Climate change and environmental education: the challenges of language use, curriculum design and making meaningful connections

Altaf Qadeer

Teacher and researcher in Canada

Abstract: Environmental awareness education is an important topic in our current curriculum. The use of language to describe certain terms of this field requires clarity to make a meaningful impact. In order to consider the global level dimension of climate change the multilingual aspect is also an important need for developing learning resources. The curriculum needs an effective design to meet the ongoing challenges related to the understanding of climate change. The making of the meanings from certain science terms by the general public can be an important factor in our profound understanding of environment related terminology. A survey is used to explore some pedagogical and conceptual challenges related to this issue. The research question explores the ways in which climate change and environment education are viewed in terms of effective learning, language use, curriculum design and concept attainment. Some possibilities are discussed to find connections between theory, research and practice. Further studies will be needed to analyze the outcomes for some specific curriculum needs at various levels.

Keywords: climate change, language of communication, curriculum design, concept attainment

Contact: dr.altafqadeer@gmail.com

1 Introduction

The aim of this research paper is to explore possibilities to facilitate the learning about climate awareness and the environment education using some effective approaches. Our profound understanding of the depth and nature of a problem can play an important role to consider actions in this regard. The crucial importance of climate change and environmental issues is being echoed from various levels. The education related to climate change and environmental issues is one of the high need topics of this time. How well educators, scientists, curriculum designers and learners clearly understand the meaning behind certain terms being used to explain these topics? How well do we inculcate profound understanding of these concepts? There are many dimensions to this problem, and we can compare a few factors, such as explaining scientific terms with clarity to all stakeholders, multilingual needs, and explanatory understanding. The concepts explained within the scientific community

and other fields are analysed in many ways.

According to Gould (2003):

> Because we have cut ourselves off from scholars in the humanities who pay closer attention to the modes of communication, we have spun our own self-referential wheels and developed artificial standards and rules of writing that virtually guarantee the unreadability of scientific articles outside the clubhouse (p. 132).

1.1 Multilingual factors in environment education

In a world with increasing multilingual needs the solution is to empower our diverse communities with multilingual power. Multilingualism and linguistic diversity are a part of many international efforts for education. Although it requires extensive work at a number of levels from policy implementation to preparing learning resources, prescribed curriculum, delivered curriculum, with well-integrated collaboration of all stakeholders. The use of latest technological advances can be a useful tool for multilingual education related to climate change.

According to Stein-Smith (2016):

> A key aspect of this future, and of the potential benefits of increased global sustainability, is multilingualism (p. 2257).

1.2 Explanatory understanding challenges

In order to make conceptual clarity about climate change and environmental education, one aspect is explanatory understanding. It also includes explanatory sentences, explanatory diagrams and explanatory communication modes. The learning resources which are designed for climate change and environmental education can include this essential dimension. Communication in this regard has to focus on giving the details of concept attainment, reasoning, the scientific background behind some common observations and reducing possibilities which can lead to miscommunication.

According to Keil and Wilson (2000):

> It seems to us that placing a phenomenon in some larger conceptual framework is the conceptual core of people's everyday use of explanation. For example, suppose someone asks, 'why did this balloon expand when placed in the sun?' Statements that do not place the phenomenon in a larger conceptual framework, such as 'I saw it get bigger' or 'I like balloons,' simply do not constitute

> explanations, whereas statements such as 'it contains a gas, and gases expand when they are heated' or 'the gas in the balloon is composed of molecules, and they strike harder against the sides of the balloon when they are heated' are canonical examples of explanations (p. 280).

The possibilities can be explored to find some pathways to bring the desired message given by the scientists on climate change with profound understanding to the non-scientists. Some experts have explained this with a possibility.

Keil and Wilson (2000) remark:

> We think that there is much overlap between the form of everyday explanation used by non-scientists and explanations used by scientists (p. 281).

This analysis opens some possibilities to design learning materials and improve the communication of science ideas to the general public.

1.3 Use of certain words to describe climate change concepts

One aspect is to emphasize the use of relatively more effective language to convey the message on climate change; the common words in our common use to such environmental disruptions may not have the desired meaningful impact on all stakeholders (cf. Hassol, 2023). Susan Joy Hassol has given a rubric to show the impact of the choice of words for the same concept, for example, climate change may refer to any change, what if we use the term climate disruption. The change in the impact of the meanings has to be analyzed from various perspectives. There are many other words which can be reviewed to explain our environment related concepts in order to convey the meaning in the desired form (cf. Hassol, 2023).

