Emotion, Fact, and Anthropogenic Disturbances: Undergraduate Attitudes Toward Wildfire and Urbanization after a Brief Intervention

Mali M. Hubert,[†‡*] Maryrose Weatherton,[†§] and Elisabeth E. Schussler[†]
[†]Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville TN 37996; [‡]Department of Natural Sciences, Tennessee Wesleyan University, Athens TN 37303; [§]Department of Theory and Practice in Teacher Education, University of Tennessee, Knoxville TN 37996

ABSTRACT

Understanding attitudes towards anthropogenic disturbances, especially among undergraduates, is important to inform educational practices because of the theoretical link between attitude and behavior. We evaluated the attitudes of undergraduate students in a biology majors course and nonmajors course toward two anthropogenic disturbances: wildfire and urbanization. Student attitudes were assessed via an online Wildfire and Urbanization Attitude survey (WUAS) before and after a video intervention, randomly delivered as either fact- or emotion-based versions. Student beliefs regarding wildfire and urbanization were positively correlated with their general intention to act toward environmental issues on both pre- and postintervention surveys, as suggested by theory. Student belief that urbanization was bad for the environment increased from pre- to postintervention. However, beliefs and intention to act did not statistically differ between majors/nonmajors or intervention video type. This study hints that brief interventions can impact student disturbance beliefs, but more research is needed to guide curriculum development. Despite some research suggesting the value of emotion to inspire climate action, our results suggest that more work needs to be done regarding the value of emotion to increase environmental action toward other anthropogenic disturbances.

INTRODUCTION

In recent years, special attention has been paid to understanding how people feel about the anthropogenic disturbance of climate change, with most research targeting the general public and secondary schools (Aksit *et al.*, 2018). Few studies exist on college students' knowledge, attitudes, and beliefs about climate change (Aksit *et al.*, 2018) and we have been unable to find any studies that examined college students' attitudes toward additional anthropogenic disturbances. As human populations expand and biodiversity is threatened, there is a strong need to understand student attitudes toward all types of anthropogenic changes. This study responds to that need by researching student beliefs and intentions to act regarding two increasingly common anthropogenic disturbances that often occur in conjunction: wildfire and urbanization.

Balch *et al.* (2017) note that humans have extended the spatial and seasonal fire niche in the United States through their influence on global climate and population growth; due to this, human-caused wildfires represent 84% of all wildfires in the United States. Large human-caused fires are becoming more frequent as fire regimes shift with warming temperatures (Parisien *et al.*, 2016; Halofsky *et al.*, 2020) and humans encroach into wildland areas (Radeloff *et al.*, 2018). Approximately one-third of all homes in the United States are surrounded by or within wildland vegetation, which creates the wildland – urban interface, or WUI (Radeloff *et al.*, 2018; Kramer *et al.*, 2019). Beyond direct human disturbances on habitat, the WUI can facilitate new

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*Address correspondence to: Mali M. Hubert (mhubert@tnwesleyan.edu).

fire ignition opportunities due to the proximity of residential structures to vegetation (Cardille *et al.*, 2001), potentially causing significant environmental consequences both in wildland areas and via its spread into human-occupied areas.

Urbanization refers to the process of population concentration and the transformation of rural areas into urban centers (United Nations, 2019). Urbanization is a significant global trend that has far-reaching implications for economies, societies, and the environment. Urban environments can often provide opportunities like improved standard of living (Duranton and Puga, 2014), improved access to services and opportunities, and increased social diversity and cultural and academic learning opportunities (Florida, 2003; Autor and Dorn, 2013). Urban living also presents challenges including social disparities (Sassen, 2014), commuting and transportation limitations (Schwanen and Kwan, 2008), and health impacts such as pollution, overcrowding, and the spread of infectious diseases (Kinney, 2008). Beyond societal challenges and direct human impacts, urbanization significantly impacts the environment through the loss of wildland and natural areas which leads to habitat loss and fragmentation (McDonald *et al.*, 2008), urban heat island effect (Oke, 1982), and increased waste generation (Hoornweg and Bhada-Tata, 2012).

Given the significant environmental impact of multiple and ongoing anthropogenic disturbances, like wildfire and urbanization, college student knowledge and beliefs surrounding these changes need to be understood. This information can then guide potential curricular changes focused on what students will need in their lives beyond college. Students in classrooms today, for example, may eventually be in positions to make environmentally conscious land management decisions as urban planners or policy makers (Ryan, 2012). Many will likely be voters, and all will make their own personal decisions about the ways they will impact resources on the planet. Therefore, it is imperative that students do so from an informed perspective and with an understanding of the potential effects of anthropogenic disturbances.

To educate students about anthropogenic disturbances, instructors need an understanding of existing student knowledge, concerns, and attitudes toward disturbance events (Wachholz *et al*., 2014), but also what classroom practices might shift these constructs. This can inform teaching practices and curricula that foster scientific literacy and environmental advocacy (Wachholz *et al*., 2014). Some climate change research has suggested that instead of providing students fact-based information to influence advocacy, there may be more motivational benefit to using emotion-based materials (Whitmarsh *et al.*, 2013; Morris *et al.*, 2019). One question guiding this study is whether negative facts or negative emotions related to anthropogenic disturbances will differentially influence student beliefs about them and subsequent intention to act. On one hand, negative emotions may encourage knowledge gain and inspiration to take future action against these changes; however, previous work has also revealed that strong negative emotions can cause "eco-anxiety" (or "climate-anxiety") and additional unwanted psychological responses, including increased levels of PTSD and depression toward the knowledge of negative climate change impacts (Clayton, 2020). Additionally, we ask whether these educational approaches toward anthropogenic disturbances should be the same for students who are science majors versus those who are nonscience majors because it is unclear how the impact of understanding anthropogenic disturbances may differ between these students.

