2022

Into the Unknown Wilds: Fostering Productive Uncertainty in Information Literacy

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INTRODUCTION

This paper collects our thoughts and ideas about a concept we are calling productive uncertainty. Productive uncertainty is a theory of how we can engage with information even when it is difficult to claim to know anything for certain. In most academic fields, new knowledge is produced through prolonged conversation across a body of literature. No single study or published paper represents certain new knowledge. Scholars and researchers who read and write these types of papers know that each represents a possible solution, which may be more or less probable based on the strength of the evidence provided.

Our definition of productive uncertainty has two parts: the expectation or understanding that aspects of research and learning are necessarily "non-obvious and contingent" (Manz, 2018), and the ability to engage with what is still unknown or uncertain in order to acquire or create further knowledge or to make decisions. Our definition draws on Manz's research on K-12 science education, which argues that having students learn scientific "facts," as most K-12 curricula do, does not really equip them to be educated consumers of scientific research. Scientists and other researchers aim to formulate better answers over time, but they know that an answer can be the best currently available while not being final. That which is unknown or uncertain in science is exciting to scientists, because the state of ignorance drives inquiry, innovation, and new discoveries (Firestein, 2012). In other words, they work in a state of productive uncertainty about what they know and what they might possibly learn.

However, when scientific research is translated into popular media and discourse, much of the nuance of this uncertainty is lost. A study that shows a correlation between eating bacon and occurrence of cancer becomes "Yes, bacon really is killing us" in an online headline (Wilson, 2018). To a certain extent, the journalists or editors who write these headlines are catering to an audience that views uncertainty as unexciting or potentially invalidating to the research presented (Han et al., 2018). But media misrepresentations (whether willful or not) about how uncertainty functions in academic research, particularly in the sciences, provide the public with further evidence that certainty can and should be expected before taking new information on board. This feedback loop can lead to more extreme positions, such as dismissing evidence of global climate change, or questioning whether tobacco products are responsible for causing cancer.

As we will discuss, some traditional methods for evaluating sources used in libraries may also reinforce misunderstanding about the role of uncertainty in academic writing. In this paper, we offer ideas about using the concept of productive uncertainty to introduce more nuance into discussions around evaluating information, to reframe aspects of information literacy instruction, and to help learners navigate our current information climate.

BROADER IMPLICATIONS OF DEVALUING UNCERTAINTY

Classroom

Students often enter college at a stage of intellectual development that Perry (1970) refers to as "dualism," where they believe that one correct answer to any question exists, and that authorities are reliable sources (similar to what Kuhn et al. (2000) call the "absolutist" stage). At this stage, seeing experts disagree on an issue is disturbing, because it disrupts the sense that all authorities are correct (clearly if authorities hold opposing views, either one of them is not an authority or one of them is wrong). A

dualistic mindset makes research-based assignments challenging to students, who often feel they should be reporting on previously vetted facts. To become comfortable with uncertainty as a condition of learning, students have to reach what Perry (1970) refers to as the stage of commitment in relativism. At this stage, the individual can commit to a position as having merit relative to other available possibilities, while understanding that another, better answer may supersede the current one.

One way that librarians can unwittingly reinforce dualistic modes of thinking is through evaluation checklists like the CRAAP test (Meriam Library, 2010). We are certainly not the first to point out concerns about evaluation checklists (see Houtman, 2015 and Lenker, 2017, for example), but viewing them through the lens of productive uncertainty further illuminates some of their shortcomings. For example, to a student, the CRAAP test seems to be built on the premise that if your source meets all the criteria indicated, then it must be a "good source." If a source is "good," then it stands to reason that it would also be true or present undebatable facts. If your source is true, what do you do with another source that also passes the CRAAP test, but contains contradictory information? How do you decide which source to use in your paper? Do you just choose the one that you agree with most? While going through the criteria might be a good starting point for many students, the CRAAP test does not give students enough information about whether they should use the source.

As we will discuss in the Ideas for Teaching section, there are other ways to approach evaluating information that take into account states of uncertainty. One of the key tenets of productive uncertainty is that a single article or study cannot provide conclusive answers, and that we only reach a closer understanding (though not absolute) of an area of research through prolonged negotiation of ideas. The CRAAP test and other source evaluation checklists take a single article or source out of the context of its body of literature, so students are not encouraged to compare evidence and reasoning across multiple sources.

A related challenge in the classroom is that educators tend to believe that students can be inoculated against incorrect or sensationalized information by mastering a collection of facts. We assume that people who have more information about politics will be less likely to be taken in by fake news and that people who know more about science will be more likely to believe in global warming. In fact, research has indicated that this is not the case. Polarization on hot-button topics is greater among people with higher levels of science literacy and education (Drummond & Fischhoff, 2017), who may be better able to re-interpret evidence to support the conclusion they already favor. In Rabinovitch and Morton's 2012 study, however, people who had been prompted to see science as an ongoing debate were more likely to act in response to texts that acknowledged uncertainty in science, whereas people who were prompted to view science as a search for inarguable truths were more likely to act in response to texts where uncertainty was not acknowledged. This seems to indicate that our students are better served by an emphasis on the process of research and comfort with uncertainty than an emphasis on facts (which can be in any case be superseded by new discoveries).

Policy

Misunderstanding or misuse of uncertainty is not just an esoteric scientific or academic issue. An inability to tolerate uncertainty can lead to the premature closure of questions, such that answers viewed as "certain" become unquestionable. People with low tolerance for uncertainty also tend to remember or prioritize negative interpretations, experience higher anxiety in uncertain situations (Dugas et al., 2005), and adopt extreme or totalizing narratives in order to feel less threatened in the face of ambiguous evidence (Douglas, Sutton, & Cichocka, 2017). It's not hard to see these tendencies operating in the current political climate, perhaps most strongly in the propagation of "fake news" and the misframing of research results in mainstream media. If the general public does not understand how uncertainty is supposed to work in science, they are vulnerable to arguments for inaction where action needs to be taken.

