Your liking is my curiosity: a social popularity intervention to induce curiosity

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Abstract

Our actions and decisions are regularly influenced by the social environment around us. Can social environment be leveraged to induce curiosity and facilitate subsequent learning? Across two experiments, we show that curiosity is contagious: social environment can influence people's curiosity about the answers to scientific questions. Our findings show that people are more likely to become curious about the answers to more popular questions, which in turn influences the information they choose to reveal. Given that curiosity has been linked to better learning, these findings have important implications for education.

Keywords: curiosity, intervention, social influence

Introduction

"Education takes for granted that sight is there but that it isn't turned the right way or looking where it ought to look, and tries to redirect it accordingly." –Plato, *Republic.*

From Sophocles' *Oedipus* to Plato's *Republic*, seeing has been a dominant metaphor for learning. In the latter text, Plato describes education as training to "look" in the right direction, thus equating curiosity with the figurative desire to see.

What stimulates such curiosity in the learner? Psychological accounts of curiosity posit that curiosity is piqued when we observe discrepancies (Berlyne, 1960; Loewenstein, 1994) or expect the resolution of our curiosity to improve the utility of our knowledge (Dubey & Griffiths, 2017). Studies based on these theories have explored methods to stimulate curiosity (Pluck & Johnson, 2011; Gentry et al., 2014), and curiosity has in turn been linked with better learning (Von Stumm et al., 2011), memory (Kang et al., 2009), and decision-making (Pierce et al., 2005). There thus lies tremendous value in identifying effective ways to promote curiosity, especially in pedagogical contexts.

In the current paper, we test a novel approach to stimulating curiosity: changing the learner's social environment. A wealth of prior work suggests that our actions and decisions are strongly influenced by social factors (Cialdini & Trost, 1998). Research in marketing and social psychology shows that people rely on the judgments of others to infer the value of an action (Rao et al., 2001; Amblee & Bui, 2011; Moyer et al., 2015). Research in education suggests that children's learning is informed not only by the material available to them, but also by the active work of other children and their social and cultural environment (Parr & Townsend, 2002; Kashdan & Fincham, 2004). As the internet and social media become ever-more pervasive, we can expect wide-spread effects of social cues on a variety of judgments and behaviors (Kim & Srivastava, 2007; Gruzd & Wellman, 2014).

On the basis of these findings, we explore the potential influence of a particular social cue—popularity—on people's curiosity for everyday questions about science. We focus on questions in the scientific domain for their potential significance in education. If popularity indeed affects curiosity, then interventions on social environment could be a powerful tool for educators of all kinds.

Background

Theories of curiosity

Berlyne proposed one of the earliest theories of curiosity within psychology. According to his account, curiosity is triggered by incongruity and violation of expectations (Berlyne, 1960). Building on these ideas, Loewenstein proposed that curiosity is a state of deprivation prompted by a perceived gap in knowledge or understanding; the result is a desire to close the "information gap" between one's existing information set and a desired state (Loewenstein, 1994). More recently, Dubey and Griffiths (2017) proposed a rational model of curiosity. This model posits that curiosity is evoked whenever people perceive an opportunity to increase the value of their knowledge. While theories continue to be tested and developed, these three accounts provide useful starting points for developing interventions on curiosity, and for considering why social cues might play a role.

Stimulating curiosity

Despite theoretical disagreements, curiosity is universally positively regarded, and it is acknowledged as a significant predictor of academic achievement (Von Stumm et al., 2011). Thus, a plethora of studies have explored methods to stimulate curiosity effectively. For instance, Berlyne's incongruity theory led the way for a number of studies that stimulated curiosity by designing "optimally incongruent" stimuli (Berlyne, 1963; Nakatsu et al., 2005). Loewenstein's "information-gap" theory has been used by many researchers to induce curiosity in education (Pluck & Johnson, 2011; Gentry et al., 2014), design (Law et al., 2016), and marketing (Menon & Soman, 2002). As one example, Law et al. (2016) showed that incomplete information (i.e., inducing an information gap) can be used to prompt curiosity and motivate participants in crowdsourcing tasks. Finally, the rational model of curiosity (Dubey & Griffiths, 2017), while relatively new, is consistent with earlier

work showing that adults' perceived value of information is a strong predictor of their curiosity and motivation to learn about a new topic (Rossing & Long, 1981).

