

The moral side of the climate crisis: the effect of moral conviction on learning about climate change

Benjamin C. Heddy, Doug Lombardi & Robert W. Danielson

To cite this article: Benjamin C. Heddy, Doug Lombardi & Robert W. Danielson (2022) The moral side of the climate crisis: the effect of moral conviction on learning about climate change, Educational and Developmental Psychologist, 39:1, 58-69, DOI: [10.1080/20590776.2021.2011203](https://doi.org/10.1080/20590776.2021.2011203)

To link to this article: <https://doi.org/10.1080/20590776.2021.2011203>



Published online: 12 Dec 2021.



Submit your article to this journal [↗](#)



Article views: 215





View related articles [↗](#)



View Crossmark data [↗](#)



The moral side of the climate crisis: the effect of moral conviction on learning about climate change

Benjamin C. Heddy ^a, Doug Lombardi ^b and Robert W. Danielson^c

^aEducational Psychology, University of Oklahoma, Norman, OK, USA; ^bDepartment of Human Development and Quantitative Methodology, University of Maryland, College Park, MD, USA; ^cDepartment of Kinesiology and Educational Psychology, Washington State University, Pullman, WA, USA

ABSTRACT

Objective: Moral convictions have been shown to impact learning about science topics including evolution and COVID-19. However, how moral convictions influence learning about climate change – another science topic perceived as controversial – has not been studied in depth. The goal of our research was to investigate the predictive relationship between moral convictions, engagement, plausibility, emotions, and knowledge when learning about climate change.

Method: Undergraduate pre-service teacher students (N = 348) rated their moral convictions about climate change and read a refutation text on the topic.

Results: The majority of students indicated that acting to mitigate climate change was a moral imperative (n = 268) compared with those without a position (n = 80). Results indicate that whether an individual perceives acting on climate change as morally imperative is a powerful precursor to their learning experience. Moreover, those who developed a stronger moral conviction indicated deeper learning, engagement, and stronger negative emotions. Finally, stronger moral convictions, emotions, knowledge, and engagement all predicted seeing the scientific model of climate change as more plausible.

Conclusion: Taken together, our results have implications for how moral convictions may influence how educators should engage students and the general public about the topic of climate change.

KEY POINTS

What is already known about this topic:

- (1) Research has shown that moral convictions can influence learning, engagement, emotions and plausibility.
- (2) There is contradicting research on whether moral convictions improve or hinder the learning process.
- (3) There is a lack of research on moral convictions and learning about climate change.

What this topic adds:

- (1) Most participants reported that acting to mitigate human induced climate change was morally imperative.
- (2) An increase in moral convictions was associated with an increase in learning, engagement, and negative emotions.
- (3) Stronger moral convictions, learning, emotions, and engagement predicted perceiving the scientific model of climate change as more plausible.

ARTICLE HISTORY

Received 18 June 2021

Accepted 23 November 2021

KEYWORDS

Climate change; learning; emotions; plausibility; engagement

The moral side of the climate crisis

Climate change may be one of the greatest crises of our time. And while almost all scientists agree that humans are a driving factor of climate change, the general public is less convinced (Ballew et al., 2019). This is problematic because people need to work together to conserve resources and generate a more ecologically sustainable society. We will need effective educational material to teach people about climate change and how to behave in a more sustainable manner (Meehan et al., 2018;

Román & Busch, 2021). Instructional strategies and materials about climate change need to be designed to facilitate optimal learning and engagement to be the most effective (Lombardi et al., 2013; Quarderer et al., 2021; Reid, 2019). However, even if climate change related instruction is optimally designed from an informational dissemination perspective, educators may fail to consider people's moral convictions. Moral convictions have been shown to impact the learning processes around a number of topics, including vaccines and the COVID-

19 virus (Skitka, 2010; Skitka & Mullen, 2002; Trevors & Duffy, 2020). This is especially true for the topic of climate change, which is morally charged (Feinberg & Willer, 2013; Misch et al., 2021). When people learn about climate change, they can be morally in favour of mitigating human influence, morally opposed to mitigating human induced climate change, or they can feel morally neutral to the topic (lack of moral convictions). Thus, the moral convictions that people feel when learning about climate change may have a big impact on the quality of their learning experience. Given the importance of mitigating the effects of climate change, understanding how moral convictions influence learning about the topic is essential if we want to design educational material that will be the most impactful in teaching people about the climate crisis.

The goal of this research was to explore the influence of moral convictions on learning about climate change. Our focus included several important aspects of the learning process. In particular, we investigated the relationship between moral convictions and learning, engagement, emotions, and plausibility judgements. More specifically, we used a priming technique to elicit participants' moral convictions (or lack thereof) when learning about climate change. Then we gave them climate change instructional material and investigated the extent of their learning and engagement. The instructional material was a refutation text, which has been shown to facilitate learning and engagement in previous research (Sinatra & Broughton, 2011; Tippett, 2010). We aimed to explore how priming of moral convictions influenced learning about climate change when reading a refutation text. Furthermore, we explored their positive and negative emotions related to learning about climate change. Finally, we investigated to what extent their moral convictions, learning, engagement, and emotions predicted the extent to which they perceived human induced climate change as plausible. By investigating these features of the learning process related to climate change, we can design instructional material that will consider students' moral convictions in a way that will increase seeing human induced climate change as plausible. In doing so, we may be able to design instruction that will facilitate optimal learning and lead to more action to mitigate the devastating effects of the climate crises.

Moral convictions and learning about climate change

Moral convictions have been largely ignored in climate change education research. However, researchers

suggest that people believe that protecting nature is a moral obligation (Kahn, 1997; Kahn & Lourenço, 2002). Thus, moral convictions may be especially relevant when learning about climate change if students see acting to mitigate climate change as protecting nature. Additionally, moral convictions have been shown to significantly influence learning about science topics that are perceived to be controversial (Rutjens et al., 2018). We define moral convictions as cognitive evaluations of right and wrong related to a target topic (Skitka, 2010). People reference what is right or wrong based on their "interlocking sets of values, virtues, norms, practices, identities, institutions, technologies, and evolved psychological mechanisms" (Graham & Haidt, 2012). Thus, people have moral convictions about topics that they perceive as being right or wrong. In this case, people may perceive acting on climate change as morally right or wrong. On the one hand, people may believe that acting on climate change is morally imperative because human contribution is wreaking havoc on ecosystems and destroying animal habitats. On the other hand, some people are morally opposed to acting on climate change because doing so could lead to the limitation of industrial progress or the shuttering of industries (e.g., coal industry) and the subsequent loss of livelihoods and destabilization of communities. There may also be a subset of people who feel neutral towards acting on climate change and have no moral convictions related to the topic. For instance, some people may believe that there is nothing they can do to contribute to climate change or its mitigation and thus do not feel morally inclined to act. Based on people's moral convictions or lack thereof, their engagement with climate change instruction may fluctuate.

