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Climate Change Study: Teachers Perspective

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Abstract: ***This study provides an insightful analysis of the awareness and understanding of climate change among secondary school science teachers in India. It investigates the depth of knowledge, beliefs, and misconceptions about climate change held by educators, a key factor given their role in shaping future generations. Conducted with 310 secondary school science teachers across four categories of schools. Government lower income, government middle income, private middle-income, and private higher income, the research seeks to identify variations in climate change pedagogy influenced by socio-economic factors and school infrastructure. The study evaluates the causes of climate change as perceived by teachers, their factual understanding, interest in attending awareness seminars, and time devoted to teaching this critical topic. Given the increasing enrolment in Indian schools, as highlighted by the Ministry of Statistics and Program Implementations 2016 statistical yearbook, this research is timely in assessing the preparedness of educators in addressing one of the 21st century's most pressing environmental challenges.***

Keywords: Climate Change Awareness, Educator Knowledge, Indian Secondary Schools, Pedagogical Differences, Socio-Economic Influences.

1. Introduction

Climate change has become one of the most serious environmental problems faced in the 21st century threatening public health and food security. Very few people are aware of negative effects of climate change. So far, many studies have taken place to check the level of climate change awareness in general public but no such evaluation has been done for educators of the society.

India has a great history of education since ancient times. According to statistical yearbook 2016 published by „Ministry of Statistics and Program Implementation, India" (MOSPI), the current status of upper primary and secondary schools in India is as follows:

Year	Type of school	Number of schools	Enrolments in school (millions)	Total number of teachers
2013-14	Upper primary	421524	66.5 (32.3 females)	
	Secondary	133542	37.3 (17.6 females)	–
2014-15	Upper primary	425094		
	Secondary	135335	_	602381

We can clearly see that no. of schools as well as no. of enrolments in schools is increasing as compared to previous years. Thus, for such a large learning population, there needs to be proper management of education system as well as sufficient number of effective educators, which is not an easy task.

This study tries to reveal what teachers already know, believe and support as well as their misconceptions about climate change. Further, this study tries to answer following questions:

- What, according to teachers, are the causes of climate change?
- What percentage of teachers actually knows the exact reason for climate change?
- What percentage of teachers is interested in attending Climate change awareness seminars?
- What amount of time do teachers devote, in delivering lectures regarding climate change, per week?

A survey of 310 Secondary School Science teachers was conducted during the course of this project. The survey was done in four types of schools, namely

1) Government lower income schools (Fee range – Rs. 0)
2) Government middle income schools (Fee range – Rs. 0 to Rs. 5000)
3) Private middle-income schools (Fee range – Rs. 5000 to Rs. 15000)
4) Private higher income schools (Fee range – Rs. 15000 and above)

The reasons behind conducting this type of categorised survey are:

1) There might be a difference in pedagogy followed by teachers in different schools. High income level schools may be using advanced technologies, they might have better labs as well as classroom facilities as compared to low-income schools
2) High income schools might differ in strength of faculty also. As they have sufficient number of teachers, personal attention towards students increases. Higher and middle-income schools generally have specific teachers (with subject expertise) for each subject which is not seen in low-income schools.

