HOW DO THE DEMOGRAPHICS OF ENVIRONMENTAL SCIENCE STUDENTS AT THE UNIVERSITY OF TEXAS AT SAN ANTONIO RELATE TO STUDENT PERCEPTIONS, KNOWLEDGE OF, AND WILLINGNESS TO PURCHASE AN ELECTRIC VEHICLE?

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Executive Summary

Carbon dioxide emissions continue to rise despite countries' efforts to meet their goals set in the Paris Agreement (Levin & Lebling, 2019). While the climate crisis continues to unfold, a greater amount of carbon dioxide emissions needs to be eliminated. In fact, if every other car on the road in the world were electric, it would be like wiping Russia's greenhouse gas (GHG) emissions clean. Russia is currently the world's fourth worst GHG emitter in the world (Harrabin, 2020). Governments can electrify their postal fleets and fire trucks, but convincing corporations and every day consumers to change to electric vehicles continues to be difficult. This study aims to better understand environmental science students 'willingness to purchase an electric vehicle (EV) based on their demographics, their desire to curb emissions, and knowledge of EVs.

To find the perceptions of the students, a survey was created using Qualtrics and analyzed using IBM SPSS. The faculty of the Environmental Science department at the University of Texas at San Antonio sent an email to the students with a link to the survey and out of the 440 students invited to take the survey, 23 responded. Analysis revealed the most significant predictor of willingness to purchase an EV was desire to curb emissions ($R^2 = 0.344$, $F(1,24) = 12.048$, $p<0.05$). This result was surprising, as income was expected to play a role but ended up not being statistically significant. This could be attributed to the increase of makers and models of electric vehicles available for purchase, and the continuous price drop as more EVs are added to the market. Male and female respondents had no significant difference in knowledge on EVs ($t(23) = -0.211$, $p>0.05$) or desire to curb emissions ($t(23) = -0.211$, $p>0.05$),($t(23) = -0.728$, $p>0.05$). As environmental science students, it's understandable that the men and women equally care about curbing emissions and are knowledgeable about electric vehicles.

This study is important for understanding consumer perceptions and intentions of EVs. The climate crisis is time sensitive and the more quickly countries can push policies to reduce their fossil fuel emissions, the safer the future will be for everyone. Driving electric vehicles has been shown to be one of the most effective ways to reduce those emissions. This study produced results showing that among environmental students at the University of Texas at San Antonio, men and women both equally had a desire to curb emissions and knowledge of electric vehicles. However, more information needs to be collected; a larger sample of students from across all disciplines. The most noteworthy result was that the desire to curb emissions was the most significant predictor of willingness to purchase an EV.

Although the participants in this study were all environmental students in San Antonio, it is interesting to note that a recent survey done in 2020 showed that men and women had a difference in knowledge and desire to help curb emissions around the country. Especially since Texas is a traditionally conservative state and there are no voluntary emissions standards laws, it's fairly surprising that the students had no difference in knowledge or desire to curb emissions according to their gender.

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Introduction

Since the Industrial Revolution, carbon dioxide emissions have been accumulating in the atmosphere. These molecules intensify the radiation emitted from the sun and the earth, trapping the heat and increasing average surface temperatures around the globe. A degree or two increase in this temperature increases storms like hurricanes and typhoons, is raising sea level, intensifying droughts and floods, and worsening tensions among nations. According to the United States Environmental Protection Agency (EPA), the earth has warmed about 1.8 degrees Fahrenheit since 1901 (“Climate Change Indicators”, 2020). In fact, of the ten warmest years since 1880, nine of them occurred after 2005 (MacMillan & Turrentine 2021). In order to reduce the consequences of the climate crisis, drastic steps need to be taken.

The Paris Agreement was signed during the 21st Conference of Parties, where nearly 200 countries chose how they would best reduce emissions and then promised to do so. However, countries are moving slowly since it was signed in 2015, especially after Donald Trump announced the U.S. withdrawal from the agreement in 2017. This slow reaction in reducing emissions will result in worsening consequences for every nation, which we began to see in 2020 with the record for the highest number of storms ever (NOAA, 2020).

One way to reduce emissions drastically, especially in nations like the United States where light duty trucks and cars account for the largest carbon dioxide emissions would be incentivising every driver to buy an electric vehicle (“Light Duty Vehicle Emissions,” 2019). A study done by researchers in Nijmegan, Netherlands found that if every other car were electric in the world, it would reduce the amount of GHG emissions that Russia produces every year afterwards

(Harrabin, 2020). In 2019, about 2.6% of car sales globally were electric vehicles, which increased global car stock to 1% electric (IEA, 2020).

