Refutation Texts: A New Approach to Changing Public Misconceptions About Education Policy

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Individuals often have misconceptions about education policy issues. Prior research has shown that refutation texts can address misconceptions in other areas (e.g., climate change, GMOs); this study is the first to explore whether participants' views on controversial education policies—the Common Core State Standards and charter schools—are similarly malleable through refutation text interventions. Results of two experiments show that refutation texts reduced participants' misconceptions and increased their correct conceptions about both policy issues. These impacts persisted for at least a week in both cases. Our findings hold promise for policymakers, implementers, and researchers seeking to buttress support for policies through direct, evidence-based refutation texts.

Keywords: conceptual change; educational policy; experimental design; psychology; survey research

It is important to have a well-informed citizenry who can use evidence-based knowledge to express their positions through the democratic process. Yet, there is growing concern about the extent to which individuals possess the relevant knowledge and understanding of key political issues to do so (Abramowitz, 2010). This concern has resulted in popular and academic discussion about addressing the general public's lack of understanding of important issues in science, politics, and other areas. The issue of so-called "fake news," and its effects on knowledge and behaviors, for example, has been a major focus of discussion—especially since the 2016 presidential election (Lewendowsky, Ecker, & Cook, 2017). This concern extends to the realm of education. De Bruychere, Kirschner, and Hulshof (2015), for example, identified 35 common "urban myths" held by the public. Of those, eight are educational policy myths including: "class size does not matter," "more money necessarily means better quality instruction," and "education never changes."

The public's lack of knowledge about education is problematic, because research has shown that adherence to false beliefs, myths, and misconceptions interferes with acceptance of scientific positions (Shtulman, 2017; Sinatra, Kienhous, & Hofer 2014). If misconceptions are corrected, however, acceptance is more likely (Heddy, Danielson, Sinatra, & Graham, 2017). It seems reasonable to suggest that acceptance of education policies could similarly be limited by misconceptions and, perhaps, similarly affected by correcting misconceptions. There are a variety of research-based approaches demonstrated to be effective in changing individuals' beliefs and conceptions, but most of them involve extensive time and in person engagement, such as critical thinking pedagogical approaches, simulations, and group discussions (see Lin et al., 2016).

An alternative—and less cumbersome—approach that has shown promising results is the use of refutation texts (Sinatra & Broughton, 2011). Refutation texts are targeted prose that range in length and type but are written for the express purpose of changing widely held misconceptions. Refutation texts have three major components. First, they call attention to a specific misconception (e.g., "Some people think that Earth is flat"). Second, they directly "refute" that misconception (e.g., "However, scientists have shown that Earth is in fact a sphere"). Finally, they support the refutation with explanation based on evidence (e.g., "The shadow Earth casts on a moon during an eclipse, for example, provides evidence that Earth is actually round"). A refutation text can address one or multiple misconceptions in the same text, so long as this general structure is observed for each misconception. Refutation texts were first introduced in education to overcome misconceptions about science, and they have been used extensively and effectively to do so (Sinatra & Broughton, 2011; Tippet, 2010). Reading refutation texts has been shown to reduce misconceptions about controversial science topics (e.g., climate change; Danielson, Sinatra,

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& Kendeau, 2016), and non-controversial science topics (e.g., seasonal change; Cordova, Sinatra, Jones, Taasoobshirazi, & Lombardi, 2014). Refutation texts have also been used in other domains including mathematics (Lem, Onghena, Verschaffel, & Van Dooren, 2017) and history (Donovan, Zhan, & Rapp, 2018).

There are several theoretical accounts of why refutation texts have proven effective in other contexts (for an in-depth discussion of multiple theoretical accounts see Sinatra & Broughton, 2011). We chose to frame our investigation using the Knowledge Revisions Components (KReC) framework (Kendeau & O'Brien, 2014). Central to this framework is the process of co-activation. The KReC framework explains that knowledge revision is most likely to occur when the reader's general world knowledge is activated at the same time as the target information. Co-activation provides the reader with the opportunity to compare the two ideas. The structure of refutation texts supports co-activation by stating the misconception and then, immediately and directly, refuting it. Another key component according to this framework is providing a clear and coherent explanation of the new idea, which supports the integration of the new information into the reader's prior knowledge (Kendeau, Butterfuss, Van Boekel, & O'Brien, 2017). We followed these principles in the design of our texts.

