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Going beyond facts and opinions: Developing students' knowledge structures to include inferences and interpretations

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Abstract

The drive to introduce critical thinking into the Japanese university presents a paradox. On the one hand, Japanese pre-tertiary problem-solving skills are evaluated as world-class (OECD, 2014), yet the consensus opinion of university teachers agrees that Japanese undergraduates are ill-prepared for critical thinking (Armand, 2016; Dunn, 2014, 2015). This paper argues that the failure to introduce critical thinking skills is due to the knowledge belief structure held by undergraduates and is reinforced by governmental expectations and university pedagogic practices. Three quasi-experiments provide evidence for a limited knowledge structure belief that contains only facts and opinions. The paper introduces an extended classification of propositional sentence types and it ends with an extended pedagogic demonstration of how these types may be taught in the university classroom as a necessary prior to the teaching of critical thinking proper.

Introduction

Pre-tertiary education in Japan is seen to be world-class in dealing with single-answer problems. Indeed, in the OECD PISA assessment of problem solving, Japanese fifteen-year-olds scores are among the top worldwide (OECD, 2014). PISA problem solving questions rely on finite-state automata (Buchner & Funke, 1993), where solutions to problems are inherently situated within the given problem space. The PISA scores at the secondary level provide strong evidence for Japan's high abilities in fixed-answer problem solving. Yet, this same strength becomes a weakness when the nature of problem-solving shifts from fixed, or discernible answers, to ill-structured problem solving. Wakita (2017) notes that the vast majority of primary and secondary educational testing utilises single-answer questioning. The Japanese educational culture produces excellent pre-tertiary PISA scores but leads to the phenomenon of undergraduates being "unprepared for what they find on the first day of university classes: high expectations of autonomous thinking" (Armand, 2016, p. 2).

One crucial expectation included in "autonomous thinking" is the ability to think critically (Armand, 2016). Yet, critical thinking skills are largely missing in first-year undergraduates

due to the importance of memorisation of information for the university entrance tests (Wakita, 2017). The importance of critical thinking is emphasised by the Japanese Ministry of Education (MEXT: 2019a, 2019b) who actively promote critical thinking skills in both Japanese and English language arts. MEXT hopes that the cognitive development of critical thinking abilities in students enables them:

> "to go beyond a mere understanding of facts and opinions by comparing your understanding with other facts and opinions, including your own, analysing and evaluating it based on your own knowledge and experience, and integrating it with your existing knowledge" (MEXT, 2010, translated by Mineshima, 2015, pp. 460–461).

This hope, however, reveals a serious deficit, limiting knowledge to facts and opinions. The ability to think critically is predicated on a number of lower-level epistemic beliefs and knowledge (Moon, 2008). Without a belief system than can challenge knowledge claims, critical thinking development is seriously threatened (Dunn, 2016). In current critical thinking pedagogy, the assumption is that practice of questioning of information leads to more sophisticated critical thinking skills (Cottrell, 2005; Moon, 2008; Stanovich, West, & Toplak, 2016), but if the student holds naïve epistemic beliefs, such as information in textbooks is necessarily correct and are unquestionable facts, critical thinking cannot be meaningful (Moon, 2008). In this paper, I will argue further that basic elements of an extended knowledge structure need to be in place before instruction in critical thinking can even begin. This paper provides a framework for locating critical and academic thinking within a multilevel sequence. Furthermore, I argue that most Japanese undergraduate students' knowledge structures are pre-epistemic, and that the expectation of true critical thinking development will be frustrated if steps are not taken to overcome the structural knowledge weaknesses.

The six-level framework

MEXT's exhortation is instructive as it is itself limited to only facts and opinions. If MEXT's belief itself is indeed problematic, the structural weaknesses may be endemic to the entire education system. To frame this example, I present a six-level classification of propositional meaning.

Table 1

Six levels of propositional meaning

Type	Definition	Estimated closeness to 'truth'
Truth statements	statements of fact	≅ 100%
Textual transformations	factual statements rephrased but retains the meaning	95%
Text-bound inferences	inferences derived from text	≅ 100%
Non-text inferences	world knowledge or cultural knowledge used as base for inferences	75%
Personal epistemological interpretations	reflective or unreflective use of personal world beliefs to derive interpretations of a phenomenon	unstable
Theoretical interpretations	deliberate use of theoretical models to derive interpretations of a phenomenon	stable

The first level describes factual statements, which, by definition, are believed to be true. The notion of *truth* is highly complex (Fitzgerald & Cunningham, 2002). Here it is defined as an external representation in linguistic text that corresponds to a real-world phenomenon (Stenning, Lascarides, & Calder, 2006). Stenning and colleagues (2006) note the importance of knowing about which conditions allow truth statements to be checked and defended as fact. There remains the possibility that statements of fact may actually be mistaken, wrong, or incomplete. We will return to this crucial possibility later. Textual transformations reword factual statements but generally retain their propositional content (Perfetti & Stafura, 2015). The rephrasing process introduces aspects of nuance into the propositional meaning, but the propositional content does not fundamentally alter. Perfetti and Stafura (2015) discern two types of inference, those that whose implicit meanings are closely bound to textual referents and those that rely on non-textual referents. Their example is instructive:

> *"When Cathy saw there were no dark clouds in the sky, she took her bike for a ride in the park. The rain that was predicted never occurred" (Perfetti & Stafura, 2015, p. 6)*

The first sentence contains a *she*, which is a text-bound inference tying *she* to *Cathy*. The *rain* in sentence two demonstrates a semantic association of *dark clouds* and *sky* that prime the quick retrieval of *rain*. There is no direct statement that connects *dark clouds* and *rain*, but the real-world knowledge allows readers to infer the possibility of *rain* without effort, as evidenced in event-related potential studies (Perfetti & Stafura, 2015). Inferences that are bound by their textual referents are stable; but non-text-bound inferences rely on real-world knowledge and as such may be incorrect if viewed against the intention of the writer. However, real-world inferences may be considered relatively stable, although the possibility of being mistaken is present. For example, in the following conversation, a number of facts can be inferred.

June : Good morning, May.

May : Good morning, June.

People generally say *Good morning* before lunch, so we can assert with reasonable confidence that the conversation is *likely* to be in the morning. Also, we can assert that it is *likely* to be the first time that June and May have met that day. These inferences are not perfectly defensible. It may be the case that June and May have a game in which they repeat *Good morning* whenever they meet; or in translation, it is customary for evening part-time workers in Japan to say *Ohayo (gozaimasu)* when arriving at work. Such exceptions deny full confidence in inferences, but when they are noted, most inferences prove to be stable. The pedagogic technique of noting inferences and then providing the occasion for reflecting on their epistemic stability is a crucial method if true academic and critical thinking is to be developed. We will return to this later.

All academic thinking is based on inference drawing. Scientific theories are generalistic frameworks that allow the analysis of a specific phenomenon. The result of the application of the theoretical lens provides inferential knowledge that is occluded yet present in the phenomenon. This cognitive process is interpretational (Stenning et al., 2006). An interpretation is the result of an inference when a specific point of view is adopted.

Two broad types of interpretation may be differentiated. A personal epistemology refers

to a privately-held set of beliefs about how the world operates (Alexander, Winters, Loughlin, & Grossnickle, 2012) everyday conceptions of knowledge, information, and truth were investigated as 161 US undergraduates completed three online tasks that investigated understandings of these foundational constructs. For the first task, respondents graphically represented the interrelations of knowledge, information, and truth; the second task required them to justify those representations; and the third involved defining each term. Representations were compared to written justification to gauge consistency and data were analyzed to identify relational patterns, with six stable patterns emerging from the conceptions (e.g., knowledge establishment and truth establishment. Sometimes called a *folk theory* (Greene, Sandoval, & Bråten, 2016; Hofer, 2016), individuals differ in their reflective awareness of how their own belief system influences their inference and interpretations of the world. Naïve individuals have little reflective awareness and tend to believe in the real world as "the way things are" (D. Kuhn, 1999, p. 21). Stenning and colleagues (2006) ask; "All cats bark. Fido is a cat. Does Fido bark?" (p. 37). When the personal epistemology of students is unreflective, it influences how this text is to be understood. Cats do not bark, they argue; so Fido cannot bark. They fail to interpret the text in its own right and evaluate the question in reference to the given information. Stenning et al. (2006) show that when the preparatory sentence *On this really strange planet* is given, everyone answers Fido does actually bark.

Personal epistemologies provide people with an interpretative framework through which to interpret our world (Baxter Magolda, 1992). When we arrive at conclusions about the world (whether reflectively or not), we do so through the prism of our belief structures. We cannot hold knowledge without belief (A. I. Goldman, 1986). Our understanding is not our *opinion*. An opinion is generally accepted to be a statement of belief that requires no questioning. Houtlosser (2001) notes that opinions centre on "the sincerity of his words, not to the truth of what he says" (p. 36). But this characteristic of opinion is problematic due to the dimensional nature of the concept. An *expert opinion* carries the connotation of truth, but lay opinions do not. The potential for a lay *opinion* to be confused with an interpretation derived from one's unreflective personal epistemology is high. A knowledge framework that clearly distinguishes one's opinion, one's reasoned opinion and one's interpretation becomes essential as a cognitive base prior to the development of higher-level academic thinking.

The final level of propositional meaning is the deliberate application of a scientific theory as an interpretative lens through which to gather new information. It must be stressed that information derived from the technical application of a theoretical lens is stable. It is not an *opinion*. The logic runs like this:

1. A set of beliefs about the world is written down (a theory)
2. A new object is studied using the theory
3. New knowledge is created *because of the theory*
4. This new knowledge is correct *if the theory is correct*

To most readers of academic papers such as this, this process may seem obvious. Yet, naïve thinkers' personal epistemologies deny this process. A third-year student who is preparing for the national English teacher's exam claimed that he cannot accept Krashen's

beliefs about second language learning (Smiley, forthcoming). In particular, the notion of implicit learning, whereby language is learned without direct recourse to explicit rule knowledge (Krashen, 1982), cannot be correct. This student argued that he learned English through an explicit grammar method, and because of this experience, Krashen cannot be right. The student's personal epistemology is formed by his experience, and that influences how he interprets Krashen's meaning. A student who holds such views will have difficulty accepting stably derived knowledge from theories that do not match his or her experience. I did not ask this particular student about Fido, but in-class experiments with students confirm the correlation of naïve epistemic beliefs with the inability to decouple hypothetical meanings in texts (Stanovich, 2009).