This study aims to better understand environmental science students 'willingness to purchase an electric vehicle (EV) based on their demographics, their desire to curb emissions, and knowledge of EVs.

The purpose of this research is to evaluate the relationship between ethnicity, gender, and socio-economic status and perceptions of electric vehicles among environmental science students at the University of Texas at San Antonio. This study will ask three questions: *To what extent does a student s gender relate to their perception, knowledge, and misconceptions about electric vehicles and hybrids among undergraduate and graduate students? To what extent does a student s race/ethnicity relate to their perception, knowledge, and misconceptions about electric vehicles and hybrids among undergraduate students? To what extent does a student s socioeconomic status relate to their perception, knowledge, and misconceptions about electric vehicles and hybrids among undergraduates?* Addressing the research question, the proposal offers five hypotheses. *H1: Income, gender, ethnicity, desire to curb emissions, and knowledge of electric vehicles will determine willingness to purchase electric vehicles and* H_0*: Income, gener, ethnicity, desire to curb emissions, and knowledge of electric vehicles will not determine willingness to purchase electric vehicles. H2: Income is the main contributing factor to purchasing an electric vehicle.*H_0*: Income is not a main contributing factor to purchasing an electric vehicle. H3: Women are more likely to want to help curb emissions than men.* H_0*: Women are not more likely to want to help curb emissions than men. H4: Men will have more accurate information on electric vehicles.* H_0*: Men will not have more accurate information on electric vehicles. H5: There will be no variance in ethnicity in willingness to buy an electric vehicle.* H_0*: There will be a variance in ethnicity in willingness to buy an electric vehicle.*

The following report will review the literature surrounding carbon emissions and climate change, current perceptions of electric vehicles from non environmental science students, the petro-nostalgia of burning fossil fuels, and how Texans 'drive. Following the literature review, will be the methods, results, and discussion.

Literature Review

The past thirty years have shown warmer surface and ocean temperatures than any year since the end of the Industrial Revolution. Since 1880, the temperature has risen 0.85°C and by the end of the century, the temperature is likely to increase between 0.3°C and 4.8°C depending on mitigation intensity. These findings from the Intergovernmental Panel on Climate Change (IPCC) are confirmed by the catastrophic consequences already occurring around the globe. The rising surface and ocean temperatures have increased storms, risen sea levels, and increased precipitation and drought events (IPCC, 2013). The year 2020 holds the record for the highest number of tropical/subtropical storms in one year- the record which was previously held by the year 2005 (NOAA, 2020). As the storms, droughts, and sea level rise increase, the core component for rising surface and ocean temperatures, must be mitigated.

According to the IPCC, greenhouse gasses (GHGs) have increased since 1750 due to human activities. Gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxides (N_2O) have saturated the atmosphere which has increased mean surface temperatures. These gases are

the result of fossil fuel combustion. Every day billions of people are burning gasoline with the internal combustion engine of their cars and trucks, energy companies use coal and gas to move a turbine for citizens to turn on lights and televisions, and even fueled the rocket to put a man on the moon. These technologies have certainly enriched the lives of many people on the globe, but their emissions have reached the point of destroying lives (IPCC, 2013).

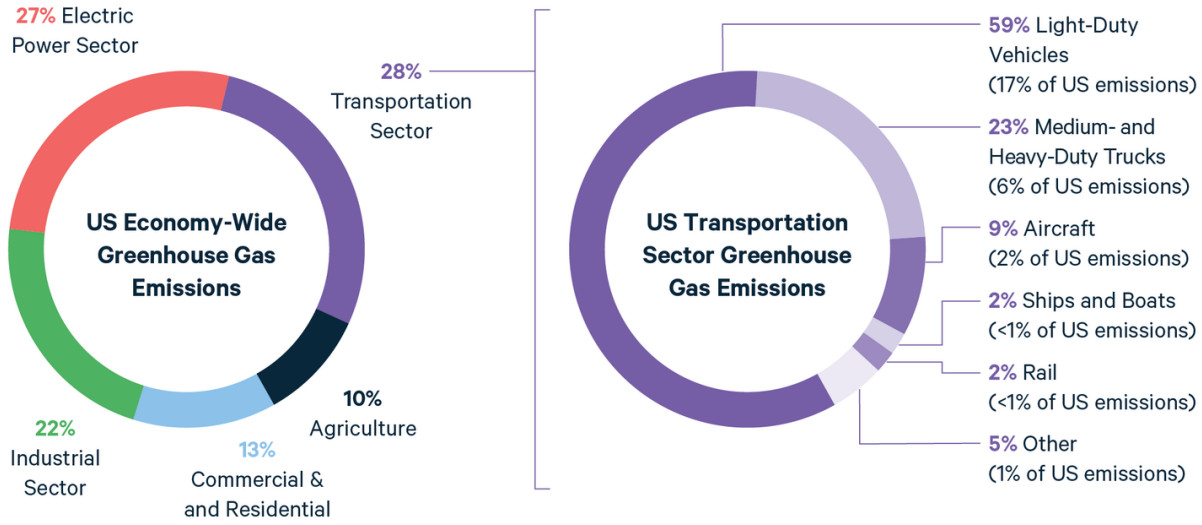
Many countries have begun reducing fossil fuel emissions. In 1994 the United Nations Framework Convention on Climate Change began recruiting countries to make legally binding commitments to reduce fossil fuel dependence. Since then, the Kyoto Protocol and Paris Agreements have been signed by over 175 countries, and the United States joined again in 2021, which is especially important as it is the number two carbon dioxide emitter in the world (UNFCC, 2021). In order to reach the greenhouse gas reduction goals each country set itself, they made policies to incentivize renewable energy generation, higher miles per gallon standards, and green building practices while simultaneously taxing fossil fuel companies.