The present research

Here we explore a novel way to stimulate curiosity: by manipulating the social environment. Specifically, we consider whether changing the perceived popularity of a question affects people's curiosity about the answer.

Despite the sizable literature on curiosity, little to no work has explored methods to influence curiosity by manipulating social environment. Yet there are good reasons to expect social environment to be a potent force: a large corpus of literature has shown that simply observing the behavior of other individuals or groups can affect an individual's thoughts, feelings, attitudes, and behaviors (Rao et al., 2001; Berns et al., 2010; Cha et al., 2010; Amblee & Bui, 2011; Moyer et al., 2015). Interestingly, a number of ecological studies have also shown that social cues regularly influence animals' foraging as well as habitat and mate choice (Dall et al., 2005). One explanation is that observers are simply motivated to conform, but recent work suggests that observing others' choices can also change the intrinsic value that the observer attaches to a chosen item (Berns et al., 2010).

The aspect of social environment that we manipulate is the popularity of a question. Why might popularity influence curiosity? Other people's interest in a question could itself be a source of incongruity or surprise, thereby stimulating people's curiosity (Berlyne, 1963; Loewenstein, 1994). Given that other people's choices can affect perceptions of value, we might also expect the popularity of a question to indicate the value of knowing the answer. Dubey and Griffiths's account of curiosity (2017) would predict that as the anticipated value of information increases, so too should curiosity.

Guided by these ideas, this paper asks the following questions:

1. Do social cues influence curiosity? More specifically, are people more curious about the answer to a question that is high in popularity?

2. Does the posited effect of social popularity on curiosity lead to differences in information search? Specifically, are people more likely to seek the answers to popular questions because they are more curious about them?

To address these questions, we conduct two experiments in which we present participants with questions about science, have them indicate their curiosity about the answers, and give them the opportunity to reveal a subset of those answers. To manipulate social environment, we use questions from a popular on-line forum, and we present the questions along with a high or low number of up-votes as a social cue to popularity.

Across experiments, we consider the effects of popularity on curiosity in both an *impoverished* and a *rich* information environment. In Experiment 1, participants were told only about the *topic* of a question. In this impoverished environment,

Sample Questions	Topic
Why can't the asteroid belt accumulate into one rocky planet?	Asteroids
How do our lungs prevent or eliminate dust?	Lungs
Why do your eyelids get puffy after crying?	Eyelids

Table 1. **Sample questions and topics.**

they were less informed than those who provided the up-votes, so we might expect them to rely on popularity as a good cue to the true value of a question. For example, they might be more curious about a popular question about asteroids than an unpopular question about eyelids because they infer that the former question is a better or more valuable question. In Experiment 2, we consider the stronger possibility that popularity affects curiosity even in a rich information environment, in which the full content of the question is known, and participants have access to the same information about the question as do those providing the up-votes.

Experiment 1

In Experiment 1, we investigated whether social cues (in the form of popularity) drive people's curiosity in a situation with "impoverished information," and whether this boost in curiosity affects subsequent information search. Participants received the *topics* of scientific questions, along with their up-votes. Participants were informed that the up-votes were made by people who saw the full question (and not just the topics), and thus participants were impoverished in another way—they had less knowledge than those who provided the up-votes. Participants then reported their curiosity about the full question and answer and later had the opportunity to reveal a subset of questions and answers.

The experiment tested the following three predictions: (1) Participants will report greater curiosity about popular questions relative to unpopular questions, (2) Participants will be more likely to choose to reveal the full questions and answers for popular questions relative to unpopular questions, and (3) The effect of popularity on information search will be mediated by curiosity.

Method

Participants 300 participants were recruited from Amazon Mechanical Turk and were paid $1.00 for their participation in a 7-8 minute study. Informed consent was obtained using a consent form approved by the Institutional Review Board at the University of California, Berkeley.