Stanovich (2004; 2009, 2011; Stanovich et al., 2016) has written extensively on the cognitive mechanisms that are involved in higher-order thinking. As a prominent proponent of dual-process theory, Stanovich (e.g. 2009) models the mind in a binary lower and upper form, the lower consisting of automatic and over-learned mechanisms and the upper containing algorithmic and reflective mechanisms. The key operation in the upper part is the action of decoupling, or holding in memory, of informational inputs from perception or memory and performing algorithmic and reflective operations on them. The process of decoupling allows minds to entertain hypothetical situations while conducting investigations into their truth value. This is at the base of the ability to tentatively accept (that is, be prepared to accept the potential truth of) a given text *as being true under the conditions of the text*. In other words, an expert reader can look at a text and assess the logic of the information in the text without recourse to their own personal beliefs about how the world works.

At this point, it is useful to return to the first level, of truth statement. In academic thinking, truth statements are only as stable as the technical analyses and the evaluatory processes that they are predicated on. If the method of applying the theory is conducted appropriately and the methodology itself is appropriate for the phenomenon and question in hand, the resulting inferred and interpretational knowledge will also be accurate. If a student does not approve of a theoretical stance, their rejection of that theory is a matter of personal, not academic, interest. If the student is able to articulate his or her objections at the level of theory, then their rejection becomes genuinely academic. Students have not demonstrated this ability in my research so far (Smiley, 2018a, 2018b).

As a corollary, finding errors in academic technical analysis or in the application of evaluatory processes can and does lead to the revision of old knowledge. Erstwhile knowledge can become mistaken fact, and old beliefs may be replaced by new ones (T. S. Kuhn, 1963). And armed with the cognitive ability to conceive mistaken facts that are not conceived as mere opinions, one can traverse through the six levels of propositional meaning once more, this time factoring in the notion of error.

Three investigations

In the following section, three small-scale projects are described. Investigation 1 tests the contents of students' knowledge belief structure. It provides evidence to support the claim that most students conceive informational content as being dichotomous: either it is fact or an opinion. Investigation 2 tests the degree to which students' personal beliefs about the world influence their reading of a text. A significant number of students seem to have difficulty decoupling a text and consciously ignoring their personal epistemologies during the decoupled reflective analysis of the text. Investigation 3 probes students' beliefs regarding the veracity of the source of information. The questions used in investigations 1 and 2, it must be noted, are extremely simple. Studies in non-Japanese children of the Fido question show that most children by the age of five answer it correctly (Stenning et al. 2006).

Investigation 1: Fact or opinion?

Investigation 1 attempts to find out what kinds of knowledge structures in relation to truth claims are held by undergraduate students. A series of in-class experiments were conducted using the following text from Karino (2019). Karino presents three Japanese sentences each with an associated image and asks if the sentence is a fact or an opinion based on the sentence/image combination. (次の文章は「意見」と「事実」のどちらでしょうか。(1) Aという問題集を使ったたかしくんは100点を取った。(2) Aという問題集はとても良い問題集だ。(3) 平成の次の年号は「平和」だ。(Question: Are the following sentences opinion or fact? (1) Takashi, who used an exercise book called A, got 100 points [in the test]. The associated image shows Takashi holding up a test paper marked 100 points. (2) The exercise book called A is a very fine exercise book. The associated image shows an exercise book with bright stars around it. (3) The era after Heisei is Heiwa. The associated image shows an official-looking man holding a placard on which the text "Heiwa" is written. Translation mine.)

The total number of students asked was 136. The results were as follows (see Table 2). Q1 136 answered fact. Q2 136 answered opinion. Q3 121 answered opinion and 15 selected fact.

For Q3 only, students were asked to discuss why they had selected opinion. After discussion, the number of responses changed to 103 maintaining their earlier answer of 'opinion', but 18 changed to 'fact'.

Students offered explanations as to why they had selected fact from each class group. If the English level of the class group was low, participants responded in Japanese; otherwise, they responded in English. Their responses fell into four similar categories and are as follows in Table 3.

Table 2

Fact or Opinion student responses		
Statement type		
Question	Opinion	Fact
Q1	0	136
Q2	136	0
Q3 (before discussion)	121	15
Q3 (after discussion)	103	33

Table 3

Reasons for believing that a mistaken fact is an opinion	
Response type	Sample reason for selecting 'opinion'
1	It's wrong. It's not true.
2	The current era is 'Reiwa'. This person said the wrong thing.
3	If it's not true, it's only his opinion.
4	I don't know why. I chose 'opinion' because I don't think it's right.

