الكشف عن تصور معلمي العلوم العمانيين أثناء الخدمة ومستوى قلقهم من تغير المناخ وعلاقته بممارساتهم التدريسية

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مستخلص الدراسة

هدفت الدراسة الحالية إلى الكشف عن تصور معلمي العلوم العمانيين أثناء الخدمة ومستوى قلقهم من تغير المناخ وعلاقته بممارساتهم التدريسية. وللتحقق من ذلك طُبقت استبانة إلكترونية عبر جوجل فورم على ٤٥٠ معلمًا عمانيًا من معلمي العلوم أثناء الخدمة. وشملت الاستبانة ٣١ عبارة في ستة محاور، هى: تصور المعلمين لتغير المناخ، ومستوى القلق المدرك من تغير المناخ، ومستوى الإجهاد الناجم عن تغير المناخ، والتأثير المعرفي لتغير المناخ، والتأثير الفسيولوجي لتغير المناخ، وتأثير تغير المناخ على الممارسات التدريسية لدى معلمي العلوم أثناء الخدمة. وقد أظهرت نتائج التحليل الوصفي والإحصائي باستخدام ANOVA أن التخصص العلمي الدقيق لهؤلاء المعلمين كان له أثر في تصورهم، وكذلك في مستوى قلقهم من تغير المناخ. كما أن معلمي العلوم العمانيين أثناء الخدمة لديهم مستوى عالٍ من القلق بشأن تغير المناخ. وكشفت الدراسة أيضًا عن وجود علاقة ارتباط سالب بين الممارسات التدريسية المتعلقة بتغير المناخ وكل من تصور ومستوى قلق المعلمين من تغير المناخ.

الكلمات المفتاحية: معلمو العلوم أثناء الخدمة، تصور تغير المناخ، وقلق تغير المناخ.

Investigating Omani In-service Science Teachers' Perception of Climate Change, Climate Change Anxiety Level and its Relationship with their Teaching Practices

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Abstract

This study examines 450 Omani in-service science teachers' (ISSTs) perceptions and anxiety about climate change and its corresponding impact on their teaching practices. An online questionnaire was applied to the Omani ISSTs. It consisted of 31 questions pertaining to six domains: perception of climate change, reported level of climate anxiety, level of stress caused by climate change, the impact of climate anxiety on cognitive functioning, the impact of climate anxiety on physiological function, and teaching practices pertaining to climate change. Descriptive and ANOVA statistical analyses showed that Omani ISSTs' perception of climate change was affected by their science specialization but not their gender. The findings suggest that the Omani ISSTs had a high level of anxiety about climate change. Their teaching practices pertaining to climate change are significantly negative related to both their perception and level of climate change anxiety.

Keywords: Science, in-service teachers, climate change anxiety, perception of climate change.

Introduction

Climate change is one of the most pressing issues of our time. While some continue to deny its existence and question human's

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contributions to its effects, climate change is an undeniable fact (e.g., IPCC, 2018; IPCC, 2022). Media addresses climate change by describing it using doomsday language such as catastrophic, urgent, irreversible, and devastating. Popular climate change advocate Greta Thunberg (2019) reinforces the fear by stating, I don't want you to be hopeful. I want you to panic. I want you to feel the fear I feel every day. And then I want you to act. I want you to act as you would in a crisis. I want you to act as if our house is on fire. Because it is. (para. 20)

With extensive exposure to the negative impact climate change can have on individuals, their family, community, and the world, it is not surprising that individuals are experiencing climate anxiety (Albrecht, 2011; Clayton, 2020; Maran & Begotti, 2021; Ojala, 2015; Reyes et al., 2021, Weintrobe, 2019). The impact of climate change on mental health is not limited to those who have lived through a natural disaster associated with climate change (Howard-Jones et al., 2021). Within schools, classroom discussions and analysis of the effects of climate on one's country and across the global may affect students' and teachers' mental health in the form of climate anxiety (Helm et al., 2018; Maran & Begotti, 2021). As teachers play a key role in the Sultanate of Oman's objective to control greenhouse gas emissions, the current study examines Omani in-service science teachers' perception and anxiety level about climate change and its perceived impact on their teaching.