Prior studies have shown that non-STEM (Science, Technology, Engineering, and Mathematics) majors are able to engage with the scientific process; however, they may be less motivated and confident compared with STEM majors (Hebert and Cotner, 2019). A study by Cotner *et al.* (2017) found that non-STEM majors were more likely than biology majors to hold misconceptions about the nature of science, though they were not completely unaware of how science functions. Additionally, non-STEM majors are less likely than biology majors to see science as personally relevant or influential in their lives (Cotner *et al.*, 2017), which may impact attitudes toward particular topics, such as anthropogenic disturbances. For many non-STEM majors, an introductory life science course can be a meaningful (or potentially the only) opportunity to engage with science and encourage positive attitudes toward changing environmental problems.

Theoretical Model

An early model of environmental behavioral intention proposed that increasing an individual's knowledge about the environment leads to a shift in attitudes and may ultimately lead to changes in behavior (Hungerford and Volk, 1990; Yu and Yu, 2017). Ajzen's theory of planned behavior proposes that an individual's intention to act can be influenced by their attitude associated with the action (Ajzen, 1985). In this theory, if the attitude associated with the intended behavior is positive, then there is a greater drive to perform the behavior (i.e., intention to act; Ajzen, 1985; Christensen and Knezek, 2015). A 2012 study that measured student attitudes toward human-induced climate change found that students who had positive attitudes and beliefs toward regulating climate change effects on the environment were more likely to want to act to reduce its effects (Sinatra *et al.,* 2012). Interestingly, negative emotions can also yield positive intentions to act. According to Morris *et al.* (2019), negative emotions (i.e., worry), can drive risk management and encourage action toward a potential problem. In the context of climate change disturbances, fear and anxiety can often lead to action among individuals (Weber, 2006; Morris *et al.*, 2019). We note, however, that some studies have found that fear and anxiety can result in passivity due to lack of belief in personal efficacy and feelings of powerlessness (Clayton *et al.*, 2021) leading some to question the use of emotion as a motivator for environmental change. Thus, multiple studies have provided support for Ajzen's theory that intentions to act are manifestations of the values and attitudes of individuals, but the matter of how to change attitudes remains less clear.

To change attitudes, and thus intention to act, instructors may choose emotion-based curricula or fact-based curricula. Several empirical and theoretical studies have indicated that emotion can drive an individual's attitude and behaviors toward social topics like climate change (Morris *et al.*, 2019). Previous studies have found that positive emotions have elicited hope and engagement with sustainability issues, whereas negative emotions, such as fear, can provoke more careful processing about potential solutions (Meijnders *et al.*, 2001a, 2001b; Ojala, 2012; Nabi *et al*., 2018). The most used approach in

science communication regarding sustainability issues, such as climate change, has been the information deficit approach (Dickson, 2005). This approach posits that communicating more peer-reviewed scientific evidence to the general public will encourage action and reduce skepticism (Dickson, 2005; Morris *et al.*, 2019). However, previous studies have shown that using a fact-based approach is minimally effective at motivating lasting behavioral change (Whitmarsh *et al.*, 2013; Morris *et al.*, 2019). Rather, it has been suggested that emotions are the key to prompting a public response to social issues; even negative emotions, such as worry, drive risk management and can invoke action (Peters and Slovic, 2000; Morris *et al.*, 2019). Given that emotions associated with environmental-related issues may influence successive attitudes and behavioral change (Nabi *et al.*, 2018), this study aimed to test these relationships via an intervention.

Using Ajzen's theory of planned behavior (1985), this study assessed attitudes toward wildfire and urbanization in undergraduate biology major and nonmajor students. Attitude in this study is defined as "positive or negative feelings and predispositions" toward wildfire, urbanization, and general environmental change (Lovelace and Brickman, 2013). According to Christensen and Knezek (2015), attitudes toward environmental issues consist of "beliefs, affect, and behavioral intentions that combine to illustrate attitudes toward environmentally related activities or issues." Though this study did not assess behavior directly, Ajzen (2002) stated that attitudinal beliefs and intention to act may be a predecessor to behavior (Christensen and Knezek, 2015). Thus, in this study, we measured the constructs of student "beliefs" about wildfires, student "beliefs" about urbanization, and general environmental "intentions to act". Beliefs in this study were related to a student's perception of the impact of wildfire or urbanization disturbances on the environment. A positive belief for this study meant they perceived these as bad for the environment, while a negative belief meant that they perceived the disturbances as good for the environment. Intention to act was the student's willingness to act toward general environmental concerns, not necessarily intention to act specifically to reduce wildfire or urbanization. Finally, we explored the impact of a fact-based versus emotion-based intervention on the above-mentioned dependent variables to determine if they differentially affected students. We collected quantitative data to test three hypotheses: (H1.) Student beliefs toward wildfire and urbanization disturbances and intention to act toward environmental concerns will be positively related and will change from pre- to postintervention; (H2.) From pre- to postintervention, biology major attitudes toward environmental disturbances will be significantly different while non-biology major attitudes will not; and (H3.) Type of intervention (fact-based or emotion-based videos) will impact students' beliefs toward disturbances and intention to act, with emotion-based videos having a stronger effect.