The above discussion highlights some important factors which can be applied in the climate awareness education. The research question explores the ways in which climate change and environment education are viewed in terms of effective learning, language use, curriculum design and concept attainment.

2 Theoretical grounds

The learning and clear understanding of climate awareness is related to multiple fields. The background of this process requires exploring this question from various lenses. The field of science education which is also closely linked to environment education has highlighted a number of aspects which play an important role in

developing our understanding. Those aspects include the use of effective language to convey the meaning of climate related concepts, the multilingual needs, presenting a core idea of science to the general public, the nature of science, explanatory understanding, an interdisciplinary dimension of science, social science and other fields, use of effective diagrams to explain a concept related to climate change.

Theories of learning have close connection with science education, environment education and climate change understanding. Over a period of time many improvements have been made in the learning theories, however one theory that can explain everything on how we learn can be a task for future research with multidisciplinary parameters (cf. Geake 2009).

2.1 Nature of science focus and environment education

Nature of science (NOS) has been a focus for many reforms in science education.

McComas (2008) remarks that:

> Increasingly widespread agreement exists that the nature of science (NOS) must be an integral element of the K-12 science curriculum with emerging consensus on what specific NOS elements should be the focus of such instruction (p. 249).

In order to constantly engage the learner about the changing concepts of science through research and incorporate a mindset that will continue to explore with critical thinking, the use of the elements of the nature of science is crucial (cf. McComas, 2008). This approach may also provide an opportunity to analyze the trends of misinformation and explore the changing patterns of research in environmental education, climate change and related fields.

The concept of environment education has to be seen from a multidisciplinary lens to incorporate the understanding of multiple forms of environment. Those multiple forms may include physical environment, social environment, cognitive environment and language environment.

2.2 Curriculum frames to understand environment issues

The learning of a concept with profound understanding involves numerous factors.

According to Vygotsky (1997):

> Every function in the cultural development of the child appears on the stage twice, in two planes, first, the social, then the psychological, first between people as an interpsychological category, then within the child as an intrapsychological category (p. 106).

The field of science education is constantly on a journey to explore solutions to the challenges of conveying science concepts with a profound understanding. Some concepts of science are very common; however, the profound understanding of these concepts is being studied to explore the best way to explain them in the curriculum.

For example, the concept of energy is commonly described as 'ability to do work'. Science education experts have been working to find ways to facilitate the learning of the concept of energy, which is going through many theoretical and pedagogical frames (cf. Duit and Haeussler, 1992).

2.3 Understanding and communicating science concepts

Some precise variations in our understanding and clearly presenting a science concept plays an important role for the overall communication of science ideas in our learning resources and classroom interactions. This complex process is also reflected in our prescribed curriculum and the delivered curriculum.

The concept of energy is taught across many strands of the science curriculum. Duit and Haeussler (1992) have explained about the understanding of the concept of energy; one of the distinctions they have given relates to energy transformation and energy transportation. It can be compared, many learning resources do not provide that precise detail of the concept of energy with an emphasis on the distinction of energy transformation and energy transportation. The use of common definition of the word energy in the science learning resources needs clarity with this distinction of energy transformation and energy transportation (cf. Duit and Haeussler, 1992).

Another idea discussed in physics and science education is about the meaning of

$$E = mc^2$$

It is commonly described as mass is equivalent to energy. Newton postulated the distinction between the inertial mass of matter and its ability to do work as energy.

As Sachs (2007) shows a precise distinction as:

> Mass and energy are totally different concepts! What should be said, instead of saying that mass is equivalent to energy, is that *mass* (the inertia of matter) is

> a *measure* of the capability of this matter to do work (its intrinsic *energy*) (p.84).

The field of conveying science concepts has many lenses to examine the profound understanding for various levels of learners. This process can enhance the effectiveness of learning for all stakeholders if they are also part of the research process. The designing of curriculum resources includes many factors in research and application, which also encompasses the process of understanding, teaching and finding an effective use of language and diagrams which can facilitate explanatory understanding.