An example that comes to mind is the long-standing "debate" around global climate change, where a handful of doubters are given equal consideration to near scientific consensus (Boykoff & Boykoff, 2007). Some commentators argue that if there is any uncertainty (e.g., a few scientists who say that global climate change is not caused by humans), then we shouldn't have to change policy, how companies act, or our own behavior. Absolute certainty and agreement cannot exist in this case, but the preponderance of evidence points towards action, so it's in our best interest collectively to act despite any remaining uncertainty.

To give a more specific example of how uncertainty can be used to undermine action, take the case of Dr. Mona Hanna-Attisha, the Flint pediatrician whose research uncovered high levels of lead in the drinking water. As described in her memoir, *What the Eyes Don't See* (Hanna-Attisha, 2018), she understood the need to mitigate uncertainty as much as possible when presenting her research to city politicians:

> Jenny and I had worked on dozens of academic studies over the years, but putting together an utterly perfect and unassailable one - in a matter of days, no less - was a bit of a leap. The pressure was intense. *One minor error, even one that didn't affect the findings, would give critics the ammunition to undermine me.* (emphasis added)

In Dr. Hanna-Atisha's estimation, an error would lead to inaction, even if the bulk of evidence pointed towards the need to act. Politicians and corporations interested in protecting themselves from lawsuits and backlash could emphasize the uncertainty inherent

in scientific research to make Dr. Hanna-Atisha's claims seem false or at least inactionable. In a similar way, tobacco companies in the 1960s worked to protect themselves from scientific consensus linking smoking and cancer by publicizing studies which didn't show evidence for a link (Gallagher & Berger, 2019). As with climate change, people who understand that the scientific research process always involves some degree of uncertainty will be less vulnerable to this kind of reasoning. To people who think of uncertainty as tantamount to inaccuracy, it may seem reasonable not to act in cases where there are any doubts. The consequences of such inaction, however, are potentially life-threatening.

It's possible to view public health crises like the one in Flint as threats to human life, rather than as theoretical or nebulous concerns, and we hope to help students learn how to do this when it's warranted. The above policy examples could serve as discussion starters in a classroom setting. While the students we teach in information literacy classrooms may never regulate tobacco or set policy in Flint, we hope to teach them to be comfortable with some ambiguity when responding to evidence as private citizens. Even if they may be proven wrong in the future, it seems better to act in the public interest with productive uncertainty, than to wait for certainty and not act at all.

IDEAS FOR TEACHING

Evaluating Scholarly Information

One way that we've used productive uncertainty in information literacy classrooms is to change the way we frame source evaluation for students. Instead of asking them whether a source is "good/bad" or "reliable/unreliable," we might instead ask them to focus on how the source itself handles uncertainty within a larger scholarly conversation. Take, for example, two sets of questions that students could use to examine a scholarly article:

Table 1: Source Evaluation Questions

The reframed questions ask students to examine a scholarly article within a larger context, and resist evaluating each article as an individual work. They point students to notice how uncertainty is inherent in most scholarly sources and encourage them to move beyond right/wrong types of thinking.

Limitations vs. Headlines

Another way of using productive uncertainty in the information literacy classroom is to ask students to look at the ways that scientists themselves express uncertainty about their research in peer-reviewed literature. One way to do this is to examine the limitations section of a published paper. These sections can be surprising to non-scientists, because they can sometimes seem to undermine the entire argument of the article.

Not understanding how the limitations section works in scientific literature can lead to over-hyped headlines and sweeping generalizations not warranted by the actual research. To help students recognize when this is happening, give students a scientific article and ask them to write a headline based on the title and abstract (the more eye-catching, the better). Then direct them to look at the limitations or conclusion section, and use the following questions as a guide:

- What do the authors say is possible to know or not know, based on their study?
- What would happen if you accepted the conclusions of the paper without considering the limitations?
- What further research could you conduct based on this conclusion? What questions does this study open up?
- How would you have to change your original headline for it reflect the actual findings of the study?

This can be used as a jumping-off point for students to practice considering an entire body of literature, rather than taking the conclusions of a single scholarly article as certain fact.

CONCLUSION

Our current public discourse about science, news, history and politics is fundamentally at odds with how new information is produced and disseminated. Although uncertainty is an integral part of discovery in most academic fields, we may be told that any uncertainty makes something unreliable. Traditional source evaluation methods that ask students to identify "good" and "bad" information may reinforce this discourse. We propose productive uncertainty as a conceptual frame to help librarians theorize the role of "not knowing for sure" in information literacy. By embracing uncertainty as a key component of academic knowledge, librarians can help fortify our students, colleagues, and ourselves against the forces of misinformation.

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Images for Tables and Figures (Editor will put in body of the text later)

Table 1

Standard Questions	Productive Uncertainty Questions
• Who is the author of the article? Are they an expert in their field? • Does the document use straightforward or technical language? Would you describe the writing as formal, informal, or in between? • Where was the article published? Who is the audience for that publication? • What evidence does the author use to support their claims?	• Who is the author, and what is their connection to the content? • What can we know and what can we not know from reading this article? • How certain/uncertain is the author about their claims? Do the data support that level of certainty? • How does the article relate to other information about the same or similar content? • How is the publisher/journal connected to larger conversations about similar topics?