Climate Change in Oman

In 2018, the Intergovernmental Panel on Climate Change (IPCC) stated that climate change is a variation, as measured by statistical tests, of mean weather patterns and properties that persists for an extended period, usually of decades or more. While climate change can be brought about by natural internal processes, the rapid climate change currently being experienced is tied to anthropogenic changes, that is, human activities (IPCC, 2022). Anthropogenic changes include overfishing, deforestation, and the introduction of invasive species; however, the greatest anthropogenic change is greenhouse-gas, with the largest contribution derived from carbon dioxide followed by methane and nitrous oxide (Brown et al., 2022).

Increases in greenhouse gas correspond to an increase in surface temperature, which strengthen land-sea thermal contrasts shifting the projection of tropical storms and precipitation northward (Monerie et al., 2022). Since preindustrial times global surface temperatures have risen approximately 1.09ºC and are predicted to rise an additional 1 ºC to 2.4 ºC by 2100 (IPCC, 2022). Although a one degree increase in temperature may seem insignificant, a 1 ºC increase will trigger a rise in sea levels resulting in millions of people being displaced by coastal flooding. An increase of 1.5 ºC would result in catastrophic biodiversity loss, and a 2 ºC increase would result in irreversible extinctions of plants, animals, insects, and coral reefs (IPCC, 2022). It is apparent, therefore, that the effects of climate change can and will be devastating.

According to Charabi (2021) the Sultanate of Oman is an arid, water-stressed coastal region whose temperatures are affected by Arabian Peninsula, Polar Continental, and Tropical Continental air masses. The air masses contribute to Oman's 3,165 km coastline being vulnerable to destructive tropical depressions, severe cyclonic storms, tropical cyclones, flash floods, and rising sea levels. Over the last 30 years, Oman has experienced an increase in temperature of 0.1 ºC per decade in the Salalah region, 1.1 ºC increase per decade in the Sur region, and a decrease in rainfall. The climate change that Oman is experiencing exposes the country to an increase in coastal flooding, the intrusion of seawater into aquifers, and more frequent intensified tropical cyclones. Oman as is an active partner in the Paris Agreement of COP-21 it has agreed to do its part to control greenhouse gas emissions by encouraging low carbon economy and technology and implementing cost-effective efficient and renewable energy projects (Charabi, 2021). To meet its objective Oman has developed government regulations and standards for real estate development in high-risk coastal areas, developed booklets and programs outlining the role families and schools can play in reducing emissions, harnessed the power of social media to communicate climate change information and alerts, and promoted social participation in climate change (Charabi, 2021). The heightened awareness of climate change has resulted in the topic being incorporated into Oman's science

curriculum. Within the curriculum, climate change is addressed in terms of "when" and not "if" it occurs; potentially further heightening fear that the climate will have a devastating impact on people's lives. While all these endeavours may help achieve the goal of lowering greenhouse gas emissions, the influx of information pertaining to climate change may result in an increase in climate anxiety.

Climate Change Anxiety

Climate change anxiety refers to uncontrollable and chronic stress, worry and fear about endangerment to all forms of life from environmental threats and catastrophes to such a significant degree that it affects an individual's emotional, cognitive, and physical well-being (Dodds, 2021; Ramadan et al., 2021; Reyes et al., 2021). Therefore, climate anxiety can be viewed as excessive stress and worry about one's ability to survive amid climate change (Weintrobe, 2012). Unlike generalized anxiety, which may be associated with an unlikely event (American Psychiatric Association, 2013), climate change is a real and ongoing threat. Hence, individuals' perception of climate change may affect their level of climate anxiety.

Like climate anxiety, an individual's perception of climate change is a complex process that includes a range of psychological constructs such as knowledge, beliefs, attitudes, and concerns about if and how climate change occurs (Whitmarsh and Capstick, 2018). Furthermore, individuals' perception of the effects of climate change influences their actions to reduce climate change (Chowdhury et al., 2021; Jakučionytė-Skodienė and Liobikienė, 2022). Therefore, it is reasonable to expect that as information about climate change increases, it shall directly impact individuals' perceptions of climate change thereby increasing their climate anxiety (Clayton, 2020).