Karino's (2019) question format is flawed because it contains an either-or fallacy, or false dilemma where only two options are allowed but in fact other options are possible (Mercier & Sperber, 2017). However, other options may have become articulated during the discussion and response time. That they did not is telling. The knowledge structures held by students seems to be dichotomous, consisting of facts and opinions only. Relate this to MEXT's hope mentioned earlier "to go beyond a mere understanding of facts and opinions by comparing your understanding with other facts and opinions" (Mineshima, 2015, pp. 460-461). Here, too, knowledge consists only of facts and opinions.

Karino (2019) acknowledges that the answer to Q3 is (3) 事実：ただし「間違った事実」です。(Fact: but it is a mistaken fact.) The knowledge of the existence of propositional sentence types that are not opinion but that are also not true is absent from this data set. To students, if something does not match their personal epistemology, it is an opinion. And opinions may be unproblematically incorrect. Response type 2 indicates that the speaker's world knowledge is more important than any propositional meaning of the text. Philosophically, there may be sophisticated arguments for defending the selection of opinion, including separating lay from expert opinion and discussing all that entails. However, no participant demonstrated this ability.

Investigation 2: Fido barks

The phenomenon of personal epistemological stances influencing textual statements resembles the earlier Fido barks example. A small-scale in-class experiment was conducted with 45 undergraduate students using Fido (Stenning et al. 2006). Table 4 shows the results.

Table 4

Decoupling hypothetical knowledge: Does Fido bark?		
Question	Yes	No
Fido is a cat. All cats bark. Does Fido bark?	28	17

The majority of students were able to decouple their world knowledge from the hypothetical proposition set up for Fido. Yet, a significant number of students could not separate their personal world views from the made-up textual world. It is unknown currently if there is a correlation between students whose decoupling abilities is low, which is hypothesised to be caused by their personal epistemology, and their subsequent difficulties with academic thinking. One reason for not knowing is that in my own research to date, very few students demonstrate sophisticated epistemic abilities (Smiley, 2018a, 2018b; Smiley & Masui, 2016). Students report that information in textbooks is correct and unquestionable and that they believe or disbelieve information based on their personal experience (Smiley, 2018a).

Investigation 3: The gatekeeper

Students' disregard of deeper issues in epistemic verification is consistent with their beliefs about how textbooks and authority figures gain their trust. A number of students were asked to express their beliefs about various aspects of academic thinking and epistemology. The format was an online secure discussion board (Blackboard Coursesites). Nine English major students participated over two weeks during which they responded to a number of questions, including the question under review here. Table 5 shows three representative responses based on the question When you hear or read new information, how do you judge the reliability of the source?

Table 5

Beliefs about trust in academic reading

Question:	
When you hear or read new information, how do you judge the reliability of the source?	
Response 1	Besides, famous specialist's opinion tends to be right and trustworthy. Usually famous specialist's theory is widely accepted as valid, for example, Generative grammar in field of language acquisition such as Chomsky.
Response 2	If the information is said by a person whose position in that academic opinion is obviously high, or it is very persuasive, you believe the information regardless.
Response 3	Also, the publisher of information is also important. If the person is a specialist of the field or have experience to learn it, it is more reliable.

(Note that students' English has not been altered.)

The notion of the gatekeeper is dominant in these responses. There are many serious dangers in relying on famous names or reputable publishers as being sufficient to validate informational sources. At one level, this strategy (if, indeed it is conceived as a strategy by students) avoids many of the sourcing issues reported in undergraduate reading that include the naïve acceptance of any printed or internet material (Bråten, Ferguson, Strømsø, & Anmarkrud, 2014; Bråten, Strømsø, & Salmerón, 2011). Yet, scientific inquiry is predicated on questions based on the unknown (Gray, 2009). Furthermore, the nature of scientific argumentation is such that there are usually at least two positions on every conceivable question (Moses & Knutsen, 2012). Putting blind faith in a reputable source misses the key questions that are vital in understanding how knowledge is conceived in academic thinking.

Another question arises at this point. When students read academic material that contains

the background to a research question, the competing theoretical positions and the choices that led to the paper being read by students, *how do students internally represent textbook information?* Responding more fully to this question is work-in-progress (Smiley, forthcoming), but a contradiction becomes apparent. If academic papers and textbooks introduce students to both the informational content of academic knowledge and the conceptual apparatus that undergirds it, surely the reading experience should be a constructive force in shaping students' conceptions of academic thinking? However, even third- and fourth-year students fail to grasp the conceptual level of academic thought (Smiley, forthcoming).

This paper helps to answer this contradiction. When students' knowledge structures are primarily dichotomous, falling into 'fact' or 'opinion', students' experience of reading does not alter their existing structures. Information that concurs with personal epistemologies is accepted as truth, and that which does not is rejected as opinion. My own experience of conducting a fifteen-week intensive course on academic thinking failed to radically alter the conceptions of third-year students (Smiley, forthcoming). I had believed that exposure to and practice of investigating their personal epistemologies over the course of a term would result in more sophisticated epistemic thinking. It did not. I had not realised the need to consider the more basic propositional elements that are required in academic thinking: hence the six-level approach. Efforts to introduce critical thinking into the university are also likely to fail for similar reasons.