Currently, the European Union, Morocco, and India are leading the globe in cutting carbon dioxide emissions while the United States 'actions have been "critically insufficient," as the Trump Administration censored climate science and rolled back Obama era carbon policies (Mulvaney, 2019). Under new administration, the United States can begin to substantially curb emissions, beginning with electric vehicles.

The Environmental Protection Agency (EPA) lists the transportation sector as the highest GHG emitter. Within this sector, light duty vehicles account for the most emissions; 17% of total emissions (6.66 billion metric tons of GHG), equal to about 1.14 billion metric tons of greenhouse gases ("Greenhouse Gas Inventory Data Explorer", 2021). Under the Paris Agreement, the United States committed to lowering GHG emissions to 25% below the 2005

amount (7.39 billion metric tons) by 2025 (Renewing US Commitment, 2021). In fact, by electrifying the United States fleet, emissions would reduce to the goal exactly.

Figure 1. Greenhouse gas emissions in the United States by sector (left) and within the transportation sector (right). Created by MacInnis & Krosnick using data from the Environmental Protection Agency (2020).



While electric vehicle adoption across the United States would drastically reduce GHG emissions, adoption has been slow. There are many reasons for the slow adoption, some are more obvious than others. When consumers are shopping for cars, they might assume rumors about electric vehicles and therefore not consider them: they are too expensive, they have a short range before you need to charge, they are more expensive to maintain, and that they don't even help to curb emissions (MacInnis & Krosnick, 2020). With recent improvements and price reduction, thanks to policies which drive up MPG standards, there are many perceptions about electric vehicles which relate to a person's gender.

The study done by MacInnis & Krosnick (2020) in Research For the Future showed that there is a difference in knowledge of EVs, desire to curb emissions, and willingness to purchase an EV based on gender. Their study showed that women believed EVs help curb emissions as opposed to most men who did not. The genders also differed in their understanding of how EVs work, like whether EVs are more expensive to maintain or if EVs will lose value quickly, which more women answered correctly (MacInnis & Krosnick, 2020).

Another interesting study on electric vehicle adoption considers a self-identity created by fossil fuels.The article focused on gender and ethnicity, specifically white men in the United States and the status quo provided to them during a time when Jim Crow and the internal combustion engine were beginning to take over. This mentality was recently reinforced during former President Trump's Administration. His campaign slogan to "Make America Great Again," was, the author describes, "petro-nastalgia, in that the achievement of the mid-20th century patriarchal ideal in the US was predicated upon an ongoing supply of cheap fossil fuels," (Daggett, 2018, p. 31). The author points out, also, that it was not just white men who were clinging on to the status quo but also over one half of white women voters. Fossil fuels are an unfortunate mascot for a traditional type of masculinity where men were in charge, their women and children were their property, and gas was cheap. In fact, this type of masculinity appears in the American far- Right as a "kind of hypermasculinity, which … arises when agents of hegemonic masculinity feel threatened or undermined, thereby needing to inflate, exaggerate, or otherwise distort their traditional masculinity," (Dagget, 2018, p. 33). This study suggests that white men will be less likely to want to purchase an electric vehicle. However, it may be important to note that it would most likely be Conservative white men as opposed to the more Liberal.

