Science Communication
1–12

DOI: 10.1177/1075547016674320
scx.sagepub.com

Cumulative Advantage in Sustainability Communication: Unintended Implications of the Knowledge Deficit Model

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Abstract

The knowledge deficit model proposes that more information increases public knowledge levels about a given topic and thus leads to improved attitudes and practice. However, research critiques the varying and limited ability of the deficit model. We argue that the deficit model can also produce an unintended cumulative advantage system: growing inequality between and within the knowledge-attitude-practice (KAP) gap of individuals and groups due to a wide variety of possible moderators. Over time, these effects can exacerbate gaps between individuals' and groups' levels of KAP. We discuss the negative effects of increasing inequality in sustainability KAP and provide recommendations for future research.

Keywords

cumulative advantage, sustainability, knowledge deficit model, knowledge gap, knowledge-attitude-practice, science communication

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The importance of general environmental care, sustainability, and climate change has stimulated research agendas, political ideologies, government policies, academic courses and centers, economic and infrastructure decisions, and media headlines across the globe (Boykoff & Roberts, 2007; Intergovernmental Panel on Climate Change, 2007). Yet, many polls reveal large discrepancies between the public's and scientists' knowledge and opinion on science topics. For just one of many examples, a Pew Research Center (2015) survey reported that although the interdisciplinary (i.e., not restricted climate scientists) scientist population overwhelmingly (87%) supported the statement "The earth is getting warmer because of human activity," only 50% of nonscientists agreed.

One might reasonably expect lay people to have deficient and discrepant science knowledge, compared to scientists, simply because of their different levels of training, awareness, access to information, and interest. Thus, the *knowledge deficit model* assumes that providing relevant knowledge is the best remedy for knowledge deficiencies and discrepancies (Bauer, Allum, & Miller, 2007). The knowledge-attitude-practice (KAP) model proposes that such knowledge (K) increase can change attitudes (A), and changed attitudes can then change practice (P; Bandura, 1986; Fishbein & Ajzen, 2011). In particular, effective sustainability communication should improve knowledge about, change attitudes toward, and motivate improved practice in sustainability (Godemann & Michelsen, 2011). However, the knowledge deficit model has been widely critiqued as too simplistic and not particularly effective (Sturgis & Allum, 2004). We argue that, in addition, a simple deficit-based sustainability communication paradigm can contribute to a *cumulative advantage* system, including *knowledge gaps*, *divergences*, and *divergence gaps*.

Moderators of Sustainability Communication Effects in KAP

While sustainability communication is presumed to improve K, A, and P, many factors moderate and mediate the KAP progression:

Group Identification: People are more accepting of information and persuasion from in-group sources (Mackie & Queller, 2000). According to self-categorization theory, when an advocated position is associated with an out-group's norms, the result is polarization away from it (Hogg, Turner, & Davidson, 1990). This is often the case in sustainability communication, where the out-group is a sustainability scientist, policy maker, or ideological/political group.

Existing Beliefs: Motivated reasoning (Kunda, 1990) proposes that individuals construe incoming information to support their existing attitudes and beliefs. This is a significant source of continued polarization, or even boomerang effects, in attitudes about climate change or sustainability issues, despite the efforts of sustainability communication (Hart & Nisbet, 2011; Kahan, 2012).

Ideology: Broader ideological orientations can influence sustainability knowledge, attitudes, and practice. For example, individualism and belief in a free market economy are negatively related to agreement with the existence, anthropogenic nature, and danger of climate change (Guy, Kashima, Walker, & O'Neill, 2014).

Party Affiliation: Political party affiliation is often the best predictor of an individual's attitudes toward the scientific consensus on climate change (Guber, 2013), and other issues such as recycling behavior and bottled water consumption (Coffey & Joseph, 2013; O'Donnell & Rice, 2012).