Excessive climate anxiety may impact cognitive function and physiological function (Clayton, 2020). Cognitive function may be impaired in the form of excessive worry (Pattee, 2020). Worry is a cognitive activity consisting of temporary negative thoughts and feelings about the outcome of a present event or future event (Hirai et al., 2008). In general, worry does not impair your ability to function because you are able to control the intensity and duration of your worry through problem solving (Szabó, 2011). Therefore, worry does

not necessarily equate to a deterioration in cognitive function as it can serve as a motivator and positively affect ability to meet their responsibilities. In conjunction with worry, an individual may also experience stress. Stress is a physiological response to internal and/or external stressors (Pattee, 2020; Tavakoli et al., 2019). When stressed your limbic system generates the behavioural response of flight-or-fight regardless of whether the perceived threat is real or unrealistic.

Climate anxiety, however, should not necessarily be viewed as pathological because effective coping strategies may mediate any detrimental effects (Reyes et al., 2021). One strategy to address climate anxiety is problem-focused coping, which requires an individual to identify a means to solve a problem (e.g., what can I do to stop climate change). In terms of climate change, problem-focused coping is challenging because climate change cannot be easily solved or controlled by an individual and can; therefore, result in an increase in anxiety (Hayes, 2020; Ojala, 2013; Ramadan et al., 2021). However, increased anxiety is not necessarily detrimental as individuals who experienced high and increasing levels of climate anxiety often have higher rates of societal engagement and activism (Helm et al., 2018; Ojala, 2013; Sciberras & Fernado, 2022).

A second strategy that may assist individuals with coping with climate anxiety is meaning-focused coping (Ramadan et al., 2021). “Meaning-focused coping occurs when one finds benefits and/or meaning within a challenging or difficult circumstance and is able to adapt goals and behaviours to address one’s reactions and actions toward the circumstance” (Hayes, 2020, p. 36). Meaning-focused coping proposes that effective coping requires “1) the need for dealing with emotions sufficiently/adequately and developing emotional skills (emotion-focused coping) and 2) the need for sufficient/adequate opportunities to act and be active (problem-focused coping)” (Pihkala, 2019, p. 11). Meaning-focused coping results in increased activism, environmental efficacy, and overall optimism about climate change thereby decreasing climate anxiety (Ojala, 2013). Since meaning-focused coping focuses on activating positive emotions and not on getting rid of negative emotions optimism is increased and climate anxiety is decreased (Ojala, 2013).

Teachers and Climate Change Anxiety

While research has examined climate anxiety from the perspective of its impact on youth, adults, teachers' perceptions of climate change, and teaching praxis (e.g., Ahmed et al. 2021; Bhattacharya, 2020; Steward et al., 2021), very limited research examined the impact climate change has on teachers, particularly the anxiety teachers experience around climate change. The few existing studies have indicated that teachers' perception of climate change affects how they teach about it (Glackin, 2016; Seow & Ho, 2016) and that teachers who value nature and/or believe in climate change were more inclined to teach it (e.g., Higde et al., 2017). By teaching about climate change, it may help decrease the climate anxiety teachers experience as teaching about climate change may be viewed as a form activism thereby serving as a copying mechanism (Pihkala, 2019).

Teachers regularly experience high rates of anxiety and stress resulting in high burnout rates and adverse health conditions (García-Carmona et al., 2019; Jones-Rincon & Howard, 2019; Osipova et al., 2018). Heavy workload, student misbehaviour, student motivation, control over occupational decisions, and level of support from peers and administrators have all been identified as sources of stress and anxiety (Harmsen et al., 2018; Ghasemi, 2021). Therefore, as "climate change often introduces more stress factors to situations, which traditionally already carry a lot of stress" (Pihkala, 2019, p. 9) it is highly probable that ISSTs are susceptible to climate anxiety and behavioral inefficacy about climate change (Coffey et al., 2021; Hibberd & Nguyen, 2013) because they must teach, analyze, discuss, and address student's worries and stress about the impact of climate change. Furthermore, a high exposure to information about climate change increases the likelihood of experiencing climate anxiety and feeling less able to effectively address the issue (Albrecht, 2011; Kellstedt et al., 2008).

