International Journal of Social Science and Humanities Research-MIYR

ISSN(print): 2788-9092 ISSN(Online): 2788-9106

Volume 4. Issue 4. 2024.12

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MISHEEL
INSTITUTE FOR YOUNG RESEARCHERS

International Journal of Social Science and Humanities Research-MIYR
Volume 4, Issue 4, pp.24~36, 2024
ISSN(print): 2788-9092, ISSN(Online): 2788-9106
https://youngres.com https://doi.org/10.53468/mifyr.2024.04.04.24

An analysis of the current state of climate change literacy: a case study of junior high school students

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***Abstract*—**In today's rapidly changing climate, understanding climate change literacy is essential for students. This study assesses the current state of climate change literacy among junior high school students. A total of 2,323 second-grade students from eight cities in the Inner Mongolia Autonomous Region participated in the survey.The questionnaire, developed using the Sojump platform, was conducted electronically.Based on research indicators, students' knowledge of climate change literacy was classified as follows: high (32%), above average (35.5%), below average (23.9%), and low (8.1%). The evaluation of skills, attitudes, and behaviors related to climate change literacy yielded scores of 3.49, 3.91, and 3.75, respectively, on a 5-point Likert scale. Although the overall literacy scores were above average, further efforts are needed to enhance students' understanding of climate change concepts and implications.

***Keywords*—**Climate change, Climate change literacy, Knowledge, Skills, Attitudes , Behaviors

1. INTRODUCTION

Climate change is one of the greatest challenges facing humanity, and education plays a crucial role in addressing it([1]–[5]). UNESCO emphasizes that "the strongest weapon against climate change is education," prioritizing climate change education in its

Received: 2024.11.05
Reviewed: 2024.11.07
Accepted: 2024.12.14
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initiatives[6]. The objective of climate change education is to enhance students' understanding of the issue, thereby improving their literacy regarding climate change.

As a responsible large country, China has actively engaged in the international community's response to climate change and has implemented numerous policies related to climate change education. Notably, the "21st Century Agenda of the People's Republic of China"[7], the "National Plan for Addressing Climate Change," and the "Policies and Actions for Addressing Climate Change in the People's Republic of China"[8] have introduced climate change education at all levels in their policy documents.These initiatives aim to raise public awareness of environmental issues and shape students' attitudes and emotions toward the environment, thereby fostering a sense of responsibility to society. Consequently, there is a clear emphasis on changing unsustainable behaviors and lifestyles regarding the environment.Despite the implementation of climate change education for some time, research in this area remains insufficient, with most studies focusing primarily on policy advocacy and implementation[9]. The goal of climate change education is to enhance students' understanding of climate change. Junior high school represents a crucial period for students to develop personal thinking patterns and values, making it essential to systematically improve their climate change literacy.

Research question:

1) What is the level of climate change literacy of junior high school students?
2) Can the methods used in this study assess the current state of students' climate change literacy?

Research purpose: The purpose of this study is to assess the current state of climate change literacy among junior high school students.

Research objectives:

1) Conduct an analysis of the current theories and research on climate change literacy
2) Design a questionnaire to assess the current state of students' climate change literacy
3) Perform statistical analysis on the collected data

Scope of research: The study, which involved 2323 second-year junior high school students from eight cities in the Inner Mongolia Autonomous Region, focuses on establishing a solid foundation for climate change education, which is being introduced at the junior high school level.

Research method:

1) Method of document analysis / To analyze the theory and research on climate change literacy /
2) Questionnaire method /Assessing the current situation of students/
3) Mathematical statistical methods/ Utilizing IBM SPSS Statistics 27 software to process the results and conduct a reliability analysis of the questionnaires

2. LITERATURE REVIEW

Research on climate change literacy, both internationally and domestically, is rooted in the concept of climate literacy.

In 2007, the U.S. National Oceanic and Atmospheric Administration (NOAA) introduced the concept of "climate literacy" in its report titled Climate Literacy: Essential Principles of Climate Science.This concept refers to the ability of individuals or social groups to understand climate-related issues, encompassing knowledge of climate, the impacts of human activities on climate, and the effects of climate on human life and social development[10].

Researcher Vladimir Lay[11] argued that climate-literate individuals grasp the fundamental principles of the global climate system, acquire relevant scientific information, communicate effectively, and make responsible decisions.Building on this, Alenda-Demoutiez J[12] defined climate change literacy as the knowledge and skills to comprehend the causes, effects, and solutions to climate change.