There is conflicting research which suggests that the activation of moral convictions could support positive learning outcomes. Researchers have shown that when people's moral convictions come into play, they are likely to stand up for what they believe is right or fight against what they believe is wrong (Skitka, 2010). In this case, people may be more likely to pay attention to the message to learn about counter arguments, which could increase learning. That is, when people's moral convictions are activated, they may pay greater attention to the message (regardless of the side they choose). When the morally relevant topic arises, people may become engaged because they are invested in it. Alternatively, there is evidence to support the idea that moral convictions will inhibit learning outcomes. Researchers suggest that people who see topics in a moral light are more likely to be closed off to incoming information (Mullen & Skitka, 2006). This could lead

people to become entrenched in their current beliefs and to not pay attention to conflicting information. When this occurs, they are less likely to learn. This could especially be the case if they already have pre-conceived misconceptions about the topic. Having misconceptions and strong moral convictions may close people off to engaging in conceptual change (Trevors & Duffy, 2020). However, this needs to be studied in greater depth as not all research supports this stance. Thus, there is a dearth of research exploring the relationship between moral convictions and engagement. Given that engagement is a significant factor predicting learning and that climate change is morally charged, investigating this relationship is important for understanding how moral convictions influence learning about climate change.

Engagement and moral convictions

An integral aspect of the learning process is the extent and quality of student engagement. Engagement has been defined as the “holy grail” of student learning outcomes because it has been linked with many learning benefits (Sinatra et al., 2015). We define engagement as students’ behavioural (e.g., effort), cognitive (e.g., learning strategies), and affective (e.g., enjoyment) participation in their learning (Fredricks et al., 2004). More specifically, we investigate engagement when reading a text about climate change. When students are engaged in the learning process, they also show increased achievement (Wigfield et al., 2015), conceptual change (Johnson & Sinatra, 2013), interest (Renninger & Hidi, 2017), and positive emotions (Liu et al., 2018). Thus, facilitating student engagement is a laudable goal for educators. This could be particularly beneficial when teaching about climate change. That is, if students experience deep engagement when learning about climate change, they will be more likely to learn important ideas and will then be more likely to act to address the climate crisis. Therefore, we should design climate change instruction that is engaging to facilitate optimal learning. Indeed, researchers have shown that high engagement when learning about climate change predicted conceptual change (Heddy et al., 2018). However, the role of moral convictions in this process has not been investigated in depth.

When a student perceives content as moral or immoral it may influence engagement with the content (Misch et al., 2021; Skitka & Bauman, 2008). On the one hand, a student may be morally opposed to learning about human induced climate change because the theory conflicts with their political perspective which could lead to low engagement. This low engagement or

disengagement may cause the student to lose interest (affective engagement), give little effort (behavioural engagement), and not relate material to prior knowledge (cognitive engagement). On the other hand, a student may feel that caring for the earth by going green is a moral imperative. Due to the students’ moral convictions, they would be highly engaged. While learning about climate change in class they value the content (affective engagement), participate in all related activities (behavioural engagement), and relate the climate science concepts to their prior experiences (cognitive engagement). Given this contradictory evidence, we sought to explore the relationship between moral convictions and student engagement when reading a text about climate change. Another important factor that influences learning about climate change is student emotion.

Emotions and moral convictions

In addition to engagement, we investigated the relationship between moral convictions and emotions while learning about climate change. We investigated topic emotions, which are defined as emotions that emerge from achievement related to the topic of instruction (Broughton et al., 2013). Researchers have shown that people have strong emotions about the topic of climate change (Broughton et al., 2010; Lombardi et al., 2013). Moser (2007) found that teachers and students exhibit negative emotions about climate change such as anger, anxiety, fear, and hopelessness. These emotions could have an influence on the extent of learning about the topic. Indeed, researchers have found that emotions play an integral role in the learning process (Linnenbrink, 2007; Op’t Eynde & Turner, 2006; Pekrun, 2006). For example, negative emotions have a mixed relationship to learning (small amounts can facilitate learning and large amounts can hinder learning; Linnenbrink, 2007), while positive emotions are either not related or positively related to learning (Broughton et al., 2013; Heddy & Sinatra, 2013). Therefore, investigating the influence of moral convictions on emotions when learning about climate change could be beneficial.

Moral convictions may have an impact on the emotions that people feel related to learning about climate change, which could influence learning. Indeed, researchers have found a relationship between emotions and moral convictions (Carnes & Lickel, 2018; Skitka & Wisneski, 2011; Wisneski & Skitka, 2017). For example, Skitka and Wisneski (2011) found that individuals feel positive emotions towards policies that they morally support and negative emotions towards policies that they morally oppose. We posit that a similar relationship may be found between moral convictions and emotions when learning about

climate change. That is, people who have high moral convictions related to mitigating human induced climate change will likely report higher positive and negative emotions. These resulting emotions will influence the extent of learning about climate change and could in turn influence whether or not people act on mitigating the climate crisis. To our knowledge this is the first study that investigates the relationship between moral conviction and emotions when learning about climate change.