Uncertainty Portrayals: The journalism norm of *balance* can imply that an issue has (only) two positions, with support for each. This frames the state of climate change science as being uncertain and debatable (Boykoff & Boykoff, 2004), dramatically underrepresenting the scientific consensus (Oreskes, 2004). Uncertainty framing of sustainability communication can perpetuate or increase the gap between public opinion and scientific consensus (M. C. Nisbet, 2009; Weber & Stern, 2011), although this effect is itself moderated by environmental ideologies (Corbett & Durfee, 2004).

Income: "Green consumerism" and proenvironmental behavior and attitudes positively correlate with income (Finisterra do Paço, Barata Raposo, & Filho, 2009), often because of the costs involved. Income may also moderate the effects of green advertising on attitudes and practice regarding "ethical" or "socially responsible" consumption of green products (Atkinson, 2013).

Visual and Numeric Literacies: Visual literacy (the abilities to think, learn, and communicate visually) plays a central role in the processing and retention of visual components of information (K) offered by science communication (Rebich-Hespanha et al., 2015; Trumbo, 1999). Numeracy (the ability to think in, and learn through, numbers) influences risk assessment and knowledge gain (Peters, Hibbard, Slovic, & Dieckmann, 2007) and can moderate the effect of ideology on perceived climate change risks (Kahan et al., 2012). Interestingly, low numeracy can sometimes facilitate *more* attitude change about climate change messages (Hart, 2013), arguably because of increased persuasibility.

Knowledge Gaps and Cumulative Advantage

Knowledge Gaps

In 1965, *Sesame Street* debuted on American television as an attempt to use educational entertainment to boost the knowledge level of children who were underprepared for kindergarten or were underperforming in school. Indeed, *mean levels* of knowledge increased. However, follow-up research found that the *difference* between initially high- and low-performing children also increased (Cook et al., 1975). "The Knowledge Gap Hypothesis: Twenty-Five Years Later" (Viswanath & Finnegan, 1996) explained such outcomes by positing that the result of information diffusion is not equal individual gains but, rather, differential gains. Those with more resources—such as socioeconomic status, physical resources such as income, cognitive resources such as intelligence and learning abilities, or opportunities for education or career advancement—are able to better grasp and apply the knowledge. Although the mean level increases, so does the disparity between those with initially high and low knowledge, exacerbating the relative deficiency of those who needed the knowledge gain the most.

Cumulative Advantage

Over time, even slight initial knowledge gaps can generate a *cumulative advantage* system, also known as the Matthew effect (Merton, 1968), whereby "the rich get richer." Myriad social contexts reflect the ubiquity and power of cumulative advantage (DiPrete & Eirich, 2006).

Civic Participation. Economic and social disadvantage perpetuate differences in civic participation (Pacheco & Plutzer, 2008). In a vicious cycle, economic hardship stagnates voter turnout, which causes underrepresentation in the political process, leading to inadequate antipoverty policy and subsequent increased hardship.

Digital Divide. Information and communication technologies are most often and most effectively used by those already socially, cognitively, or economically advantaged, representing a "digital divide" (Katz & Rice, 2002; van Dijk, 2005), enabling subsequent access to more and diverse resources.

Education. Students who pretest at a high cognitive ability level—relative to their peers—enjoy proportionately higher gains from subsequent instruction (Walberg & Tsai, 1983). Variance in reading performance increases with grade level (Daneman, 1991).

Public Health. Over life spans, the gap in overall health between healthy and unhealthy people steadily increases (Willson, Shuey, & Elder, 2007).

Science Communication. Increases from media consumption in overall mean level of science knowledge are moderated by party affiliation, causing increasing differences in attitude and knowledge between conservatives and liberals (E. C. Nisbet, Cooper, & Ellithorpe, 2014; Zhao, Rolfe-Redding, & Kotcher, 2016).