As fear causes people "to avoid situations that pose threats to their lives" (Routledge & Vess, 2019, p. 304) it is possible that teachers with high climate anxiety will avoid teaching about climate change. Cross (1998) found that when teachers believed that their

students perceive the topic of climate change as fearful and distressing, the teachers worried that discussing climate change would negatively affect students' hope for the future. However, an emotional response to climate change discussion does not mean that the topic should be avoided. The degree of climate anxiety may be associated with how climate change information is framed and conveyed (Clayton, 2020). Classroom discussion about climate change may generate symptoms of anxiety and other emotional responses, including feelings of feelings of helplessness and disempowerment (Ojala, 2015; Soutar & Wand, 2022). The feelings experienced when discussing climate change may be more manageable when the emotions are shared within a safe space and options for actions are discussed (Dodds, 2019; Ojala, 2015). For example, the degree of constructive hope high school students experience in relation to climate change and whether that hope is based on denial is influenced by their perception of their teachers' communication about emotions generated by climate change (Ojala, 2015). Furthermore, how students react to climate change discussions may be tied to their teacher's emotions. If the teacher views climate change as bleak, they may present climate change in a "gloom-and doom" manner. When climate change is presented in a foreboding manner, students may be more inclined to base their hope on the denial of the seriousness of climate change. Therefore, increased exposure and attention to climate change issues may increase efficacy beliefs and motivation for change thereby by spurring an individual to take constructive action (Helm et al., 2018; Maran & Begotti, 2021; Ramadan et al., 2021; Sciberras & Fernando, 2022). If ISSTs view teaching about climate change as a form of activism for countering the effects of climate change it could suggest that teaching about climate change provides teachers with both a problem-focused and a meaning-focused coping strategy.

Aims of the study

The aim of the current study is to examine Omani ISSTs' perception, anxiety level of climate change and its relationship with their teaching practices pertaining to climate change.

To guide our research the following questions were addressed:

1. What is the level of Omani ISSTs' knowledge about climate change?
2. What are Omani ISSTs' perceptions of climate change?
3. What are the effects of Omani ISSTs' gender and science specialization on their perception of climate change?
4. What is the level of Omani ISSTs' climate change anxiety?
5. What are the effects of Omani ISSTs' gender and science specialization on their level of climate change anxiety?
6. What is the relationship between Omani ISSTs' teaching practices pertaining to climate change and their:
   - perception of climate change;
   - level of climate anxiety.

Hypotheses of the Study

1. Omani ISSTs have a high level of knowledge about climate change.
2. All Omani ISSTs perceive climate change as a scientific fact and an immediate threat to the future.
3. There are no statistically significant differences (p= or <0.05) between the score means of the Omani ISSTs' perception of climate change attributed to demographic variables (gender and science specialization
4. Omani ISSTs have a low level of climate change anxiety.
5. There are no statistically significant differences (p= or <0.05) between the mean scores of the Omani science teachers' level of climate change anxiety attributed to demographic variables: gender or science specialization.
6. There is no significant correlation (p= or <0.05) between the Omani ISSTs' teaching practices pertaining to climate change and their:
   - perception of climate change
   - level of climate anxiety.

Significance of the Study

- The present study is a response to the current national and international issue of climate change, which requires teachers to be prepared for addressing climate change in their classes.

- The possibility of benefiting from using the developed teachers' climate anxiety scale by other researchers in evaluating climate anxiety level of teachers in Oman or in any other countries.
- The results of the present study imply a feedback of pre- and in-service science teacher education programs in Oman in terms of employing climate change topics effectively.

Study Terminology

- Climate Change Perception: is a complex process that encompasses a range of psychological constructs such as knowledge, beliefs, attitudes, and concerns about if and how the climate is changing (Whitmarsh and Capstick, 2018). In the current study, **the procedural definition** of Omani science teachers' climate change perception refers to their knowledge and views about what climate change is and its reasons. It is determined by calculating the percentage of the Omani science teachers' mean score in the prepared scale.
- **Climate Change Anxiety**: Is defined in Collins English Dictionary (n. d.) as *a state of distress caused by concern about climate change.* The Handbook of Climate Psychology (2020, 7836) also defines climate anxiety as a "heightened emotional, mental or somatic distress in response to dangerous changes in the climate system". In the present study Omani science teachers' climate anxiety is defined as a state of emotional, cognitive, and physiological response in the face of the perceived danger of changes in the climate system and is measured by calculating the percentage of their score mean in the identified four domains of the prepared climate anxiety scale.

Methods

A research proposal describing the study's aims, participants, and procedures along with the questionnaires were submitted to both the Sultanate of Oman's Ministry of Education and the university governing the study. Ethical approval was obtained from both institutions.