Scientific knowledge can often be personally relevant, and a lack of science understanding can affect policy decisions, personal choices, and general decision-making (Cotner *et al.*, 2017). This study collected data to explore the link between student course selection (represented as major), intervention type, and their beliefs and intention to act specific to two anthropogenic disturbances. Results from this study can be used to evaluate student perceptions and understandings of global change phenomena beyond climate change, such as wildfire and urbanization, and inform anthropogenic disturbance curricula in the classroom.

METHODS

Participants and Recruitment

This study focused on students in one majors and one nonmajors biology course ($N = 3$ sections of one majors course; $N = 3$ sections of one nonmajors course) at a large four-year research institution in the southeastern United States in spring 2021. The majors course was part of the freshman introductory biology sequence and had approximately 550 students enrolled across the three lecture sections; the nonmajors course was a general education course with approximately 700 students enrolled across the three-lecture sections. For both the majors and nonmajors courses, the semester topics were focused on ecology, evolution, and biodiversity.

Students invited to participate in this study were those who registered for the selected biology sections and whose instructors agreed to send the study information to their students. Any student in the identified sections who agreed to the consent information, took the pre- and postsurveys, and watched the videos were included in the study, except for those who were not 18 years of age. Those under 18 years of age could answer the questions, but their answers were not included in analyses. Students were incentivized to complete the surveys and watch the video by the instructors offering three extra credit points toward the students' final course grade upon completion of the survey (courses typically had 800–1000 points total). If students wanted the opportunity to receive extra credit but did not want to participate in the study, a separate assignment was given to earn credit.

Survey Design

Students were asked to complete a preintervention online survey about wildfire and urbanization disturbances (hereafter, the Wildfire and Urbanization Attitude Survey [WUAS]; Supplemental Material, Table S1). The survey consisted of a total of 34 questions: eight Likert-scale questions on wildfire beliefs, one Likert-scale question about wildfire intention to act, seven Likert-scale questions on urbanization beliefs, one Likert-scale question about urbanization intention to act, five Likert-scale questions measuring intention to act toward general environmental issues, three open-ended questions about wildfire, urbanization, and general environmental disturbances (i.e., why do you feel this way about wildfire?), two open-ended questions about personal experience with wildfire and urbanization (i.e., have you ever been personally impacted by a wildfire?), and seven demographic questions (i.e., gender, race, hometown, first-generation college student status, etc.). The answers to the openended questions were not used in this study.

The beliefs and intention to act questions ($N = 17$) were modified from an existing climate attitude survey from Christensen and Knezek (2015). Christensen and Knezek's (2015) climate attitude belief constructs were modified to include the words "wildfire" or "urbanization" in place of "global climate change." Questions were reworded slightly if direct word replacement was not feasible. No modifications were made to the original questions from Christensen and Knezek (2015) measuring general environmental intention to

act ($N = 5$). Though multiple climate attitude surveys exist, the one created by Christensen and Knezek (2015) was the most relevant for adaptation to wildfire and urbanization attitude questions for undergraduate students. The rest of the survey questions on the WUAS (openended questions and the demographic questions) were created by M.M.H. and reviewed by M.W. and E.S.

Intervention

Before beginning this study, emotion-based and fact-based videos were created and piloted by M.M.H. and in consultation with E.S. and a content expert on anthropogenic disturbance. These videos (Supplemental Material, p. 8) contained descriptive information on general anthropogenic disturbances, wildfire, and urbanization, as well as location-specific disturbance information in areas of interest (e.g., urbanization and wildfires in Gatlinburg, TN). The script for each video was the same, the only difference was the images presented. In the fact-based video the images were scientific figures and diagrams; in the emotion-based video the images were pictures of charred landscapes and animals displaced by human habitat disturbance. Each video was approximately 9 min long and was created in Microsoft PowerPoint then transferred to video format on the same software. The narrator (M.M.H.) was the same for both videos to reduce confounding variables such as instructor differences in anthropogenic disturbance knowledge, attitude, or pedagogy. In fall 2021, these videos were presented to a pilot group of nonmajor introductory biology students ($N = 204$) to test for differential emotional perceptions (UTK IRB-20-06152-XP). To do so, students watched the videos and then rated their emotional response on a scale from 1 (no emotional response) to 5 (strong emotional response) as well as answering an openended question explaining their response.

To conduct the study, students first took the WUAS in March 2021 (preintervention survey). The intervention video and postintervention survey was then distributed to students by the course instructor one week after taking the preintervention survey. The intervention, which consisted of watching one of the videos, was randomized so that students within each class either received a "fact-based" video or an "emotion-based" video (hereafter "video type"; Supplemental Material, p. 8). Randomization occurred by students selecting their birth month where January–June birthdays watched the fact-based video and July–December birthdays watched the emotion-based video. Students took the postintervention WUAS immediately after watching the video; the post-WUAS was the same for all students, and the same as the pre-WUAS survey. Therefore, comparison of the postintervention survey with the preintervention survey allowed the assessment of changes in beliefs associated with wildfire, urbanization, and intention to act toward environmental issues in general.