Let me finish this section with a vital observation. In a meaningful way, academic knowledge creation and subsequent propositional knowledge declarations are deliberate interpretational statements. Without a knowledge structure that includes inferencing and then interpretation from theory, critical and other academic thinking is impossible. Naïve student readers will simply interpret believable propositions as *being* fact and reject all others as opinions that do no mesh with their own. It is to the development of a fuller knowledge structure that I will turn to next.

Towards a pedagogy of propositional meaning

The following section outlines a pedagogic sequence and some examples of how each element may be introduced to students. The sequence is based on Table 1.

1 The truth statement

The reconceptions of fact into truth claim and opinion into interpretation represents crucial threshold concepts. A threshold concept in education:

> "can be considered as akin to a portal, opening up a new and previously inaccessible way of thinking about something. It represents a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress" (Meyer & Land, 2006, p. 3)

When knowledge structures consist only of facts and opinions, the notion of a mistaken

fact (Karino, 2019) has no place. Students' cognition needs to expand to understand the notion that so-called 'facts' are claims to truth (A. I. Goldman, 1986), and claims may have a positive, that is, true value or a negative, that is, false value (Mercier & Sperber, 2017). The development of a reflective awareness of truth value of propositional content is critical to higher-order thinking (Stanovich et al., 2016). Therefore, it seems logical to begin a pedagogy of propositional meaning with an introduction to truth statements. Yet, I suspect that this will fail. Naïve readers will interpret truth statements as external representations on paper of real-world meanings. The challenge is to help students realise and move away from their naïve realist personal epistemologies (Fitzgerald & Cunningham, 2002) and onto more sophisticated conceptions of how truth is represented externally and subsequently internally. As mentioned earlier, this first step needs to be repeated iteratively throughout any pedagogic treatment.

A key aspect in helping students become aware of the threshold conceptual step from seeing textual representations as simple copies of the world to seeing text as possible representations is to emphasise the active, even if submerged, nature of belief.

2 Textual transformation

The same propositional content may be expressed in different language. The meaning of *This text is printed on this paper* and *On this paper, there is some text printed on it* convey very similar propositional meanings. Similarly, *The man bit the dog* and *The dog was bitten by the man* (however unlikely that may be) relate to the same event, the same actors and patients and actions.

It may be difficult to see the value of teaching textual transformation. If both versions point to the same phenomenon, it may not matter which version is used. However, many language learners in particular fail to realise that language exams primarily test textual transformations and the upcoming text-based inferences. In this view, the propositional content of language testing is not on language meaning but on recognition of similarity between language items. For this reason, the notion of textual transformation serves a useful function in aiding students' understanding of the mechanisms in language, and in particular the failure of language exams to test for meaning. Another reason for introducing textual transformation is to begin the process of reflection on truth value beyond the single sentence propositional level.

For example, *The bus is running 10 minutes late* and *I'm going to get to Morioka at 1:40 not 1:30* can be shown to be transformations of the same underlying real-world phenomenon. Students are invited to question how similar these two different representations actually are when they refer to the same bus, same person and same action in time. Additionally, students can question the stability of these representations. They may reject or accept them as being similar. The point is not to enforce any particular version, but to locate the reflective process in a concrete language example. Students can learn to transfer their learning on these sentence prototypes to others that they encounter.

3 Text-bound inferences

This level remains in the linguistic sphere and features anaphoric and other pointer references. In *I've been to Hong Kong. I went there five years ago*, the *there* refers to *Hong Kong*. Such inferences are performed automatically, and students may not be aware of their own constructive agency in associating the meaning of *there* with *Hong Kong*. However, this level introduces inferences, and is, as such, a critical juncture in awareness development.

The anaphoric reference *there* is unproblematic. It points stably to *Hong Kong*. Typically, pointers have clear antecedents or will be easily decipherable from the context. Many cognitive scientists explore the boundaries of linguistic logic and human inferential capabilities. The famous Wason card experiment is a case in point (Mercier & Sperber, 2017; Stanovich et al., 2016; Stenning et al., 2006). Most people 'fail' the card test as Wason interprets it, yet different interpretations show that most people actually pass it under natural language conditions (Stenning et al., 2006). The discovery of cognitive boundaries and subsequent testing of human capabilities at those boundaries is in no way a reflection of any human innate dysrationality (Mercier & Sperber, 2017). Rather, it reflects cognitive scientists' predilections and interest at finding boundaries. Students can be urged to practice developing their sense of plausibility and stability of communicative intent through text-bound inferential training. This is the shallow end of the pool, the cognitively easy part of the process.

4 Non-text-bound inferences

Much of the mental representations readers construct during the reading process involve the associative pairings of textual and non-textual elements (Britt, Perfetti, Sandak, & Rouet, 1999; Perfetti & Stafura, 2015). Learning to see non-text-bound meanings is a crucial skill needed to progress to the higher levels of understanding. There are two types of non-text-based inferences. The first stays close to the text, or it is based on natural human experiences. However, the second relies on other outside information to complete the text. Very often, this outside information is cultural.

Let us return to our morning greeting.

June : Good morning, May.

May : Good morning, June.

Earlier, we discussed some meaning implications of this exchange. Here, I introduce a set of pedagogic techniques aimed at developing students' conceptual abilities related to inference building. Students see the greeting and then have to answer the following questions. The rubric is: Look at the following statements. Decide which are *likely to be* true (T), false (F), or unknown (U) based on the conversation.