Participants

The participants consisted of in-service science teachers (ISSTs) (n = 450; female = 311; male = 139) recruited from Omani governorate schools located throughout Oman. The participants ranged in age from 24 to 56 with a mean age of 33.5. The Omani ISSTs taught chemistry (n = 182; female =131; male =51), biology (n = 111; female =91; male =20), and physics (n = 157; female = 89; male =68) to students in grades 1 to 12. The years of teaching experience ranged from 1 to 25 years with a mean of 13 years of teaching experience. The number of climate change lessons the ISSTs taught ranged from 0 to 12 with a mean of 6.

Survey Tool

To examine the participants' climate anxiety an online survey was adapted from Stewart's (2021) Climate Change Worry Scale and von der Embse et al.'s (2021) Multidimensional Test Anxiety Scale. The survey consisted of two parts. The first part of the survey gathered demographic information while the second part consisted of 31 questions pertaining to six domains: perception of climate change, reported level of climate anxiety, level of stress caused by climate change, the impact of climate anxiety on cognitive functioning, the impact of climate anxiety on physiological function, and teaching practices pertaining to climate change. The questions required a response on a five-point Likert scale (from 1-5), with highest number corresponding to responses indicating an emotion or perception that they always experience.

Each participant's overall level of climate change anxiety was calculated by tallying their scores in four domains of the scale: perceived level of climate change anxiety (consisting of five questions), level of stress (consisting of six questions), level of cognitive impacts (consisting of five questions), and level of physiological impacts of climate anxiety (consisting of five questions). The maximum total score of the overall level of climate anxiety level equaled 105.

Cronbach's alpha was measured to consider the internal reliability of the surveys. The Cronbach's alpha reliability for the accuracy data was 0.78 for perceptions of climate change, 0.87 for

perceptions of climate anxiety, 0.90 for climate change stress, 0.87 for cognitive impact, and 0.91 for physiological impact.

The survey was administered online via Google Form and took approximately 10 minutes to complete. The participants completed the survey at a time and in a location of their choosing. The response rate was 10.71%.

Study Findings

Table 1 displays the descriptive statistics of the Omani ISSTs' Climate Change Anxiety Survey.

Table 1: *Descriptive statistics for the Omani ISSTs' Climate Change Anxiety Survey*

Scale Domain	***Min.***	***Max.***	***M***	***SD***
Perception of climate change	2	10	7.8	1.66
Perceived/Reported Level of Climate Anxiety	5	25	13.15	4.55
Level of Stress due to Climate Change	6	30	16.35	5.65
Impact of Climate Anxiety on Cognitive Functioning	5	24	10.6	4.26
Impact of Climate Anxiety on Physiological Functioning	5	24	8.91	4.11
Calculated Climate Anxiety	21	96	48.92	15.87
Impact of Climate Anxiety on Teaching	5	22	12.76	3.479

First: Omani In-service Science Teachers' Knowledge Level about Climate Change:

The first hypothesis of the current study states that: "Omani science teachers have a high level of knowledge about climate change and perceive it as a scientific fact and an immediate threat to the future. To verify this hypothesis, the score means and percentage of the ISSTs' perception of climate change were calculated.

With regard to Omani ISSTs' knowledge level about climate change, it was revealed that 19.11% ISSTs reported that they had extensive knowledge about the causes of climate change, 50.7% reported that they knew a lot about the causes of climate change, 25.6 % reported that they have some knowledge about the causes of climate change, 3.33% reported they knew a little bit about the causes of climate change, and 1.33 % had no knowledge about the causes of climate change. Furthermore, although the majority of ISSTs stated that they knew a lot about the causes of climate change, when divided by specialization, 24.32% of the biology teachers claimed that they had extensive knowledge about the causes of climate change in comparison to 15.9% of the physics teachers and 18.7% of the chemistry teachers.

The Omani ISSTs' overall level of knowledge about climate change was also calculated and it was 76.6%, which is high; therefore, the first hypothesis is accepted. In other words, Omani in-service science teachers have a high level of knowledge about climate change.

Second- Omani In-service Science Teachers' Perception of Climate Change:

To verify the second hypothesis which states that:" all Omani in-service science teachers perceive climate change as a scientific fact and an immediate threat to the future", the percentages of the five categories of the ISSTs' perception of climate change were calculated. It was found that only 44.9 % of the participants viewed climate change as a scientific fact and an immediate threat to the future, 36 % viewed climate change as a scientific fact, but a distant threat to the future, 6.22% viewed climate change as a natural phenomenon that is

not influenced by humanity, 1.56% viewed climate change as a hoax, and 11.33% viewed climate change as "other".