Plausibility and moral convictions

Climate change understanding requires reasoning about and knowledge of the underlying scientific principles and causal mechanisms underlying phenomena, such as global increases in temperature and extreme weather events (Lombardi et al., 2020). For example, relatively recent science education reform efforts suggest that students should scientifically evaluate linkages between various lines of evidence and explanations of climate change to effectively understand the validity of claims that human activities are causing the current climate crisis (National Research Council, 2012). Doing this in a classroom setting is often challenging, but instructional scaffolding can help students make more scientific evaluations about the connections between evidence and explanations of climate change, while also deepening their knowledge of the topic (Lombardi, Bailey, et al., 2018; Lombardi, Bickel, et al., 2018; Sinatra & Lombardi, 2020). Lombardi (2016) specifically suggest that when students explicitly evaluate the connections between evidence and competing claims, this may help them to reappraise their plausibility judgements towards a more scientific stance. Further, because plausibility is an epistemic judgement about explanations that most consider tentative and provisional, students may more easily disengage from their prior beliefs. Reappraising plausibility may be particularly effective in promoting students' cognitive and affective engagement and learning about complex and controversial topics, such as human-induced climate change (Lombardi et al., 2016; Sinatra & Lombardi, 2020).

Moral convictions, plausibility, engagement, and emotions

There is a dearth of research that investigates the relationship between moral convictions and plausibility. Thus, we draw from theoretical tenets to hypothesize about this relationship. Researchers have shown that when learners scientifically evaluate the claims of an explanation, they may shift plausibility judgements to a more scientific stance (e.g., judging that the scientific explanation that humans are causing current change is more plausible

than non-scientific claims, for example, greater solar output is the cause of current climate change). An important aspect of this theory is that learners may often make implicit and automatic plausibility judgements that are influenced by biases and heuristics (e.g., a negative moral conviction with respect to the climate crisis). Such implicit judgements may be non-scientific and associated with low levels of engagement or even disengagement (Lombardi, 2016). However, positive moral convictions and emotions related to learning about climate change may facilitate more explicit and purposeful plausibility judgements because convictions may facilitate deeper engagement and more scientific evaluations. If the former is true, disengagement would predict less evaluation of scientific claims and less perceived plausibility of scientific models. In the latter case, moral convictions may increase engagement with evaluating claims and thus facilitate greater perceived plausibility of scientific models. Given that there is conflicted research on the impact of moral convictions on engagement, the relationship between moral convictions and plausibility is unclear. Therefore, we sought to investigate the relationship between moral convictions and plausibility judgements of climate change. This research will have important implications for understanding how moral convictions influence plausibility and thus how to design interventions to increase plausibility judgements related to climate change and potentially mitigate the climate crisis.

Research questions

Based on our search of the literature and our understanding of the topics of interest, we designed the following research questions:

- (1) To what extent do participants rate climate change as morally imperative?
- (2) What is the relationship between the strength of a moral stance related to climate change and knowledge of scientific consensus, engagement with the text, and emotions?
- (3) To what extent does knowledge of scientific consensus, engagement with the text, emotions, and moral convictions predict perceived plausibility of climate change models?

Method

Participants

Three hundred and forty-six pre-service teacher education students from the Educational Psychology department at a large, midwestern university were

recruited via purposeful sampling for the study and received course credit. We chose preservice teachers due to the implications of teachers understanding climate change. Teachers have an opportunity to teach K-12 students about climate change and increase understanding and activism from an early age. The participants were mostly Juniors (36%) and Seniors (42%) with 83% indicating ages between 18 and 23. The participants reported 80% self-identifying as Female. The participants reported the following ethnicities: 83% White, 5% Hispanic, 3% Asian, 2.6% African American, 2.3% Native American, and 3.2% other. While this population is overwhelmingly White and Female, recent reports by the American Psychological Association indicate that these demographics are reflective of the overall profession of teachers (while not reflective of the overall learners; Rimm-Kaufman & Thomas, 2021).

Design

The study follows a 2 between (moral prime: imperative vs no conviction) x 2 within (Time: pre vs post) design with repeated measures on the time variable. The independent variable was the moral stance of the participants. The dependent variables were learning, engagement, emotion, moral conviction, and plausibility.

Materials

The experimental materials were composed of measures of climate change knowledge, moral convictions, engagement, emotions, plausibility, a moralized engagement prime, a climate change text (refutation), and a demographic questionnaire.

Climate change knowledge

Comprising 27 items, the Human Induced Climate Change Knowledge instrument (HICCK, Lombardi et al., 2013) was used to measure participants' current conceptions of scientific consensus around climate change. Participants rate these items (on a 5-point Likert scale) to the degree they believe *climate scientists* would agree with the statements. In this way, the instrument measures participants' knowledge about the relative scientific consensus (rather than their own personal beliefs). For example, scientists would disagree with the statement that, "current climate change is caused by an increase in the Sun's energy". In the present study, HICCK reliability was good, with an overall Cronbach's alpha of .85.

Moral convictions

To measure students' moral convictions around human induced climate change, we utilized the two items from Skitka's moral conviction scale (Skitka, 2010). One item asked participants, "To what extent is your attitude about human induced climate change a reflection of your core moral beliefs and convictions?" This instrument asked participants to respond to a 5-point Likert scale with the anchors strongly disagree and strongly agree. Overall reliability was $\alpha = .85$, which suggests that the instrument was reliable.

Engagement

We used twenty items developed by Greene and Miller (1996) designed to measure students' engagement. The items focused on deep strategy use when studying. For example, one item read, "While reading the text, I put together ideas and concepts and drew conclusions that were not directly stated in the text". The items were on a five-point Likert-scale ranging from strongly disagree to strongly agree. The reliability of this instrument was good, $\alpha = .94$.

Emotions

To measure participants' topic emotions around climate change, a modified version of the instrument used by Broughton and colleagues (Broughton et al., 2013) was developed. We modified the instrument description to include climate change as the topic. The instrument uses a 5-point Likert scale to measure the degree to which participants feel a given emotion when hearing that humans are causing climate change. These 10 emotions included angry, anxious, ashamed, bored, curious, fear, frustrated, happy, hopeless, and surprised. The emotions scale had an overall reliability of $\alpha = .72$, suggesting that the instrument was reliable.

Model plausibility

To measure participants' plausibility of alternative explanations of climate change, we utilized the model plausibility rating task (Lombardi, Bailey, et al., 2018; Lombardi, Bickel, et al., 2018). Contrasting two models, the scientific consensus model (human induced climate change, "Model A") and an alternative sceptic model (increasing solar energy causes climate change, "Model B"), participants rate both models on a 10-point Likert scale (1 = greatly implausible, 10 = highly plausible).