According to Zhao Feng et al. [13], climate change literacy refers to students' understanding of climate change after receiving climate change education.This understanding includes recognizing the effects of human activities and the impact of climate change on social development, as well as students' ability to address the complex problems associated with climate change, which is defined by values, unique qualities, and key skills. It is important to emphasize that while climate change literacy research originates from climate literacy research, the two concepts are not synonymous. Climate literacy is a broader concept that encompasses a comprehensive understanding of the climate system, whereas climate change literacy focuses specifically on the phenomenon of climate change, including its causes, trends, and impacts.

Research by Leiserowitz A[14], Lombardi D[15], and Hestness et al. [16] examined perceptions of climate change systems and global warming causes, effects, and solutions among U.S. adolescents and adults, revealing significant misunderstandings among students. In a study conducted by Jarrett and Takacs[17]with 229 students aged 13-16, they assessed understanding of climate change concepts, such as "the difference between weather and climate," and found that students who had studied subjects like biology and chemistry could better grasp the mechanisms underlying climate change.

Chen Tao[18] discovered that gender, age, awareness of climate change, and attention levels significantly influence students' willingness to combat climate change, based on a Binary Logistic model analysis using survey data.Xu Fuhui et al. [19] compared measures of climate change attitudes and analyzed four aspects: cognition, emotion, intention, and behavior.

According to research on climate change and environmental protection awareness among primary and secondary school students in the People's Republic of China, over 50% of the more than 4,000 surveyed students lacked a sufficient understanding of climate-related terminology, while 59.5% acknowledged the importance of climate change.

Additionally, more than 80% expressed readiness to respond to climate change through daily practices such as saving water and electricity[20].

A survey conducted by Wang Xueqi and Chen Jin [21]involving 1,539 students aged 12-14 in Xiamen, Shenzhen, and Ningbo, China, revealed that coastal adolescents exhibited low levels of climate science knowledge but had a moderate awareness of climate change and mitigation measures.

Overall, previous research has primarily focused on assessing students' understanding and knowledge of climate change, along with their knowledge, attitudes, and behaviors. However, there is a lack of comprehensive research that considers all four aspects: knowledge, skills, attitudes, and behaviors related to climate change.This highlights the need for further exploration of students' concepts in this regard and the development of a comprehensive methodology for their enhancement.Therefore, this study propose evaluating not only students' knowledge but also their skills, attitudes, and behavioral levels, in order to identify effective strategies for their development.

3. METHODOLOGY

3.1 DESIGN OF THE RESEARCH

This study employed a questionnaire method and collected data electronically.The survey questionnaire was developed based on previous studies, including the Yale University Climate Change Communication Project and research on U.S. middle school students' perceptions of climate change causes. The questionnaire, which consists of 52 questions, aims to assess students' climate change literacy across four categories: knowledge, skills, attitudes, and behaviors.Each question is designed to allow only one response. The knowledge section includes 8 questions, with 1 point awarded for each correct answer and 0 points for incorrect answers. The skills section contains 16 questions, the attitude section includes 12 questions, and the behavior section has 16 questions. These sections use a 5-point scale (1 - Strongly Disagree to 5 - Strongly Agree) to measure responses. Students' climate change literacy was evaluated based on their scores in these four areas: knowledge, skills, attitudes, and behaviors.

Table 1. Students' climate change literacy level (score)

Level	**Climate change knowledge**	**Climate Change skills, attitudes, and behaviors**
	Quantification (total score)	**Quantification (average score)**
Higher (positive)	[6; 8]	[4; 5]
Above average	[4; 6]	[3; 4]
Below average	[2; 4]	[2; 3]
Down (negative)	[0; 2]	[1; 2]

3.2 STUDY GROUP

A total of 2,323 second-grade secondary school students from eight cities in the Inner Mongolia Autonomous Region participated in the survey.Among them, 64% (1,485) were from rural areas, and 36% (838) were from urban areas. The sample comprised 51% male students (1,170) and 49% female students (1,153).Regarding age distribution, 14-year-olds made up 73% of the participants (1,696), followed by 13-year-olds at 18% (418), and 15-year-olds at 9% (209). Additionally, 87% (2,020) reported practicing green travel in their daily lives, while 13% (303) did not.