Accordingly, not all Omani science teachers perceive climate change as a scientific fact and an immediate threat to the future. Therefore, the second hypothesis is rejected.

Third- The Effect of the Omani In-service Science Teachers' Demographic Variables on their Perception of Climate Change:

The third hypothesis which states that: "there are no statistically significant differences (p= or <0.05) between the score means of the Omani ISSTs' perception of climate change attributed to demographic variables (gender and science specialization). This hypothesis can be divided into the following sub-hypotheses:

3-a. There are no statistically significant differences (p= or <0.05) between the score means of the Omani male and female ISSTs' perception of climate change.

3-b. There are no statistically significant differences (p= or <0.05) between mean scores of the Omani ISSTs' level of climate change anxiety attributed to their science specialization.

A one-way analysis of variance (ANOVA) was conducted. It revealed that there is a significant difference between the male ISSTs' and female ISSTs' perception of climate change [$F(1, 449) = 8.36$, $p = 0.004$, $\eta_p^2 = 0.19$].

Specifically, the score means of Omani male ISSTs' perception of climate change as a scientific fact and immediate threat of the future was 8.2, which is higher than the score means of the female ISSTS' perception of climate change which is 7.7. Therefore hypothesis (3-a) is rejected.

When the Omani ISSTs' area of science specialization was considered and a one-way analysis of variance (ANOVA) was conducted, it revealed that there was a significant difference between the ISSTs' science specialization and their perception of climate change [$F(2, 448) = 8.65$, $p < 0.01$, $\eta_p^2 = 0.039$].

A Tukey's multiple comparison test, Tukey's HSD, revealed a significant difference between Omani in-service biology teachers and

physics ones in their perception of climate change (0.59, p =0.002) in favor of biology teachers. It also revealed a significant difference between Omani in-service biology teachers and chemistry ones in their perception of climate change (0.63, p = 0.001) in favor of biology teachers. There was no significant difference between Omani in-service physics and chemistry ones in their perception of climate change (0.04, p = 0.821). Therefore, hypothesis (3-b) is rejected.

Fourth- Omani In-service Science Teachers' Level of Climate Change Anxiety:

To verify the fourth hypothesis which states that**"** Omani ISSTs have a low level of climate change anxiety", the ISSTs' score means were calculated.

Overall, it was revealed that all the percentage of the ISSTs' score means of climate change anxiety is 46.6%, which refers to a high level of climate change anxiety. All the ISTTS reported experiencing climate anxiety, with 12.67% reporting mild climate anxiety, 35.33% reporting moderate climate anxiety, 28% reporting high climate anxiety and 24% reporting severe climate anxiety. Moreover, the ISSTs' perceived level of climate anxiety was high at 52.602%. When the ISSTs' climate anxiety was calculated, based only on their scores in the four domains of the scale: level of stress, level of cognitive impacts, and level of physiological impacts of climate anxiety, it was revealed that 46.6% of ISSTs had high levels of climate anxiety and 45% of the ISSTs had severe levels of climate anxiety. Therefore, the fourth hypothesis is rejected.

Fifth- The Effect of the Omani ISSTs' Demographic Variables on their Level of Climate Change Anxiety:

The fifth hypothesis states that: "There are no statistically significant differences (p= or <0.05) between the mean scores of the Omani science teachers' level of climate change anxiety attributed to demographic variables: gender or science specialization." This hypothesis can be divided into the following sub-hypotheses:

5-a. There are no statistically significant differences (p= or <0.05) between mean scores of the Omani male and female ISSTs' level of climate change anxiety.

5-b. There are no statistically significant differences (p= or <0.05) between mean scores of the Omani ISSTs' level of climate change anxiety attributed to their science specialization.

To verify these sub-hypotheses, planned comparisons were obtained from one-way analysis of variance (ANOVA) and revealed no significant differences with regards to the ISSTs' level of climate change anxiety and their gender [$F(1, 449) = 3.392$, $p = 0.066$]. Therefore, hypothesis (5-a) is accepted.

