capacity differentiated IEB scores. Conversely, both annotation and balanced reasoning goals yielded improved gains in IEB, but there was a negative interaction effect when they were combined. The results demonstrate the benefits of annotation and balanced reasoning goals but suggest the need to address possible difficulties in using multiple scaffolds.

1. Introduction

Online inquiry has been touted as student-centered, active learning (Lee et al., 2011; National Research Council, 1999). One key component is information evaluation (Brand-Gruwel & Stadtler, 2011; Wiley et al., 2009). Inquiry initially asks students to build on their knowledge to form interesting questions and hypotheses, yet students seek and integrate additional information sources to challenge and advance their knowledge. Despite many known benefits, inquiry typically starts with vague ideas, misconceptions, or biases, which paradoxically limit how students search and process and the extent to which they integrate different pieces of information (Butcher & Sumner, 2011; Kobayashi, 2010; Land, 2000). Studies have shown that information evaluation can help resolve this self-directed learning paradox. For instance, information evaluation can help learners (a) narrow down the initial search scope (Tabatabai & Shore, 2005), (b) judge the coherence of information collection (Rouet, 2006), (c) increasingly seek more elaboration (Wu & Tsai, 2005), and (d) resolve inconsistencies between different sources to construct deeper understanding of a given topic (Wiley et al., 2009).

Unfortunately, information evaluation is knowledge and skills taken for granted or inappropriately addressed in many college courses (Head & Eisenberg, 2009; Iding, Crosby, Auernheimer, & Barbara, 2008; Meola, 2004). Students report that they base their evaluation only on a few limited cues, such as titles, author affiliation, and the presence of statistics (Bråten, Strømsø, & Britt, 2009; Britt & Aglinskas, 2002). Their simple evaluation behavior is optimized for initial source screening but cannot address the multidimensional evaluation needs that evolve during inquiry (Meola, 2004). Thus, students might readily filter key sources, but they ignore ways in which those sources might be incoherent or incomplete. This observation necessitates support for contextual and global evaluation. A more critical but less examined challenge is that given such support, students still do not voluntarily use their evaluation knowledge (c.f., Eysenbach & Köhler, 2002; Gerjets, Kammerer, & Werner, 2011). This inconsistency mainly results from complex psychological dynamics that typical support strategies rarely consider. We noted that novice students trade off

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http://dx.doi.org/10.1016/j.chb.2016.02.044

cognitive load against critical evaluation by relying on a few surface cues (c.f., Rouet, 2009). Also, naïve task perception directs mental effort and direction towards low evaluation standards regardless of evaluation knowledge (Wu & Tsai, 2005). Accordingly, any efforts to support critical evaluation need to address such dynamic interactions among task, student, and information environments (Lazonder & Rouet, 2008; Tanni & Sormunen, 2008).

Given this background, the current study considered the multiple dimensions of evaluation and their associated challenges. We examined (a) Source Representation Scaffolds (checklist or digital annotation + checklist) to address limited cue awareness and cognitive load and (b) Goal Instructions (persuasion goal or balanced reasoning goal) to address naïve task perception. We assumed that the additional digital annotation and balanced reasoning goals would improve information evaluation behavior (IEB). The purpose of the study was to investigate the impact of various interventions on IEB over time. In the following section, we detail our theoretical model of IEB and how this model informed our scaffolding approaches.

2. Re-defining IEB in online inquiry contexts

We define information evaluation as metacognitive knowledge and skills used to judge and control the quality of one's *knowledge sources* (e.g., “Is my understanding based on a credible source?”) (Hofer, 2004; Kuhn, 2000; Mason, Boldrin, & Ariasi, 2010). As is the case for any metacognitive activity, IEB involves multiple cycles, each cycles having three basic steps: (a) eliciting evaluation standards for a task, (b) representing and comparing cues (i.e., source properties) against standards, and (c) interpreting the difference to match an appropriate action (i.e., re-reading, marking source distinctions, and seeking additional sources) (c.f., Pressley, 2002; Rouet, 2006).