1. June and May have met many times already that morning.
   T F U
2. June and May know each other well.
   T F U
3. June and May have just met for the first time that morning.
   T F U

4. June and May are close friends.
T F U
5. June and May hate each other.
T F U

Again, the point is not to enforce any particular correct answer but to continue the process of self-awareness and reflective thought. Readers build up representations of text in their mind based partially on their comprehension of the linguistic elements and partially on their beliefs about the world. The notion of epistemic confidence only has meaning when it is coupled with an ability to articulate the reasons for the confidence. A naïve "that's the way the world works" does not suffice; rather it occludes the possibility for deeper reflection and subsequent development of cognitive abilities. This activity provides the opportunity for students to develop their investigation into their own linguistic intuition.

A similar example comes from Smiley (2019):

Person A : I like this new Upple® computer.
Person B : Me, too.

Question: Do Persons A and B have the same opinion?

On the surface level, the opinion is the same, but deeper questioning may reveal that Person A, for example, likes the Upple® computer because of its processor speed and keyboard feel, while Person B likes it because of its design and light weight. This, I suspect, is what MEXT was suggesting when they urge students "to go beyond a mere understanding". However, the exchange of ideas should not be a "mere" reporting of positions; it should encompass reasons at least.

Currently in English language arts and in secondary-level science education in the United States, there is a movement that encourages a tripartite form of self-expression. Any claim needs to be supported by evidence and then by reasoning that links the evidence to the claim (S. R. Goldman, Ko, Greenleaf, & Brown, n.d.). This tripartite expression serves as a benchmark level for articulatory abilities and could be usefully applied in the Japanese context. Requiring students to articulate their understanding of why Person A's position is (potentially) divergent from Person B's utilises the claim-evidence-reasoning form.

The next stage is to provide space for students to develop their sensitivity towards their linguistic and social intuition. Teachers need to ask; "How confident are you in that belief?" for each claim-evidence-reasoning chain provided by students. Let us look at another example.

June was angry with herself for forgetting her umbrella. She wanted to get to work looking reasonable at least.

The rubric is; Look at the following statements. Decide which are likely to be true (T), false (F), or unknown (U) based on the text.

1. June knew that it was going to rain.
T F U
2. Jane loses her umbrella regularly.
T F U
3. Jane saw the weather forecast sometime before she went out.
T F U

If a student is completely confident that Jane did see the weather forecast before she left her house (#3), the student should investigate their own personal habits and expectations. They may find to their surprise that their own personal habits are at the base of their reading of the text. One student read *I've already told my parents about my plan to go to Australia* and wrote *The student needs a lot of money to get there*. Upon being asked why he thought the *I* was a student, initially, he did not know. After some time, he realised that he had imagined himself as being the *I* in the text and had imagined what he would need to go to Australia, providing more evidence showing that the process of word-to-text integration during reading (Perfetti & Stafura, 2015) is mediated by personal epistemologies. Such moments are instructive to students in helping them develop a more sensitive awareness of their own mental operations during reading.

Non-textual inferences often derive their meaning from cultural knowledge. The following example demonstrates this point.

With 82 minutes gone and three-nil down and exhausted, Paul couldn't stand the thought of meeting his co-workers on Monday.

Rubric: Answer the questions in the usual way.

1. There are eight more minutes left.
   T F U
2. Paul is losing at a sports match.
   T F U
3. The sports match is taking place on a Thursday.
   T F U

To anyone with even a superficial knowledge of football, its ninety-minutes rule and the severe difficulty of coming back from a three-zero deficit in only eight minutes, the first clause in the text can be processed relatively straightforwardly. Question 1, then, poses few difficulties for those with the requisite cultural background. However, without such knowledge, a reader may not be able to discount, for example, rugby at eighty minutes and its scoring system which would make a three-point difference near the end into an exciting finish. Question 2 is unproblematic, but question three requires many cultural referents to be invoked to achieve a meaningful representation. Once more, the point is not that the reader can find the truth, but that the student is investigating his or her own sense of intuition and developing the ability to articulate that intuition. Time spent in raising awareness about degrees of confidence about the inferences is also essential.

When inferences are discovered and the confidence levels regarding their likely truthfulness are not high, educators may probe students towards finding out what kind of conditions would make the inferences true and what conditions would invalidate them. This step further develops students' abilities in reflective awareness.

5 Personal epistemological interpretational inferences

The *Fido* example is a good bridge between cultural inferences and interpretation. Many students have difficulty answering the Fido questions because they hold strong beliefs about how the world is. Cats do not *bark*. Only dogs bark. Cats *meow*! When students are given

the new information that *On this really strange planet*, they can answer the questions easily. But it brings up important questions: what does it mean to believe that the world is a particular way?; and how certain should we be that our way of knowing the world is a good way?

