

Health Impacts of Climate Change: Secondary School Teacher's Beliefs and Their Understanding and Teaching Practices in Karachi, Pakistan

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ABSTRACT

Objective: The objective of this cross-sectional study was to investigate the understanding, attitudes, and teaching practices of secondary school teachers in Karachi, Pakistan, regarding global climate change.

Methodology: A representative sample of 603 teachers was selected using a multistage sampling strategy. Data were collected through a standardized questionnaire administered by trained enumerators. The questionnaire assessed teachers' understanding of climate change, perceptions of its impacts, and engagement in environmentally sustainable practices. Demographic information such as age, gender, educational qualifications, marital status, and teaching experience was also collected.

Results: The majority of respondents were female teachers from private schools, below the age of 35, and with less than five years of teaching experience. 89% of the teachers characterized their knowledge of climate change as limited or moderate. Only 11.3% considered their understanding sufficient or comprehensive. Over 80% of the teachers could identify the primary causes of climate change. The study also found a significant awareness of climate change impacts among the teachers, including extreme weather patterns, water scarcity, increased diseases, and elevated sea levels.

Conclusion: The findings of this study indicate a lack of comprehensive knowledge among secondary school teachers in Karachi regarding global climate change. However, there is a high level of awareness about its impacts. These results highlight the need for improved climate literacy and education among teachers, particularly in integrating climate change topics into the curriculum. Effective adaptation and mitigation strategies require a better understanding of context-specific climate challenges.

Key words: Climate Literacy, Teaching Practices, Environmental Awareness, Cross-sectional Study, Secondary Education

Authors' Contribution:

^{1,2}Conception; Literature research; manuscript design and drafting; ^{2,3}Critical analysis and manuscript review; ^{1,3}Data analysis; Manuscript Editing.

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Introduction

Global climate change poses significant threats in the 21st century through rising temperatures, altered precipitation patterns, and increasing extreme weather events.¹ According to the

Intergovernmental Panel on Climate Change, global warming exceeding 1.5°C from pre-industrial levels will severely impact societies and natural systems. Developing nations are especially vulnerable to the health, economic, and environmental costs of

climate change.² Amongst the countries most at risk is Pakistan. Located in a highly climate-sensitive region, Pakistan already experiences impacts including heatwaves over 1°C higher than historical levels.^{3,4} Its largest city, Karachi, faces intensifying threats due to rapid urbanization and geographic features.⁵ Situated along the Arabian Sea with low-lying coastal areas, Karachi is exposed to risks from cyclones and encroaching seas exacerbated by sea level rise.⁶ The region additionally grapples with water scarcity from diminished glaciers and rainfall variability further disturbed by climate change.⁷ Understanding context-specific climate challenges is crucial for effective adaptation and mitigation strategies. Education plays a pivotal role through disseminating climate science and cultivating solutions-oriented thinking, especially amongst youth who will drive future decision-making.⁸ Despite high climate vulnerability, there remains a lack of climate literacy in Pakistan, including at sub-national levels.⁹ Previous work found climate topics integrated inconsistently into South Asian curricula, with teacher understanding still nascent.¹⁰ In 2012, Pakistan's Ministry of Climate Change recommended mainstreaming climate education across grade levels¹¹, yet implementation efficacy is unclear. The present study investigates Karachi secondary school teachers' climate change knowledge, attitudes, and self-reported behaviors.