Table 2. General information of study participants

General information		Quantity(N)	Percent(%)
Residence	Urban	838	36
	Rural	1485	64
Gender	Male	1170	51
	Female	1153	49
Age	13	418	18
	14	1696	73
	15	209	9
Green travel	Yes	2020	87
	No	303	13

3.3 PROCEDURE OF DATA COLLECTION

A panel approach was employed to translate a questionnaire aimed at assessing students' climate change literacy into Mongolian. The translation team included doctoral and master's students specializing in geography and education. The questionnaire on the current status of students' climate change literacy was translated from English and Chinese into Mongolian and then back into Chinese and English to ensure translation accuracy. The reliability of the questionnaire was also tested using Cronbach Alpha (α=0.976) and showed high nternal consistency.

4. RESULTS

4.1 RESULTS ON STUDENTS' LEVELS OF KNOWLEDGE IN CLIMATE CHANGE LITERACY

Two questions were developed for each of the four aspects of climate change knowledge: concepts, causes, consequences, and management. According to the survey results, 62% (1.445) answered correctly regarding the concept of climate change, while 38% (878) selected the incorrect answer, with some students confusing climate change with global

warming. Concerning the primary cause of climate change in the modern era, 60% (1.402) correctly identified human activities, while 40% (921) incorrectly attributed it to volcanic eruptions and ozone depletion.Regarding the consequences of climate change, 54% (1.244) had a correct understanding, though some students mistakenly believed that global temperatures would rise uniformly. Only 44% (1.025) answered correctly on climate change management, indicating that students' overall knowledge about climate change is inadequate.

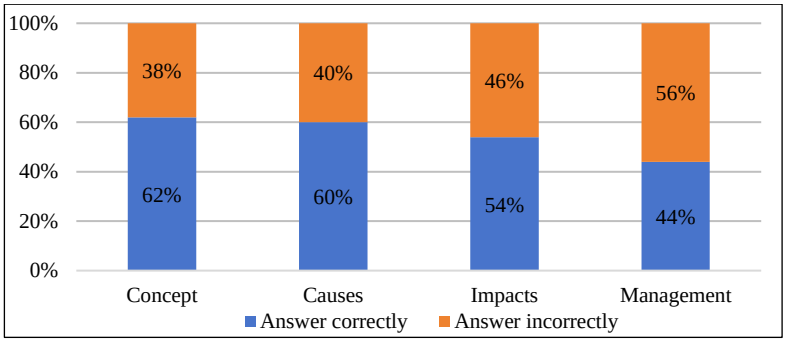

Figure 1. Students' knowledge of climate change

In terms of climate change knowledge, 32% of all students surveyed were rated as above average, and 35.5% as average, while 23.9% were rated as below average, and 8.1% as well below average.

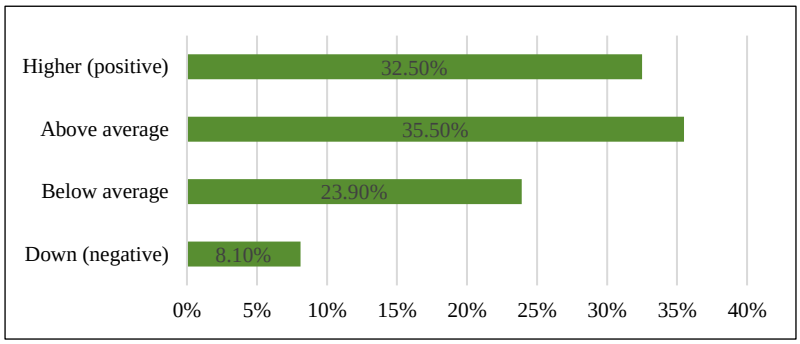

Figure 2. Level of climate change knowledge among students

4.2 RESULTS ON STUDENTS' LEVELS OF SKILLS, ATTITUDES, AND BEHAVIORS IN CLIMATE CHANGE LITERACY

The factor analysis conducted to assess the validity of the research questions categorized the 44 items into three groups, excluding those related to knowledge of climate change. The reliability analysis results indicated a Cronbach's Alpha ($\alpha = 0.976$), suggesting that the research questions effectively reflect the current state of students'

climate change literacy. This provides statistical confirmation that these questions can be used to evaluate the situation.