2.4 The use of diagrams to explain some science concepts

Justi and Gilbert (2000) and Harrison and Treagust (1996) have shown many analyses of the model of atoms which are used in teaching and curriculum resources. Some commonly used diagrams have a nucleus in the centre and orbits outside to represent the electrons, as well as more modern models with electron clouds in which the atom appears like a ball made of very small dots. The curricular model of atoms (orbit shape) and the model of atoms which scientists see through the modern technology (cloud of electrons in a sphere); the effective use of both types can be explained to students for developing a gradual concept attainment with a possibility of profound understanding. In this context, our explanatory understanding has to include explanatory sentences, explanatory diagrams, explanatory discourse and explanatory interaction models (cf. Qadeer, 2013).

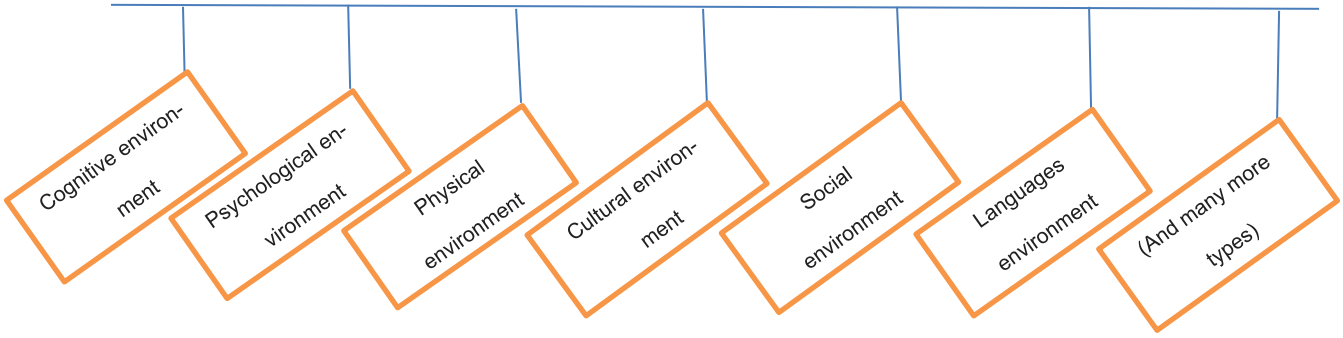
2.5 Multiple factors influencing our understanding of environment factors

The concept attainment about environmental issues and climate change is not just a matter of conveying our ideas; there are many inner and outer interaction frames that influence our profound understanding. Taking a positive action for climate change is also related to many visible and invisible frames of various forms of environments. How we make our opinions about climate change? Marc J. Stern has compared many theories of social science and vigorously explained some challenges attached to it. An important result explained is about considering the knowledge bases in the minds of people and the cultural commitments which play a role. Stern (2018) remarks:

> Despite what many people think, scientific facts don't change people's minds when cultural commitments are in play. In multiple studies, researchers have found that increasing scientific knowledge is not consistently linked to the acceptance of the existence of environmental risks (p.81).

One possible way of looking at our multiple forms of environments is considering physical environment, cognitive environment, social environment, language environment and other forms. There are many ways to extend this thinking and compare multiple factors which possibly play a role in our profound understanding.

Figure 1. Examples of various forms of environment



3 Data analysis

In order to analyse the reflections given by a variety of population, on how they view climate change and environment education in terms of effective learning, language use, curriculum design and concept attainment, a survey was used. The background of the development of the questionnaire is based on some research studies. To develop the survey questionnaire, some previous research studies were also the focus of it. This includes, the research studies related to the use of language about the climate change (cf. Hassol, 2023), conveying the ideas of science for clear understanding (cf. Duit and Haeussler, 1992), science education challenges of language use (cf. Gould, 2003), multilingual factors in the curriculum resources (cf. Stein-Smith, 2016), the application of social science theory for environmental sustainability (cf. Stern, 2018)**.** The survey questions reflect a range of participants from various backgrounds. This step is useful to make this research a reflection of a diverse population.

In this survey 52 respondents (n=52) have given their feedback on 10 questions, which covers a variety of topics.