Every person has their own personal world view, our *personal epistemology* (Baxter Magolda, 2010). Sophisticated thinkers have the ability to articulate their own world view, assumptions, beliefs and values (King & Kitchener, 1994). An example of cultural inferences is fireworks festivals. In Japan, most people make the inference of summer when they think about fireworks. This is because in Japan in summer the dark night begins around 7 o'clock. At this time, families with young children can still enjoy fireworks. However in the UK, fireworks are associated with late autumn and winter—for the same reason as Japan: the ability of families to enjoy an event in the dark; it gets dark in the early evening only in late autumn in the UK. It is light until 9 o'clock in the evening in the summer in the UK. That is too late for families with young children to enjoy fireworks. Without an awareness of the connection of *light evening* and *firework* and how that links with the seasons in your country, some may think that *it's natural, it's the way things are* to have fireworks in the summer (or winter, depending on where you come from).

This personal epistemology shapes knowledge representation during language comprehension. The following example demonstrates how personal epistemology affects thinking.

The government is here to protect us. Of course, I should follow their advice.

The personal beliefs about the role of the government affects the thinking of this speaker, who has a system of beliefs that centre on the idea that the existence of the government is to protect the people. Using this statement, what other beliefs can be understood? At the very least, it may be expected that the speaker *trusts* the government.

Something very interesting and important happened in the previous paragraph. A sentence was used as a base to understand other new knowledge that was not printed. This new knowledge (e.g. trust the government) is *not an opinion*. It may be the case that the speaker's opinion that *we should trust the government*, but that is categorically different from using it to generate the notion that the speaker *trusts the government*. We have *interpreted* the statement to make new knowledge. It is likely that most people will also arrive at the same conclusion (or accept the likelihood of the conclusion).

Interpretational processes do not produce opinions. A tenet of physical science quantitative research is reproducibility (Moses & Knutsen, 2012), but even qualitative research produces interpretational stable results when a similar interpretational frame is applied. Wertz (2011), for example, edited a volume in which a cancer patient's text is analysed according to five qualitative paradigms; including phenomenological psychology, grounded theory and narrative theory. The significant overlap in the analyses may be surprising to those who believe that qualitative inquiry produces unstable and divergent results.

Knowing what an interpretation is vital. As argued earlier, students' knowledge structures consist of only fact and opinion. There is no place for interpretational statements. When we ask *How likely is it that the speaker trusts the government?* we can state that it is probably

very likely. We cannot be 100% sure because it is not written directly. But based on the statement, we can say with *reasonable confidence* that the speaker trusts the government. It is not our *opinion* that the speaker trusts the government. It is our *interpretation* based on what outside world connections are hidden inside the statement. The difference between *opinion* and *interpretation* is one of the most important threshold concepts that students need to fully understand. Higher-level thinking is impossible without knowing how to interpret information because all academic (and textbook) 'facts' are in fact the result of interpretational processes. The next example is taken from the Flat Earth Society.

> *The world is not round: it is flat. How do we know this? The world looks flat; the bottoms of clouds are flat; the movement of the sun shows that the world is flat. These are all examples of how we know that we do not live on a round world (The Flat Earth Society, 2019).*

Rubric: Answer the following questions based on the passage.

1. Is the Earth flat?
2. If you answered 'no' for question 1, why?
3. What is the evidence for the flat earth belief?
4. How good is the evidence for the flat earth belief?
5. If you think that the evidence is weak, how can you show this?
6. Did you answer the questions 1 and 3 based on the text or based on your own personal epistemology, way of knowing the world?

If students' personal epistemology is the only way of knowing the world, they will face difficulties in understanding academic thinking. Let's look at why this is so. The flat earth belief is similar to the trust the government statement; it shows a belief that we can use to *interpret* new information. The first step is to *believe* the flat earth theory. Readers may not believe it at the end, but at the beginning, they need to accept it as being the truth *for the moment* as a product of the conditions of logic within the text.

A way to interpret the passage is to think; someone believes that the world is not round. They give evidence to support their belief. They make a conclusion based on their evidence. In other words, this person has interpreted the evidence to arrive at the belief that *it is true* that the Earth is flat. Readers must provisionally accept that truth. So, question 1 has to be 'yes'—based on the text only, not readers' own personal beliefs. Question 3 also needs to come from the text directly, not from our readers' beliefs.

In answering questions 4 and 5, students may realise that their own knowledge of the Earth's roundness came from textbooks and not from their own experience. Their own knowledge is only a belief in a similar way to the beliefs of the Flat Earthers. Most people cannot *prove* the Earth's roundness, but somehow, we still believe that the Earth is round. The point is to help students realise that what they think they know influences what they *choose* to believe, a cognition that is active for sophisticated thinkers, passive for naïve thinkers.

6 Scientific theory based interpretational inferences

A scientific theory is similar to a personal epistemology with one key difference. Scientific

theories write out their beliefs in as much detail as possible. In other words, scientific theories aim for maximal self-awareness and reflection. When scientific theories are written out, they can be challenged and improved. People, on the other hand, are often unaware of their own personal theories. But the point here is to demonstrate how new knowledge is created using such theories and how students' reflective awareness may be supported.

Flat Earth theory is an easy example to study because it is clearly wrong. However, are students aware of how much information in academic textbooks is wrong, changeable, or at least questionable? In the following section, I demonstrate a mini lesson that presents some issues in interpretation that may trouble students. My example comes from cognitive science. The language used is targeted at a competent English reader Japanese undergraduate who is taking a course in communication theory. The 'you' in the text refers to the student reader.

