



Climate Change Awareness among the Teachers of Higher Secondary Schools

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Climate change has been a global threat, however, promoting awareness of climate change will reduce its risk. The study analyzed awareness on three aspects of climate change—causes, impacts, and mitigation among 90 teachers from three high schools, selected using stratified random sampling. We identified a total of 15 statements or variables from each of the causes, impacts, and mitigation to study the teacher's awareness of climate change. We found that teachers have a medium level of awareness, being more aware of impacts than causes and mitigation of climate change. Three factors—teaching field, education level, and seminar attendance have significantly influenced the teachers' awareness level on climate change. The result suggests that upgrading education, incorporating environmental studies in educational curriculum, and promoting seminar and workshop on environmental issues increases awareness on climate change.

Keywords: Awareness; climate change; education; teachers; seminar; teaching field.

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1. INTRODUCTION

The bodies of the scientific community, scientists, and academics have proven that climate change is real and happening. Climate change is a widespread global issue; however, awareness and perception of climate change including causes, impacts, mitigation and adaptation vary across the world [1-3]. Studies have shown that developed countries are more aware of climate change than developing country [4]. Despite high vulnerability to the impacts of climate change, developing countries are still unaware [5]. Besides, uneven distribution of awareness on climate change across regions, individual perception is affected by cultural, national, and geographic factors [6-7] therefore, assessing awareness factors should be country-specific [4]. The awareness and perception of climate change are also based on experience and physical observation [8-9], psychological [10], social and cultural [11] variables. Identifying these factors and variables is indispensable, however, which takes a bigger role or who all are involved in creating awareness is more significant. Several studies have suggested that climate change education is essential for creating awareness on climate change [12-14], and its integration in school curriculum will disseminate information to a wider audience through teachers [15] therefore, understanding teacher's awareness is crucial in the first place because several studies have found teacher's low level of awareness and misunderstanding on climate change [16-19] that hinders the knowledge transfer and information sharing. The knowledge on climate change has been the predictor of pro-environmental behaviour in the general public including in students [20- 22].

One of the emphases has been on creating awareness on climate change on a par with building community capacity for mitigation and adaptation strategies [23] [9]. In doing so, many countries have focused on the pre-service teacher (PST) education for climate change to enable future policy makers including students to be informed through climate literacy [24]. However, relatively little study has explored awareness and understanding of climate change through the educational curriculum. It is also important to study awareness on individual or group level on all the aspects of climate change; causes, impacts, mitigation, and adaptation, so awareness variation on this individual aspect can be identified and improve awareness through strategic solutions. In a way, individual predictors

can also be defined and promote to enhance awareness. In essence, identifying the contributing factors is a central theme to create and augment the awareness of climate change.

Here, we assessed the climate change awareness on causes, impacts and mitigation among high school teachers with the fact that teachers are fundamental in creating awareness among students, thereby securing a better future of the world. Teachers can provide a vital link in the delivery of environmental knowledge and create awareness on climate change [25]. We used qualitative data to assess teachers' awareness and also studied several factors that are significantly affecting their awareness of climate change. We selected five statements for each of the causes, impacts, and mitigation to assess the individual's awareness of each of the statements and also, awareness on summative score to assess overall awareness among teachers of three high schools. The statements were selected based on both local and global contexts, so teachers' awareness was assessed on both global and local levels.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted among the teachers of three higher secondary schools (HSS) in Punakha-Wangdue valley in Bhutan. Punakha lies at 27°41'60.00" N and 89°50'60.00" E and Wangdue at 27° 27' 20.2284" N and 90° 4' 28.8372" E respectively. The study area covers a *Gewog* (sub-district) each from the two *Dzongkhags* (Districts). The schools sampled were Punakha Central School and Ugyen Academy HSS located at Guma *Gewog* in Punakha *Dzongkhag* and Bajothang HSS at Thedtsho *Gewog* in Wangduephodrang *Dzongkhag*. The reason to choose these areas for the study was based on the fact that these areas are most vulnerable to climate change. The area is most prone to the Glacial Lake Outburst Flood (GLOF) which would result from a sudden outbreak of Thothormi Lake which is strongly related to the effect of climate change. The most destructive GLOF event occurred in 1994 costing human and animal lives, economic and property loss including washing off fertile lands. Today, a valley is still vulnerable to climate change through mitigation and adaptation measures are taken into place. One of the country's biggest hydro power- Punatshangchu-I and II is installed in this valley which solely

depends on snow-fed rivers and summer rainfall. Any increase of temperature and erratic rainfall will hugely affect the hydropower project. A dry spell in winter that facilitates forest fire and the flood and erosion in summer in the region is also linked to climate change.