Our two experiments are the first we are aware of to use refutation texts to shift misconceptions about educational policies. This is a fruitful area to explore, because educational policies, such as controversial science topics, can also be subject to polarization and partisan misconceptions (e.g., Polikoff, Hardaway, Marsh, & Plank, 2016). Furthermore, refutation texts are relatively easy to develop, and they are well suited to use in online forums. With the ubiquity of the internet, smart phones, and other computing devices, refutation texts can be easily deployed to blogs or web-based content news sources. This makes refutation texts a promising intervention for addressing common misconceptions about educational policies.

We report results from two experimental studies designed to test whether refutation texts can be used to change individuals' conceptions about two well-known and controversial educational policies: the Common Core State Standards (CCSS), and charter schools. As we describe below, we used randomized survey experiments via Amazon's Mechanical Turk (MTurk) to test the impact of refutation texts relative to a control text. In short, we found that refutation texts reduced participants' misconceptions and increased their correct conceptions about both policy issues. These impacts, moreover, persisted for at least a week in both cases. Our findings hold great promise for policymakers, implementers, and researchers seeking to buttress support for policies through direct, evidence-based refutation texts.

Research Questions

Our goal for the two experiments reported below was to examine whether a refutation text-based intervention could be effectively applied to two policy problems: 1) misconceptions about Common Core standards, and 2) misconceptions about charter schools. We focus our analyses on the following questions for each policy area:

Research Question 1: What is the effect of the refutation text on correct conceptions and misconceptions?
Research Question 2: To what extent do these effects persist over a week?

General Method

Overview

In the experiments reported here, we used a between-subjects design with random assignment into one of two conditions: 1) a refutation text designed to correct misconceptions about salient education policy issues, or 2) a control text covering the same issues, but in a more common expository form typical of blogs and other web content. We chose control texts with a mind toward ecological validity. Thus, control texts were adapted from actual texts found online after searching for information about Common Core standards and charter schools. We note that this is both an affordance and limitation of our design; our process for finding control texts yielded articles that would likely be found were someone to search for information on the Common Core or charter schools, but such expository texts are not necessarily designed to reduce misconceptions; rather, they are simply written to present accurate information. Our final control texts and refutation texts were comparable in length and readability, and we describe them below. (Both sets of texts, as well as readability statistics, can be found in the online appendix, available on the journal website.) We identified what we believed were likely to be misconceptions on these two topics from our knowledge of the policy and media conversations about each. Next, we tested their prevalence in state representative samples in the PACE/USC Rossier poll of California voters (see Polikoff et al., 2016). Finding that these misconceptions were indeed prevalent, we then selected them for this study. Though we did not test the misconceptions in national samples prior to this study, we believed the misconceptions would be prevalent outside California given the nearly-national prominence of Common Core (originally adopted in 46 states) and charter schools (currently existing in 44 states). Thus, we made no effort to restrict the sample geographically.

Participants

Participants for both experiments (*n* = 595 for Experiment I, *n* = 599 for Experiment II; *n* = 1,194 total) were recruited from Amazon's MTurk—a service offered by Amazon that has been used to connect researchers to research participants in an online marketplace, although this is not its sole purpose. Individuals who agreed to participant in MTurk tasks received a nominal fee for their time. Participants in this study were compensated $0.50 for their time, and given an opportunity to earn an additional $0.50 to complete a follow up survey one week later. Though seemingly low, these are typical to higher-than-average compensation rates for MTurk studies.

A recent article in *Educational Researcher* suggests that MTurk is a useful tool for educational research because it enables the researcher to obtain "large and more diverse" samples (Follmer, Sperling, & Suen, 2017). "MTurkers" have been shown to be more attentive to instructional manipulation checks in comparison to college students (Hauser & Schwarz, 2016), provide

high-quality data, and are somewhat representative of the general population across various psychological dimensions (McCredie & Morey, 2018). Recent concerns were raised about the integrity of the data from MTurk (Litman, 2018), suggesting that that "bots" (i.e., automated fake accounts) were being used to answer surveys with fake data. This issue was shown to be rare to non-existent in a recent analysis (Moss & Litman, 2018). Instead, cultural and linguistic barriers were found to drive poor responses. We mitigated against bots, fake accounts, and multiple submissions in our recruitment by ensuring that participants had an approval rate on other tasks they'd been assigned at, or above, 90%, had completed more than 1,000 tasks, and were based in the U.S. Those who submitted multiple responses to the same questionnaire (to obtain multiple payments) were not approved for payment and their data are not included in our sample.