Data Preparation

There was a total of 1250 students in the classes for this study, of which 611 responded to the preintervention survey, and 417 responded to the postintervention survey. Pre- and postintervention responses were then matched using the respondents' email addresses. Students who did not take both the pre- and postsurvey were removed from the data set, resulting in a matched sample of $N = 364$. Students under the age of 18 were removed from the analysis resulting in a sample of $N = 363$, as were incomplete responses to the questionnaire resulting in a sample of $N = 355$. Matched pre- and postintervention data were additionally filtered to ensure that students watched the intervention video before beginning the postintervention WUAS. Students who viewed the video for less than 540 s were removed from the analysis, resulting in a remaining matched sample of $N = 188$. This postintervention time requirement was used because both videos (i.e., fact-based or emotion-based) were slightly over 9 min long, thus ensuring that students were watching the full intervention video before completing the survey. Finally, some respondents had to be removed from the data set because they selected that they were taking both the majors and nonmajors courses, thus potentially confounding the results. This left 164 students who took the pre- and postsurvey and met all inclusion criteria for the final analyses.

Likert-scale survey responses for the wildfire beliefs, urbanization beliefs, and intention to act constructs were summed separately for the pre- and postsurveys. Items on the WUAS that indicated a negative environmental attitude or belief (i.e., "We cannot do anything to stop wildfires"; items 9, 17, 20, 21, and 22) were reverse scored so they could be compiled with the positively phrased items on the WUAS. Finally, data were coded to delineate major and non-major students and the type of intervention they received.

Reliability and Validity

Reliability and validity are important features of instrument measurement. Reliability is related to the consistency of the instrument in measuring the intended construct (Arjoon *et al.*, 2013). Validity is the extent to which the instrument measures what it is intended to measure (Arjoon *et al.*, 2013). Cronbach's alpha was calculated as a one measure of reliability, internal consistency, for the entire survey as well as for the individual constructs (Cronbach, 1951; Taber, 2018). Validity evidence for the constructs of the WUAS (i.e., wildfire and urbanization beliefs and intention to act) was collected via confirmatory factor analysis (Supplemental Material, Supplemental Table S2; Supplemental Figure S1) to confirm the three constructs (wildfire, urbanization beliefs, and intentions) indicated by Christensen and Knezek (2015). The validity of the criteria of the WUAS was assessed using Spearman correlations for the pre- and postintervention survey responses since the data were nonparametric. As detailed in the results, the individual intention to act toward wildfire (item 9) and urbanization (item 17) questions were not affirmed via the confirmatory factor analysis in the full model, nor was Question 15. As a result, they were not used in quantitative modeling, although averages for items 9 and 17 were assessed via a *t* test.

Analyses

The number of participants, means, SD, and standard error (i.e., descriptive statistics) were calculated for the questions that formed the constructs of wildfire beliefs, urbanization beliefs, and intention to act toward general environmental disturbances for the pre- and postintervention surveys. We fitted generalized linear mixed models (GLMMs) that modeled differences in individual beliefs about fire and urbanization and intention to act both pre- and postintervention as three separate models: [wildfire beliefs ~ survey type (pre/postintervention) *

video type (emotion/fact-based)], [urbanization beliefs approximate survey type * video type], and [intention to act approximate survey type * video type]. The fixed effect variables we used were survey type (pre- or postintervention), video type, major type, and their pairwise interactions, as well as the random effect of respondent. The response variables of the GLMM (wildfire and urbanization beliefs, and intention to act) were modeled as having Poisson errors to account for sampling twice within each classroom. Models using the Poisson distribution were assessed for overdispersion.

Data analyses and instrument validation for this study were based on the study by Christensen and Knezek (2015) with reference to Sinatra *et al.* (2012). All exploratory analyses, reported statistics, and graphical representations were performed using the packages: "corrplot" (Wei *et al.*, 2021), "EFAtools" (Steiner and Grieder, 2020), "ggplot2" (Wickham, 2016), "ggpubr" (Kassambara, 2020), "GPArotation" (Bernaards and Jennrich, 2005), "lavaan" (Rosseel, 2012), "lme4" (Bates *et al.*, 2015), "ltm" (Rizopoulos, 2007), and "psych" (Revelle, 2017) in RStudio v. 4.0.3 (R Core Team, 2022).

TABLE 1. Descriptive statistics for all 22 Likert-scale questions on the preintervention WUAS for majors and non-majors. Questions were grouped into the constructs of: (1) wildfire beliefs, (2) urbanization beliefs, and (3) intention to act. Analyses were completed on the group of students that completed both the pre- and postintervention survey with the time requirement of 540 s. Wildfire beliefs range from 0–40, urbanization beliefs range from 0–30, and intention to act ranges from 0–25

	n	Mean	Standard deviation	Standard error
Wildfire beliefs				
Majors	95	34.01	3.681	0.378
Nonmajors	69	33.84	5.012	0.603
Urbanization beliefs				
Majors	95	22.84	3.062	0.314
Nonmajors	69	23.28	3.464	0.417
Intention to act				
Majors	95	19.76	3.276	0.336
Nonmajors	69	20.96	3.137	0.378

RESULTS

Video Pilot Study

The pilot study of the two video types revealed that the majority of students in the fact-based group (56.3%; $N = 98$) rated the video as a 4–5 (on a scale of 1 = no emotion, 5 = strong emotions), whereas 65.5% ($N = 106$) of the emotion-based group rated the video as a 4–5. We used this as evidence that there were different emotional experiences for each video.