2.2 Sampling Technique

The study used a stratified random sampling method to select 90 respondents from three HSSs within the Punakha-Wangdue valley. A structured questionnaire was used to collect data. The respondents were well briefed about the objectives of the research and distributed the questionnaire to each respondent to personally tick the responses given in the questionnaire. The questionnaire was framed based on the Five Likert scale responses. The study recorded a response rate of 100%. The questionnaire included factors influencing awareness including gender, age, subject teaching, education, seminar attendance and year served in teaching in the region and climate change awareness based on causes, effects, and mitigation (Tables 1 and 2).

2.3 Awareness Level Calculation

The awareness level scale was developed according to Ochieng & Koske [2] however, we modified it with regards to the scope of our study. The awareness scale was developed based on the three aspects of climate change—causes, mitigation, and impacts with five potential statements or variables of each aspect (Table 1). In total, 15 variables were studied. Each of the variable were assigned with five response Likert scale (1 = strongly disagree, 2 = disagree, 3 = I don't know, 4 = agree, and 5 = strongly agree). The strongly disagree and disagree are negative response and strongly agree and agree are positive responses, while I don't know is neutral at 3 in the scale. The overall awareness level towards climate change was assessed based on these 15 variables each consisting of 5 Likert scale responses making 75 Likert scale responses in total (Fig. 2). Therefore, the scale of awareness level is the summative score of the responses from each variable. The awareness scale ranges from 15 to 75.

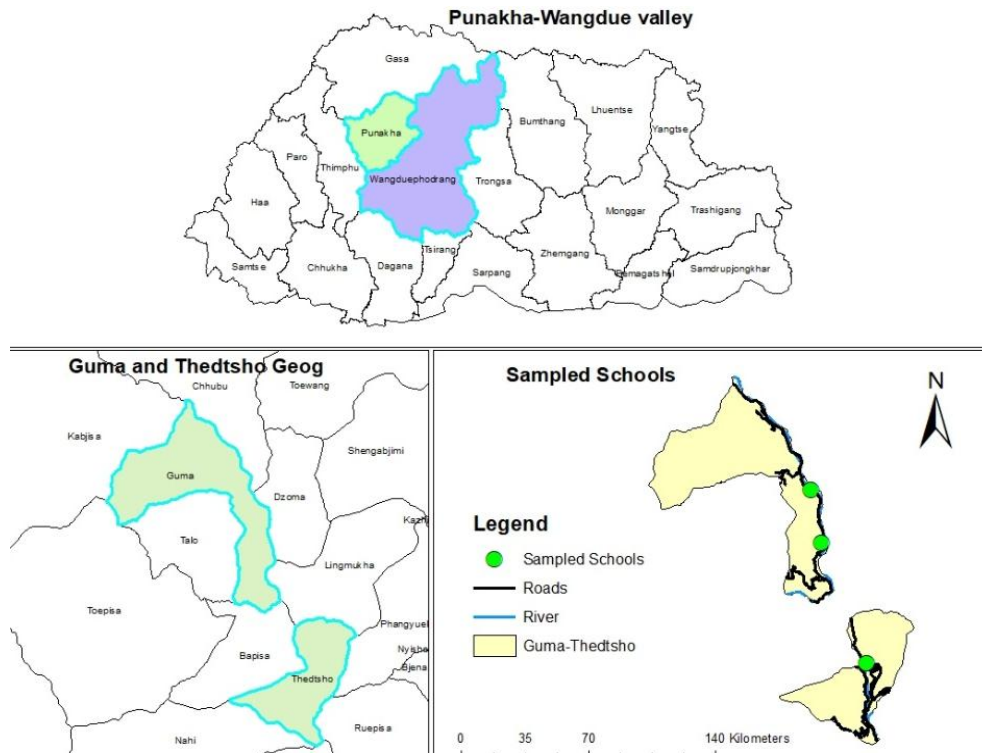


Fig. 1. Map showing study area and sampled schools in Bhutan

It was expected that a respondent who scored 5 in all the 15 items would have a composite awareness score of 75 while one who scored 1 in all the 15 items would have a composite awareness score of 15. Hence, a composite awareness scale ranging from 15 to 75 was designed.