Moralized engagement prime

To prime students' moral convictions on the topic of human induced climate change, students were asked

to indicate which of the three following statements best described their moral convictions around climate action: that it was a moral imperative, they morally were opposed to action, or they had no moral position. This prime was designed with the goal of making any moral convictions salient to the students before they engaged with the refutation text. Furthermore, students were asked to enter three reasons why they selected the moral conviction above.

Climate change text

The text was adapted from Danielson et al. (2016) and Nussbaum et al. (2016), and has been previously used in studies by Jaeger and Wiley (2015) and Lombardi et al. (2016). This analogy-enhanced refutation text consisted of 54 sentences across 6 paragraphs for a total length of 1000 words. The text had a Flesch-Kincaid grade level of 10.8 and a reading ease score of 49.4. We chose this text because it has been shown to be effective for facilitating learning related to climate change in previous research (Danielson et al., 2016). An effective instructional tool allowed us to test moral stance on cognitive and motivational outcomes. An example excerpt from the text follows:

“Of those that acknowledge that Earth’s temperature is increasing, some believe this global warming is due to natural causes alone. They believe that humans have no impact on the climate. However, it is also incorrect to believe that the climate cannot be affected by humans or that current global warming is due to natural causes alone. Although it is true that climate changes can and do happen naturally, the rapid warming that the earth is currently experiencing cannot be explained by natural factors alone. The climate can and is being changed by humans. In fact, almost all climate scientists (97%) agree that human activities have added to the natural greenhouse effect”.

Demographics

To understand the current group of participants in more depth, participants completed a demographic questionnaire. This instrument asked about participants’ age, year in school, current or intended major, as well as their self-identified race/ethnicity and gender.

Procedures

This study was approved by the Institutional Review Board at the institution of investigation. Participants were sent a link to the Qualtrics website, which housed all experimental materials. After reading and agreeing to the informed consent (those who did not were exited from the study), participants completed the measures of knowledge, moral convictions, engagement, emotions,

and model plausibility. They were then presented with a moral engagement prime where they stated their moral stance and three reasons why they held that stance. Then, participants read the refutation text on climate change and completed the HICCK. Finally, all pre-measures were repeated, with demographics questions at the end. Participants were then thanked for their time and excused.

Results

Data screening

All skewness and kurtosis values were less than or equal to an absolute value of 3, indicating that we could assume normality in the remainder of the analyses (Tabachnick & Fidell, 2001). Furthermore, no outliers were found in any of the data either statistically (i.e., $z \leq 3$) or after visual inspection. All reported tests are two-tailed. All data screening techniques, descriptive statistics, and advanced statistical analysis were conducted using the SPSS 23 software.

Primary results

To answer question one, “To what extent do participants rate climate change as morally imperative?”, the vast majority of students indicated that acting on climate change was a moral imperative (76%) compared with those without a position (22%). Those who were opposed were left out of initial analyses due to small sample size (2%). This finding was somewhat surprising given the small but rather vocal group of climate change deniers that can be found online. In the present study, only 2% of the students were morally against climate change, which might suggest that for many, acting on climate change is seen as morally imperative or not morally charged at all.

To answer question two, “What is the relationship between the strength of a moral stance related to climate change and knowledge of scientific consensus, engagement with the text, and emotions?”, two analyses were conducted. First, independent sample t-tests indicated that those who viewed climate change as morally imperative, on average, were more knowledgeable ($t(361) = 8.4$, Cohen’s $d = 1.98$, $p < .001$), and professed stronger negative emotions ($t(360) = 7.0$, Cohen’s $d = 0.83$, $p < .001$) initially. In contrast, those with no moral position indicated greater levels of boredom, surprise, and happiness. Perhaps not surprisingly, while a separate paired sample t-test indicated that those who viewed acting on climate change as a moral imperative significantly

preferred the scientific model to the sceptic model, those who had no moral position preferred both models equally. Running a Bonferroni adjustment to correct for inflated Family-Wise Error indicated these results are still within the acceptable alpha range. Secondly, change scores were calculated and correlated with one another to more accurately determine the influence of the engagement prime on changing students' scores. Results of the Pearson correlation indicate a significant relationship between learning, engagement, and changes in the strength of moral convictions and negative emotions. Specifically, an increase in moral convictions was associated with a significant increase in learning ($r(346) = .203, p < .05$), stronger engagement ($r(353) = .15, p < .05$), and an increase in negative emotions ($r(351) = .11, p < .05$). The increase in negative emotions is notable, but not altogether surprising. While many other topics may see a decrease in negative emotions after overcoming misconceptions (vaccines and GMFs are generally safe, for example), climate change may be unique in that learning more about the topic makes students more aware of the impending (and sometimes unavoidable) negative outcomes that will be experienced in the future. We discuss this potentially counter-intuitive finding later in the discussion.

To answer question three, "To what extent does knowledge of scientific consensus, engagement with the text, emotions, and moral convictions predict perceived plausibility of climate change models?", regression analyses were used to predict which variables above predicted seeing model A (the scientific consensus model) as more plausible. An omnibus regression found a significant relationship $F(6, 338) = 24.42, p < .05$, accounting for approximately 30% of the variance (i.e., a robust effect size; see Table 1). We discuss these predictors using Standardized Betas so the reader can gauge their predictive strength relative to one another. Significant predictors included knowledge ($B = .42$), and moral convictions ($B = .12$), and negative emotions ($B = .14$), with engagement nearing significance ($B = .08, p = .08$). While being more knowledgeable about the

scientific consensus around climate change and deeper engagement with the passage should predict closer alignment with the scientific consensus model, even after controlling for these variables we see that negative emotions and moral convictions are still significant predictors. Specifically, having more negative emotions around climate change predicts *more* acceptance of the scientific consensus model. This is notable since positive emotions are typically associated with *learning*, whereas in this outcome negative emotions are associated with *acceptance*. Another notable finding is that moral convictions are associated with more acceptance above and beyond knowledge, engagement, and despite the negative emotions. Said another way, this analysis might suggest that educators should frame arguments and educational practices not just to increase knowledge and engagement but tap into students' sense of morality as well. We expand on these findings and interpretations in the following section.