3.1 The main trends from the survey results

The questions asked in the survey and the responses reflecting the main theme were as follows.

- Question number 1; how important is it to teach about environment protection and climate change? (On a scale from 1 to 10, please select a number)

The responses show 63.5% of the respondents checked the scale to point number 10. This shows majority considers environment protection as an important issue.

- Question number 2; When you were in school, from your memories, please indicate the emphasis made in your school curriculum about the topic of environment protection and climate change.

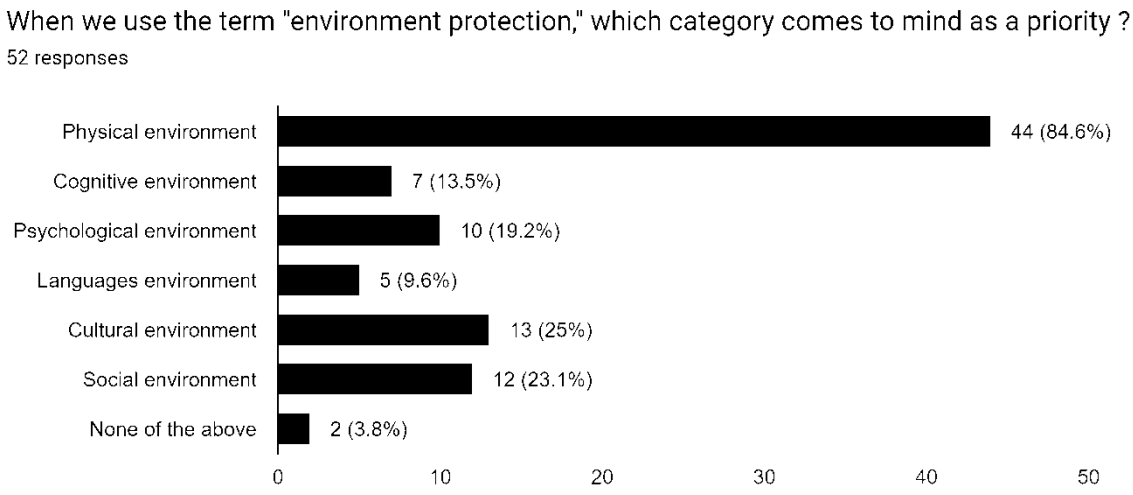
The respondents indicate 25% found it was average, 21.2% found it was low and 40.4% found it was very low.

- Question number 3; in our current curriculum on environment protection and climate change, what changes would you recommend?

The responses provided the following replies: 36.5% considers curriculum content is not strong enough to include the relevant information as well as the time allocation to teach this topic is not enough. The shortage of curriculum resources is reported by 26.9 % of the population. It is notable to see 38.5 % have responded misinformation & misconceptions makes it difficult to convey the idea of environment protection. Learning resources availability in various languages is reported by 25 % of the respondents.

- Question 4; when we use the term "environment protection," which category comes to mind as a priority? The response are as follows.

Figure 2. Survey responses on various forms of environment



- Question number 5; what is the meaning of climate change that comes to mind?

From the survey it is concluded that 38.5% find that it refers to any type of change in climate, 13.5% responded a change is better so the climate change is helpful. A large percentage of the population finds that climate is getting disrupted as it is responded by 44.2% of the population.

- Question number 6; do you think the terminology being used to communicate the ideas about environment protection and climate change is not reflecting a clear sense to the general public?

The responses show that 23.1% strongly agree to this statement, 34.6% agree, and 26.9% are in the not sure category.

- Question number 7; do you consider there is a gap between how scientists understand a term about the environment and how the public understands that term?

From the survey respondents, 48.1% strongly agree, while 42.3% agree to this statement.

- Question number 8; multilingualism and environment education: Do you find environmental education resources are available in various languages to reach the students all over the world?

Respondents were given an opportunity to select a number on a scale from 1 to 10, from 0 the least to 10 the highest. The number 5 on the scale which is in the middle; 36.5% selected that point, and 17.3% selected point number 4 on the scale, 11.5% selected number 1 on the scale.

- Question number 9; climate science communication and environment awareness education can reach the students of all countries if it is available in various languages.