Interestingly, typical instructional support has abbreviated this cycle. Evaluation has been reduced to one stage of sequential information-retrieval (see for a review, Walraven, Brand-Gruwel, & Boshuizen, 2008). Thus, students are asked to find, evaluate, and then process their selections. Also, instruction has focused on local cues in traditional bibliographic information (e.g., author, date, and publication). This approach easily supports simple look-up search tasks (e.g., “what is lactic acid?”), but it cannot address exploratory tasks such as inquiry (e.g., “why do you feel a burning sensation during exercise?”) because both information and evaluation needs evolve and become more contextually-driven as inquiry proceeds (Saracevic, 2007; Schamber, Eisenberg, & Nilan, 1990). Thus, inquiry necessitates a new model to explain and support multiple evaluation cycles that actually regulate and change the entire task process.

We previously proposed a reference model with four dimensions of information evaluation; each dimension is not necessarily sequential but can be active during different phases of inquiry (Kim, 2014):

- Predictive evaluation: People define tasks and goals and rely on previous experiences to find specific sources. Predictive evaluation sets expectations for needed sources before inquiry (Hogarth, 1980; Rieh, 2002).
- Intrinsic evaluation: As inquiry begins, intrinsic evaluation uses the innate (i.e., local) merit of sources, such as currency, support, authority, and bias (Rieh & Hilligoss, 2008; Wineburg, 1998), to locate key information sources. Evaluation at this stage does not necessarily account for the logical coherence or strength of a source due to unclear information needs.
- Extrinsic evaluation: As task goals and information needs become clearer, extrinsic evaluation weighs the relative strength and utility of sources against the specific task (Hjørland, 2012; Meola, 2004). Accordingly, extrinsic evaluation represents rhetorical relations (e.g., supporting, weakening, rebutting) and judgmental qualifiers (e.g., consistent and strong) across multiple sources; it promotes source integration and coherent explanation (Perfetti, Rouet, & Britt, 1999).
- Reflective evaluation: Following a series of evaluations, summative reflection on the range of collected sources reconciles and reorganizes unexplained or conflicting information (Russell, Stefik, Pirolli, & Card, 1993). Reflection also triggers individuals to reconsider their evaluation knowledge in future evaluation behavior (c.f., Schraw, 1998).

This reference model helps identify an ideal course of action for evaluation during inquiry progression but also locates and reasons out the challenges that students face. The following sub-section highlights three inter-related challenges—limited cue awareness, cognitive load, and naïve task perception—to propose source representation scaffolds and goal instructions that address those challenges.

2.1. Source representation scaffolds

Mental representation of source properties is an essential step in information evaluation. Our model suggests representing increasingly contextual and global cues (e.g., main theses and rhetorical relations) during the transition from intrinsic to extrinsic to reflective evaluation during inquiry.

2.1.1. Challenge: cue awareness and cognitive load

One related challenge for novice students is limited cue awareness. In many cases, students have not been taught ‘where to look for which cues and why’ (Wiley et al., 2009). They have rather developed a loosely defined concept of quality acquired from trial and error. Another challenge is the cognitive load that accompanies multiple source representations over time (Kalyuga, 2009; Rouet, 2009). Inquiry requires students to deal with simultaneous navigation, reading, and evaluation. Students typically fall short of the cognitive capacity needed to deal with multiple source representations, while experts have automated the process. Proper support needs to help students practice and internalize increasingly contextual and global representations while considering the cognitive load generated by such complexity.

2.1.2. Checklist

Previous instructional support has only partially addressed these challenges. The most common approach, checklist, has didactically taught otherwise implicit cues. The checklist provides a concise list of criteria and cues, typically with an acronym, to aid quick memorization and application (e.g., Mucci, 2011). Though simple and efficient, this formulization has proven effective only when dealing with local cues that independent of specific tasks or content (e.g., author affiliations; c.f., Osman & Hannafin, 1992). With contextual and global cues taught in an abstract manner, students simply ignored them or used a surface approach (e.g., “How reliable is reliable enough?”) (Hjørland, 2012; Meola, 2004). Also, the simple response mechanism (“yes or no”) in a checklist cannot properly address the cognitive load issue. Rather, it is optimized for experienced evaluators who have automated the process and can manage representations across sources without a memory aid. After all, checklists tend to result in mechanical and local analyses that hinder rich source representation (c.f., Harris, 2007).

2.1.3. Digital annotation

Conversely, digital annotation tools can enhance comprehensive