Discussion

Summary of results

Our research suggests that moral convictions are relevant to learning about climate change. To summarize, first we found that most participants rated climate change as morally imperative, which is a finding that many science communicators and climate scientists may find heartening. In fact, almost all participants scored climate change as either morally imperative or morally neutral, with almost no participants reporting that they were morally opposed to acting on climate change. Second, we found an increase in moral convictions was associated with increases in learning, engagement, and negative emotions. Thus, when participants had deeper moral convictions related to acting on climate change, their understanding of climate change became more aligned with the scientific consensus. Third, we found that greater knowledge, engagement, and moral convictions, predicted higher perceived plausibility of the scientifically accepted

Table 1. Regression analysis.

Effect	Unstandardized Beta	Std. Error	Standardized Beta	T	P	95% CI	
						LB	UB
Intercept	-2.16	1.08		-1.99	.047	-4.29	-.03
HICCK	2.02	.25	.42	8.11	<.001	1.53	2.51
Negative Emotions	.311	.12	.136	2.59	.01	.075	.546
Conviction	.24	.11	.12	2.21	.028	.026	.45
Engagement	.013	.007	.083	1.72	.086	-.002	.027
Positive Emotions	-.195	.13	-.072	-1.48	.139	-.453	.063
Plausibility Model B	.05	.04	.07	1.40	.165	-.02	.14

HICCK, Emotions, Convictions, and Plausibility measured at post-test. Engagement was only measured at post-test.

model of climate change (additionally, *less* positive emotions also predicted greater perceived plausibility). Therefore, the increased learning outcomes associated with moral convictions predict plausibility, which has shown to be an important outcome related to learning about and acting on climate change. However, effect sizes were small to medium and we approach these results with some caution in terms of overall meaningfulness. Below, we discuss how our research fits into the extant literature, the theoretical and practical implications, and the limitations and future directions of this promising programme of research.

General discussion

We found that most participants viewed acting on climate change as morally imperative. For those who want to encourage actions to mitigate climate change, this is a positive finding because research has shown that when people view climate change as a part of their moral identity, they are more likely to support climate action (Misch et al., 2021). In addition, our participants were pre-service teachers which has implications for K-12 climate change education. If teachers see climate change as morally imperative, they may be more likely to teach the scientific consensus around human induced climate change to their students. In addition, barely any participants were morally opposed to acting on climate change. Our findings show that most participants were morally in favour of acting on climate change and we explored the resulting influence on positive learning outcomes.

Our findings showed that increases in participants' moral convictions predicted increases in learning, engagement, and negative emotions. This aligns with previous research which found that moral concern can predict learning (Mullen & Skitka, 2006; Skitka, 2010; Trevors & Duffy, 2020). Moral convictions evoke emotions which can facilitate engagement and in turn learning (Wisneski & Skitka, 2017). However, Trevors and Duffy (2020) found that the extent of conceptual change was influenced by type of moral foundation (binding vs individualized). More research needs to be conducted on how different moral foundations influence learning about climate change. This was a primary foray into investigating the impact of moral convictions on learning about climate change and researchers should explore this in much greater depth.

Participants with increased moral convictions reported an increase in levels of engagement. This may be an important finding because engagement is a predictor of learning and motivation (Sinatra et al., 2015). The more engaged people are, the more likely

they will learn the content deeply. Therefore, educators should attempt to facilitate high engagement when teaching about climate change. Priming students' moral convictions in favour of acting on climate change could predict this engagement and lead to learning and possibly acting to mitigate the climate crisis. Given the importance of engagement for learning, researchers should explore the relationship between moral convictions and engagement in more detail. More specifically, it would be valuable to explore how different moral foundations (Graham & Haidt, 2012) uniquely influence engagement.

We found that participants who reported an increase in moral convictions also reported increased negative emotions. Emotions are a powerful predictor of learning and motivation (Linnenbrink, 2007; Op't Eynde & Turner, 2006; Pekrun, 2006). When moral convictions are activated, emotions are evoked, which influence learning (Haidt, 2003; Pekrun, 2006; Trevors & Duffy, 2020). Thus, moral convictions may have a powerful influence on learning about climate change via emotion induction. In the case of climate change, participants feel negative emotions due to the harmful impact of the climate crisis. Researchers have found that negative emotions have mixed results on learning (Linnenbrink, 2007). That is, in some cases negative emotions can cause learners to engage deeper and in other cases negative emotions can distract learners and lead to lower engagement. In this study, increased moral convictions were associated with increased negative emotions as well as increased learning and engagement. Thus, higher moral convictions combined with increased negative emotions, may be an instance of when negative emotions can contribute to increased learning and engagement. More research needs to be conducted to replicate this finding and investigate if this finding generalizes to other morally charged topics. Activating moral convictions could be a useful way to influence emotions that could be productive for learning about climate change and motivating people to act on the climate crisis.

Finally, we found that learning, engagement, positive emotions, and moral convictions predicted plausibility judgements related to climate change. Participants who experienced an increase in moral convictions were more likely to be higher on each of these target variables. This suggests that moral convictions could predict how students appraise evidence and assess plausibility. Evaluation, appraising, and reappraising plausibility of claims—particularly when evaluating how evidence supports a scientific claim, in light of alternatives—can be effective in encouraging students' cognitive and affective engagement and

learning about human-induced climate change (Lombardi et al., 2016; Lombardi, Bailey, et al., 2018; Lombardi, Bickel, et al., 2018; Sinatra & Lombardi, 2020). Moral convictions may aid this process. However, very little research has explored the relationship between moral convictions and plausibility. Researchers should take a more nuanced approach to investigating this relationship and explore how different moral foundations influence plausibility reappraising related to climate change.

Theoretical implications

Moral convictions have been largely overlooked in theories of change related to learning, engagement, emotions, and plausibility. Researchers should take moral convictions into consideration when designing theories related to these constructs, especially related to learning about constructs that are morally relevant, such as climate change. For example, conceptual change theory is a learning theory related to changing knowledge from misconceptions to scientifically accepted conceptions (Sinatra, 2005). Moral convictions have been almost completely ignored in conceptual change theory (Trevors & Duffy, 2020). The goal shouldn't be to mitigate moral convictions, but instead address morals directly. Doing so may lead to increased engagement, which has been shown to facilitate conceptual change (Heddy & Sinatra, 2013). Thus, conceptual change theory should include moral conviction as a primary factor that contributes to change.