Respondents were given an opportunity to select a number on a scale from 1 to 10 from 0 the least to 10 the highest. From the responses it is concluded that 28.8% selected the highest level, point number 10 on the scale, 11.5% selected point number 9 and 23.1% selected point number 8 on the scale.

- Question number 10; if any success is achieved in the environment protection and climate change efforts; is it effectively conveyed to the general public to motivate them for the next steps; what do you think?

Respondents were given an opportunity to select a number on a scale from 1 to 10, from 0 the least to 10 the highest. The responses of the survey show that 23.1% strongly agree, 30.8% agree, 13.5% not sure and 28.8% disagree

4 Discussion

The survey questions included a variety of parameters to explore the views of the respondents on effective learning, language use, curriculum design and concept attainment.

The survey results show, the majority of the respondents find it is important to teach about environment education and climate change. From the comments of the respondents, it is also further highlighted as an alarming issue, teaching on this topic has to start from the very early years of learning and despite many efforts made the lack of understanding exists on this issue. The majority of the respondents also recall from their time in school that it was not highly emphasized in their school curriculum. This trend indicates the critical change in our climate has prompted the learning of this issue to a relatively higher level. It is notable that 36.5% respondents find the curriculum content is not strong enough to include the relevant information and the time allocation is not enough. The shortage of teaching resources is also an

issue which is reflected by a quarter of the respondents. The role of misinformation and misconceptions is also a concern that emerges from the feedback of the survey. It is notable to see that 38.5% of the respondents find misinformation & misconceptions makes it difficult to convey the idea of environment protection. In the recent years this issue is highlighted through many lenses. The need of multilingual resources is indicated by 25% of the survey participants.

A topic which is not very commonly explored in our surveys is about exploring our views on various forms of environment, such as physical environment, cognitive environment, psychological environment, languages environment, cultural environment and social environment. In this survey a question reflects the majority of the respondents (84.6%) find the category of physical environment comes to mind as a priority when the term environment protection is used. Cultural environment comes to mind reported by 25%, followed by social environment (23.1%). Cognitive environment is also a very important aspect, this is reflected by 13.4% which is a relatively lesser number of the participants.

As Hassol (2023) has compared the effects of changing the language and finding the meanings made about climate change, one example is the word itself: climate change. In the survey a question was given about the meaning of climate change that comes to mind. The survey participants indicate that 38.5% find it means any type of change in climate, 13.5 % find that a change is better, so the climate change is helpful, 44.2% find that they find it as climate is getting disrupted. The survey results show the need to use an effective language to convey the idea behind the term climate change. This finding can also help to apply the meaning making process in the future learning resources development and using these terms in the educational forums and media.

In the survey a question included about the terminology being used to communicate the ideas about environment protection to reflect a clear sense. The majority finds it is not being reflected to make a clear sense, as 23.1% strongly agree, while 34.6% agree. This result also reinforces the use of effective language to make profound understanding which may relatively improve communication at various levels of the learners.

The use of terms about environment; the understanding by the scientists and the understanding by the public, this survey response is an indicator of the view of the survey participants to find pathways to fill this gap. The majority of the survey participants finds there is a gap between the understanding of the terminology of

environment, as it is seen by the scientists and as it is seen by the public. From the survey it is discovered 48.1% strongly agree to it and 42.3% agree to the notion of gap in understanding the terms.

From the survey it is indicated that on the scale from 1 to 10 (one the lowest and ten the highest point), 36.5% of the participants find this at the middle point of 5 that the multilingual resources are available. On point 4 of the scale indicate 17.3% and on point number 1 of the scale 11.5%. The highest point on the scale was 10, on which only 3.8% have marked.

From the survey it is also reflected that 28.8% of the participants checked point number 10 on the scale to find the usefulness of the availability of multilingual communication to understand information on climate change in various countries.

In a number of studies (cf. Stein-Smith, 2016) it is also indicated that the need to develop multilingual resources is obvious for many countries.

To respond to this question, if any success is achieved in the environment protection and climate change efforts, does it help to communicate to the public to motivate them. The majority is in favour of it as 23.1% strongly agree, 30.8% agree on this. On the other hand, 28.8% of the participants also disagree to it.

4.1 Some outcomes from the survey and comparing with the research question

A comparison of the research question and the feedback of the survey participants highlights some important findings. These comparisons provide some possible answers to the research question. Some aspects are highlighted below.