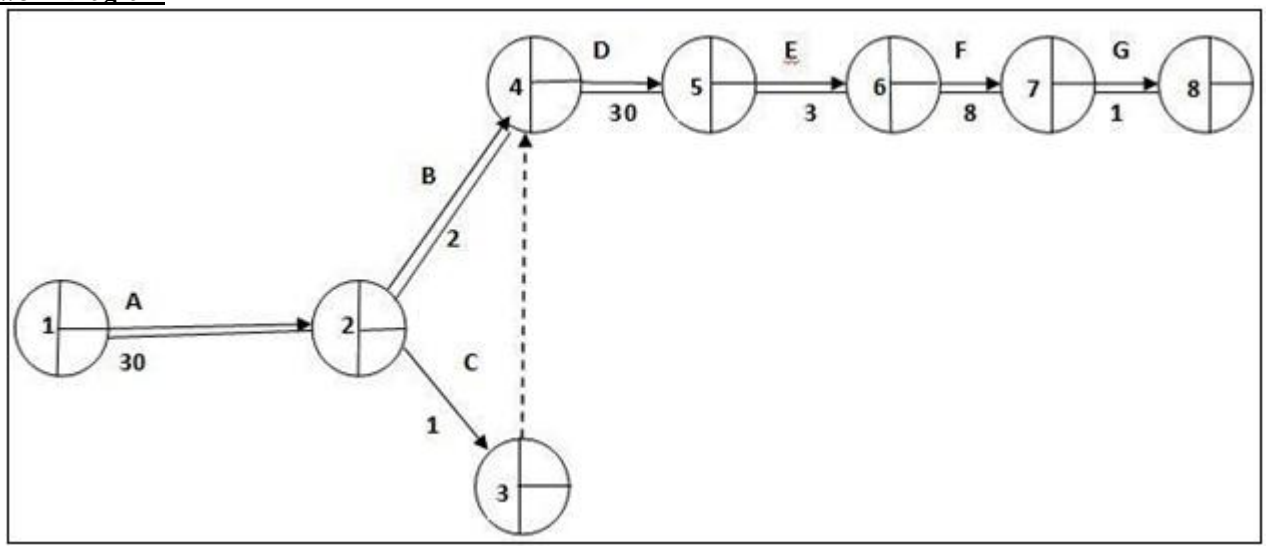
CPM and PERT network

Activity	Description	t_o(days)	t_m(days)	t_p(days)	t_e(days)	Var(days)
A	Preparing Questionnaire	25	30	33	29.67	1.78
B	Selecting Schools	1	2	2	1.83	0.03
C	Printing Questionnaire	1	1	2	1.17	0.03

D	Data Collection	26	30	36	30.33	2.78
E	Data Entry	2	3	5	3.16	0.25
F	Analysis	5	8	10	7.83	0.7
G	Conclusion/Report Writing	1	1	2	1.17	0.03

where, $t_e=[t_o+4(t_m)+t_p]/6$
$Var=[t_p-t_o]^2/36$

Network Diagram



Critical Path Determination

Paths	Duration (Days)
A-B-D-E-F-G	74
A-C-Dummy-D-E- F-G	73

Thus, the critical path is: **A-B-D-E-F-G**

1) Expected length of critical path=74 days.
2) Variance of critical path (V_e) = Var(A)+ Var(B)+ Var(D)+ Var(E)+ Var(F)+ Var(G) = 5.57 days
3) Y: Project duration to find the probability of completion of project by scheduled time T_s(90 days)

i.e. $P[Y \leq T_s]=P[(Y-T_e)/\sqrt{(V_e)} < (T_s- T_e)/ \sqrt{(V_e)}]$
$=P[Z<6.68]$
$=1-P[Z>6.68]$
$=1-0.00$
$=1$

Therefore, the **probability of completing the project within 90 days is 1**.

1) The project duration which will have 95% confidence of completion is,

$P[Z\leq(T_s-T_e/\sqrt{(V_e)})]=0.05$
$P[Z \leq(T_s-74)/(2.36))]=0.05$
$P[Z \leq 1.65]=0.05$
$(T_s– 74)/2.36=1.65$
$T_s=77.894$
$T_s\approx 78$ days

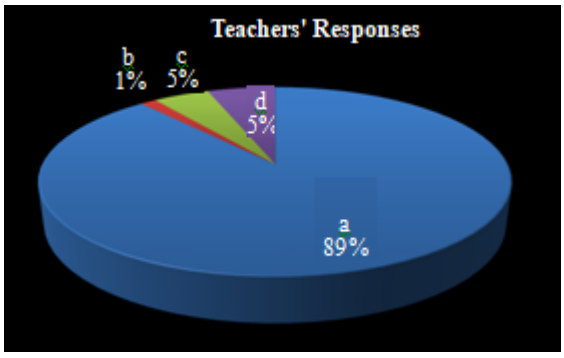
Therefore, **project duration of 78 days will have 95% confidence of completion**.