As another example, moral convictions are not considered in theories of student engagement (Fredricks et al., 2004). Moral convictions may predict student engagement, which could lead to increased learning. Thus, there may be a specific type of cognitive engagement that occurs when moral convictions are activated. For example, priming students' moral convictions related to a topic and then teaching the topic may predict higher engagement (Misch et al., 2021; Skitka & Bauman, 2008). This may be a unique form of engagement that we are tentatively calling *moralized engagement*. Moralized engagement could be a theoretically distinct form of engagement and important to consider for designing instruction on morally relevant topics, such as climate change.

Practical implications

Practical implications of this research include considerations for designing educational material for teaching about climate change. Our findings suggest that activation of moral convictions predicts positive learning

outcomes. Educators may be inclined to reduce morals during instruction, fearing that they may cause intense emotions that may conflict with learning. On the contrary, priming moral convictions may lead to increased engagement and learning despite these negative emotions. Thus, teachers could design instructional content to directly address the morality of climate change. More specifically, educators could discuss why acting on climate change is a moral obligation. Indeed, focusing on teaching why mitigating and adapting to human induced climate change is morally important could lead to future learning, engagement in, productive emotions about, and scientific plausibility judgements of climate change science (see, for example, Chen, 2020; Sabherwal et al., 2021).

Additionally, the participants of this study were pre-service teachers, which is of particular significance. That is, when pre-service teachers are morally in favour of acting on climate change, they are more likely to learn the content. This is important because they will be teaching future generations about the climate crisis (Ceyhan & Mugaloglu, 2020; Ceyhan et al., 2021; Governor et al., 2021). Therefore, climate change instructional material for pre-service teachers should activate moral convictions and teach about the moral relevance of climate change. This could lead to better climate change instruction from practicing teachers and in turn better learning outcomes from students (Tolppanen & Kärkkäinen, 2021).

Limitations and future directions

As with all research, there were limitations to this study including (a) lack of morally opposed participants, (b) characteristics of the participants, and (c) lack of behavioural instrumentation. First, our goal was to investigate the impact of moral stance on learning outcomes related to the topic of climate change. Almost all participants were morally in favour of acting on climate change or morally neutral. We did not have enough participants who were morally opposed to acting on climate change to conduct an analysis comparing the three moral stance groups (in favour, opposed, neutral). While finding that there were almost no morally opposed participants is positive, understanding how morally in favour vs morally opposed influences learning and engagement is important to comprehending how moral conviction influences learning about climate change. That is, people who are morally opposed to acting on climate change may engage less with messages that conflict with their beliefs, while people who are morally in favour of acting may engage more with messages (Skitka & Bauman, 2008). Future researchers

should increase the sample and seek morally opposed participants to better understand the relationship between learning and moral convictions.

A second limitation is the characteristics of the participants, who were education majors, pre-service teachers, and college students. This particular group may be more inclined to support acting on climate change and to have a proclivity towards learning and engagement. We posit that studying pre-service teachers is an affordance of this research, however their data may skew the results. In addition, education majors tend to be more politically liberal and thus more supportive of acting on climate change. Despite these limitations, these students are on-track to become new teachers. In this role, they will be communicating the scientific consensus to students, as well as potentially parents and policy makers. So while this population may share some inherent biases as described above, we believe they are a very important demographic to study. Future research would benefit from including the general public as participants to explore if the results have stronger ecological validity.

A third limitation was that we did not include any measure of participant behaviour. That is, learning, engagement, moral conviction, and plausibility are important outcomes, but future researchers should explore if moral convictions predict actually acting to mitigate the climate crisis. This could include asking participants to report conservation activities, measuring recycling behaviour, or observing participants' water bills to explore if they conserve more based on their moral stance. Connecting moral convictions and learning outcomes to behavioural outcomes would be a laudable next step in this research. Encouraging people to change their behaviour to conserve and contribute to creating a more sustainable society should be the goal of climate change education.

Conclusions

Mitigating the climate crisis is one of the most important tasks of our generation. Education is one of the key factors to teaching the populace about the problem and how to mitigate human induced climate change. We need to design the most effective educational content possible. That is, the instructional material needs to facilitate optimal learning and engagement. To do so, learners' moral convictions need to be considered when designing instructional content. We found that moral convictions influence learning, engagement, emotions, and perceptions of plausibility. Future researchers should explore this phenomenon in greater depth as it has important implications for climate change education.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Benjamin C. Heddy  <http://orcid.org/0000-0003-2564-653X>
Doug Lombardi  <http://orcid.org/0000-0002-4172-318X>

Data availability statement

The data that support the findings of this study are available from the corresponding author, BH, upon reasonable request.

References

- Ballew, M. T., Leiserowitz, A., Roser-Renouf, C., Rosenthal, S. A., Kotcher, J. E., Marlon, J. R., Lyon, E., Goldberg, M. H., & Maibach, E. W. (2019). Climate change in the American mind: Data, tools, and trends. *Environment: Science and Policy for Sustainable Development*, 61(3), 4–18. <https://doi.org/10.1080/00139157.2019.1589300>
- Broughton, S. H., Sinatra, G. M., & Nussbaum, E. M. (2013). "Pluto has been a planet my whole life!" Emotions, attitudes, and conceptual change in elementary students' learning about Pluto's reclassification. *Research in Science Education*, 43(2), 529–550. <http://dx.doi.org/10.1007/s11165-011-9274-x>
- Broughton, S. H., Sinatra, G. M., & Reynolds, R. E. (2010). The nature of the refutation text effect: An investigation of attention allocation. *The Journal of Educational Research*, 103(6), 407–423. <https://doi.org/10.1080/00220670903383101>
- Carnes, N. C., & Lickel, B. (2018). Moral binding: How emotions, convictions, and identity fusion shape progroup behavior. *Self and Identity*, 17(5), 549–573. <https://doi.org/10.1080/15298868.2018.1451362>
- Ceyhan, G. D., Lombardi, D., & Saribas, D. (2021). Probing into pre-service science teachers' practices of scientific evaluation and decision-making on socio-scientific issues. *Journal of Science Teacher Education* 32(8), 865–889. <https://doi.org/10.1080/1046560X.2021.1894762>
- Ceyhan, G. D., & Mugaloglu, E. Z. (2020). The role of cognitive, behavioral and personal variables of pre-service teachers' plausibility perceptions about global climate change. *Research in Science & Technological Education*, 38(2), 131–145. <https://doi.org/10.1080/02635143.2019.1597695>
- Chen, M. F. (2020). Moral extension of the protection motivation theory model to predict climate change mitigation behavioral intentions in Taiwan. *Environmental Science and Pollution Research*, 27(12), 13714–13725. <https://doi.org/10.1007/s11356-020-07963-6>
- Danielson, R. W., Sinatra, G. M., & Kendeou, P. (2016). Augmenting the refutation text effect with analogies and graphics. *Discourse Processes*, 53(5–6), 392–414. <https://doi.org/10.1080/0163853X.2016.1166334>