Given previous work on the MTurk population and our own precautions, we argue that MTurk was a particularly appropriate venue for this research, as we sought to assess the general population's view of education policy issues and did not want to use a convenience sample of university students who might be unaware of—or uninterested in—such policies. While not perfectly representative, the sample is reasonably diverse along a number of dimensions.

Procedure

At the start of each session, participants were presented with a series of statements regarding an education policy that were either factually true (e.g., "The majority of charter schools are managed by for-profit organizations"), or factually false (e.g., "Common Core requires more testing than previous standards"). Participants were then asked to mark the statements as "true," "false," or "unsure." We included "unsure" so that we could distinguish between participants who overcame a misconception (i.e., selecting an incorrect answer at pretest and a correct answer at posttest) versus those who simply learned something new after reading either the control or refutation text (i.e., selecting unsure at pretest and a correct answer at posttest). Participants were randomly assigned the refutation text or control text, after which they responded to the same series of statements. Participants filled out a demographic questionnaire at the end of the survey.

Data Analysis

Participants in both experiments were randomly assigned to receive the refutation text or the control text; thus, we can be confident that any observed difference in outcomes after the treatment was caused by the differences in the texts they received. We first present descriptive statistics on the item-level and overall number of correct conceptions and misconceptions. Because the goal of the refutation text was to correct misconceptions, we conducted *t*-tests focusing only on those participants who had misconceptions at pretest. Specifically, we examined the proportion of participants with misconceptions at pretest who demonstrated correct conceptions at posttest, and whether this proportion differed between treatment and control conditions. Our results are equivalent if we use OLS regression or ANOVA, so we present *t*-tests for simplicity. In this main impact analysis, correct conceptions at posttest were scored as "1," while misconceptions and "unsure" were scored as "0" (all conclusions are substantively the same if we instead score "unsure" as missing). We also considered the average rate at which misconceptions were corrected by calculating each participant's proportion of misconceptions that became correct conceptions, and taking the average of this proportion across participants (we again tested the difference of this proportion between treatment and control conditions).

Experiment I: Addressing Misconceptions About the Common Core

Participants

Table 1 contains descriptive statistics on the samples for the two studies. For Experiment 1, the sample was 52% female; 78.5% white, 7.7% Hispanic, 8.2% black, and 7.2% Asian ($n = 595$). The mean age of participants was 39 years old ($SD = 12.5$), similar to the national average of 39.5 years. There was a 30% attrition rate ($n = 176$) for the 1-week follow up. The response rate to the follow up did not significantly differ between the refutation text group and the control group (72% vs. 69%, $p > .70$). Furthermore, the demographics of our 1-week follow up participants were similar to the overall sample—for example, 56% female vs. 52%, 6% Hispanic vs. 7.7%, and 6.5% black vs. 8.2%. Of course, it may be the case that non-responders to our follow up differ in some unobserved way from responders, but our high response rate and the lack of differential nonresponse gives us confidence that the results we observed in the follow-up study were not due to differential attrition between treatment and control conditions.

Method

Procedures. After consenting to participate in the study, participants answered a series of introductory questions about the Common Core, including their sources of information about the standards, their conceptions, and their overall support for the standards. Then, we randomly assigned half of the participants to receive the refutation text and half the control text, using the randomization function of the survey tool. After reading the text, participants received the same conceptions questions and support questions again, followed by a demographic questionnaire. One week after completing the survey, participants received a link to complete a short follow up containing the same conceptions and support questions. They were not presented with the refutation or control text at follow-up.

Texts. Our refutation text was 300 words, organized into four paragraphs, with each paragraph written to address one common misconnection about the CCSS. It did not have any headings or section headers. Readability analyses, using a Flesch Kincaid (FK) Readability index of 58.2, suggested that a typical high schooler should have been able to read the text. Our control text was a version of an *Education Week* article: "The Common Core Explained" (Gewertz, 2018). This article was found after searching for "What are the Common Core Standards," and chosen both for its prominence in the search results (at the top of the results) and because it addressed many common CCSS