Low level of awareness (15-30): Teachers in this category remained negative to the positive statements and positive to the negative statements. Respondents who fell in this category were considered unaware of climate change.

Medium level of awareness (31-60): Teachers in this category had mixed responses in either direction of the statements. Respondents who fell in this category were considered medium-level aware of climate change.

High level of awareness (61-75): Teachers remained positive to the positive statements and negative to the negative statements. Respondents who fell in this category were considered highly aware of climate change.

2.4 Analysis

Firstly, the reliability of the five responses Likert scale was tested and proven with Cronbach's Alpha of 0.859, which is considered good according to [26] rule of thumb. Secondly,

awareness level calculated from causes, impacts, and mitigations was tested using One-Way ANOVA at a 95% confidence interval. Mean of awareness level was used as the dependent variable, while gender, age, education level, teaching field, seminar attendance and teaching experience in the region were used as independent variables. The independent variables were selected as factors for predicting teachers' awareness level. Each variable or statement of each of causes, impact, and mitigation of climate was also determined for teacher's awareness level. Thirdly, the effect size for each factor was calculated (effect size, $\eta^2 = \text{sum of square}/\text{total sum of square}$) to determine their percentage of contribution to creating climate change awareness on teachers.

3. RESULTS

3.1 Aggregate Awareness on Climate Change

The teachers of three high schools have a medium level ($M=3.28\pm0.09$ or 49.2 on the awareness scale) of awareness on climate change. Of the three aspects of climate change, teachers are more aware of impact ($M=3.37\pm0.87$) than causes ($M=3.24\pm0.93$) and mitigations ($M=3.23\pm0.91$) as shown in Fig. 3. Awareness level was significantly different at $p < 0.05$ at 95% confidence interval.

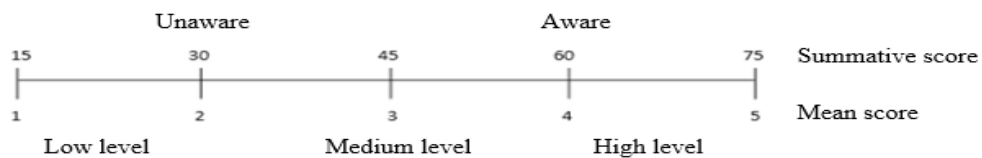


Fig. 2. A composite awareness scale

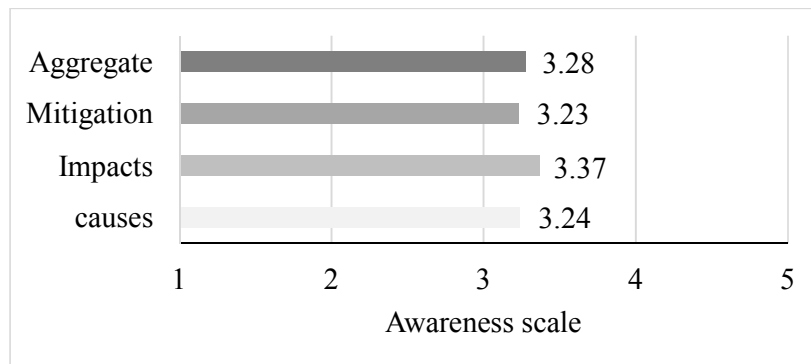


Fig. 3. Aggregate awareness and awareness scores on causes, impacts, and mitigation