- Feinberg, M., & Willer, R. (2013). The moral roots of environmental attitudes. *Psychological Science*, 24(1), 56–62. <https://doi.org/10.1177/0956797612449177>
- Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, 74(1), 59–109. <https://doi.org/10.3102/00346543074001059>
- Governor, D., Lombardi, D., & Duffield, C. (2021). Negotiations in scientific argumentation: An interpersonal analysis. *Journal of Research in Science Teaching*, 58(9), 1389–1424. <https://doi.org/10.1002/tea.21713>
- Graham, J., & Haidt, J. (2012). Sacred values and evil adversaries: A moral foundations approach. In P. Shaver & M. Mikulincer (Eds.), *The social psychology of morality: Exploring the causes of good and evil* (pp. 11–31). APA Books.
- Greene, B. A., & Miller, R. B. (1996). Influences on achievement: Goals, perceived ability, and cognitive engagement. *Contemporary Educational Psychology*, 21(2), 181–192.
- Haidt, J. (2003). The moral emotions. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 852–870). Oxford University Press.
- Heddy, B. C., & Sinatra, G. M. (2013). Transforming misconceptions: Using transformative experience to promote positive affect and conceptual change in students learning about biological evolution. *Science Education*, 97(5), 723–744. <https://doi.org/10.1002/sce.21072>
- Heddy, B. C., Taasobshirazi, G., Chancey, J. B., & Danielson, R. W. (2018). Developing and validating a conceptual change cognitive engagement instrument. *Frontiers in Education*, 3(June), 1–9. <https://doi.org/10.3389/educ.2018.00043>
- Jaeger, A. J., & Wiley, J. (2015). Reading an analogy can cause the illusion of comprehension. *Discourse Processes*, 52(5–6), 376–405. <https://doi.org/10.1080/0163853X.2015.1026679>
- Johnson, M. L., & Sinatra, G. M. (2013). Use of task-value instructional inductions for facilitating engagement and conceptual change. *Contemporary Educational Psychology*, 38(1), 51–63. <https://doi.org/10.1016/j.cedpsych.2012.09.003>
- Kahn, P. H., Jr. (1997). Children’s moral and ecological reasoning about the Prince William Sound oil spill. *Developmental Psychology*, 33(6), 1091. <https://doi.org/10.1037/0012-1649.33.6.1091>
- Kahn, P. H., & Lourenço, O. (2002). Water, air, fire, and earth: A developmental study in Portugal of environmental moral reasoning. *Environment and Behavior*, 34(4), 405–430. <https://doi.org/10.1177/00116502034004001>
- Linnenbrink, E. A. (2007). The role of affect in student learning: A multi-dimensional approach to considering the interaction of affect, motivation, and engagement. In P. A. Schutz & R. Pekrun (Eds.), *Emotion in education* (pp. 107–124). Academic Press.
- Liu, R. D., Zhen, R., Ding, Y., Liu, Y., Wang, J., Jiang, R., & Xu, L. (2018). Teacher support and math engagement: Roles of academic self-efficacy and positive emotions. *Educational Psychology*, 38(1), 3–16. <https://doi.org/10.1080/01443410.2017.1359238>
- Lombardi, D. (2016). Beyond the controversy: Instructional scaffolds to promote critical evaluation and understanding of earth science. *The Earth Scientist*, 32(2), 5–10.
- Lombardi, D., Bailey, J. M., Bickel, E. S., & Burrell, S. (2018). Scaffolding scientific thinking: Students’ evaluations and judgments during earth science knowledge construction. *Contemporary Educational Psychology*, 54, 184–198. <https://doi.org/10.1016/j.cedpsych.2018.06.008>
- Lombardi, D., Bickel, E. S., Bailey, J. M., & Burrell, S. (2018). High school students’ evaluations, plausibility (re) appraisals, and knowledge about topics in earth science. *Science Education*, 102(1), 153–177. <https://doi.org/10.1002/sce.21315>
- Lombardi, D., Danielson, R. W., & Young, N. (2016). A plausible connection: Models examining the relations between evaluation, plausibility, and the refutation text effect. *Learning and Instruction*, 44, 74–86. <https://doi.org/10.1016/j.learninstruc.2016.03.003>
- Lombardi, D., Sibley, B., & Carroll, K. (2013). What’s the alternative? Using model-evidence link diagrams to weigh alternative models in argumentation. *The Science Teacher*, 80(5), 36–41. https://doi.org/10.2505/4/tst13_080_05_50
- Lombardi, D., & Sinatra, G. M. (2013). Emotions about teaching about human-induced climate change. *International Journal of Science Education*, 35, 167–191. <https://doi.org/10.1080/09500693.2012.738372>
- Meehan, C. R., Levy, B. L., & Collet-Gildard, L. (2018). Global climate change in US high school curricula: Portrayals of the causes, consequences, and potential responses. *Science Education*, 102(3), 498–528. <https://doi.org/10.1002/sce.21338>
- Misch, A., Kristen-Antonow, S., & Paulus, M. (2021). A question of morals? The role of moral identity in support of the youth climate movement Fridays4Future. *PLOS ONE*, 16(3), e0248353. <https://doi.org/10.1371/journal.pone.0248353>
- Moser, S. C. (2007). More bad news: The risk of neglecting emotional responses to climate change information. In S. C. Moser, and L. Dilling (Eds.), *Creating a climate for change*. Cambridge University Press 64–80 .
- Mullen, E., & Skitka, L. J. (2006). Exploring the psychological underpinnings of the moral mandate effect: Motivated reasoning, group differentiation, or anger? *Journal of Personality and Social Psychology*, 90, 629–643.
- National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. The National Academies Press. <https://doi.org/10.17226/13165>
- Nussbaum, E. M., Cordova, J. R., & Rehmat, A. P. (2016, April). *Refutation texts for effective climate change education* [Paper presentation]. The meeting of the American Education Research Association, Washington, DC.
- Op’t Eynde, P., & Turner, J. E. (2006). Focusing on the complexity of emotion issues in academic learning: A dynamical component systems approach. *Educational Psychology Review*, 18(4), 361–376. <https://doi.org/10.1007/s10648-006-9031-2>
- Pekrun, R. (2006). The control–value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review*, 18(4), 315–341. <https://doi.org/10.1007/s10648-006-9029-9>
- Quarderer, N. A., Fulmer, G. W., Hand, B., & Neal, T. A. (2021). Unpacking the connections between 8th graders’ climate