Income is another factor for determining a person's willingness to purchase an electric vehicle. In a 2019 study, Nordic scientists surveyed over 4800 consumers in Denmark, Finland, Iceland, Norway, and Sweden. They found that young men with high incomes were more likely to purchase an electric vehicle. The strongest predictors in their regression analysis were financial savings and environmental value (Chen et al, 2019).

In 2012 the Electric Power Research Institute (EPRI) and CPS Energy of San Antonio conducted a survey in San Antonio and Houston to understand consumer knowledge, expectations of utilities, and perceptions of plug-in Electric Vehicles. This study found that about 8% of people surveyed at the time plan to buy an electric vehicle within a year (EPRI, 2012). The survey focused mostly on what residents currently drive, if they prefer to buy new or used, how far they typically drive, if they'd be willing to pay more for electric vehicles, etc., but the study did not highlight much about demographics, only that "respondents who are male, older, or own their residence tend to be willing to pay more for at-home charging," (EPRI, 2012, p. 15). Figure 2 shows the perceptions of participants 'on EVs from the 2012 survey.

Figure 2. Perceptions and knowledge about electric vehicles from participants during the 2012 EPRI survey on residents living in San Antonio and Houston, Texas.

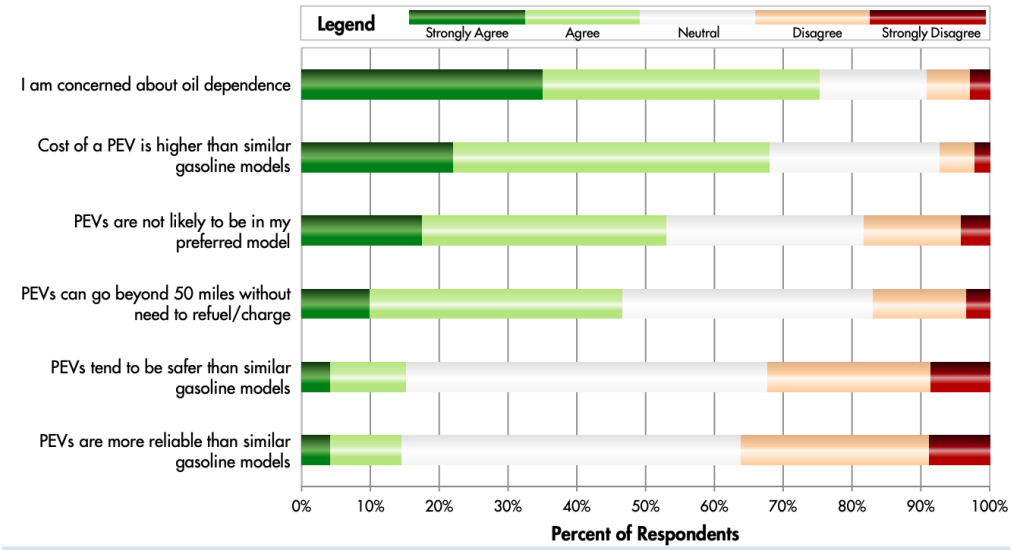


Figure 8 – Houston and San Antonio Residents' Initial Perceptions of PEVs

The United States is lagging in cultural and demographic information on electric vehicle adoption. The article in Resources for the Future surveyed and analyzed demographics in relation to their willingness to purchase an electric vehicle. MacInnis and Krosnick were able to show the current knowledge amongst Americans about electric vehicles like whether or not they believe the electric car is more likely to catch on fire. They also found differences between women and men, Democrats and Republicans, different age groups, and college and high school graduates. There are no studies concerning ethnicity and desire to curb emissions or buy an electric vehicle (MacInnis and Krosnich, 2020).

Methods

A questionnaire was designed using Qualtrics and questions were sampled from various sources to test the hypotheses (see Appendix A). Through the help of the Environmental Science Department at the University of Texas at San Antonio, emails were sent to all students

in the program. Of the 400+ students, 29 were 18 years of age and willingly participated. Figures 3, 4, and 5 show the demographics of the respondents; gender, ethnicity, and income.

Figure 3. Respondents 'gender identity from survey in Qualtrics.