Respondent Demographics

The final sample was predominately white (81%, $N = 131$) with 127 respondents identifying as female (77.4%), 36 students identifying as male (22%), and the remaining students choosing to not disclose (0.06%). Of the final sample, 95 (58%) were in the biology majors course, whereas 69 (42%) were in the nonmajors course. There were 131 students, regardless of major designation, who identified as being first-generation students (79.9%) whereas 30 students stated they were not first-generation students (18.3%). The remaining three students were unsure of their status (0.2%).

Survey Consistency and Descriptive Statistics

Guidelines provided by Kline 1999 for Cronbach's alpha were used to assess the internal consistency of the WUAS. Cronbach's alpha for the entire pre-intervention and postintervention WUAS was 0.89. Cronbach's alpha for the preintervention wildfire and urbanization beliefs constructs were 0.85 and 0.79, whereas intention to act was 0.75. Cronbach's alpha for the postintervention wildfire and urbanization beliefs construct were 0.88 and 0.85, while intention to act was 0.79. This is higher than the standard of 0.70 which indicates good survey reliability (Kline, 1999).

A Kaiser-Meyer-Olkin criterion test (KMO) was performed before conducting the factor analysis. A KMO test determines the suitability of the data set for factor analysis. Our KMO value was 0.904; a value above 0.5 is considered acceptable for conducting a factor analysis (Kaiser and Rice, 1974). A confirmatory factor analysis was performed on the 22 individual Likert-scale questions on the preintervention WUAS, using the 596 preintervention responses. This analysis indicated that two constructs (wildfire beliefs and urbanization beliefs) and a third construct (intention to act) were well represented by survey items after eliminating three items from the survey (items 9, 15, and 17 of the WUAS). Items 9 and 17 were intention to act questions that were directly related to wildfire and urbanization. Item 15 was an urbanization belief question stating, "The actions of individuals can reduce the impacts of urbanization."

Summary Statistics

The number of participants, means, standard deviations, and standard errors for the wildfire beliefs, urbanization beliefs, and intention to act constructs from the preintervention WUAS data are shown on Table 1, and from the postintervention WUAS data (by treatment group) on Table 2. Respondent scores generally ranged from 6 to 40 (40 indicating the highest agreement with all statements, specifically on wildfire beliefs, [score of 5 for each question]) with the average preintervention mean for wildfire beliefs being 33.90, urbanization beliefs being 23.02, and intention to act being 20.26 for all respondents. The average postintervention mean for wildfire beliefs was 35.40, urbanization beliefs was 25.30, and intention to act was 19.95 for all respondents. Information regarding the items on the WUAS that participants most agreed and disagreed with, categorized into majors and nonmajors, is listed in Supplemental Material, Supplemental Table S4.

Model Results

To address H1 that student beliefs toward wildfire and urbanization disturbances and intention to act toward environmental concerns will be positively related and will change from pre- to postintervention, correlation (Table 3) and GLMM tests were performed (Table 4). Correlative relationships were found between beliefs and intention to act on several occasions. Preintervention wildfire beliefs and preintervention intention to act were positively correlated with a moderate sized relationship ($R = 0.492$). Postintervention wildfire beliefs and intention to act had a large positive relationship ($R = 0.700$). Pre-intervention urbanization beliefs and intention to act had a moderately

TABLE 2. Descriptive statistics for all 22 Likert-scale questions on the postintervention WUAS for majors and nonmajors and intervention video type. Questions were grouped into the constructs of: (1) wildfire beliefs, (2) urbanization beliefs, and (3) intention to act. Analyses were completed on the group of students that completed both the pre- and postintervention survey with the time requirement of 540 s. Wildfire beliefs range from 0–40, urbanization beliefs range from 0–40, and intention to act ranges from 0–25

	n	Mean	Standard deviation	Standard error
Wildfire beliefs				
Majors (emotion video)	80	35.28	4.100	0.458
Nonmajors (emotion video)	50	36.06	3.672	0.519
Majors (fact video)	15	36.20	3.529	0.911
Nonmajors (fact video)	19	34.00	5.033	1.155
Urbanization beliefs				
Majors (emotion video)	80	32.94	3.846	0.430
Nonmajors (emotion video)	50	33.18	3.462	0.490
Majors (fact video)	15	32.53	3.226	0.833
Nonmajors (fact video)	19	32.74	4.227	0.970
Intention to act				
Majors (emotion video)	80	20.55	3.126	0.349
Nonmajors (emotion video)	50	21.46	2.873	0.406
Majors (fact video)	15	21.60	2.261	0.584
Nonmajors (fact video)	19	21.05	3.082	0.707

positive relationship (R = 0.401) that grew postintervention (R = 0.535) (Table 3). These positive correlation coefficients suggest that intention to act has a consistently positive relationship with increasing student beliefs about the negative effects of wildfire and urbanization on the environment.