Diagrammatic Representation of Teachers' responses

Q1. Which of the following comes closer to your own view?

a) Most scientists think that global warming is happening.
b) Most scientists think that global warming is not happening.
c) There is a lot of disagreement among scientists whether or not global warming is happening.
d) Don't know enough to say.

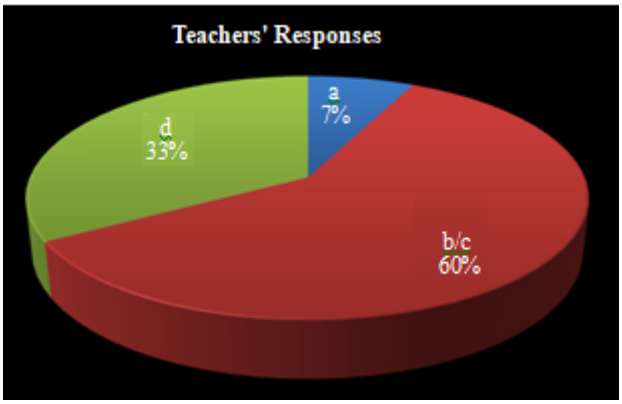
Option	Frequency	%
a	272	88.5994
b	4	1.30293
c	14	4.56026
d	17	5.53746



Q2. What is the cause of greenhouse gases?

a) Only burning of coal.
b) Natural processes (Respiration, Volcanic eruptions, etc.)
c) Human activities (Industrial revolution, Deforestation, etc)
d) Both human activities and natural processes.

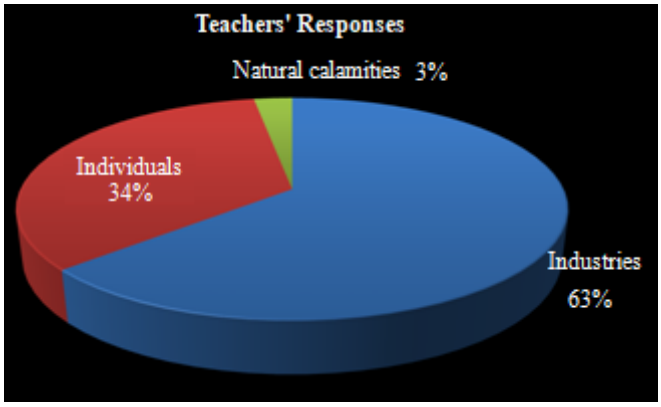
Option	Number	%
a	20	7.168459
b/c, b or c	166	59.49821
d	93	33.33333



Q3. Which of the following do you think is the worst environmental polluter?

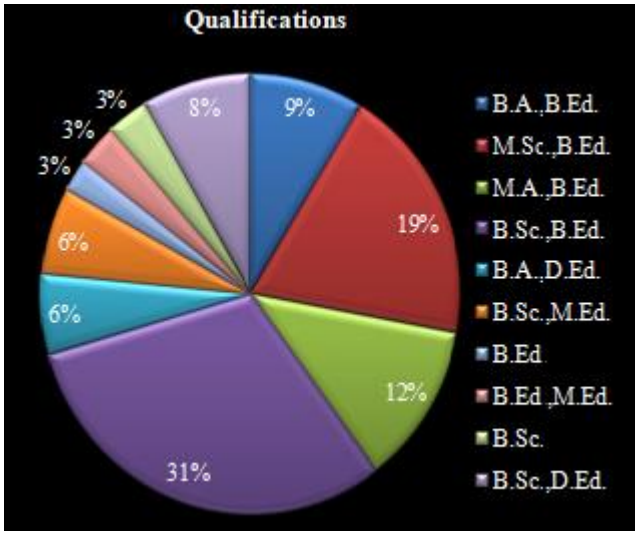
a) Industries
b) Individuals
c) Natural calamities