Cognitive science and interpretation mini lesson

In cognitive psychology, there is the idea that the brain is similar to a computer. Many textbooks use the computer idea to explain how the brain works. Indeed, the similarities between the electronic computer and the human brain are remarkable. Using the idea of the computer to study the brain is not a bad idea. But it is wrong. The human brain is not an electronic computer, and the way it works is very different from a computer. Yet, the similarities between the two make the idea useful in teaching.

A related example comes from learning a second language. You may think of your knowledge of English words as a kind of mental dictionary. The word *mental dictionary* is used often in second-language education. Scientists study how students learn new words. They use the idea of a mental dictionary. In 1977, Fay and Cutler talk about a mental dictionary and wrote:

> *We can think of it as similar to a printed dictionary (p. 509)*

Students who were learning to become language teachers in the 1980s read papers like Fay and Cutler (1977) and believed in the idea of a mental dictionary. The theory of the human mind contains the idea that we have stores of memory like a dictionary. Let's revise the four-stage theory-building process again using the mental dictionary idea.

1. A belief about the word memory being similar to a dictionary is created (*the theory*)
2. Some people's word knowledge is studied (*new object studied using the theory*)
3. New knowledge about those word memories is compared to a paper dictionary (*new knowledge created*)
4. If the paper dictionary idea is correct, the new knowledge about how humans store word memories is also correct (*the new knowledge is as correct as the theory*)

Scientists then tried to understand how humans store words using connections with the paper dictionary. So, Fay and Cutler (1977) talk about our minds linking sounds with word meanings in the same way a paper dictionary has a pronunciation guide. Note that *if the theory is correct*, the new information will also be correct. We cannot say that it is Fay and Cutler's *opinion* that the human mind is like a paper dictionary. Instead, we say they

interpreted the human mind through the lens of the computer metaphor and related theory of mental dictionaries and found similarities between the two. If you do not accept the theory, that is up to you. But it is not an opinion.

To some modern cognitive scientists, Fay and Cutler's (1977) text is similar to the Flat Earth theory. It may have been useful at one point in time, but advances in understanding have shown the belief to be problematic. Aitchison (2012) writes;

> *There is little similarity between the words in our minds and the words in book dictionaries, even though the information will sometimes overlap (p. 11)*

Aitchison (2012) then demonstrates why Fay and Cutler's idea is mistaken. Modern students who are training to be school language teachers now learn that the mental dictionary is not similar to a paper one.

The question, *which theory is right?* is not a helpful question, although because they are focussed only on facts and opinions, many students seem to want to know *the answer*. We may think about which theory is more likely to be correct. At this level, however, we do not think about *right* and *wrong*. We try to understand how the theory works and how new knowledge can be made using the theory. In this way, we can see how knowledge is correct *if the theory is used*.

Think about theory in this way. A theory is like a pair of coloured glasses. You put them on and see the world in a particular way. If you put on differently coloured glasses, you will see the world in a different way. There are many, many possible ways of knowing about the world. A theory gives you some beliefs. If you use that theory, you must accept and use those beliefs. When you use the theory, you see the world *through the lens* of the theory.

Finally, please know the importance of knowing theory. If you are not aware of the theory used in, for example, a textbook, you cannot understand how and why the knowledge there was made; and you cannot know how correct that knowledge is. And when you need to compare two different beliefs (such as Fay and Cutler with Aitchison), you will not know how to do so.

Conclusion

This mini lesson ends the first iteration of the cycle that began with understanding that a propositional statement is not a dichotomous 'fact or opinion' but rather has a truth value. From that point, the notion of text-bound and then culture-based inferences was discussed. At the final point, the foundational knowledge that academic thinking is primarily based in interpretations is reached, which is that interpretations are special forms of inference that rely on deliberate and specific conceptual frameworks. Once the sixth level is reached and finished, students would benefit from a return to the first and a repeat back through the levels because the knowledge of the final steps is likely to influence how the earlier steps are reconceived.

The notion of an interpretation means that other propositional meanings exist other than facts and opinions. Indeed, a fact is only a fact under certain conditions, and it was generated

by interpretational processes itself. There is evidence that such beliefs are currently not held by many students. The three in-class experiments are not conclusive, but they offer a proof of concept level data set that supports further investigation into students' knowledge belief structures. Experiment 1 brought up the phenomenon that students perceive many forms of propositional meaning as being reduced to either fact or opinion. Experiment 2 brings evidence that students' personal epistemology influences their ability to deal with hypothetical meanings. More work in this area is recommended. Experiment 3 demonstrates that students' beliefs about truth values is heavily dependent on more-abled others to gatekeep truth. However, in believing so, students become blind to deeper issues involved in knowledge creation.

In summary, the difficulties faced by those who wish to introduce critical thinking into the university may be partially addressed by understanding the structural content of undergraduates' knowledge beliefs. Teaching critical thinking directly without considering the cognitive bases on which it is predicated is likely to prove troublesome. Finally, I would offer the suggestion that teachers could usefully explain the interpretational processes that led to the information and not only present informational content.

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