- literacy and epistemic cognition. *Journal of Research in Science Teaching*, 58(10), 1527–1556. <https://doi.org/10.1002/tea.21717>
- Reid, A. (2019). Climate change education and research: Possibilities and potentials versus problems and perils? *Environmental Education Research*, 25(6), 767–790. <https://doi.org/10.1080/13504622.2019.1664075>
- Renninger, K., & Hidi, S. (2017). *The power of interest for motivation and engagement*. Routledge.
- Rimm-Kaufman, S. E., & Thomas, K. (2021). *How white, middle class teachers can apply psychology to teach students who are different from them*. American Psychological Association. <https://apadiv15.org/education-practice-briefs/>
- Román, D., & Busch, K. C. (2021). Textbooks of doubt, tested: The effect of a denialist framing on adolescents' certainty about climate change. *Environmental Education Research*, 22(8), 1158–1180. <https://doi.org/10.1080/13504622.2015.1091878>
- Rutjens, B. T., Sutton, R. M., & van der Lee, R. (2018). Not all skepticism is equal: Exploring the ideological antecedents of science acceptance and rejection. *Personality & Social Psychology Bulletin*, 44(3), 384–405. <https://doi.org/10.1177/0146167217741314>
- Sabherwal, A., Ballew, M. T., Van der Linden, S., Gustafson, A., Goldberg, M. H., Maibach, E. W., Kotcher, J. E., Swim, J. K., Rosenthal, S. A., & Leiserowitz, A. (2021). The Greta Thunberg effect: Familiarity with Greta Thunberg predicts intentions to engage in climate activism in the United States. *Journal of Applied Social Psychology*, 51(4), 321–333. <https://doi.org/10.1111/jasp.12737>
- Sinatra, G. M. (2005). The “warming trend” in conceptual change research: The legacy of Paul R. Pintrich. *Educational Psychologist*, 40(2), 107–115. https://doi.org/10.1207/s15326985ep4002_5
- Sinatra, G. M., & Broughton, S. H. (2011). Bridging reading comprehension and conceptual change in science education: The promise of refutation text. *Reading Research Quarterly*, 46(4), 374–393. <https://doi.org/10.1002/RRQ.005>
- Sinatra, G. M., Heddy, B. C., & Lombardi, D. (2015). The challenges of defining and measuring student engagement in science. *Educational Psychologist*, 50(1), 1–13. <https://doi.org/10.1080/00461520.2014.1002924>
- Sinatra, G. M., & Lombardi, D. (2020). Evaluating sources of scientific evidence and claims in the post-truth era may require reappraising plausibility judgments. *Educational Psychologist*, 55(3), 120–131. <https://doi.org/10.1080/00461520.2020.1730181>
- Skitka, L. J. (2010). The psychology of moral conviction. *Social and Personality Psychology Compass*, 4(4), 267–281. <https://doi.org/10.1111/j.1751-9004.2010.00254.x>
- Skitka, L. J., & Bauman, C. W. (2008). Moral conviction and political engagement. *Political Psychology*, 29(1), 29–54. <https://doi.org/10.1111/j.1467-9221.2007.00611.x>
- Skitka, L. J., & Mullen, E. (2002). The dark side of moral conviction. *Analyses of Social Issues and Public Policy*, 2(1), 35–41. <https://doi.org/10.1111/j.1530-2415.2002.00024.x>
- Skitka, L. J., & Wisneski, D. C. (2011). Moral conviction and emotion. *Emotion Review*, 3(3), 328–330. <https://doi.org/10.1177/1754073911402374>
- Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics*. Allyn and Bacon.
- Tippett, C. D. (2010). Refutation text in science education: A review of two decades of research. *International Journal of Science and Mathematics Education*, 8(6), 951–970. <https://doi.org/10.1007/s10763-010-9203-x>
- Tolppanen, S., & Kärkkäinen, S. (2021). The blame-game: Pre-service teachers views on who is responsible and what needs to be done to mitigate climate change. *International Journal of Science Education* 43(14), 1–24. <https://doi.org/10.1080/09500693.2021.1965239>
- Trevors, G., & Duffy, M. C. (2020). Correcting COVID-19 misconceptions requires caution. *Educational Researcher*, 49(7), 538–542. <https://doi.org/10.3102/0013189X20953825>
- Wigfield, A., Eccles, J. S., Fredericks, J., Roeser, R., Schiefele, U., & Simpkins, S. (2015). Development of achievement motivation and engagement. In R. M. Lerner (Ed.), *Handbook of child psychology and development science* (Vol. 3, 7th ed., pp. 657–700). Wiley. <https://doi.org/10.1002/9781118963418.childpsy316>
- Wisneski, D. C., & Skitka, L. J. (2017). Moralization through moral shock: Exploring emotional antecedents to moral conviction. *Personality & Social Psychology Bulletin*, 43(2), 139–150. <https://doi.org/10.1177/0146167216676479>