Moderators of Cumulative Advantage Patterns. Many scholars have argued for various moderators of knowledge gap (and cumulative advantage) patterns. Individual motivation, often resulting from perceptions of severe or proximate threats, can facilitate knowledge acquisition in individuals who would normally be left behind by a knowledge gap pattern (Ettema & Kline, 1977; Viswanath & Finnegan, 1996). However, while some types of motivations generate proenvironmental responses to threats, others do not (Fritsche & Häfner, 2012). Furthermore, the same factors that moderate the sustainability KAP progression can also be the mechanisms by which sustainability communication has cumulative advantage effects. For example, differential "advantages" in ideology beget differential knowledge (or attitude or practice) change, which compounds over time.

The Disadvantages of Cumulative Advantage

Cumulative advantage systems and other inequalities are expected and normal in some systems, such as nature or the market economy (Kluegel & Smith, 1986). However, we argue that increasing inequality in sustainability KAP is inherently negative and especially counterproductive to the goals of sustainability communication. One negative consequence of cumulative advantage is a polarization or social segmentation of sustainability. For example, if a sustainability behavior required economic resources, this behavior would be practiced—to increasing disproportion—by high-income groups. Over time, that sustainable behavior could grow to be socially understood as a "rich person's thing," a stigma counterproductive to widespread participation. Similarly, due to the increased political polarization of sustainability issues, sustainability communicators face the Herculean task of convincing people that sustainability is *not* just a liberal's cause—it is a human, global cause. Furthermore, the increased gaps in sustainability K, A, and P by income, ideology, partisanship, culture, or other groupings (Hoffman, 2015) can reduce the likelihood of crucial intergroup collaborative and interdependent efforts (at interpersonal, community, national, and global levels). More directly, the

disadvantaged are more likely to bear the brunt of the potential consequences from environmental threats (Adger, 2006; Roberts & Parks, 2007).

Cumulative Advantage in KAP

The deficit model's reliance on the KAP process can perpetuate and exacerbate unintended effects mentioned above. Specifically, groups with differing levels of a given relevant moderating variable would experience differential effects of sustainability communication, resulting in increasing *knowledge gaps* between individuals or groups in K, A, or P; continued or increased *divergence* within the KAP progression; and *divergence gaps* between K, A, and P across groups over time, each contributing to a cumulative advantage system.

KAP Gaps

Extending the standard *knowledge gap* (Figure 1, *GK*), the cumulative advantage effect can also apply to A or P directly (Figure 1, *GA*, *GP*) and to the KAP sequence, resulting in further cumulative advantage (thus replicating and increasing the knowledge, attitude, and practice gaps).

For example, *GK* illustrates the gap effect on knowledge, where *Kh* and *Kl* portray different increases in knowledge as a response to sustainability communication.

KAP Divergence

Presume the *y*-axis in Figure 1 represents the percentage of the optimal level of K, A, or P, respectively. The KAP model assumes that knowledge initially is higher, attitude is lower, and practice is lowest. The knowledge deficit model assumes that with appropriate K increases, A and P would then follow suit, *and* that these initial differences would converge over time to some higher, near-optimal level. But hierarchical persuasion effects models (McGuire, 2012) suggest that any given degree of change in an initial step (K or A) results in much less change in the next step (A or P), due to mediating and moderating factors. Thus, even if sustainability communication does increase K, we expect *KAP divergence* (either *Dh* or *Dl* in Figure 1).

KAP Divergence Gaps

Finally, we should also expect *KAP divergence gaps*—that is, variation across groups in the divergence of individual or group K, A, and P (*DGh* and *DGl* in