Option	Frequency	%
a	191	63.45515
b	102	33.88704
c	8	2.657807



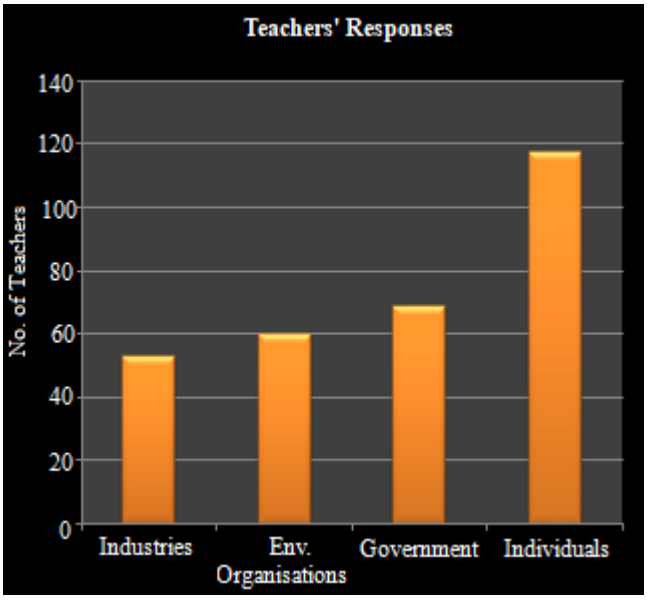
Q.4 Educational qualification of teachers surveyed

Qualification	%
B.A., B.Ed.	8.76494
M.Sc., B.Ed.	19.12306
M.A., B.Ed.	11.95219
B.Sc., B.Ed.	30.67729
B.A., D.Ed.	5.976096
B.Sc., M.Ed.	6.374501
B.Ed.	2.390438
B.Ed., M.Ed.	3.187251
B.Sc.	3.187251
B.Sc., D.Ed.	8.366534

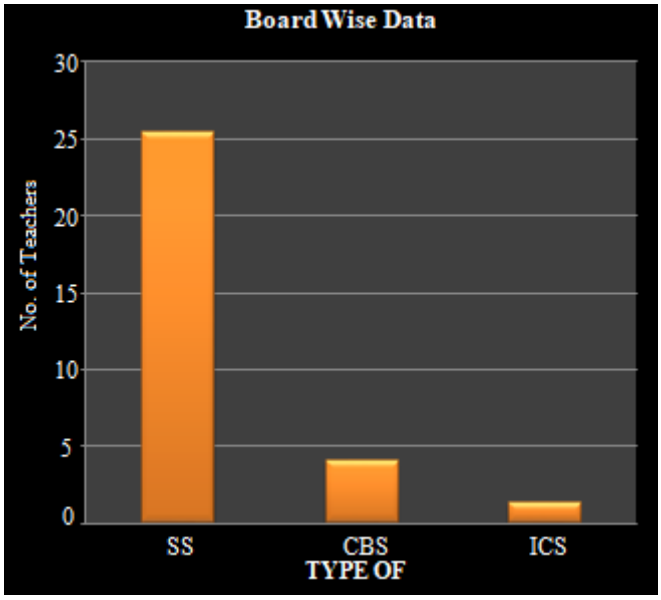


Q5. Who should be responsible for making sure that we have a healthy environment?