3.2 Awareness on Causes, Impacts and Mitigation of Climate Change

The teachers' awareness of the causes of climate change shows a significant difference at $p < 0.05$. Specifically, teachers are aware that 'cutting down of the trees aggravates climate change' with about 46.7 percent agree and 43.3 percent strongly agree and only 1.1 percent disagree and strongly disagree with the statement (Fig. 4 (a)). For the same statement, teachers scored the highest mean score of all the statements in the awareness level as indicated in Table 2. While, 'combustion of fossil fuels' is also perceived as the potential cause of climate change with a mean score more than average, 42.2 percent of teachers agree with the statement, while 34.4 percent being neutral in the awareness level. Teachers' score for the other statements for the causes of climate change was below average (>3) mostly supporting the 'I don't know' response. These statements are 'air pollution from industries, poor agricultural practices, and waste generation and poor management of waste' as indicated in Table 1.

From five statements selected for the impact of climate change, only 'climate change leads to increasing in sea levels' scored below average ($M=2.26 \pm 1.06$) in the awareness level (Table. 1). However, 44.4 percent of teachers still agree that this statement is the impact of climate change. Teachers are more aware about 'climate change

is associated with the increased frequencies of droughts and floods, land degradation and desertification, an outbreak of new diseases and shrinkages of freshwater resources' scoring mean awareness level above average. Except 'climate change is associated with the increased frequencies of droughts and floods' with 42.2 percent of teachers being neutral or 'I don't know', more than 40 percent of the teachers agreed that the other four identified statements are the potential impact of climate change (Fig. 4(b)). All five statements are significant at $P < 0.05$ at a 95 percent confidence interval.

The potential ways of mitigating climate change as teachers are aware are through 'planting trees and waste management through reusing, reducing, and recycling' than 'organic farming, relying on renewable energy sources' instead of 'fossil fuels and minimizing air pollution from industries' (Table 1). The earlier two are above the mean score while the later three are below the mean score as an indicative awareness of the teachers. More than 60 percent and about 35.6 percent of teachers agreed that planting trees and reusing, reducing, and recycling waste can help mitigate climate change, respectively. While on the other three statements, the majority of teachers claimed that they are neutral or 'I don't know' level of awareness for the mitigation of climate change (Fig. 4(c)). All the variables were tested at a 95 percent confidence interval and were significantly different at $p < 0.05$.



Fig. 4. Awareness percentage of teachers showing each variables (statements) with each response option. a) causes, b) impacts, and c) mitigations. The full form of statements reflected as an abbreviated code such as C1, C2... I1, I2... and M1, M2.... are shown in table 1.

3.3 Factors Influencing Awareness of Climate Change

Teachers' awareness of climate change is influenced by the teaching field, education level,

and workshop or seminar attendance, however, gender, age, and teaching experience in the region did not make a significant difference in the teacher's level of climate change awareness (Table 3).

Table 1. Mean, standard deviation, and significance of the statements of causes, impacts, and mitigations of climate change

Code used in figure	Causes	M \pm SD & P
C1	Combustion of fossil fuels cause climate change	3.32 \pm .98*
C2	Cutting down of trees can cause climate Change	4.30 \pm .76**
C3	Climate change is caused by air pollution from industries	2.99 \pm .97**
C4	Climate change is caused by poor agricultural practices	2.63 \pm 1.07*
C5	Increasing waste generation and poor management caused climate change	2.98 \pm .86*
Impacts		
I1	Climate Change is associated with the increased frequencies of droughts and floods	3.29 \pm .88*
I2	Climate Change can lead to land degradation and desertification	3.77 \pm .88*
I3	Climate Change can cause an outbreak of new diseases	3.82 \pm .79*
I4	Climate Change leads to an increase in sea levels	2.26 \pm 1.06*
I5	Climate Change leads to the shrinking of freshwater sources (Streams, Lakes and Spring)	3.69 \pm .76*
Mitigations		
M1	We can mitigate climate change by planting more trees	3.84 \pm .69*
M2	We can mitigate climate change through organic farming	2.81 \pm .98**
M3	Reuse, Reduce and Recycling waste can help mitigate climate change	3.62 \pm .89*
M4	We can mitigate climate change by using renewable energy sources instead of fossil fuel	2.97 \pm 1.02*
M5	We can mitigate climate change by minimizing air pollution from industries	2.92 \pm .99*