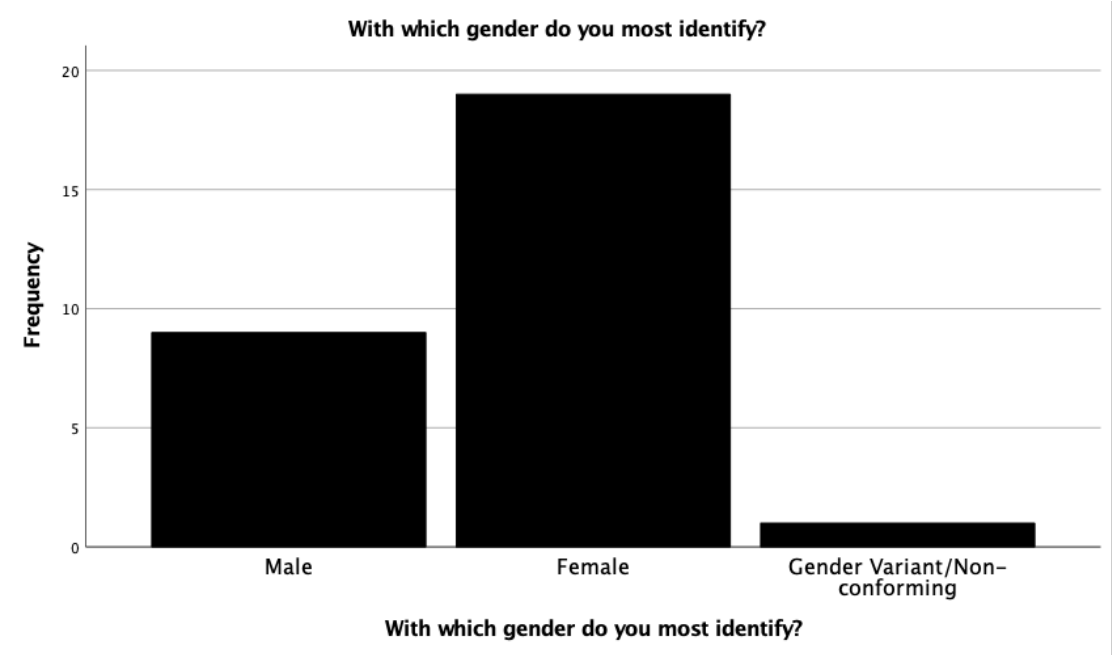


Figure 4. Ethnicity of respondents who took the survey in Qualtrics.

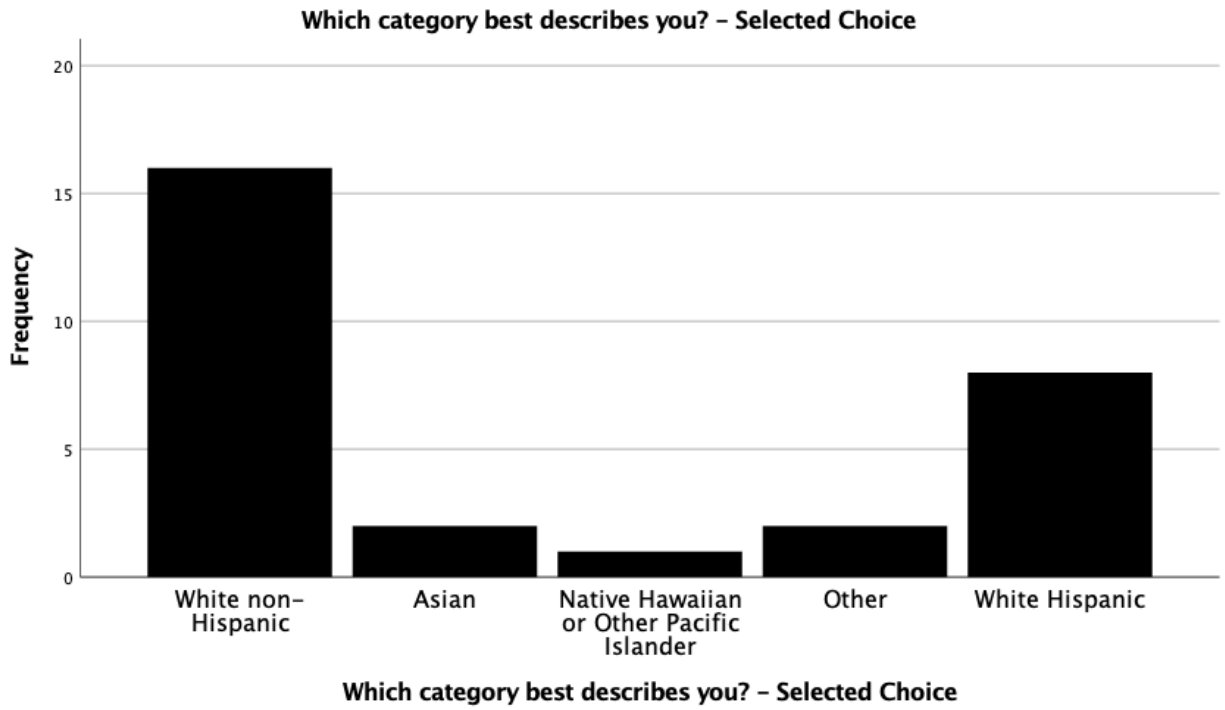
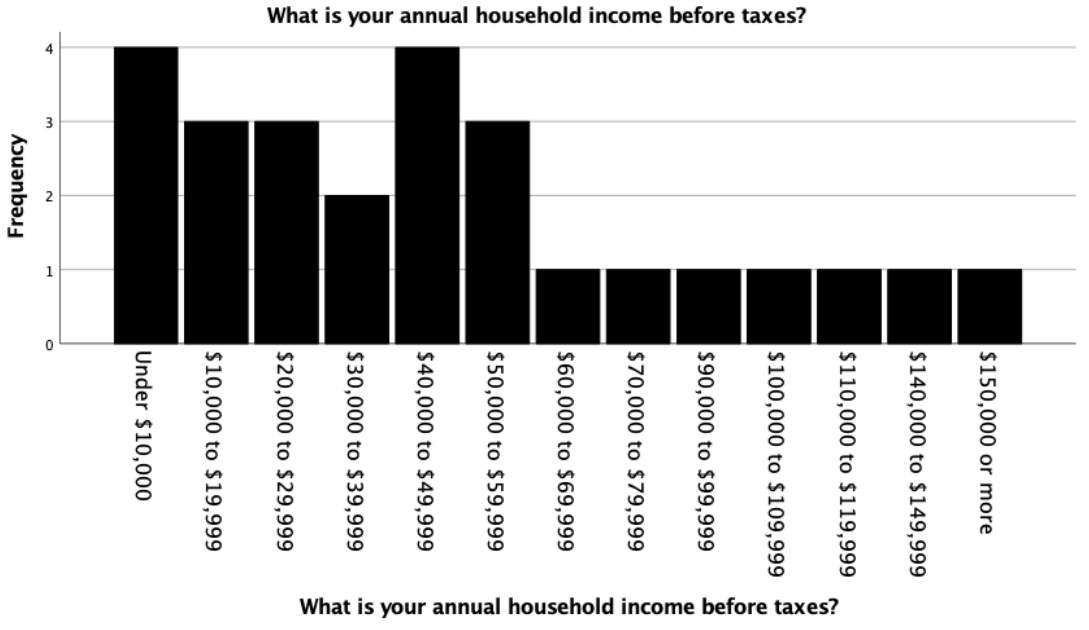