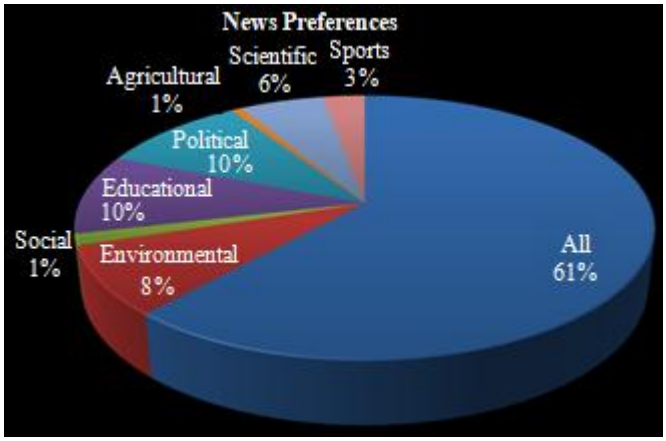
a) Industries
b) Environmental organisations
c) Government
d) Individuals



Q6. Simple bar diagram representing number of teachers surveyed from different school boards.

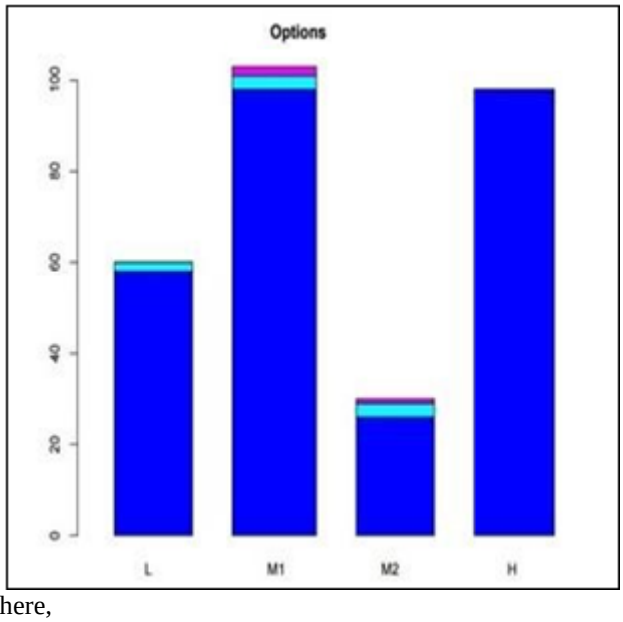


Q7. What kind of news do you prefer?



Q8. Do you think that global warming is happening?

A. Yes
B. No
C. It is what we hear about, but I'm not sure.



where,
L : Government lower income schools (Fee range – Rs. 0)
M_1 : Government middle income schools (Fee range – Rs. 0 to Rs. 5000)
M_2 : Private middle income schools (Fee range – Rs. 5000 to Rs. 15000)
H : Private higher income schools (Fee range – Rs. 15000 and above)

t -Test For One Sample Mean (For Middle Income Schools)

To Test:
H_0: $\mu = \mu_0$
H_1 : $\mu > \mu_0$
We have standard class strength μ_0= 55 for middle income schools as per RTE act.

Test Statistic:
$t_{cal} = (- \mu_0) / (s/\sqrt{n})$
where, **s =** sample mean square = $\sum(x_i -)^2/ (n-1)$

Output:
t = -0.28928, df= 137, p-value = 0.6136 alternative hypothesis: true mean is greater than 55
95 percent confidence interval:
52.3686 Inf sample estimates : mean of x = 54.6087

From the output since the p-value is greater than level of significance $\alpha = 0.05$ we accept the null hypothesis.

Conclusion:
Middle income classrooms surveyed obey the RTE Act and have class strength of 55 students.

t -Test for One Sample Mean (For Higher Income Schools)
To Test:
H_0: $\mu = \mu_0$
H_1: $\mu > \mu_0$

We have standard class strength μ_0= 35 for high income schools as per RTE act.

Test Statistic: $t_{cal} = (- \mu_0) / (s/\sqrt{n})$ where, **s =** sample mean square = $\sum(x_i -)^2/ (n-1)$

Output:
t = 10.082, df= 103 , p-value < 2.2e-16 alternative hypothesis : true mean is greater than 35
95 percent confidence interval:
44.14093 Inf sample estimates : mean of x= 45.94231
From the output since the p – value is less than level of significance $\alpha = 0.05$ we reject the null hypothesis.