Table 1
Demographic Characteristics of Participants

	Experiment I: CCSS		Experiment II: Charter Schools	
	N	*%*	*N*	*%*
Female	312	52.4%	338	56.4%
White	467	78.5%	480	80.1%
Black/African American	49	8.2%	47	7.9%
Hispanic	46	7.7%	51	8.5%
American Indian/Alaska Native	10	1.7%	5	0.8%
Asian	43	7.2%	42	7.0%
Native Hawaiian/Pacific Islander	0	0%	0	0.0%
Two or more races	19	3.2%	17	2.8%
Prefer not to say	5	0.9%	5	0.8%
Other	2	0.3%	3	0.5%
4-year college degree or higher	323	54.3%	345	57.6%
Employed	509	85.6%	519	86.6%
Reported Income < $60,000	370	62.6%	353	58.9%
School-aged children (K-12)	172	28.9%	207	34.6%
N	595		599	

misconceptions and was written for a lay audience. The original article was 1,400 words, and we edited it down to 359 words by removing information that did not address the CCSS misconceptions. The readability of the control text was similar to the refutation text (FK = 60.6). Unlike our refutation text, it did have organizing language in the form of section headers that posed questions such as "Who organized the initiative? Who wrote the common-core standards?" (Both texts are available in the online appendix.)

Misconceptions. We used the Common Core misconceptions tested in a 2015 poll of California voters (see Polikoff et al., 2016). We measured the following misconceptions by asking participants to mark the following statements as "true," "false," or "unsure":

1. *The Common Core State Standards only apply to English and mathematics.*

    This is true, but in our 2015 poll we found that only 21% of participants correctly identified it as such (32% said it was false).

2. *Common Core requires more testing than previous standards.*

    This is false, which 17% of participants correctly identified in 2015 (37% said it was true).

3. *The federal government required states to adopt the Common Core.*

    This is false, which 22% of participants correctly identified in 2015 (28% said it was true).

4. *The Common Core State Standards were developed by the Obama administration.*

    This is false, which 29% of participants correctly identified in 2015 (18% said it was true).

5. *States adopting the Common Core are allowed to add content to the standards.*

    This is true, which 28% of participants correctly identified in 2015 (19% said it was false).

We scored items that were actually true as a correct conception if participants said "true" and a misconception if they said "false." Similarly, we scored items that were actually false as a correct conception if participants said "false" and a misconception if they said "true."

Previous research has shown that some of these misconceptions are strongly related to voters' views about the Common Core standards (Polikoff et al., 2016). We also included a sixth misconception in our refutation text: "Common Core limits teachers' ability to be creative in the classroom," but exclude it from analysis because it did not constitute a factual statement and because of the ambiguous nature of what could be considered "teacher creativity."

Results and Discussion

The effects of the refutation text on conceptions and misconceptions. Before the intervention, participants held a number of misconceptions about the standards—the proportions of correct conceptions and misconceptions were similar to the results from the California poll, mentioned above. Table 2 shows the conceptions and misconceptions by treatment group at pretest, posttest, and the follow-up a week later. At pretest, participants lacked knowledge and had a number of misconceptions about the standards. For example, just 16% of participants correctly identified that the CCSS do not require more testing than previous standards. However, 32% correctly responded that the CCSS were not created by the Obama administration (although this means that nearly two thirds of the sample did not know or were

Table 2
Percentage of Participants in Common Core Study With Either Correct Conceptions or Misconceptions

Correct Conceptions

	Control			Treatment		
	Pretest	**Posttest**	**Delay**	**Pretest**	**Posttest**	**Delay**
The Common Core State Standards only apply to English and mathematics. (True)	29.8%	68.1%	62.4%	30.0%	69.8%	60.4%
Common Core requires more testing than previous standards. (False)	15.9%	32.2%	22.8%	16.7%	77.3%	59.1%
The federal government required states to adopt the Common Core. (False)	21.0%	57.0%	53.0%	25.7%	58.7%	54.8%
The Common Core State Standards were developed by the Obama administration. (False)	31.9%	48.8%	46.5%	37.8%	85.3%	76.0%
States adopting the Common Core are allowed to add content to the standards. (True)	27.5%	54.6%	53.5%	33.7%	83.3%	78.8%
Average # of correct conceptions	1.26	2.61	2.38	1.44	3.74	3.30