Methodology

This cross-sectional study was conducted from February 2014 to May 2016. The Aga Khan University's Ethics Review Committee in Karachi provided ethical approval for the study. A sample size of 635 participants was calculated to ensure a representative sample and adequate power for statistical analysis. Given the scarcity of existing literature on Pakistani teachers' perspectives on climate change, we hypothesized a 50% baseline awareness. With a 95% confidence interval and a $\pm 5\%$ margin of error, the initial sample size was

calculated to include 385 educators. Considering an anticipated 10% non-response rate and a design effect of 1.5, the sample size was adjusted to 635. We employed a multistage sampling strategy to obtain a representative sample of educators from Karachi's varied educational settings. Lists of all public and private secondary schools were obtained from the Board of Intermediate and Secondary Education, Karachi, comprising 789 private and 2,454 government schools. From these schools, we systematically selected a stratified random sample of 100 private and 25 public schools for inclusion in the study. Data were collected using a standardized questionnaire administered by trained enumerators to ensure consistency and accuracy. A field coordinator supervised the data collection process to ensure adherence to study protocols. The questionnaire gathered comprehensive socio-demographic data including age, gender, educational qualifications, marital status, and teaching experience. Educators' understanding of climate change was measured using seven knowledge-based questions. Correct answers were scored as one, and incorrect or uncertain responses scored as zero. The survey further investigated teachers' perceptions of climate change impacts through structured questions evaluating attitudes towards environmental issues and beliefs. Additionally, we explored the extent to which educators engage in and promote environmentally sustainable practices within their schools, such as energy conservation, recycling, water saving, use of public transport, and personal waste reduction. While this study uses a cross-sectional design, this limits our ability to determine causality. Additionally, the self-reported nature of the questionnaire relies on participants' accurate recall and responses

Results

Out of the 635 educators approached, 603 completed surveys were eligible for analysis,

equating to a non-response rate of 5%. The demographic characteristics of the respondents included predominantly female teachers (86.2%), a majority below the age of 35 years (53.9%), from private schools (71.6%), with nearly half married (46.2%), and 43.5% possessing less than five years of teaching experience (Table I).

Variables	Frequency(n)	Percentage (%)
Age		
<35 years	325	53.9%
>35 years	278	46.1%
Sex		
Males	83	13.8%
Females	520	86.2%
Marital Status		
Married	324	53.8%
Unmarried	279	46.2%
Education System		
Public	171	28.4%
Private	432	71.6%
Teaching Experience		
0-5 years	262	43.5%
6-10 years	111	18.4%
11-20 years	112	18.6%
>20 years	118	19.5%

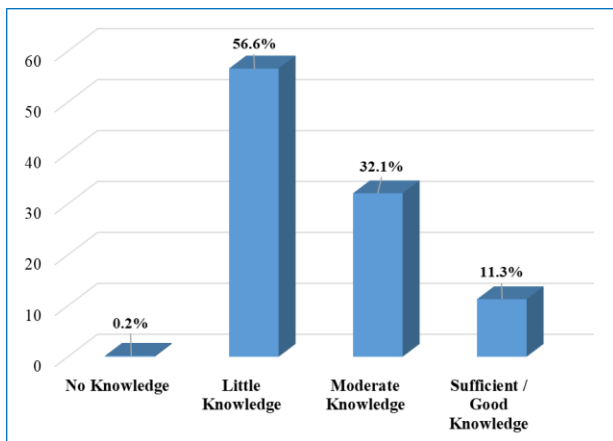


Figure:1 Self-Perceived understanding of climate change among secondary school teachers in Karachi, Pakistan (n=603)

Regarding their understanding of global climate change, 89% of educators characterized their knowledge as either limited or moderate. A near-unanimous consensus (98.8%) recognized it as a significant environmental issue ($p < 0.001$), with only 11.3% feeling their understanding was sufficient or comprehensive (Figure 1).

The data reflects a significant awareness about climate change impacts ($p < 0.001$); over 80% could identify the primary causes (Table II). Moreover, 95% linked climate change to extreme weather patterns ($p = 0.002$), 82% associated it with droughts and water scarcity, and more than 75% connected it to increased diseases, food and agriculture deficits, elevated sea levels, and diminished productivity (Table III), underscoring a detailed perception of diverse effects.