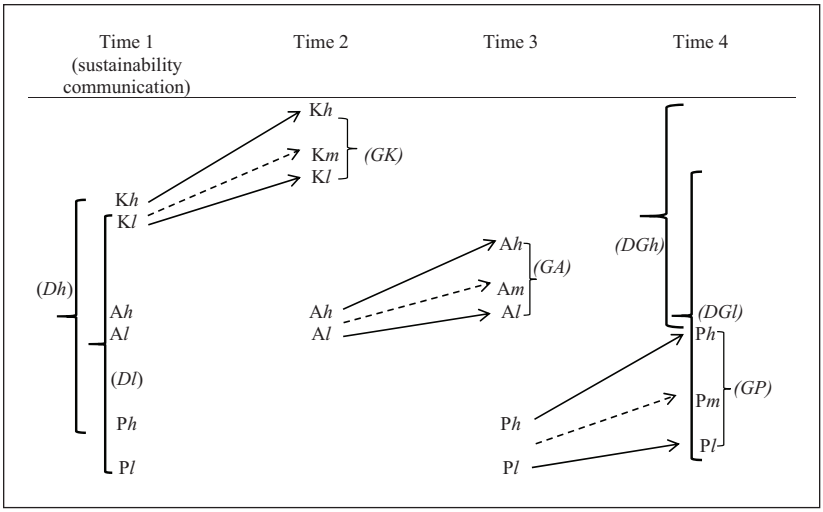

Figure 1. An illustration of three cumulative advantage effects in the sequential knowledge (K), attitude (A), and practice (P) process.
Note. These three effects are gaps (*G*), divergence (*D*), and divergence gaps (*DG*). The relative levels of K, A, or P in an individual or group are denoted as follows: *h* = high, l = low, *m* = mean.

Figure 1), due to the moderators fostering KAP divergence. This can also foster cumulative advantage at societal levels. This pattern compounds over time, because KAP divergence gaps create higher inequality in mean K, A, and P across groups and less convergence among K, A, and P relationships within and across groups.

It should be noted that the K, A, and P of those initial high performers cannot increase infinitely and therefore neither do the gaps, the divergence, or the divergence gaps. Thus, the nature and causes of such ceiling effects must also be investigated, in conjunction with the study of the nature and causes of cumulative advantage effects.

Implications for Future Research

To summarize, *even if* positive direct effects of sustainability communication on mean K, A, and P separately are observed, cumulative advantage effects may exist and persist. An application of a knowledge deficit model of sustainability communication that assumes an unmoderated, consistent, sequential, and homogenous KAP can create unintended effects in the forms of

increasing *KAP gaps* between groups, continued *KAP divergence* within individuals and groups, and increasing *KAP divergence gaps*.

Therefore, it is imperative to develop a program of research that accomplishes the following objectives. First, synthesize (through meta-analysis) and test (through longitudinal designs) the proposed relationship of the over-time cumulative advantage effects of sustainability communication that cause increasing knowledge, attitude, and practice *gaps* and *divergences* through differing levels of relevant moderating variables. Second, measure the change in divergence within KAP when K is increased, while also assessing the effect of moderating variables. Third, test the possibility of increasing *divergence gaps*. Fourth, identify the role of ceiling effects on gap, divergence, and divergence gaps. Fifth, develop and test a nuanced understanding of which moderating variables are most likely to produce cumulative advantage effects (in KAP gaps, divergence, or divergence gaps) across the diverse sustainability communication topics, methods, contexts, and audience groups. Sixth, assess how well other models of science communication, such as the dialogue or participation models (Bucchi, 2008), or rational choice or context models (Weigold, 2001), can reduce these negative implications.

Most importantly, scholars and practitioners should develop practical modes of sustainability communication that can mitigate cumulative advantage effects. When communicating to a diverse public, this might take the form of identifying which moderating variable(s) might be especially likely to create a cumulative advantage pattern for this topic, and then specifically design communication efforts to resonate with (or to not alienate) groups or individuals that are "low" on these moderating factors. But, in the meantime, we should at least be aware that when sustainability communication efforts are successful in changing the *mean* level of K, A, or P, this does not necessarily constitute "success." Because, ironically, the inequalities that are *increased* by this cumulative advantage system are precisely what the knowledge deficit model and sustainability communication were designed to *reduce*.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This project was funded by support from

the Mellichamp Academic Initiative on Sustainability at the University of California–Santa Barbara (http://sustech.ucsb.edu/).

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