Misconceptions

	Control			Treatment		
	Pretest	**Posttest**	**Delay**	**Pretest**	**Posttest**	**Delay**
The Common Core State Standards only apply to English and mathematics. (True)	32.9%	20.7%	23.3%	33.0%	22.3%	29.5%
Common Core requires more testing than previous standards. (False)	48.5%	45.1%	56.4%	52.0%	15.3%	22.1%
The federal government required states to adopt the Common Core. (False)	43.4%	29.5%	28.7%	41.7%	24.7%	30.9%
The Common Core State Standards were developed by the Obama administration. (False)	25.1%	31.5%	33.2%	27.3%	9.3%	14.8%
States adopting the Common Core are allowed to add content to the standards. (True)	22.0%	20.0%	19.8%	20.7%	9.3%	9.7%
Average # of misconceptions	1.72	1.47	1.61	1.75	0.81	1.07
N	295	300	202	295	300	217

incorrect about the source of the standards). In total, participants averaged about 1.7 misconceptions and 1.3 correct conceptions at pretest. The descriptive results in Table 2 also suggest that the treatment increased correct conceptions and decreased misconceptions relative to the control text. For example, the total number of misconceptions in the treatment group decreased to 0.8, while the number in the control group remained close to the pretest mean at 1.5. As expected, given randomization, the refutation text and control text groups did not significantly differ on any of the five conceptions, the total number of misconceptions, or the correct conceptions at pretest.

In Table 3, we present a formal test of the refutation text's impact on misconceptions. As shown, the refutation text caused between a 37% and 77% reduction in misconceptions for three items. This was significantly greater than for the control text, in which misconceptions were reduced by 18–54% for those items. The control text out-performed our refutation text at immediate posttest (49.2% misconceptions corrected vs. 36.8%, p < .05) on "the federal government required states to adopt the Common Core," item. On average, the refutation text resulted in 65.2% of misconceptions changing to correct conceptions; for the control text, just 42.2% of misconceptions became correct conceptions, $t(450) = -6.29$, $p < .001$, $d = 0.60$. In short, the refutation text was effective: It reduced misconceptions and increased correct conceptions.

Do these effects persist? While it is promising that the refutation text has an immediate effect on individuals' conceptions and misconceptions about the standards, it is important to see if the effects are ephemeral.

Table 2 shows large descriptive differences between treatment and control one week after the treatment. For instance, treatment group participants averaged 3.30 correct conceptions and 1.07 misconceptions at follow-up, versus 2.38 correct conceptions and 1.61 misconceptions for the treatment group. Formal testing of these differences in Table 3 shows that there remained a significant impact of the treatment on the same three misconceptions noted above at follow-up. Furthermore, the significant effect at posttest favoring the control text for "the federal government required states to adopt the Common Core," item was no

Table 3
Percentage of Common Core Misconceptions That Were Corrected

	Control		Treatment	
	Posttest	Delay	Posttest	Delay
The Common Core State Standards only apply to English and mathematics. (True)	65.0%	55.2%	60.0%	55.2%
	$n = 97$	$n = 76$	$n = 99$	$n = 76$
Common Core requires more testing than previous standards. (False)	24.5%	16.7%	76.3%***	53.8%***
	$n = 143$	$n = 102$	$n = 156$	$n = 117$
The federal government required states to adopt the Common Core. (False)	49.2%	42.4%	36.8%*	35.8%
	$n = 128$	$n = 92$	$n = 125$	$n = 95$
The Common Core State Standards were developed by the Obama administration. (False)	41.9%	38.3%	75.6%***	64.8%**
	$n = 74$	$n = 47$	$n = 82$	$n = 54$
States adopting the Common Core are allowed to add content to the standards. (True)	40.0%	46.2%	77.4%***	75.6%**
	$n = 65$	$n = 36$	$n = 62$	$n = 45$
Average percentage of misconceptions corrected	42.2%	37.0%	65.2%***	53.2%***
	$n = 220$	$n = 153$	$n = 230$	$n = 169$

Note. Significance tests compare treatment proportions to corresponding control proportions.
*$p < .05$, ** $p < .01$, *** $p < .001$

longer present after one week. Overall, the refutation text resulted in 53% of misconceptions changing to correct conceptions; for the control text, just 37% of baseline misconceptions had become correct conceptions one week after the intervention, $t(320) = -3.67$, $p < .001$, $d = 0.41$. In short, our brief refutation text had meaningful effects on participants' conceptions and misconceptions about the standards, and these effects persisted for at least a week.