Stimuli

The stimuli used in the experiment were fifty questions sampled from Reddit's *Explain Like I'm Five* subreddit, collected over the course of four months. We chose questions that were moderately popular, as reflected in up-votes between 200 and 600, to avoid outliers in either direction. For each question, we manually identified the main topic (Refer to Table 1).
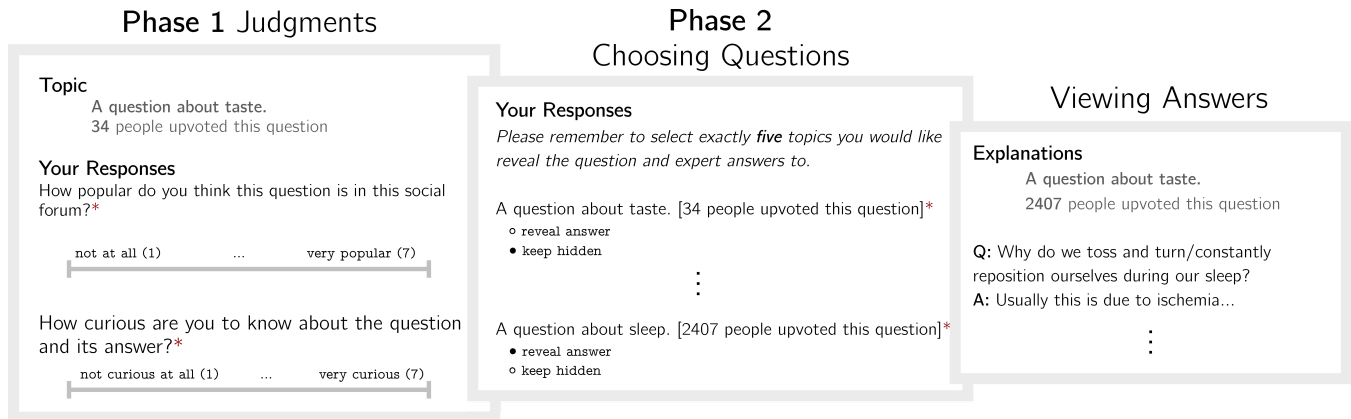
Phase 1 Judgments

Phase 2
Choosing Questions

Viewing Answers

Topic
A question about taste.
34 people upvoted this question

Your Responses
How popular do you think this question is in this social forum?*

not at all (1) ... very popular (7)

How curious are you to know about the question and its answer?*

not curious at all (1) ... very curious (7)

Your Responses
*Please remember to select exactly **five** topics you would like reveal the question and expert answers to.*

A question about taste. [34 people upvoted this question]*
  ○ reveal answer
  ● keep hidden

⋮

A question about sleep. [2407 people upvoted this question]*
  ● reveal answer
  ○ keep hidden

Explanations
A question about taste.
2407 people upvoted this question

Q: Why do we toss and turn/constantly reposition ourselves during our sleep?
A: Usually this is due to ischemia...

⋮

Figure 1. **Design of Experiment 1**. The experiment was divided into two phases. In Phase 1, participants were presented with the topics and number of up-votes for each of ten questions and asked to rate their curiosity and perception of the question's popularity. In Phase 2, participants had the choice to reveal the questions and answers for five of the previously shown question-topics. Finally, the selected questions and answers were revealed. Note that instructions were provided before each phase.

Procedure   At the start of the experiment, each participant was assigned to ten questions randomly sampled from our fifty-question database. The experiment was then divided into two phases, described below (see also Figure 1).

Phase 1   In the first phase, participants were presented with each of the 10 questions, but indicated only in terms of their topic (e.g., "a question about sleep"). For each question, participants were also presented with the number of up-votes that the question putatively received on a "popular online forum." While participants could only see the topic of the question, they were told that the up-votes were given by members of the online community who viewed the full question text, and not just the topic. Participants were also told that the up-votes were based only on the questions, and not on the answers to those questions. Crucially, out of the ten questions presented to each participant, five were randomly assigned a high number of up-votes, and five were assigned a low number of up-votes. These numbers were drawn from low-variance normal distributions with means of 2405 and 24, respectively. After seeing each question and its corresponding up-vote, participants were asked to rate how popular they thought the question was on a scale from 0-6. This question was a manipulation check to ensure that participants correctly interpreted the number of up-votes. Participants also rated their curiosity in knowing the full question and its answer, again on a scale from 0-6. This was the key variable of interest in Phase 1.

Phase 2   In the second phase, participants were given the opportunity to reveal the questions and answers corresponding to five of the ten question-topics that were rated in Phase 1. The question-topics and up-votes from Phase 1 were again presented, and participants indicated their five choices. The corresponding questions and answers were then revealed.

Results

For the analyses that follow, we removed participants whose ratings across all questions (of popularity and curiosity) had extremely low variance ($\sigma^2 \leq 0.75$); these participants consistently used one of three consecutive ratings for every judgment. Eight participants were excluded on this basis, but their inclusion does not affect the significance of our findings. The final sample consisted of 292 participants.