Conclusion:
Higher income classrooms surveyed don't obey the RTE Act and have class strength greater than 35 students.

Correlation between Hours Spent in Class Discussing

Environmental Issues and No. of Correct Answers given by a Teacher

X: Number of hours spent in a class in discussing environmental topics. Y: Scores of the teachers spending „X" hrs. in classroom

Sr. No.	X	Y
1	0	5.64
2	1	6.02
3	2	5.8
4	3	6.3
5	4	5.14
6	5	5.29
7	6	5.23

Correlation co-efficient = -0.55619
Interpretation: There is a negative correlation between number of hours spent in the classroom by a teacher in discussing environmental topics and score of the teachers in conceptual questions in this survey. This may be due to the fact that number of hours spent in the classroom in discussing environmental topics includes different activities as well and is not necessarily 100% time to task.
By R Software:
Correlation coefficient: -0.55619

Two Way Analysis of Variance (Anova)

Here, we wish to test if the performance of teachers surveyed for this project is affected by the income levels of the schools and the interviewers conducting the survey.

Thus, in this application:
Treatments: Income level (i.e. fees paid by students) of the schools.
t = 4
Blocks: Pairs of interviewers conducting the survey. b = 5
Observations are denoted by $X_{ij.}$

X_{ij}= No. of correct answers given by teachers for Q.20 and Q.21 where
Q.20 What do greenhouse gases do?
Q.21 What is greenhouse effect?

We obtain a table as follows after classifying data.

		Income Level (Treatments)			
		L	**M_1**	**M_2**	**H**
Interviewers (Blocks)	**1**	2	4	1	6
	2	1	4	2	10
	3	1	6	3	9
	4	1	6	2	9
	5	9	9	1	6

where:
L – Government low-income schools.
Fees – Rs.0
M1 – Government middle income schools.
Fees – Rs. 0 to Rs. 5000
M2 – Private middle-income schools.
Fees – Rs. 5000 to Rs. 15000
H – Private high-income schools
Fees – Rs. 15000 and above.

To Test:
1) **H_{01}:** Treatment means are same.
i.e. Income level of schools does not affect performance of the teacher.

H_{11}: Treatment means are not same.
i.e. Income level of schools affects the performance of the teacher.

2) **H_{02}:** Block means are same.
i.e. Interviewers do not influence the teacher's performance.

H_{12} : Block means are not same.
i.e. Interviewers influence the teacher's performance.

Model :
$X_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$
i = 1, 2, 3, 4; j = 1, 2, 3, 4, 5

Where: μ = general effect.
α = effect due to i^{th} income level. β = effect due to j^{th} interviewer.
ε = random error component.

Assumptions:
1) ε_{ij} are assumed to be independent and identically distributed, coming from $N(0,\sigma^2)$ population.
2) $\sum\alpha_i = \sum\beta_j = 0$

Here, t = 4
b = 5
n = bt = 20

Calculations:

Summary	Count	Sum	Average	Variance
Row (Block) 1	4	13	3.25	4.9166667
Row (Block) 2	4	17	4.25	16.25
Row (Block) 3	4	19	4.75	12.25
Row (Block) 4	4	18	4.5	13.666667
Row (Block) 5	4	25	6.25	14.25
Column (Treatment) 1	5	14	2.8	12.2
Column (Treatment) 2	5	29	5.8	4.2
Column (Treatment) 3	5	9	1.8	0.7
Column (Treatment) 4	5	40	8	3.5

ANOVA Table:

Source of Variation	SS	Df	MS	F	P-value	F crit (5%)	F crit (1%)	Decision
Rows (Blocks)	18.8	4	4.7	0.8867925	0.500878	3.259167	5.41	NS
Columns (Treatments)	120.4	3	40.13333	7.572327	0.004194	3.490295	5.95	**
Error	63.6	12	5.3					
Total	202.8	19						