Figure 5. Income of respondents from the survey in Qualtrics.



The questionnaire on Qualtrics contained five parts, with a total of thirteen questions (See Appendix A). The first page of the survey asked the age of participants and included the informed consent statement, and the second page asked the rest of the questions. The first three questions asked demographics: gender, income, and ethnicity, while the last nine questions asked about knowledge of EVs, desire to curb emissions, and the willingness to purchase an EV. The last nine questions were formatted for the participant to answer in a five-point Likert scale. Testing for knowledge of EVs consisted of three questions: is fuel cost less expensive than a traditional gasoline vehicle; maintenance requirements of EVs are lower than traditional gasoline; and whether an EV can travel over 100 miles before needing a recharge. The results of these three questions were later summed to create an aggregate metric for EV knowledge.The next three questions looked for participants 'desire to curb emissions: EVs will contribute to environmental sustainability; EVs reduce carbon emissions; and "I'm willing to pay more to buy environmentally friendly products." The results of these three questions were later summed to create an aggregate metric for desire to curb emissions.The last section looked for students 'willingness to purchase an electric vehicle: EVs are reasonably priced; I will consider buying an EV; and with the same price, I prefer to buy EV over gasoline. The results of these three questions were later summed to create an aggregate metric for willingness to purchase an EV.

In order to analyze the data, IBM SPSS 27.0 was used. As mentioned, the knowledge, desire to curb emissions, and willingness to purchase metrics were aggregated from existing questions. This way all three questions for each category could be summed together and used to test the hypotheses. The five hypotheses were tested using, in order, a multilinear regression (H1), a spearman correlation (H2), independent samples t-tests (H3 &H4), and lastly, with a chi-square test (H5).

Results

This section summarizes the resulting data after using four different statistical tests in SPSS to test the hypothesis of the study: a multilinear regression (H1), a spearman correlation (H2), the independent samples t-test (H3 &H4), and a chi-square test (H5).

Using the frequency analysis for question 14: “Next time I buy a car, I will consider buying an electric vehicle,” 76% of students said they “strongly agree” or “agree,” (See Appendix A). The next question asks, “Under a similar price, I prefer to buy electric vehicles compared to traditional gasoline/diesel vehicles.” 80% of respondents answered “agree” or “strongly agree.”