According to the GLMM model, student beliefs toward urbanization were significantly different from the predictor variable pre- to postintervention ($P = 4.04 \times 10^{-13}$), indicating that student concerns and beliefs toward addressing these disturbances increased postintervention (Table 4). Wildfire beliefs were not statistically significant in the full model suggesting no changes pre- to postintervention for this construct. Similarly, intention to act did not significantly change from pre- to postintervention (Table 4). The intention to act construct was focused mainly on students' feelings toward general environmental issues and their willingness to personally address them. Though they had to be removed from the study because they lacked validity in a statistical model, questions 9 ("We cannot do anything to stop wildfires.") and 17 ("We cannot do anything to stop urbanization.") centered on students' intention to act specifically toward the individual disturbances of wildfire and urbanization. According to Diamantopoulos *et al.* (2012), researchers are advised to use multi-item scales in empirical investigations as opposed to single-item scales. Questions 9 and 17 were separately assessed from the full model and were found to be significantly different from pre- to postintervention. Both questions indicated that students increased their intention to act from pre- to postintervention; question 9 returned a p value of 2.442×10^{-5}, whereas question 17 returned a p value of $< 2.2 \times 10^{-16}$.

There were multiple positive correlative relationships between beliefs and intention to act, but only urbanization beliefs changed from pre- to postintervention, thus H1 was only partially supported.

H2 posited that biology major attitudes toward environmental disturbances would be significantly different compared with nonbiology majors from pre- to postintervention. Mean values for the wildfire and urbanization belief construct as well as the intention to act construct generally increased from pre- to postintervention for both major and nonmajor groups (Supplemental Table 1 and Table 2). However, GLMM tests showed that there were no significant differences between major and nonmajor beliefs toward wildfire (P = 0.856), urbanization (P = 0.787), or intention to act (P = 0.567) from pre- to postintervention (Table 4). Thus, H2 was rejected.

Our third hypothesis (H3) was that type of intervention (fact-based or emotion-based videos) would impact students' beliefs toward disturbances and intention to act. GLMM tests found that there were no significant differences between the fact-based and emotion-based videos regarding student beliefs toward wildfire (P = 0.734), urbanization (P = 0.732), or intention to act (P = 0.854) after the intervention (Table 4). Nonmajors who watched the fact video had the lowest mean values for wildfire beliefs, majors who watched the fact video had the lowest mean values for urbanization beliefs, and majors who watched the emotion video had the lowest mean values for intention to act (Table 2). However, there were no significant differences across video type (Table 4), thus rejecting H3.

DISCUSSION

In our study, we analyzed the differences between biology major and nonmajor student attitudes (i.e., beliefs and intention to act) toward wildfire and urbanization disturbances before and after watching two types of videos meant to influence those

TABLE 3. Correlative relationships and p-values between pre- and postintervention beliefs and intention to act toward wildfire and urbanization disturbances. Spearman correlation values are represented in gray, whereas p values are represented in white. Pre- refers to "preintervention" whereas post- refers to "postintervention"

	Prefire beliefs	Preurban beliefs	Preintentions	Postfire beliefs	Posturban beliefs	Postintentions
Prefire beliefs	1.0	8.137×10^{-10}***	2.177×10^{-11}***	0.671	0.103	0.151
Preurban beliefs	0.456	1.0	9.895×10^{-8}***	0.409	0.539	0.986
Preintentions	0.492	0.401	1.0	0.352	0.602	0.007*
Postfire beliefs	0.033	–0.065	0.073	1.0	$<2.2 \times 10^{-16}$***	$<2.2 \times 10^{-16}$***
Posturban beliefs	–0.128	–0.049	0.041	0.606	1.0	1.604×10^{-13}***
Postintentions	0.113	0.001	0.212	0.700	0.535	1.0

Statistical significance is denoted by the following: $p < 0.0001$'***', $p < 0.001$ '**', $p < 0.01$ '*', $p < 0.05$ '.'

TABLE 4. Effects of major type and video type on pre- and postintervention fire and urban beliefs, and intention to act analyzed with a GLMM. Associated estimates (E) standard error (SE), z value, and *P* values (*P*) are reported for the predictor variables pre- and postintervention, major type (biology major and nonbiology major), video type (fact-based or emotion-based), and their interactions

Predictor variables	Fire beliefs				Urban beliefs				Intention to act			
	E	*SE*	*z*	*P*	*E*	*SE*	*z*	*P*	*E*	*SE*	*z*	*P*
Intercept	3.570	0.018	198.560	2×10^{-16}***	3.495	0.019	187.219	2×10^{-16}***	3.029	0.024	128.713	2×10^{-16}***
Pre- and Postsurvey	−0.037	0.026	−1.450	0.147	−0.202	0.028	−7.524	4.04×10^{-13}***	−0.045	0.034	−1.323	0.186
Video Type	−0.018	0.033	−0.545	0.586	−0.013	0.034	−0.380	0.704	0.014	0.042	0.325	0.745
Major Type	0.004	0.027	0.153	0.878	0.007	0.028	0.255	0.799	0.028	0.035	0.817	0.414
Survey * Major Type	−0.007	0.038	−0.182	0.856	0.011	0.041	0.270	0.787	0.028	0.050	0.572	0.567
Survey * Video Type	−0.016	0.047	−0.339	0.734	−0.017	0.051	−0.342	0.732	−0.011	0.060	−0.184	0.854