About 54.2% reported concern over impacts, with 42% specifically anxious about local effects. Skepticism prevailed, with 66% doubting authenticity and over half questioning efficacy of individual mitigation. Additionally, 40% were uncertain about educational content on mitigation, and 31% believed modifying children's behavior would have a negligible effect ($p = 0.05$). However, 73.8% identified absence of topics as a hindrance. There was strong agreement on teachers' role in fostering environmental behaviors (95.8%, $p < 0.001$) and need for integration into curricula (97.5%, $p < 0.001$). (Table IV).

Teachers' responses underscored an emphasis on encouraging conservation practices. More than 80% regularly promoted energy (83.5%, $p = 0.02$) and water conservation (80.5%, $p = 0.05$), with nearly 91% endorsing waste reduction. Nonetheless, less attention was given to reducing combustion of natural (49.9%) and fossil fuels (53.9%). Recycling (63.8%) and tree planting (75.5%) were also encouraged. (Table V)

Causes of climate change	Yes	No	Did not answer
Burning mineral fuel play's role in climate change	539 (90.1%)	59 (9.9%)	5 (0.8%)
Burning natural fuel play's role in climate change	485 (81.9%)	107 (18.1%)	11 (1.8%)
Transportation, such as driving a car, bus, or boat plays role in climate change	518 (86.8%)	79 (13.2%)	6 (1.0%)
Industry or factories play role in climate change	558 (93.5%)	39 (6.5%)	6 (1.0%)
Land use/clearing of forests plays role in climate change	555 (94.4%)	33 (5.6%)	15 (2.5%)
Household garbage plays role in climate change	505 (85.0%)	89 (15.0%)	9 (1.5%)

Beliefs regarding climate change	Unlikely	Not Sure	Likely	Did not answer
Extreme changes in weather patterns are caused by climate change	26 (4.3%)	5 (0.8%)	569 (94.8%)	3 (0.5%)
Drought and water shortage are caused by climate change	95 (18.3%)	28 (5.4%)	396 (76.3%)	84 (13.9%)
Significant changes in population size of certain animal species are caused by climate change	88 (14.8%)	9 (1.5%)	499 (83.7%)	7 (1.2%)
Rising sea levels are caused by climate change	106 (18.6%)	29 (5.1%)	436 (76.4%)	32 (5.3%)
Human health, such as increase in sickness and diseases are caused by climate change	17 (2.8%)	4 (0.7%)	580 (96.5%)	2 (0.3%)
Coastal changes, such as an increase in flooding or erosion are caused by climate change	45 (7.6%)	11 (1.9%)	Likely	547 (90.7%)
Decreased production of food by farming or fishing are caused by climate change	96 (16.7%)	29 (5.0%)	451 (78.3%)	27 (4.5%)

Variables	Disagree	Neither	Agree	Did not answer
Climate change is a real problem	197 (32.7%)	8 (1.3%)	394 (65.3%)	4 (0.7%)
Climate change influenced by individual efforts	234 (38.8%)	10 (1.7%)	353 (58.5%)	6 (1.0%)
Teaching about climate change is necessary	526 (87.2%)	7 (1.2%)	68 (11.3%)	2 (0.3%)
Know what to teach about climate change	329 (54.6%)	27 (4.5%)	241 (40.0%)	6 (1.0%)
Changing behavior makes a difference	185 (30.7%)	14 (2.3%)	397 (65.8%)	7 (1.2%)
Lack of topic in curriculum restricts teaching	0 (0.0%)	15 (2.5%)	0 (0.0%)	6 (1.0%)
Teachers responsible for promoting good behavior	13 (2.2%)	12 (2.0%)	576 (95.5%)	2 (0.3%)
Doing everything to teach about climate change	105 (17.4%)	43 (7.1%)	450 (74.6%)	5 (0.8%)
Curriculum does not provide info on climate change	132 (21.9%)	30 (5.0%)	438 (72.6%)	3 (0.5%)
Climate change education should be emphasized	12 (2.0%)	3 (0.5%)	585 (97.0%)	3 (0.5%)

Table V: Secondary school teachers' practices in encouraging students' environmental awareness in Karachi, Pakistan (n=603)