H1: Income, gender, ethnicity, desire to curb emissions, and knowledge of electric vehicles will determine willingness to purchase electric vehicles and H_0*: Income, gender, ethnicity, desire to curb emissions, and knowledge of electric vehicles will not determine willingness to purchase electric vehicles.* Multilinear regression analysis was used to test if desire to curb emissions significantly predicted participants ’willingness to purchase an electric vehicle. The results of the regression indicated the predictor explained 34.4% of the variance ($R^2 = 0.344$, $F(1,24) = 12.048$, $p<0.05$). It was found that desire to curb emissions significantly predicted willingness to purchase EVs ($b = 0.822$, $p<0.05$). Originally this test was done using five predictors: income, ethnicity, gender, desire to curb emissions, and knowledge of EVs. The several predictors were removed from the model once it was seen that they were not statistically significant. The null was partially rejected based on the fact that one of the predictors was found to be significant, but not all.

H2: Income is the main contributing factor to purchasing an electric vehicle. H_0: Income is not a main contributing factor to purchasing an electric vehicle. A Spearman correlation was used to test whether income was a significant predictor of willingness to purchase an electric vehicle. The two variables were not strongly correlated, ($\rho(22) = -0.126$, $p = 0.58$) and we do not reject the null hypothesis.

H3: Women are more likely to want to help curb emissions than men. H_0: Women are not more likely to want to help curb emissions than men. An independent samples t-test was used to find a difference in mean desire to curb emissions and gender. There was not a significant difference between the genders and desire to curb emissions, $t(23) = -0.728$, $p>0.05$, so we do not reject the null hypothesis.

H4: Men will have more accurate information on electric vehicles. H_0: Men will not have more accurate information on electric vehicles. Another independent sample t-test was used to find a difference in mean knowledge of electric vehicles based on gender. There was not a significant difference between the genders and knowledge of electric vehicles, $t(23) = -0.211$, $p>0.05$, so we do not reject the null hypothesis.

H5: There will be no variance in ethnicity in willingness to buy an electric vehicle. H_0: There will be a variance in ethnicity in willingness to buy an electric vehicle. Lastly, a Pearson chi-square test was used to look for a difference based on ethnicity and willingness to purchase an electric vehicle. There was not a significant difference in willingness to purchase an EV and ethnicity, $\chi^2(1,21) = 15.75$, $p = 0.783$, so we do reject the null hypothesis.

Discussion

These findings show how students within the environmental science department at the University of Texas San Antonio perceive electric vehicles. 80% of these students answered that they “agree” or “strongly agree” that they “prefer to buy electric vehicles compared to traditional gasoline/diesel vehicles.” This leaves twenty percent of environmental science majors unwilling to purchase, in fact 24% of the respondents answered “disagree” or “strongly disagree” to “next time I buy a car, I will consider buying an electric vehicle.” The data also showed that the main component for students ’willingness to buy an electric vehicle is their desire to curb carbon dioxide emissions ($b = 0.822$, $p<0.05$).

While students in this department at UTSA learn about climate change and the damage it will cause in the coming years, there are no classes which teach students about electric vehicles. This is shown in a couple of respondent answers where the student answered incorrectly for the knowledge portion of the survey and then selected that they would not likely purchase an EV. This could be partially due to the outdated perceptions of electric vehicle prices, range, and available charging stations. Only within the last few years have completely electric, long range models been made available to the middle class consumer, like the 2020 Kia Niro EV, which has an MSRP of $39,999 (Kia Motors, 2021).

However, there were a couple of other respondents who answered that they would not buy en EV, but they did answer correctly for the knowledge portion. This could be a result of petro-nestalgia or that there aren’t yet models available for the consumer's preference, like a light duty truck, for example.

These results are important for understanding why some people choose not to buy an electric vehicle, even when they know that they can help curb emissions. It also shows that when people want to help avoid the climate crisis, they are likely to make important purchasing decisions in alignment despite income. While it was hypothesized that men would have a higher knowledge of electric vehicles and a lower desire to curb emissions, there wasn't a strong enough correlation to reject either null hypotheses ($t(23) = -0.211$, $p > 0.05$) and ($t(23) = -0.728$, $p > 0.05$) respectively. There was also no significant difference among ethnicity and willingness to purchase an EV ($\chi^2(1,21) = 15.75$, $p = 0.783$).