Discussion. Our analysis indicates that many people have negative attitudes toward—and misconceptions about—Common Core standards, and that a refutation text can directly reduce those misconceptions and increase accurate conceptions (Kendeau et al., 2017). We also found that these effects persist for at least a week. We speculate that the one instance where our refutation text underperformed relative to the control text (i.e., "The Common Core State Standards only apply to English and mathematics"), may be a result of the relatively minor mention of the misconception in the refutation text, which consisted of one sentence at the beginning of the text. Regardless, reading the refutation text was more effective overall than reading the control text.

Experiment II: Addressing Misconceptions About Charter Schools

Participants

The sample was 56% female; 80% white, 8.5% Hispanic, 7.9% black, and 7% Asian ($n = 599$). The mean age of participants was 41 years old ($SD = 12.8$). There was a 39% attrition rate ($n = 230$) for the 1 week follow up. The response rate to the 1 week follow up did not significantly differ between the refutation text group and the control group (49% vs. 51%, $p > .55$). As before, we cannot preclude the possibility that non-responders to our follow up differ in some unobserved way from responders, but our high response rate and the lack of differential

nonresponse gives us some confidence that the results we observed in the follow-up study were not due to differential attrition.

Method

Procedures. After consenting to participate, participants completed a series of introductory questions about charter schools, including their sources of information for learning about them, their conceptions about them, and their overall support for them. We then randomly assigned half the participants to receive the refutation text, and half the control text. After viewing the text, participants received the same conceptions questions and support questions again, followed by a demographic questionnaire. One week after completing the survey, participants received a link to complete a short follow-up containing the same conceptions and support questions. They were not presented with the refutation or control text again.

Texts. Our refutation text was 240 words organized into four paragraphs, with each paragraph written to address one common misconnection about charter schools. It did not have any headings or section headers. Readability analyses suggest that a typical high school senior should have been able to read the text (FK = 53.0).

The basis for our control text was found by searching for "What are charter schools?" We chose the article "Public vs. private vs. charter schools," taken from "Great Schools.org" (Pascual, 2018), because it addressed many common charter school misconceptions, was written for a lay audience, and was prominent in the search results. The original article was 1,725 words, and we edited it down to 238 words by removing information that did not address charter school misconceptions (such as information on private schools). The readability of the control text was similar to the refutation text (FK = 55.5). Both texts are available in the online appendix.

Misconceptions. We measured the following misconceptions about charter schools by asking participants to mark the following statements as "true," "false," or "unsure." Again, we drew these misconceptions from the PACE/USC Rossier poll of California voters, except for one which we added specifically for this study.

1. *The majority of charter schools are managed by for-profit organizations. (False)*

   This is false [in California it is approximately 3% of charter schools (Zinshteyn, 2017)], but in our 2014 poll we found that only 26% of participants correctly identified it as such (45% said it was true).

2. *State policies allow charter schools to charge tuition. (False)*

   This is false, which 39% of participants correctly identified in 2014 (31% said it was true).

3. *State law forbids charter schools from picking and choosing which students to enroll. (true).*

   This is true, which 31% of participants correctly identified in 2014 (25% said charter schools could select which students they prefer when over-enrolled).

4. *Charter schools are held to the same testing and accountability laws as traditional public schools. (True)*

   We did not ask this question on our poll, but we believed it might be a common misconception; we added it to our study for length.

We scored the items for conceptions and misconceptions as described above in the first experiment.

Results and Discussion

The effects of the refutation on conceptions and misconceptions. Before the intervention, participants held a number of misconceptions about the standards. Table 4 shows the conceptions and misconceptions by treatment group at pretest, posttest, and follow-up 1 week later. At pretest, participants lacked knowledge and had a number of misconceptions about charter schools. The item with the most correct conceptions was that the charter schools were held to the same testing and accountability laws as public schools, to which 53% of participants responded correctly. The item with the fewest correct conceptions was that the majority of charter schools are not managed by for-profit organizations, to which just 26% of participants responded correctly. In total, participants averaged about 1.4 misconceptions and 1.4 correct conceptions at pretest. As expected, given randomization, the refutation text and control text groups did not significantly differ on any of the five conceptions, the total number of misconceptions, or the correct conceptions at pretest. The descriptive results in Table 4 also suggest that the treatment increased correct conceptions and decreased misconceptions relative to the control text. For example, the total number of misconceptions in the treatment group decreased to 0.5, while the number in the control group remained close to the pretest mean at 1.2.