Phase 1   We first confirmed that our manipulation of up-votes successfully manipulated perceived popularity. As shown in Figure 2(a), the mean popularity rating for questions with high up-votes was 3.18 points higher than that for questions with low up-votes. A paired-samples t-test revealed that this difference was significant, $t(291) = -31.7, p < 0.001$, indicating that our manipulation of up-votes was an effective social cue. We next tested whether our popularity manipulation influenced participants' curiosity. As shown in Figure 2(a), the mean curiosity rating for questions with high up-votes was 1.23 points higher than that for questions with low up-votes. A paired-samples t-test confirmed that this difference was also significant, $t(291) = -14.2, p < 0.01$, indicating that the manipulation of up-votes had a reliable effect on curiosity.

Phase 2   To investigate whether participants were more likely to reveal the full questions and answers for questions that were presented with more up-votes, we tested whether questions presented with high up-votes were revealed more often than the chance value of 50%. As shown in Figure 2(b), participants revealed high up-vote questions 64.7% of the time (and conversely, revealed low up-vote questions 35.3% of the time). A single sample t-test showed that this proportion was significantly different from the prediction of the null hypothesis, $t(291) = 11.1, p < 0.001$. Finally, we considered whether curiosity mediated the effect of up-votes on whether a question-answer pair was revealed. We first ran a logistic regression predicting whether a question was chosen from the experimental manipulation of up-votes; this yielded a significant and positive coefficient of 0.298 ($z = 15.597, p < 0.001$). We next considered a regression predicting whether a question
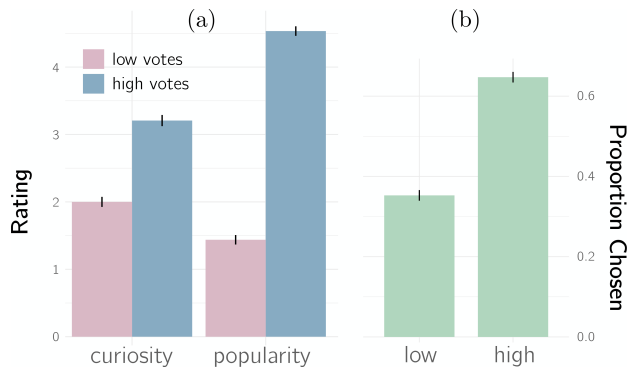
Figure 2. **Popularity influences people's curiosity (Experiment 1)**. (a) Participants gave higher average ratings for both the perceived popularity of the questions within the social forum and about their own curiosity to learn about the question and its answer. (b) Questions with higher up-votes were more likely to be revealed by participants.

was chosen from rated curiosity, yielding a significant and positive coefficient of 0.517 ($z = 22.015, p < 0.001$). We then fit a multiple regression with both curiosity and popularity as predictors; this yielded coefficients of 0.459 and 0.112 respectively ($z = 17.807, p < 0.001$ and $z = 5.165, p < 0.001$), suggesting partial mediation. These findings are consistent with the idea that up-votes affected whether a question/answer was revealed in part because they affected curiosity about that question/answer.

Discussion

Experiment 1 tested and found support for three predictions about the effects of popularity in an impoverished information environment. Participants were more curious about popular questions (vs. unpopular questions), and they were more likely to reveal the full questions and answers for popular (vs. unpopular) questions. Moreover, the effect of popularity on information search was partially mediated by curiosity.

Experiment 2

Experiment 2 had two aims. First, we sought to investigate whether the key findings from Experiment 1 would generalize to a situation with "rich information." Specifically, participants were given access to the full text for each question – not only its topic – along with high or low up-votes. This environment was also *rich* in the sense that participants had the same knowledge about the questions as the people who provided the up-votes. As in Experiment 1, we predicted that up-votes would affect curiosity and in turn affect information search. The second aim of Experiment 2 was to gain insight into *why* a social cue to popularity would affect curiosity. Based on extant theories of curiosity, we considered four hypotheses. First, up-vote information could change participants' beliefs about their own knowledge, leading to an information-gap and thereby influencing their curiosity. To test this, we asked participants to rate their *confidence* in whether they knew the answer to

the question. Second, up-vote information could lead to incongruity between participants' own expectations and the actual number of up-votes, again introducing an information-gap and prompting curiosity. To test this, we asked participants to rate how *surprised* they were by the popularity of the question. Third, participants might infer that knowing the answers to the high up-vote questions would be valuable to them in a social setting. To investigate this, we asked participants to rate the *social utility* of knowing the answer to each question. Fourth, participants might infer that knowing the answers to the questions with high up-votes would be of more general value (and not just in a social setting). To test this, we asked participants to rate how *useful* they thought knowing the answer to the question would be in the future.