Statistical significance is denoted by the following: $p < 0.0001$ '***', $p < 0.001$ '**', $p < 0.01$ '*', $p < 0.05$ '.'

attitudes. We hypothesized that: (H1.) Student beliefs toward wildfire and urbanization disturbances and intention to act toward environmental concerns will be positively related and will change from pre- to postintervention; (H2.) From pre- to postintervention, biology major attitudes toward environmental disturbances will be significantly different while non-biology major attitudes will not; and (H3.) Type of intervention (fact-based or emotion-based videos) will impact students' beliefs toward disturbances and intention to act, with emotion-based videos having a stronger effect. Overall, we found that: (1) student wildfire beliefs and intention to act and urbanization beliefs and intention to act were significantly and positively correlated at both pre- and postintervention time periods, with the strength of correlation coefficients being higher postintervention; and that student beliefs about the negative impacts of urbanization disturbances significantly increased from pre- to postintervention, but wildfire beliefs and intention to act did not change pre- to postintervention; (2) student beliefs toward wildfire and urbanization disturbances and intention to act generally did not differ between biology majors and nonmajors; and (3) the type of intervention students received did not significantly impact student beliefs or intention to act.

The theory of planned behavior (Ajzen, 1985) indicates that a relationship should exist between individual beliefs and intentions to act. Three of the five constructs that form the theory of planned behavior are particularly relevant to this study (Ajzen, 2005):

1. Attitudes – Positive or negative interest in a particular topic and/or situation.
2. Perceived power – Perceived presence of factors that may facilitate or impede performance of a behavior.
3. Perceived behavioral control – A person's perception of the difficulty associated with performing the behavior of interest.

Perceived power and perceived behavioral control can determine motivation to act (Geiger *et al.*, 2021). Correlations conducted throughout this study showed that intention to act had a positive relationship with student beliefs about the negative effects of wildfire and urbanization on the environment, and that these relationships strengthened post intervention. Thus, our results support the theory of planned behavior and perhaps suggest that students feel some level of power or control to make a difference in environmental disturbances. However, we did not find that learning more about specific anthropogenic disturbances increased intention to act, although single item measures removed from the model about intention to act toward wildfires or urbanization did change from pre- to postintervention. This suggests that brief interventions for a short time in a classroom may not be enough to uniformly alter beliefs and/or provide a feeling of control suitable to act.

An interesting result of this study was that student beliefs toward urbanization disturbances were significantly different from pre- to postintervention, but wildfire beliefs and intention to act were not significantly different. This suggests that something about the video (whether emotion-based or fact-based) was able to nudge student change on this aspect, although which part is unknown. Although there is no literature to draw from, the authors believe it is possible that participants may not view urbanization as an "anthropogenic disturbance" because it

has become such a normalized part of culture and a standard presence in everyday life. Students are more likely to experience urbanization daily than they are to see another anthropogenic disturbance such as wildfire. Likely, students tend to not think of urbanization as a cause of environmental degradation and damage; however, when presented with the information that it does, it may have caused a shift in their beliefs postintervention. Because of the inherent complexities of urban areas, this can result in "good" (i.e., providing a benefit) or "bad" (i.e., causing some level of harm) personal views of urbanization. Thus, our finding could suggest that students may perceive urbanization as initially beneficial or neutral, but once presented with the information that urbanization can be harmful, it may shift beliefs which will theoretically increase intention to ameliorate these impacts.

Two of our hypotheses were rejected. We found no statistical differences in how majors and nonmajors changed in their beliefs or intention to act pre- to postintervention. Our assumption was based on research suggesting that nonmajors find STEM less relevant to their lives (Cotner *et al.*, 2017); however, over the course of this study, neither majors nor nonmajors had significant differential responses to the intervention. This may have been due to the brief nature of the intervention, or perhaps these anthropogenic disturbances equally lack relevance to both groups of students. Studies have shown that emotions can influence environmental-related behaviors, where negative emotions toward environmental issues specifically can lead to proenvironmental behaviors (Leviston and Walker, 2012; Wang *et al.*, 2018). Some have also documented negative impacts of emotion, where it causes anxiety and fear instead of motivation (Clayton, 2020). Our study found neither to be true; our emotion video had no significant effect compared with the fact-based video on changes in beliefs or intention to act. It may be that the videos were not different enough to see a difference in impact, or that the videos did result in differences that our survey was unable to detect. We suspect that fully quantitative measures may be inadequate to capture student perceptions about these complex topics, and research should combine quantitative and qualitative methods to get a more complete understanding of student perceptions of anthropogenic disturbance interventions.

