Reasoning About Disagreements: Instructional Design to Improve Thinking About Controversial Multiple Documents

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Abstract: The aim of the present study was to develop instruction that enables students to learn, detect, and analyze disagreements among multiple conflicting texts. We developed a learning sequence to understand and to promote disagreement resolution in reasoning about conflicting information, which included (a) explanations regarding steps to analyze and identify reasons for disagreements, and (b) self-invention, peer discussion, and reflection on dialogic model of how to analyze disagreements. The goal was to help participants elaborate their reasoning about disagreements among conflicting information within and between texts. We conducted a scenario-based assessment to investigate students' epistemic criteria after a three-session intervention. Results indicated that the current learning sequence led students to focus on details of studies that appeared in the multiple conflicting information to resolve disagreements.

Introduction

Developing knowledge from conflicting information is a key to advancing learners' literacy. However, in the contemporary knowledge-based society, laypeople faced with divergent information find it challenging to resolve conflicts and disagreements among diverging information to make personal decisions (Kienhues et al., 2017); meanwhile, the quantity, diversity, and complexity of information resources have dramatically increased. When selecting multiple information even from reliable sources, people often get confused because information about vaccines, diets, educational methods, and so on, are contradictory to each other.

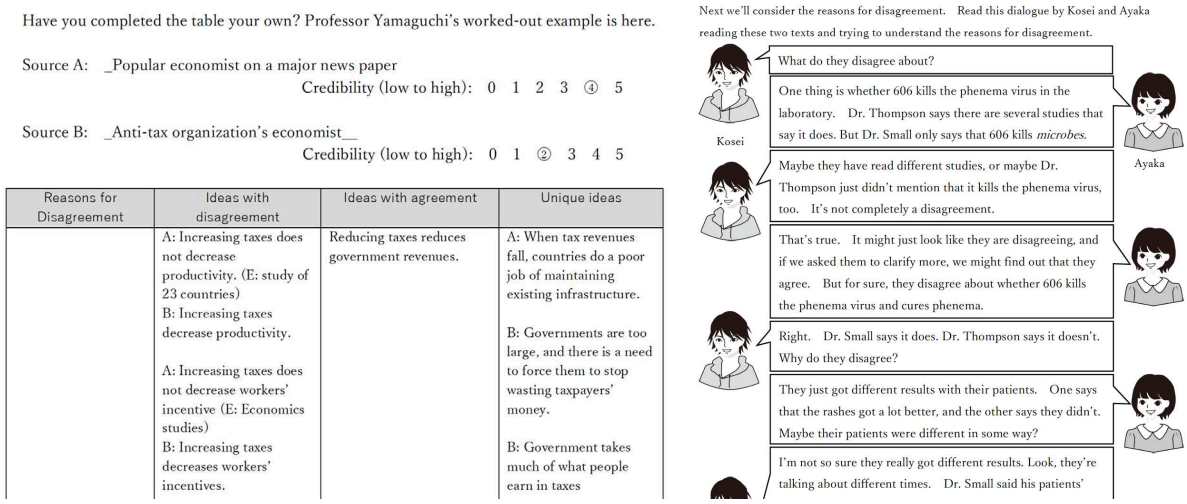
The current digital society requires both laypeople and professionals to develop proficiency in identifying and explaining disagreements (Thomm & Bromme, 2016). Many studies investigate instructional practices or scaffolds to promote integration of information from multiple documents (see Barzilai et al., 2018, for a review). Although many of those studies have confirmed the importance of the process of sourcing, there is also a need to help learners understand reasons why people disagree and what can be done to resolve these disagreements (Chinn & Rinehart, 2016). However, few studies have designed or investigated instruction focused on enabling students to acquire specific strategies to resolve disagreements among complex information. Goldman et al. (2018) pointed out that multiple conflicting information resources sometimes spur readers to closely examine details of studies and other information in documents, in addition to sources. But even if students can detect disagreements, they may not grasp why the disagreements exist or how to resolve them.

Students may benefit from learning more about the reasons why people disagree (Thomm et al., 2017) and about how different kinds of disagreement suggest different resolution strategies. Thus, the present study aims to develop effective instruction for promoting successful detection, analysis, and resolution of disagreements in information in multiple documents.