The need is very high to teach about environmental education and climate change using effective communication for concept attainment, use of language with clear meanings, use of multilingual resources, multiple forms of the concept, bridging the gap between the understanding of scientists and the learners. It can be noted that the term climate change can be very confusing for some people, as it is indicated from the results of the survey, climate change may refer to any change, for some people the word change may give another connotation. This survey also highlighted certain needs to consider developing an effective approach to teach about climate awareness and environment education. Some aspects of environment education can be inferred from the survey to apply them in the learning resources. Based on such needs some possible approaches can include; the use of effective language, conveying clear concepts (language and diagrams), multilingual needs in a global society,

the need to develop learning resources which incorporate effective tools. It can also be developing learning resources with multilingual forms by incorporating the nature of science. There is a need to develop learning resources for the nature of environment education, nature of climate awareness education and multiple use of explanatory understanding.

further studies will be needed to analyze the outcomes for some specific curriculum needs at various levels. The use of multiple forms of the concept of environment and developing the use of effective language for communication requires further research at various levels. The use of such environment related terminology has to be made common for everyone to improve our general understanding. Research is also needed to develop explanatory understanding tools with comprehensive meaningful strategies for curriculum development. As the field of artificial intelligence (AI) is expanding with some new dimensions for education and concept formation, perhaps it will be useful to use citizen science (CS) and citizen education science (CES) in some form along with artificial intelligence (AI). This interdisciplinary approach can also open doors to start a think tank to constantly enrich the work of AI in this field.

With the growing need for our climate change education, nature of environmental education, nature of science, and nature of communication has to be seen from multiple lenses of theory, research and practice. A profound and robust learning model for environment education can play an important role to enhance our understanding of many challenges related to climate awareness. In view of the theoretical frames and the experimental frames, there is a possibility to co-create multidimensional frames to develop our understanding and design learning resources.

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Appendix. Survey

(1) How important is it to teach about environment protection and climate change?

[On a scale from 1 to 10, please select a number, from 1 the least to 10 the highest.]
[Any comments]

(2) When you were in school, from your memories, please indicate the emphasis made in your school curriculum about the topic of environment protection and climate change

Very high / High / Average / Low / Very low /
No answer
[Any comments]

(3) In our current curriculum on environment protection and climate change, what changes would you recommend?

(Check all that apply)
(a) curriculum content is not strong enough to include the relevant information
(b) the time allocation to teach this topic is not enough
(c) there is severe shortage of teaching resources on this topic
(d) Misinformation & misconceptions makes it difficult to convey the idea of environment protection
(e) Learning resources are needed in various languages
(f) None of the above
[Any comments]

(4) When we use the term "environment protection," which category comes to mind as a priority?

(Select all that apply)
(a) Physical environment
(b) Cognitive environment
(c) Psychological environment
(d) Languages environment
(e) Cultural environment
(h) Social environment
(i) None of the above
[Any comments]

(5) What is the meaning of climate change that comes to mind?
(a) Any type of change in climate
(b) A change is better so the climate change is helpful
(c) Climate is getting disrupted
(d) Climate change is not a big challenge
(e) None of the above

(6) Do you think the terminology being used to communicate the ideas about environment protection and climate change is not reflecting a clear sense to the general public?

Strongly agree / Agree / Not sure / Disagree / Strongly disagree
No Answer
[Any comments]

(7) Do you consider there is a gap between how scientists understand a term about the environment and how the public understands that term?

Strongly agree / Agree / Not sure / Disagree / Strongly disagree
No Answer
[Any comments]

(8) Multilingualism and environment education: Do you find environmental education resources are available in various languages to reach the students all over the world?

[On a scale from 1 to 10, please select a number, from 0 the least to 10 the highest]

(9) Climate science communication and environment awareness education can reach the students of all countries if it is available in various languages.

[on a scale from 1 to 10, please select a number from 0 the least to 10 the highest]
[Any comments]

(10) If any success is achieved in the environment protection and climate change efforts; is it effectively conveyed to the general public to motivate them for the next steps; what do you think?

Strongly agree / Agree / Not sure / Disagree / Strongly disagree
No Answer
[Any comments]