On the other hand, one-way analysis of variance (ANOVA) revealed statistically significant differences (p= or <0.05) between the mean scores of the Omani science teachers' level of climate change anxiety and their science specialization [$F(2, 448) = 4.181$, $p = 0.016$, $\eta_p^2 = 0.019$].

Using Tukey's multiple comparison test, Tukey's HSD, revealed a significant difference between Omani in-service biology teachers and physics ones in the level of climate change anxiety (4.64, p =0.006) in favor of biology teachers. It also revealed a significant difference between Omani in-service biology teachers and chemistry ones in the level of climate change anxiety (4.64, p = 0.005) in favor of biology teachers. There was no significant difference between Omani in-service physics and chemistry ones in the level of climate change anxiety (0.00, p = 0.999).

Consequently, Omani in-service biology teachers had a higher level of climate change anxiety than the in-service chemistry and physics' levels. Therefore, hypothesis (5-b) is rejected.

Sixth- Relationship between Omani ISSTs' Climate Change Anxiety Level and their Teaching Practices Pertaining to Climate Change:

The sixth hypothesis states that: "There is no significant correlation (p= or <0.05) between the Omani ISSTs' teaching practices pertaining to climate change and their:

a) perception of climate change
b) level of climate anxiety.

To verify these hypotheses, Pearson correlation was calculated, which revealed that there is a significant negative relationship between the ISSTs' teaching practices pertaining to climate change and their perception of climate change (r = -0.322, p <0.01, adjusted R^2 =0.104). Therefore hypothesis (6-a) was rejected.

There was also a significant negative relationship between the ISSTs' teaching practices pertaining to climate change and their level of climate anxiety (r = -0.172, p <0.01, adjusted R^2 =0.0296). Therefore, hypothesis (6-b) was rejected. Consequently, the sixth sub-hypotheses were rejected.

Discussion

The impact of climate change on Oman's environment has resulted in the development of a science curriculum that focuses on climate change. As Omani science teachers are responsible for teaching about climate change, it is important to determine degree of climate anxiety experienced by the Omani ISSTs and its relationship with their teaching practices. The study aimed to: 1) investigate the level of the Omani ISSTs' knowledge about climate change; 2) investigate their perception about climate change; 3) investigate the impact of the Omani ISSTs' gender and science specialization on their perception about climate change 4) assess their level of climate anxiety; 5) investigate the impact of the Omani ISSTs' gender and science specialization on their level of climate change anxiety; and 6) examine the relationship between ISSTs' teaching practices pertaining to climate change and their perception about climate change and level of climate anxiety.

For the first two study aims, the Omani ISSTs had a high level of knowledge about climate change. Most Omani ISSTs perceived climate change as a scientific fact and an immediate threat to the future. Regarding the third aim of the study, the data analysis showed that Omani biology ISTs were more knowledgeable than physics and chemistry teachers. This finding can be explained in terms of the amount of climate change knowledge possessed by biology teachers. In other words, in addition to traditional biology topics (e.g., ecology, energy flow, carbon cycle, fossil fuels, deforestation, pollution), biology teachers are also responsible for teaching about climate

change. As a result, biology teachers are more knowledgeable than chemistry and physic teachers about climate change facts, its causes, and its impacts.

Regarding the fourth aim the study revealed that the participants' high level of climate change anxiety correlated with their knowledgeable about climate change. This finding suggests that the more knowledgeable ISSTs are about climate change, the greater their risk for experiencing climate anxiety. For example, the biology ISSTs appeared to have a higher level of climate change anxiety than chemistry and physics ISSTs. This may be attributed to the fact that biology ISSTs are exposed to more information related to climate change as it is a component of the biology science curriculum. This supports previous findings (e.g., Ahmed et al., 2022; Soutar and Wand, 2022) claim that knowledge about climate change produces anxiety. Furthermore, the fact the ISSTs high level of climate anxiety was not affected by the ISSTs gender, the fifth aim of the study that the ISSTs high climate anxiety could also be attributed to the impact climate change currently has on Oman such as aridity, soil salinity, recurrent drought, and water scarcity (Ahmed & Choudri, 2012). Thus, both knowledge about climate change and personal experience with climate change may affect the level of climate anxiety experienced by ISSTs.