Designing instructional sequence and materials for disagreement reasoning

To address these issues, we developed a short instructional sequence designed to enhance undergraduates' capacity to detect and resolve disagreements among multiple information sources. The learning sequence consisted of four phases, designed to encourage constructive and interactive forms of instruction (Chi & Wylie, 2014). First, four steps for resolving multiple conflicting information were explained: (a) evaluating sources; (b) identifying disagreements, commonalities, and unique ideas among the information; (c) identifying evidence relevant to each disagreement and commonality; and (d) identifying reasons for the disagreements (such as: different authors have different amounts of evidence, different studies have different samples or methodological procedures which produce different results, the studies examined effects over different time periods, etc.). Second, the students tried steps (a), (b), and (c) with sample texts, followed by a model of one person's analysis (Figure 1 left). Third, for each set of the texts, there was an invention phase in which students individually then in small groups generated a list of disagreements in the documents (as well as commonalities) and reasons for these disagreements in a table; this was intended to foster students' self-explanation and elaborations of their thinking about types of disagreements. Finally, each student performed step (d) individually, followed by peer conversation to elaborate their reasoning about disagreement reasons. Students developed their own list of possible reasons for

disagreement, which were then informed by reading two fictitious students' dialogue regarding why the disagreements might have occurred on the sample texts (Figure 1 right). Afterwards, students reflected together and developed a group list of reasons for disagreements that was updated after each practice problem. The students repeated these steps on several problems with gradually faded scaffolds, including: treatment for a disease; pro- and anti-taxation; pro- and anti-discovery learning; and motivation and rewards. The goal was for students to develop ideas about how to analyze reasons for why texts disagree and about how to resolve these disagreements.



Have you completed the table your own? Professor Yamaguchi's worked-out example is here.

Source A: _Popular economist on a major news paper
Credibility (low to high): 0 1 2 3 ④ 5

Source B: _Anti-tax organization's economist__
Credibility (low to high): 0 1 ② 3 4 5

Reasons for Disagreement	Ideas with disagreement	Ideas with agreement	Unique ideas
	A: Increasing taxes does not decrease productivity. (E: study of 23 countries) B: Increasing taxes decrease productivity. A: Increasing taxes does not decrease workers' incentive (E: Economics studies) B: Increasing taxes decreases workers' incentives.	Reducing taxes reduces government revenues.	A: When tax revenues fall, countries do a poor job of maintaining existing infrastructure. B: Governments are too large, and there is a need to force them to stop wasting taxpayers' money. B: Government takes much of what people earn in taxes

Figure 1. Models of how to identify disagreements/commonalities (left) and how to reason disagreements through fictitious students' dialogue (right) (both translated from Japanese into English).

Methods

Participants, design, and intervention

Participants were 96 undergraduates (female 52%) in an introductory education course in a Japanese public university. They were randomly assigned to two different conditions and studied with our materials over three weekly classes (1.5 hours per session). We developed two forms of instruction to create two conditions: (1) In the Disagreement Reasoning instruction (DR, $N = 46$) condition, students learned with the above-mentioned materials. (2) In the Creating Summaries (CS, $N = 50$) condition, students engaged in step (a). Instead of steps (b), (c), and (d) , students learned to create tables in which they entered each text's summary so that they could easily compare them. The materials also provided models of these tables to which they could compare their own tables. The CS students work with the same series of practice tasks using these different procedures. Thus, the CS condition also encouraged some attention to differences among texts, but less explicitly so than the DR condition.

Assessment

At the end of the third session, the students were given a meta-epistemic prompt asking them about how they would resolve disagreements on a problem in which multiple information sources disagreed. Specifically, they were asked to imagine that they were investigating the effectiveness of vaccines against rubella and that they found 5 websites saying that "a vaccination against rubella is not effective (e.g., a case of mass infection occurred even though vaccination was done)" and 5 websites saying that "Rubella vaccination is effective," and to answer how they would think about, judge, and act on these conflicting information in order to derive a "best answer" for themselves. They had 7 minutes to list up their ideas to respond to this assessment. (We used several other assessment measures that also extended to a fourth session; in this paper we report the results for this measure.)

Students' written responses were coded based on the AIR model of epistemic cognition (Chinn et al., 2014; Barzilai & Chinn, 2019). The AIR model posits that epistemic cognition has three components: Aims and value (the epistemic goals people set and the value they place on these goals), epistemic Ideals (the criteria for evaluating epistemic products such as explanations), and Reliable epistemic processes (the processes that make success in achieving epistemic aims more likely). Although we found few aims mentioned in the students' responses, their responses implicitly and explicitly referred to many different ideals and reliable processes. Adapting methods developed by Barzilai & Chinn (2019), we coded the students' responses according to the

specific ideals (e.g., ideals for evidence such as comprehensiveness or corroboration) and processes mentioned (e.g., checking sources, checking study conditions, identifying disagreements, etc.). These specific codes were then clustered into the larger categories displayed in Tables 1 and 2.

Results

Table 1 shows means and standard deviations of the frequencies of epistemic processes that each student listed up for resolving the disagreements among the websites. Because the data were not normally distributed, we performed Mann-Whitney *U*-tests on the categories of processes listed in Table 1, revealing that DR students more often proposed *evaluating evidence processes* ($U = 658.00$, $Z = -3.829$, $p = .000$, $r = -.391$), such as checking study conditions or details. DR students also more frequently proposed *identifying and reasoning about disagreements among the information* ($U = 880.00$, $Z = -2.915$, $p = .004$, $r = -.298$) than CS students did. In addition, DR students proposed marginally less often simply *picking or ruling one side out*) ($U = 970.50$, $Z = -2.152$, $p = .031$, $r = -.220$) than CS students (as opposed to engaging in integration of information from both sides).