** $P=0.002$, * $P=0.000$, both are significant at 95% CI

Table 2. Demographic percentage of teachers on factors

Characteristics	Response	Number (n=90) (%)
Gender	Male	47 (52.2)
	Female	43 (47.8)
Age	18-25	12 (13.3)
	26-35	43 (47.8)
	36-45	25 (27.8)
	46-55	10 (11.1)
	Masters	14 (15.6)
Education	Bachelors	70 (77.8)
	Diploma	3 (3.3)
	Certificate	1 (1.1)
	Others	2 (2.2)
Teaching field	Science	31 (34.4)
	Arts	37 (41.1)
Teaching experience in the region	Commerce	22 (24.4)
	1-5 years	30 (33.3)
	6-10 years	34 (37.8)
	Above 10 years	26 (28.9)
Seminar attendance	More than one time	12 (13.3)
	Once	49 (54.4)
	Not at all	29 (32.2)

The three common teaching fields from three schools were identified as science, arts, and commerce as shown in Table 2. The One-way ANOVA tested at 95 percent confidence interval was significant for the teaching field, $F(2, 87) = 18.582$, $P < 0.05$ as indicated in Table 3. The effect size for the teaching field ($\eta^2 = 0.30$) revealed that strong differences are accounting for 30 variances of teachers' awareness level on climate change.

We perceived that the education of teachers also makes a significant contribution to the understanding of climate change. Teachers had five categories of education level; masters, bachelor, diploma, certificate, and others. The majority (77.8 percent) had a bachelor's degree. The education level made a significant difference in teachers' awareness level of climate change, $F(4, 85) = 3.045$, $P < 0.05$ at 95 percent confidence interval. The effect size for the teaching field ($\eta^2 = 0.13$) revealed that strong differences are accounting for 13 variances of teachers' awareness level on climate change.

In line with the seminar attendance, the survey found that more than half (54.4) of the teachers attended the seminar at least once and about 13.3 percent attended more than once. The seminar attendance includes workshops related to climate change or at least environmental issues. It could be either conducted in the school or by external advocators. The seminar attendance made a significant difference in the awareness of climate change $F(1, 88) = 5.848$,

$P < 0.05$ as indicated in Table 3. The effect size for seminar attendance ($\eta^2 = 0.14$) revealed that there is a strong difference accounting for 14 percent of the variance of the awareness level on climate change respectively.

4. DISCUSSION

The study found that the teachers have a medium level of awareness on climate change is more aware of an impact than causes and mitigations of climate change. Their level of awareness is significantly influenced by the teaching field, education level, and seminar attendance. This is backed by the evidence that low awareness level [15] [27] was underpinned by inaccessible information and lack of sensitization on climate change.

The medium level of awareness was indeed assessed based on the fact that all the identified statements of the aspects of climate change were considered at both local and global themes, which could, at least, led to a fair understanding of climate change. Bringing at both local and global context was crucial to avoid overlooking of understanding of climate change either skewed to only local or global effects. This could also mean to testing the awareness of teachers not confined to the only local context. On a comparative awareness score, teachers are more aware of impacts than causes and mitigation. All four statements of impacts scored above average or medium awareness scale,

Table 3. Factors influencing teacher's awareness of climate change

Factors		SS	df	η^2	F	Sig.
Gender	Between Groups	.003	1		.010	.919
	Within Groups	25.770	88	0.00		
	Total	25.773	89			
Age	Between Groups	1.098	3		1.276	.288
	Within Groups	24.675	86	0.04		
	Total	25.773	89			
Teaching field	Between Groups	7.714	2		18.582	.000
	Within Groups	18.059	87	0.30		
	Total	25.773	89			
Education	Between Groups	3.230	4		3.045	.021
	Within Groups	22.543	85	0.13		
	Total	25.773	89			
Teaching experience in the region	Between Groups	.471	2	0.02	.810	.448
	Within Groups	25.302	87			
	Total	25.773	89			
Workshop	Between Groups	3.580	2		7.016	.001
	Within Groups	22.194	87	0.14		
	Total	25.773	89			

SS=sum of squares, effect size (η^2) = SS/Total SS

While only two statements from causes and mitigation scored above average resulting in lower awareness (Fig. 1). This demonstrates that teachers' differences of understanding of three aspects of climate change do exist. However, studies have shown that climate awareness differs across the globe with different predictors [1] and at the same time, misconception among causes, impacts, mitigation and adaptation arises [28] [29]. Since the study only used five potential aspects of each causes, impacts, and mitigations, teachers' awareness is linked around only those aspects, nevertheless, the awareness was assessed based on the summative score.