For the sixth aim, the findings uncovered a significant negative relationship between Omani ISSTs' teaching practices pertaining to climate change and their perception of climate change and level of climate anxiety. This relationship indicates that the more knowledgeable science teachers are about climate change, the less they address climate change issues during their teaching practices. It also indicates that the higher level of climate anxiety the Omani ISSTs experience, the less they address climate change issues. For example, the teachers who claimed that they were more knowledgeable about climate change reported a high or severe level of climate anxiety and reported that they rarely or never seek out ways to address climate change and avoided talking about climate change in their classes. These findings support Randall and Hoggett's (2019) supposition that scientists who are involved in climate change,

distance themselves from climate change anxiety by avoid talking or thinking about climate change.

In contrast, the weak correlation coefficient (i.e., -0.172) between Omani ISSTs' teaching practices pertaining to climate change and their level of climate change anxiety may refer to a weak relationship between these two variables. This may be attributed to the stressors the ISSTs experience as teachers (e.g., García-Carmona et al., 2019; Harmsen et al., 2018; Jones-Rincon & Howard, 2019; Ghasemi, 2021; Osipova et al., 2018) which may overshadow any anxiety that they feel about climate change. In other words, for classroom teachers, climate anxiety may be the least of their worries. Another possible explanation is that the ISSTs may be viewing teaching about climate change as a form of activism and are thereby using a meaning-focused coping strategy (Ramadan et al., 2021). As a result, the ISSTs environmental efficacy and optimism about climate change is increased and their climate anxiety is decreased (Ojala, 2013). Further research is required to verify this supposition.

Instead of involving their students in discussions about the reasons causing climate change and how these students as Omani citizenships can participate in solving this problem, the ISSTs- as reported- avoid addressing issues pertaining to climate change in their science classes. The implication of the negative effect of the teachers' climate anxiety on their teaching practices highlights the teachers' need for training courses on not only reducing climate anxiety, but also employing approaches to addressing issues pertaining to climate change in their science classes. Therefore, it is recommended that courses on climate change and approaches to addressing it in science classes be provided to teachers.

Limitations

Although the online questionnaire was distributed to in-service science teachers in all Omani government schools, only 450 teachers responded. According to the Annual Educational Statistics Book in Oman (Ministry of Education, 2021), the number of science teachers in Sultanate of Oman is 4202. Therefore, the ISSTS only represent

10.71% of the science teachers in Oman. Consequently, generalizing the findings from the current study to the entire population is limited.

A second limitation lies in the importance of identifying the participants' level of general anxiety. This is because it may be argued that a person's level of climate anxiety is influenced by his/her level of general anxiety. Therefore, it would strengthen the findings if both the Omani ISSTs' level of general anxiety and its relationship with their level of climate change anxiety were investigated.

The female ISSTs had a different perception of climate change, perceived levels of climate anxiety, and level of stress related to climate anxiety than the male ISSTs. These findings are of interest as past research has indicated that females report more concern and distress about climate change than males (e.g., Searle & Gow, 2010), while others found no gender differences in climate anxiety (Claytond & Karazisa, 2020). In the current study, the female teachers represented 69.1% of the whole participants while the males represented 30.9%. Consequently, enlarging the number of male participants needs to be considered in the future studies.

Future Research

To have a more complete understanding of Omani science teachers' climate anxiety it is necessary to conduct a comparative study that examines how the climate anxiety experienced by Omani science teacher varies from teachers in other specializations. In addition, it would be beneficial to conduct a longitudinal study that examines pre-service science teachers' climate anxiety through their teacher training and into their teaching career. Such a study would enable one to further examine whether teaching experience influences climate anxiety.

Conclusion

There are two key elements that differentiate this study from past research. One element is the fact that the participants are not from North America or Europe. As Ray (2021) and Brown (2022) argue, white voices have dominated the discussion about climate anxiety. By examining the climate anxiety of Omani in-service teachers, the current research provides new voices on climate anxiety. The second element of difference is that the participants in the current

study were not only asked to rate their level of climate anxiety, but also their degree of climate anxiety was calculated based on the characteristics of anxiety: worry, stress, cognitive impact, and physiological impact. This approach enabled clarification between those who believed they are anxious about climate change and those who are experiencing acute symptoms of climate anxiety. Using this approach, the results have indicated that Omani in-service teachers experience high to severe climate anxiety. Their teaching practices pertaining to climate change appeared to be negatively related to their anxiety about climate change.

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