In Table 5, we present a formal test of the refutation text's impact on misconceptions. As shown, the refutation text caused between 68% and 78% reduction in misconceptions, depending on the item. For all items, this was significantly greater than for the control text, in which misconceptions were reduced by 18–54%. On average, the refutation text resulted in 75% of misconceptions changing to correct conceptions; for the control text, just 39% of misconceptions became correct conceptions, $t(418) = 8.94$, $p < .001$, $d = 0.80$. As in Experiment 1, the refutation text was effective: It substantially reduced misconceptions, much more so than the control text.

Do these effects persist for a week? As with Experiment 1, we wanted to test to see if the effects would persist beyond an immediate posttest. Thus, we tested the same participants one week later without reintroducing the refutation text.

As seen in Table 4, there remained large descriptive differences between treatment and control one week after the treatment. For instance, treatment group participants averaged 3.07 correct conceptions and 0.66 misconceptions at follow-up, versus 2.17 correct conceptions and 1.30 misconceptions for the treatment group. Table 5 shows that the treatment still had a significant impact on misconception reduction at follow-up. One week after the intervention, the refutation text resulted in 75% of misconceptions changing to correct conceptions; for the control text, just 39% of baseline misconceptions had become correct conceptions, $t(261) = 6.93$, $p < .001$, $d = 0.79$. The magnitude of the effect remained almost identical at follow-up. Our results indicate that our refutation text had sustained effects on participants' conceptions and misconceptions about the standards.

Discussion. Our analysis indicates that a refutation text written about common charter school misconceptions can directly address them while also increasing accurate conceptions. We also found that these effects persist for at least a week.

General Discussion

Refutation texts have been used successfully to refute misconceptions about science topics for decades. Ours is the first study we know of that has used this technique to address misconceptions about education policies, specifically the CCSS and charter schools. Refutation texts have been used successfully with science topics for some time because they allow for the co-activation of the misconception and accurate conception according to the KReC model (Kendeou & O'Brien, 2014). Our research extends the KReC model beyond the domain of science to additional spheres where misconceptions have direct public policy impacts. In both the cases we examined (CCSS and charter schools), we were able to demonstrate that individuals' views on policy are malleable and that a relatively short informational intervention can be effective in reducing misconceptions while increasing understanding of the policy. Our results were sufficiently powerful to persist for both education policy issues, even after a week. We note, however, that examining whether or not the effects persist beyond 1 week is an important question that merits further study.

Sinatra and Seyranian (2016) have described the close relationship between attitudes and conceptions. They argued that one way to shift negative attitudes about a policy change to mitigate

Table 4
Percentage of Participants in Charter School Study With Either Correct Conceptions or Misconceptions

Correct Conceptions

	Control			Treatment		
	Pretest	Posttest	Delay	Pretest	Posttest	Delay
The majority of charter schools are managed by for-profit organizations. (False)	24.9%	32.9%	37.0%	26.2%	77.9%	65.0%
State law forbids charter schools from picking and choosing which students to enroll. (True)	27.9%	62.5%	51.9%	33.9%	72.5%	79.4%
State policies allow charter schools to charge tuition. (False)	31.2%	60.8%	56.6%	27.5%	82.9%	75.0%
Charter schools are held to the same testing and accountability laws as traditional public schools. (True)	52.5%	68.8%	72.0%	53.7%	82.6%	87.2%
Average # of correct conceptions	1.33	2.24	2.17	1.41	3.16	3.07

Misconceptions

	Control			Treatment		
	Pretest	Posttest	Delay	Pretest	Posttest	Delay
The majority of charter schools are managed by for-profit organizations. (False)	40.9%	50.2%	47.6%	42.6%	14.4%	25.6%
State law forbids charter schools from picking and choosing which students to enroll. (True)	34.6%	27.6%	35.4%	33.6%	19.8%	16.1%
State policies allow charter schools to charge tuition. (False)	37.5%	22.3%	28.6%	39.6%	8.4%	15.0%
Charter schools are held to the same testing and accountability laws as traditional public schools. (True)	22.3%	21.3%	18.5%	21.1%	9.1%	9.4%
Average # of misconceptions	1.35	1.21	1.30	1.37	0.52	0.66
N	301	301	189	298	298	180