Method

Participants   301 participants were recruited from Amazon Mechanical Turk and paid $1.50 for their participation in a 12-minute study. Informed consent was obtained using a consent form approved by the Institutional Review Board at the University of California, Berkeley.

Stimuli   The stimuli used in this experiment were the same fifty questions used in Experiment 1.

Procedure   This experiment followed the same design and procedure as Experiment 1, with two key differences. First, participants were presented with each question in full (as opposed to only presenting the topic of the question). Second, in addition to popularity and curiosity ratings, participants responded to additional prompts designed to assess factors that could have affected curiosity. Participants responded to each of the following on a scale of 0-6:

1. *Confidence*: "How confident are you that you know the correct answer to this question?"

2. *Surprise*: "How surprised are you by the popularity of this question?"

3. *Social utility*: "To what extent would knowing the answer to this question be useful to you in a social setting?"

4. *Usefulness*: "To what extent would knowing the answer to this question be useful to you in the future?"

Results

For all analyses in Experiment 2, we used the same exclusion criterion as in Experiment 1. Nine participants were thus excluded for very low variance in their judgments ($\sigma^2 \leq 0.75$). However, the significance of the results are not affected by this exclusion. Our final sample consisted of 292 participants.

Phase 1   We first tested whether up-votes again succeeded in manipulating perceived popularity. As shown in Figure 3(a), perceived popularity was 2.27 points higher for high up-vote questions when compared to low up-vote questions. This was a significant difference, $t(291) = -23.1, p < 0.001$, suggesting that up-votes once again served as an effective social cue.
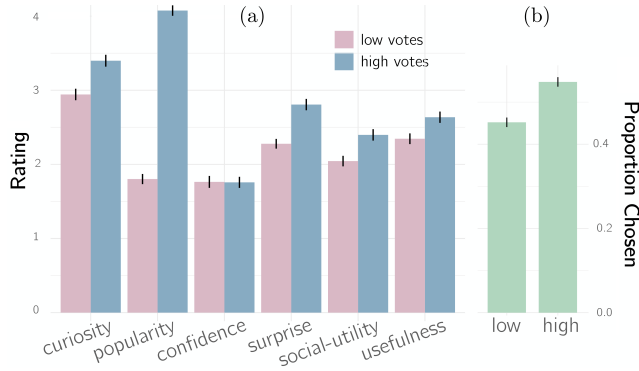
Figure 3. **Popularity influences people's curiosity in a rich information environment (Experiment 2)**. (a) Up-votes influenced participants' ratings for every judgment except for their confidence. (b) Higher up-voted questions were once again more likely to be revealed by participants.

Next, we tested whether curiosity was affected by up-votes, even in this rich information environment. As shown in Figure 3(a), curiosity was higher by 0.455 points for questions with high up-votes versus low up-votes. This difference was significant, $t(292) = -6.68, p < 0.001$, indicating that the effect of social popularity on curiosity extended to a rich information environment. We also conducted similar paired-samples t-tests for each of the remaining judgments. The results are reported in Table 2. We found that popularity did not reliably affect participants' confidence, but it did have a significant effect on participants' judgments of surprise, social utility, and usefulness. These judgments were all correlated with curiosity; however, none fully mediated the effect of popularity on curiosity.

Phase 2 To investigate whether the manipulation of popularity affected information search, we tested whether questions with high up-votes were revealed more often than the chance value of 50% (Refer to Figure 3(b)). A single-sample t-test showed that participants' choice of high up-vote questions (54.8% of the time) was significantly different from chance, $t(292) = 4.24, p < 0.001$. This suggests that even in a rich information environment, manipulating up-votes had an effect on information search.

Judgment	Effect Size	$t(292)$	p-value
popularity*	2.27	−23.1	< 0.001
curiosity*	0.455	−6.68	< 0.001
confidence	−0.001	0.112	> 0.05
surprise*	0.529	−6.48	< 0.001
social utility*	0.353	−6.46	< 0.001
usefulness*	0.290	−4.98	< 0.001

Table 2. **Impact of manipulating up-votes on judgment ratings (Experiment 2)**. Effect sizes are the mean difference of ratings, subtracting the low up-vote group from the high up-vote group; significant differences are starred.