On the response level i.e. the indication of how much teachers are aware or accept each statement such as 'strongly agree, agree, I don't know, strongly disagree and disagree', teachers scored more percentage on 'agree' both on causes and impacts, while indicating more 'I don't know or neutral on mitigations. It is with the fact that teachers are well aware of what causes of climate change and what will be the impacts. However, they are fairly aware of what are the mitigations for climate change limited by their understanding in mitigation aspects.

Specifically, cutting down of the trees is regarded as the potential cause of climate with nearly scoring the highest level of awareness (4.3 in the summative awareness scale) and similarly planting of trees substantially mitigate the climate change (3.8 in the summative awareness score), which these two are the highest score in the awareness scale. These results point to the fact that teachers understood climate change based on their day-to-day interaction with the environment; Bhutan is intact with seventy percent of forest cover [30] destruction of this forest would add up detrimental effects of climate change and regard as important to conserve for mitigation. The lowest awareness score was on 'climate change leads to increase in sea level rise' (2.26 in the summative awareness score) indicating that teachers' understanding of global aspects of climate change remains abstract in their knowledge of climate change.

Identification of the contributing factors for awareness is indispensable to promote awareness because on what level of awareness teachers are at present will remain the same. To this, though teaching field, education level, and seminar affected the level of awareness among the high school teachers as evidenced from the current study, conducting seminar and workshop

would be double edge advantages accounting for its convenience for creating awareness. The workshop has shown a positive impact on teachers' awareness on climate change [31]. In Bhutan, no prior studies were conducted to indicate teachers' awareness, however, policy makers are aware, though, they have novice knowledge on climate change (ICIMOD, 2016) indicating that the knowledge gap still exists among policy makers.

The educational curriculum of Bhutan incorporates environmental science in middle and higher secondary, specifically in the art stream in the high school, which helps to provide an understanding of environmental issues to both teachers and students. This has significantly led to creating awareness among teachers who have taught environmental subjects. This is evident from the fact that 41.1 percent of teachers are teaching the art stream. The teachers who teach subjects related to weather and climate are more likely to have come across information on climate change. Sharma [32] pointed out science education as a significant factor of societal response to climate change. The educational curriculum has become a platform for communication and disseminating information among teachers and students. Promoting basic education and climate literacy is vital to create awareness and acquire public climate action [33] [4], which can be achieved through incorporating environmental the subject in the educational curriculum (NEC, 2011; Rahman et al., 2014).

The education level of the teachers has significantly influenced the awareness of climate change. Previous studies [34] [[9] have also shown that education level is an important predictor of climate change awareness and perceptions. A majority (77.8 percent) of interviewed teachers hold a bachelors and about 15.6 percent are with master's background. Though, the educational background of the teachers has influenced the awareness level, however, this necessarily does not depict their knowledge on climate change. Moreover, the educational background also depends on the course they have studied, which this study did not take into consideration. In essence, greater educational attainment enables partisans to develop stronger arguments to support their ideological responses to the issue [35].

5. CONCLUSION

The teachers' aggregate medium level of awareness on climate change defined by the

summative score of causes, impacts, and mitigations show teachers are relatively higher awareness about impacts than causes and mitigations. This depicts that awareness must be promoted on causes and mitigations as these are two main aspects to reduce climate change, at large. Teachers' awareness of climate change is essential to create awareness not only for themselves but also to students which are the future leaders. For this achievement, climate change incorporated in educational curriculum, education level, and seminar attendance have been significant predictors, and therefore, these factors must be promoted to increase awareness of climate change.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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