climate change, for example, would be to reduce misconceptions about the causes of climate change. Indeed, previous research has shown that misconceptions about a controversial topic, such as genetically modified foods (GMFs), are linked to negative attitudes (Heddy et al., 2017). These attitudes then inform individuals' views about policies and laws such as requiring labeling of GMFs. Therefore, when individuals' views about a public policy are informed by misconceptions it is likely that those views are more negative and more resistant to the policy than they would otherwise be. However, when misconceptions are overcome, attitudes tend to shift towards a more positive valence (Heddy et al., 2017). Indeed, the KReC framework would suggest that knowledge revision occurs within an integrated network of information which includes attitudes (Thacker et al., 2017) and emotions (Trevors, Kendeou, & Buttterfuss, 2017). Kendeau and colleagues explain that "as activation is drawn away from misconceived information, the amount of interference from that information decreases accordingly" (Kendeau, Butterfuss, Kim, & Van Boekel, 2019, p. 34). It follows, then, that reducing policy misconceptions may increase acceptance of (and perhaps even adherence to) a policy. Given this, it stands to reason that refutation texts may be an effective technique for communicating education policies to the public—especially if common misconceptions about a given policy are known to exist.

Granted, there could be legitimate and rational reasons why someone is resistant to a policy; people may have well-grounded and reasoned points of disagreement with any social or educational policy. However, resistance to a policy should not be based on a misunderstanding of the policy's main points and objectives. We recommend to policymakers who are frustrated by negative views of a policy to ascertain whether there are widely-held misconceptions about the policy. Identifying and then correcting those misconceptions, through the use of the refutation text technique used here, or other strategies, can be an important first step for increasing public support for the policy and perhaps even individuals' compliance with policy regulations. We also urge would-be users of refutation texts to ensure they target *actual* misconceptions, rather than opinions—to do the latter would be to use refutation texts as persuasive texts, for which they are not intended. Persuasion is its own genre with its own objectives and it is not what we are testing or advocating here.

There are several areas for future research on refuting policy misconceptions and, based on prior research, we note that attitudes and emotions (unexamined in this study) can play a role in policy acceptance. Research on the public's understanding of science, for example, shows that negative attitudes and emotions towards a controversial issue such as climate change are associated with resistance to policies designed to reduce carbon emissions (Sinatra & Hofer, 2016). Work in this area has shown that reducing misconceptions in those contexts also reduces negative attitudes and emotions (Broughton, Sinatra, & Nussbaum, 2013; Heddy et al., 2017). A natural next step for research would be to study whether misconceptions about other policies are associated with negative attitudes and emotions toward the policies.

Table 5
Percentage of Charter School Misconceptions That Were Corrected

	Control		Treatment	
	Posttest	Delay	Posttest	Delay
The majority of charter schools are managed by for-profit organizations. (False)	18.7%	24.0%	73.2%***	57.3%***
	n = 123	n = 75	n = 127	n = 75
State law forbids charter schools from picking and choosing which students to enroll. (True)	53.8%	43.2%	69.0%*	75.7%***
	n = 104	n = 74	n = 100	n = 70
State policies allow charter schools to charge tuition. (False)	54.0%	47.9%	78.0%***	68.5%*
	n = 113	n = 73	n = 118	n = 73
Charter schools are held to the same testing and accountability laws as traditional public schools. (True)	47.8%	39.5%	68.3%*	81.8%***
	n = 67	n = 43	n = 63	n = 44
Average percentage of misconceptions corrected	39.4%	38.1%	74.6%***	71.3%***
	n = 203	n = 130	n = 217	n = 133

Note. Significance tests compare treatment proportions to corresponding control proportions.
*$p < .05$, ** $p < .01$, *** $p < .001$

A second area for future research is to explore potential backfire effects. In some cases, refuting misconceptions can result in a backfire effect where individuals "double down" (i.e., become more resolute) on their original mistaken belief in the face of contradictory evidence (Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012). While we saw no evidence of the backfire effect here, it would be important to be mindful of potential backfire effects with hot button issues and controversial policies.

We note that the length of persistence of the corrected conception induced by our refutation text should be examined. Policymakers would want to know if refuted misconceptions resurface after a longer time lag than one week. This would be crucial to appropriately time debunking efforts before an important deadline, such as a vote or pending policy decision. While important work still needs to be done to examine the effectiveness of this particular technique for reducing policy misconceptions, we believe the policymakers could benefit from this research to assure that individuals' acceptance or resistance to a policy is based on accurate conceptions and not "fake news."

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