Anthropogenic disturbance understanding in students is important and needs to be addressed; our study may provide some insight into classroom instruction. Previous studies have shown that when presenting messages surrounding anthropogenic disturbances (i.e., climate change) to an audience, audience members preferred messages that did not have emotion, as they perceived messages that were framed with emotion as "persuasive" (Bloodhart *et al.*, 2019). This perceived persuasive language did indicate strength and rationality to the audience, but participants ultimately preferred the nonemotional relay of messages (Bloodhart *et al.*, 2019). Compassion fatigue is also often associated with "popular" anthropogenic disturbances (such as wildfires or climate change), due to prevalent exposure via media, thus limiting an emotional response from audience members receiving the message. Previous studies have suggested that the general public has a "finite pool of worry" about social/environmental issues that can often cause "compassion fatigue" and eventual desensitization (Bloodhart *et al.*, 2019). Our results also found that emotion had no added benefit in beliefs or intention to act. Thus, we recommend that instructors carefully consider the use of emotion in their lectures and perhaps avoid indications that they are: (1) attempting to persuade the audience, (2) framing the message as overly emotional or negative, and (3) limiting human agency (i.e., we cannot do anything to stop these disturbances; Wang *et al.*, 2023).

However, students in our study did change their beliefs about urbanization over a very short time and with a very short intervention. This provides hope that providing information to students to raise awareness about anthropogenic disturbances and their impact can be effective. We suggest that students need to better understand the complicated relationships between everyday behaviors and how they can impact the environment. For example, most students are taught about deforestation and habitat loss, but concepts related to the wildland-urban interface (Radeloff *et al.*, 2018; Kramer *et al.*, 2019) are more of a gray area that provides space to explore the tradeoffs and complicated relationships between humans and the environment. We suggest that adding discussions about the nuances of human growth and environmental disturbances might foster critical thinking that could be transferrable to other anthropogenic issues.

Limitations

The researchers recognize that lasting attitude change after one lecture and/or exposure to information is unlikely; however, the outcomes obtained from this study can be used by future researchers to assess general class attitude surrounding wildfire and urbanization disturbances. A future study using the WUAS could be implemented longitudinally to measure lasting change rather than change over a short period of time.

Secondly, though the assignment of video type was randomized among individuals in each course, there was a greater percentage of students who watched the emotion-based video compared with the fact-based video when matching pre- and postintervention data, which can impact the power of the GLMM. Additionally, though there were emotional differences in reaction to the videos when we conducted the pilot study, creating new videos that produce a more distinct emotional difference between fact-based and emotion-based, potentially with a separate script for each video, may lead to stronger intervention results. We also recognize that the visuals for the fact video may not have matched the script as well as the visuals for the emotion video. This may have caused differential cognitive load and therefore less attention being paid to one video versus the other.

Additionally, the researchers recognize that many students had to be removed from the final analyses. There were 130 students who completed the emotion video and 34 that completed the fact video, after including all our filters. Our inference is that the fact video was perhaps not as visually appealing as the emotion video was, so students lost interest. Future iterations of this intervention should employ software that makes watching the videos mandatory before advancing to the questionnaire.

CONCLUSIONS AND FUTURE DIRECTIONS

As human populations continue to grow and expand, anthropogenic disturbance events will likely become more frequent and

intense. Studies have been conducted to understand undergraduate students' knowledge, perceptions, feelings, and attitudes toward climate change, yet minimal research exists on undergraduate understandings of disturbances outside of human-caused climate change. With almost constant exposure to anthropogenic disturbance events on social media, news platforms, and throughout daily life, it is imperative to understand existing undergraduate student attitudes toward these events. A deeper understanding of these attitudes will allow educators to adjust curricula to increase scientific literacy and knowledge that may promote future proenvironmental action. Comparisons made in this study between students from biology majors and nonmajors courses and different video types can start a conversation about students' attitude toward anthropogenic disturbances and how we as educators can better structure curricula to support a positive atmosphere that promotes action.

Future studies using the WUAS could be implemented in multiple classrooms and courses across the United States. Regional attitude differences among undergraduates could further refine anthropogenic disturbance curricula based on locality, sociocultural environmental factors, and personal and/or political values. Additionally, it would be beneficial to further explore differences or similarities in gender and first-generation status in response to the WUAS. It has generally been reported that women express greater emotional environmental concern than men, but little has been done to test this empirically (Arnocky and Stroink, 2010). To the researchers' knowledge, no studies have been conducted to assess environmental attitudes associated with first-generation status. Though, previous studies have shown that emotional response can affect task engagement in the classroom, thus altering the way students act and experience the world (Goldman *et al.*, 2021). Furthermore, a longitudinal study that would implement the WUAS throughout a semester-long global change ecology course or introductory biology course (for majors and/or nonmajors) could help to gain a greater understanding of student attitude change through time.

Broadly, our results indicated that addressing anthropogenic disturbances in the classroom is possible, but curricula need to be carefully planned and implemented. Although provoking an emotional response from students through content may invoke action (Peters and Slovic, 2000; Morris *et al.*, 2019), instructors should be mindful that this may not be an effective technique and could risk increasing "eco-anxiety" among students (Clayton, 2020). Although our intervention did not have the impacts we hypothesized, we collected novel data about student beliefs on the anthropogenic disturbances of wildfires and urbanization which is a necessary step in guiding future interventions (Nabi *et al.*, 2018). Designing anthropogenic disturbance curricula for a student population that has varied knowledge, perceptions, and skills can be complicated. However, as science educators, developing courses and lessons that optimize our students' knowledge, skills, and confidence can result in positive attitudes that can initiate action toward change.

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