Table 2 shows the means and standard deviations of the frequencies of categories of epistemic ideals that each student listed for resolving the disagreements. We again performed Mann-Whitney *U*-tests, revealing that *evidence* ($U = 624.50$, $Z = -3.966$, $p = .000$, $r = -.405$) and *conclusiveness* ($U = 814.50$, $Z = -2.687$, $p = .007$, $r = -.273$) were different between the two conditions. In other words DR students were more likely to emphasize ideals involving fit with evidence (e.g., fit with specific patterns of study results) and the methodological conclusiveness of studies (i.e., the extent to which studies rule out other information) (see also Duncan et al., 2018). There were also significant differences for *mechanisms or explanation* ($U = 940.00$, $Z = -2.384$, $p = .017$, $r = -.243$) and *focusing on the internal content of the documents* ($U = 967.50$, $Z = -2.185$, $p = .029$, $r = -.223$), which indicates that DR students tended to prefer explanations or mechanisms in addressing the controversy, whereas CS students tended to focus on the aspects of the internal content.

Table 1: Means of frequencies (and standard deviations) of epistemic processes that each student listed as approaches for resolving disagreements

Categories	DR	CS	Definition
Sourcing processes	2.00 (1.48)	2.28 (1.50)	Including asking others (such as doctors, etc.), consult original sources, compare sources, check sources, evaluate sources, check venue sources.
Evaluate evidence processes	1.35 (1.06)	0.58 (0.84)	Including checking study conditions, checking study details, checking study results, comparing study conditions, evaluating study results, comparing study results
Identifying commonalities	0.67 (0.78)	0.16 (0.51)	Including identifying commonalities among the information
Identifying and addressing disagreements	0.43 (0.72)	0.08 (0.27)	Including identifying disagreements among the information, or integration via evaluating disagreements
Miscellaneous integration process	0.22 (0.51)	0.26 (0.52)	Trying to integrate multiple information by combining trustworthy information, via comparing studies, by avoiding picking one side, via giving reasons, via synthesizing, via selecting necessary information, or finding out about mechanisms
Picking or ruling out one side or one document	0.07 (0.25)	0.24 (0.48)	Including omitting unreliable sources, preferring high reliable sources, or choose (better) one.
Other	0.22 (0.47)	0.38 (0.67)	Including non-epistemic processes, or the mere reading critically, reading texts, summarizing texts, test yourself

Discussion and conclusion

In comparison to the Creating Summaries condition, the Disagreement Resolution intervention led students to describe different processes and appeal to ideals that they would use to investigate a controversial issue. Students in the DR condition were more likely to propose strategies that involved careful comparisons of studies to try to determine the sources of the disagreement and that the information from different documents be integrated on this basis. In contrast, CS students did not propose to examine details of studies or of information among multiple conflicting information, as Goldman et al. (2018) also found.

The current study suggests that the learning sequence in this study allowed undergraduates to gain a metacognitive understanding of some practices for identifying and resolving disagreements. A limitation of the

present paper is that we have not presented results of students actually attempting to resolve conflicting information. Our ongoing analyses of other measures in the study will allow us to examine how students resolve conflicts among documents on a practical problem of determining the efficacy of dieting methods. Further investigation is necessary when the learning sequence includes more scaffolds regarding how to integrate the multiple information in efficient ways.

Table 2: Means of frequencies of epistemic ideals indicated in students' proposed resolution approaches.

Categories	DR	CS	Definition
Focusing on the internal content of the documents	0.07 (0.25)	0.32 (0.71)	Including accuracy, coherence, scientific language
Source ideals	1.41 (1.33)	1.90 (1.45)	Including authority, corroboration via sources, expertise, past success, trustworthiness, unbiased, unfiltered, venue trustworthiness
Focusing on studies or evidence	2.22 (1.36)	1.14 (1.11)	Including corroboration via empirical, empirical (includes mentioning "studies" as a good thing in some fashion), quantitative data (statistics, ratios, frequencies, tables with numbers, graphs with numbers; refers to results, not features of the method), recency
Conclusiveness	1.02 (0.95)	0.62 (1.07)	This code is the notion that a study should support its conclusions, which involves the ideal of conclusiveness. So methodological criticisms are generally in service of the ideal of conclusiveness (of the study): the study is or is not conducted well enough to support its conclusions well.
Comprehensiveness	0.07 (0.25)	0.02 (0.14)	Indicates that all information / all studies are to be included.
Personal experience	0.04 (0.21)	0.12 (0.39)	Fits with personal experience.
Mechanisms or explanation	0.30 (0.59)	0.08 (0.27)	There is an explanation of the mechanism and principle.

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