As in Experiment 1, we tested whether the effect of up-votes on information search was mediated by curiosity. First, a logistic regression predicting question choice from the manipulation of up-votes revealed a significant positive coefficient of 0.144 ($z = 7.503, p < 0.001$). A similar regression with curiosity as the predictor produced a coefficient of 0.406 ($z = 18.791, p < 0.001$). Next, a multiple regression with both curiosity and popularity resulted in a non-significant coefficient of 0.0343 for popularity ($z = 1.5994, p = 0.110$), while curiosity remained significant at 0.395 ($z = 17.606, p < .001$). This suggests that the effect of up-votes on information search was fully mediated by curiosity. Finally, we considered whether the effect of curiosity was still significant, controlling for all other judgments. We conducted a multiple regression using all six judgments to predict whether a question was revealed and found that curiosity outperformed all other predictors with a coefficient of 0.346, maintaining its significance ($z = 12.874, p < .001$).

Discussion

The findings from Experiment 2 mirror our three findings from Experiment 1, but in an environment with richer information. Even though participants had access to the full content of each question, we found that popular (vs. unpopular) questions induced greater curiosity, and that participants were more likely to reveal their answers. We also found that curiosity fully mediated the effect of popularity on information search, and that while curiosity was related to three of our additional judgments (surprise, social utility, and usefulness), the effects of curiosity could not be reduced to these factors.

Comparison of Experiments 1 and 2

Experiments 1 and 2 differed in whether questions were presented with only their topic (Experiment 1: impoverished information) or with the complete text for each question (Experiment 2: rich information). Did amount of information moderate the effect of social environment on curiosity and information search? To answer this question, we compared effect sizes across Experiments 1 and 2. In Experiment 1, manipulating up-votes increased curiosity by +1.23 points; in Experiment 2, high up-votes increased curiosity by only +0.455 points. A two-sample t-test revealed that these effects differed significantly, $t(292) = 7.04, p < 0.001$. Similarly, although participants chose questions with high up-votes more frequently in both experiments, this proportion was higher in Experiment 1 (64.7%) compared to Experiment 2 (54.8%). This difference was also significant, $t(292) = 5.71, p < 0.001$, suggesting that the impact of popularity on both curiosity and question choice was stronger when more information was unknown.

General Discussion

We began this paper by asking whether a learner's social environment can influence curiosity. Across two experiments, we find that the answer is "yes." Manipulating the perceived popularity of a question led participants to report greater curiosity

about the answer to that question. The effect of popularity extended to subsequent information search: participants were more likely to reveal the answers to popular questions, and this effect of popularity on information search was mediated by curiosity (partially in Experiment 1, fully in Experiment 2). Experiment 2 additionally revealed that popularity influenced participants' judgments of surprise, social utility, and usefulness, lending support to various theories of curiosity. Finally, the comparison of Experiments 1 and 2 suggested that effects of popularity may be greater when judgments are made with limited information.

Our findings raise new and important questions for education. If people are less likely to become curious about unpopular questions, how can educators successfully induce curiosity for unpopular topics? Some recent studies have explored the influence of group membership on curiosity (Sinha et al., 2017; Thomas & Vinuales, 2017); this raises the question of whether social distance or group-status moderate effects of popularity on curiosity. More generally, what other features of a learner's social environment might influence curiosity and subsequent learning?

Despite the promise of our results, the educational impact of our study is limited by the nature of our stimuli and task. We focused on short-term consequences of manipulating popularity through up-votes; it is not clear if effects of popularity would persist over longer time-scales and result in tangibly better learning outcomes. Similarly, while up-votes have natural analogues on social media and in online learning environments, it is unclear how they might translate to a more traditional classroom. These are important questions for future research.

Despite these limitations, the potential implications of our findings are far-reaching. Because popularity can successfully induce curiosity in an *impoverished* information environment, it could be a particularly effective cue for learners who know too little to appreciate an information gap, or to recognize the potential value of information in a novel domain. Given that popularity also has an effect in a *rich* information environment, educators can readily incorporate social cues in existing platforms, with the expectation that the popularity of particular topics or questions will affect students' curiosity and subsequent behavior. In Plato's allegory, the purpose of education is to redirect an individual's 'sight'. Our findings suggest that manipulating social environment is one way that educators can help learners figure out where to look.

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