Currently encourage school children to	Never	Sometimes	Often	Did not answer
Save electricity	27 (4.5%)	72 (12%)	502 (83.5%)	2 (0.3%)
Recycle items	69 (11.5%)	149 (24.8%)	384 (63.8%)	1 (0.2%)
Reduce water use	47 (7.8%)	70 (11.6%)	484 (80.5%)	2 (0.3%)
Plant trees	63 (10.5%)	84 (14%)	452 (75.5%)	4 (0.7%)
Decrease the amount of personal garbage or trash	29 (4.9%)	25 (4.3%)	534 (90.8%)	15 (2.5%)
Limit the burning of natural fuels	189 (31.8%)	109 (18.3%)	297 (49.9%)	8 (1.3%)
Limit the burning of fossil fuels	158 (26.5%)	117 (19.6%)	322 (53.9%)	6 (1%)

Teachers exhibited a seemingly paradoxical belief system, where 89.2% acknowledged the significant consequences of climate change ($p < 0.001$), yet 66% questioned the authenticity of climate change itself ($p = 0.005$) and over half doubted the efficacy of individual mitigation efforts ($p = 0.02$). This divergence between recognition of impacts and skepticism towards solutions mirrors patterns observed in other international study ($p = 0.001$). The data points to a need for improved curriculum materials that can help explain climate science and solutions more effectively. Only 26.8% felt existing curricula provided sufficient content on mitigation ($p < 0.001$), highlighting a scope for bolstering curriculum support and resources that would empower teachers to address this skepticism among their students

Discussion

This study examined climate change understanding among secondary school teachers in Karachi, an area not extensively explored. While other research indicated knowledge gaps among educators, teachers here demonstrated basic causal understanding, challenging some prior assumptions. This finding agrees with a study that have shown teachers in various countries have a good general awareness of climate change.^{11, 12} This could be due to similar socio-cultural context of both countries.

However, this result is in contrast with studies from other countries¹⁴ Furthermore, findings also revealed a more complex reality - while recognizing climate change importance, teachers questioned their own expertise. This mirrors findings in Pakistani¹⁵, as well as disparate contexts^{16, 17} and suggests understanding issues may transcend geography. Teachers' beliefs also exhibited nuance. Strongly associating climate change with threats, their perspectives aligned with cross-cultural work. Yet fewer believed individual mitigation mattered, evidencing a potentially common, but subtle skepticism towards personal impact. In our study, awareness and attitudes showed little demographic variation, which is in line with a study from India.¹⁸ However, disproportionate responses prevent conclusive generalization. Larger, diversified sampling addressing this limitation could provide richer insight. Moreover, relying on self-reports versus objective assessments presents a nuanced, not wholly representative understanding of teacher knowledge. Directly examining instructional practices and subsequent student outcomes would offer a particularly valuable perspective. While highlighting gaps prompts calls for enhanced training, knowledge is only one facet of this multidimensional issue. Attitudinal shifts and support for climate communication efforts may also be important. Acknowledging narrow geographical

and sectoral focus, subjective measures, and absence of downstream analysis, opportunities remain to develop an even more textured picture of educator perspectives. Continued rigorous, multi-pronged investigation of how conceptualizations differ between places and over time can better inform policy. Overall, this study presented an initial understanding, while also identifying areas where broader, more comprehensive exploration could further elucidate this complex topic with implications for climate literacy. While the study provides valuable insights, it is not without limitations. Its focus is restricted to Karachi and does not account for potential imbalances in gender and school type among participants. Response bias is also present as some of the participants may have chosen to give answers to certain options/questions. Moreover, it does not directly assess the effectiveness of teaching methods or their impact on student behavior. Future research should aim to address these gaps for a more holistic understanding of climate education's role in environmental stewardship.

Conclusion

This study revealed a significant lack of climate change understanding among secondary teachers in Karachi, regardless of demographics. While national curriculum frameworks advocate including emerging issues like the environment and climate change since 2006, findings indicate more action is needed to close teacher's knowledge gaps.

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