Decision:

1. Under H_{01},
   Fcal>Ftable
   For both 1% and 5% levels of significance.
   Hence, **we reject H_{01}. (**)**
2. Under H_{02},
   Fcal<Ftable
   For both 1% and 5% levels of significance.
   Hence, **we accept H_{02}. (NS)**

Conclusion

1) Treatment means are not same
i.e., for the given sample, income levels of different schools affect the performance of the teachers. This may be a consequence of the different types of trainings teachers receive on various topics. The quality and frequency of such trainings in turn depends on the income level of the schools. Thus, income level affects teachers‟ performance.

2) Block means are same
i.e., for the given sample, interviewers have shown no bias whatsoever in conducting the survey across different schools in Pune. Thus, they do not influence teachers‟ performance in any manner.

Comparison Of Treatments:
Here, we are applying critical difference method to check if the performance of teachers is significantly affected by any particular treatment (income level).

To Test:
H0 : $\mu i = \mu j$ **H1 :** $\mu i \neq \mu j$
We compare $|\bar{x}_i - \bar{x}_j|$ with Critical Difference (CD), where $CD = t(b-1)(t-1),\alpha/2 \sqrt{2se^2/b}$ where, b = blocks(interviewers) se^2 = mean error sum of squares.
CD = t12, 0.05/2 √2(5.3)/5
CD = 3.172672

Sr. No	Pairs of Treatments (Income Level)	H_0	H_1	-	Critical Difference (CD)	Decision
1	L, M1	$\mu_L = \mu_{M1}$	$\mu_L \neq \mu_{M1}$	3	3.172672	Accept H0.
2	L, M2	$\mu_L = \mu_{M2}$	$\mu_L \neq \mu_{M2}$	1	3.172672	Accept H0.
3	L, H	$\mu_L = \mu_H$	$\mu_L \neq \mu_H$	5.2	3.172672	Reject H0.
4	M1, M2	$\mu M1 = \mu M2$	$\mu M1 \neq \mu M2$	4	3.172672	Reject H0.
5	M1, H	$\mu_{M1} = \mu_H$	$\mu_{M1} \neq \mu_H$	2.2	3.172672	Accept H0.
6	M2, H	$\mu_{M2} = \mu_H$	$\mu_{M2} \neq \mu_H$	6.2	3.172672	Reject H0.

	INTERPRETATIONS
1	Number of correct answers given by teachers from government lower income schools is equal to number of correct answers given by teachers from government middle income schools.
2	Number of correct answers given by teachers from government lower income schools is equal to number of correct answers givenby teachers from private middle-income schools.
3	Number of correct answers given by teachers from government middle income schools is equal to number of correct answers given by teachers from private high-income schools.
4	Number of correct answers given by teachers from government low-income schools is not equal to number of correct answers given by private high-income schools.
5	Number of correct answers given by teachers from government middle income schools is not equal to number of correct answers given by private middle-income schools.
6	Number of correct answers given by teachers from private middle-income schools is not equal to number of correct answers given by private high-income schools.

2. Conclusion

The research conducted provides a critical understanding of the current state of climate change education among secondary school science teachers in India. It highlights significant disparities in knowledge and teaching approaches, influenced by the socio-economic status of the schools. The findings underscore the necessity for targeted educational programs and resources to bridge the knowledge gap among educators, ensuring a consistent and comprehensive approach to climate change education across all income levels. This is essential for equipping future generations with the awareness and understanding needed to address the environmental challenges of the 21st century. The study advocates for policy interventions and professional development opportunities focused on enhancing climate change education, which is paramount in a country with a rapidly growing student population and a rich educational history.

References

[1] Ministry of Statistics and Program Implementation, India (MOSPI) report.
[2] Right To Education (RTE) Act.