These results cannot tell us what all students 'electric vehicle perceptions are. The students undergoing an environmental science major take several classes which teach the basics of climatology and how anthropogenic carbon dioxide in the atmosphere is driving the climate crisis. However, what about students in other majors? This study cannot tell us how the market can better support their consumer preferences or whether a newer, cheaper model would be enough to change their willingness to purchase an EV. This study can not tell us about the views of people who are not taking classes in general, and since most car buyers are Gen X, a survey done outside of a University setting would reach most consumers (Birkett, 2021).

Also, while the respondents who desire to curb emissions indicated that they would like to buy an electric vehicle, there was no question to determine when that would be. Since climate change consequences are so time sensitive, the sooner more Americans purchase an electric vehicle, the sooner any kind of mitigation will happen.

With the amount of carbon emissions that could be offset through electrifying the auto market, it's pertinent that everyday consumers are made aware of electric vehicle facts and options.

Stringent MPG reducing policies will push automakers to create more options for consumers, but that may not change the way that people research and buy cars, nor will it change an overall preference for fossil fuel burning automobiles.

Electrifying our cars could help to slow down the consequences of climate change as surface temperatures are already predicted to rise over 2 degrees Celsius by 2100 (IPCC, 2013). However, with only 1% of total cars in the world being electric in 2021, there is a long way to go. This study demonstrated how students with at least a basic understanding of climate change would consume electric vehicles, but what about the rest of the student body? If the rest of the nation had updated electric vehicle information concerning extended range, lower prices, and increased charging stations, would they still continue purchasing gasoline vehicles? Further studies need to be done.

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Appendix A

1. Johns Hopkins University, Energy Policy and Climate programName of Investigators: Dr. Jennifer da Rosa, Sheridan RibbingTitle of Project: Electric Vehicle Perceptions Among The University of Texas at San Antonio Students Request to Participate in Research
    a. I consent, begin the study
    b. I do not consent, I do not wish to participate
2. What is your age?
    a. ____
3. To which gender identity do you most identify?
    a. Male
    b. Female
    c. Gender Variant/Non-Conforming
    d. Prefer not to say
4. What is your total household income?
    a. Under $10,000
    b. $10,000 to $19,999
    c. $20,000 to $29,999
    d. $30,000 to $39,999
    e. $40,000 to $49,999
    f. $50,000 to $59,999
    g. $60,000 to $69,999
    h. $70,000 to $79,000
    i. $80,000 to $89,000
    j. $90,000 to $99,999
    k. $100,000 to $119,999
    l. $120,000 to $129,999

m. $130,000 to $139,999

n. $140,000 to $149,999

o. $150,000 or more

5. Which category best describes you?
    a. White, non-Hispanic
    b. Black or African American
    c. Asian
    d. American Indian or Alaskan Native
    e. Native Hawaiian or Other Pacific Islander
    f. Other
    g. White Hispanic
    h. Black or African American
6. Which category best describes you?
    a. Other: _____

Electric vehicles are cars which do not use gasoline, but instead are charged through a plug in cable. In the statements below, please indicate how much you agree or disagree

7. How much do you agree or disagree with this statement: Fuel cost of an electric vehicle is less expensive than that of a traditional gasoline/diesel vehicle
    a. Strongly agree, agree, neutral, disagree, strongly disagree
8. How much do you agree or disagree with this statement: the maintenance requirements of electric vehicles are lower than traditional gasoline/diesel vehicles
    a. Strongly agree, agree, neutral, disagree, strongly disagree
9. How much do you agree or disagree with this statement: electric vehicles cannot travel over 100 miles before recharging (Which is incorrect)

    a. Strongly agree, agree, neutral, disagree, strongly disagree (Numbers correlate opposite in SPSS)

10. How much do you agree or disagree with this statement: Electric vehicles will contribute to environmental sustainability
    a. Strongly agree, agree, neutral, disagree, strongly disagree
11. How much do you agree or disagree with this statement: Electric vehicles will help to reduce carbon emissions
    a. Strongly agree, agree, disagree, strongly disagree
12. How much do you agree or disagree with this statement: I am willing to pay more to buy environmentally friendly products.
    a. Strongly agree, agree, neutral, disagree, strongly disagree
13. How much do you agree or disagree with this statement: Electric vehicles are reasonably priced
    a. Strongly agree, agree, neutral, disagree, strongly disagree
14. How much do you agree or disagree with this statement: Next time I buy a car, I will consider buying an electric vehicle
    a. Strongly agree, agree,disagree, strongly disagree
15. How much do you agree or disagree with this statement: Under a similar price, I prefer to buy electric vehicles compared to traditional gasoline/diesel vehicles.
    a. Strongly agree, agree, disagree, strongly disagree