Table 3. Factor analysis and mean scores of students' skiils, attitudes, and behaviors toward climate change

Criterion		Mean	Standard deviation	Validity	Cronbach's Alpha (a)
Climate change skills	Skills to acquire and process information	3.43	.840	.848	.972
	Critical thinking skills	3.39	.846	.853	
	Problem solving skills	3.55	.817	.853	
	Communication and exchange skills	3.58	.804	.842	
Climate change attitudes	Cognitive component	3.99	.807	.841	.919
	Affective component	3.78	.714	.756	
	Behavioral component	3.93	.718	.801	
Climate change behaviors	Mitigation behaviors	3.79	.804	.930	.956
	Adaptation behaviors	3.70	.885	.914	
KMO and Bartlett's Test					
Kaiser-Meyer-Olkin Measure of Sampling Adequacy					.976
Bartlett's Test of Sphericity		Approx. Chi-Square			38243.711
		df			120
		Sig.			.000
Cronbach's Alpha (For 44 questions)					.976

According to these criteria and results,the average indicators of students' skills, attitudes, and behaviors regarding climate change are all above average. However, not all are satisfactory when considering the pressing issues facing society today.Therefore, there is a need for measures aimed at enhancing students' skills to engage with climate change issues, as well as promoting their active participation and response.

4.3 RESULTS ON DIFFERENCE ANALYSIS OF STUDENTS' CLIMATE CHANGE LITERACY

In terms of climate change knowledge, urban students scored higher on average than rural students.However, no significant differences were found with respect to gender and green travel.

Table 4. Differences in students' knowledge of climate change

		N	Mean	Standard deviation	t	p
Gender	Male	1170	4.41	1.996	.196	.845
	Female	1153	4.40	1.839		
Residence	Urban	838	4.75	1.902	6.484	.000
	Rural	1485	4.21	1.903		
Green travel	Yes	2020	4.42	1.910	.826	.409
	No	303	4.32	1.982		

p<.05

Additionally, the analysis of students' skills, attitudes, and behaviors regarding climate change by gender yielded the following results.

Table 5. Gender differences in students' skills, attitudes, and behaviors regarding climate change

	Gender	N	Mean	Standard deviation	t	P
Climate change skills	Male	1170	3.525	.829	2.436	.015
	Female	1153	3.447	.710		
Skills to acquire and process information	Male	1170	3.454	.900	1.658	.098
	Female	1153	3.396	.774		
Critical thinking skills	Male	1170	3.444	.895	3.345	.001
	Female	1153	3.327	.789		
Problem solving skills	Male	1170	3.587	.873	2.026	.043
	Female	1153	3.519	.754		
Communication and exchange skills	Male	1170	3.614	.844	2.066	.039
	Female	1153	3.545	.759		
Climate change attitudes	Male	1170	3.848	.695	-4.281	.000
	Female	1153	3.961	.578		
Cognitive component	Male	1170	3.941	.856	-3.548	.000
	Female	1153	4.059	.750		
Affective component	Male	1170	3.723	.782	-3.795	.000
	Female	1153	3.835	.633		
Behavioral component	Male	1170	3.879	.782	-3.711	.000
	Female	1153	3.989	.642		
Climate change behaviors	Male	1170	3.746	.847	-.212	.832
	Female	1153	3.753	.776		
Mitigation behaviors	Male	1170	3.771	.845	-.951	.342
	Female	1153	3.803	.759		
Adaptation behaviors	Male	1170	3.714	.908	.665	.506
	Female	1153	3.689	.862		

p<.05

From the table above, it is evident that boys performed better on average than girls in critical thinking, problem-solving, and communication skills related to climate change. Conversely, girls outperformed boys in cognitive, emotional, and behavioral attitudes, with these differences being statistically significant. However, no gender differences were observed concerning students' skills to acquire and process information about climate change and their behaviors.

The results of the analysis of students' skills, attitudes, and behaviors regarding climate change in residence are presented below.

Table 6. Residence-based differences in students' skills, attitudes, and behaviors regarding climate change

	Residence	**N**	**Mean**	**Standard deviation**	**T**	**p**
Climate change skills	Urban	838	3.596	.819	5.042	.000
	Rural	1485	3.424	.74		
Skills to acquire and process information	Urban	838	3.536	.895	4.676	.000
	Rural	1485	3.362	.801		
Critical thinking skills	Urban	838	3.493	.897	4.501	.000
	Rural	1485	3.325	.809		
Problem solving skills	Urban	838	3.652	.86	4.3	.000
	Rural	1485	3.498	.786		
Communication and exchange skills	Urban	838	3.703	.84	5.434	.000
	Rural	1485	3.511	.774		
Climate change attitudes	Urban	838	4.026	.677	6.749	.000
	Rural	1485	3.835	.611		
Cognitive component	Urban	838	4.152	.822	6.919	.000
	Rural	1485	3.914	.785		
Affective component	Urban	838	3.871	.746	4.607	.000
	Rural	1485	3.726	.69		
Behavioral component	Urban	838	4.055	.745	6.133	.000
	Rural	1485	3.866	.693		
Climate change behaviors	Urban	838	3.881	.827	5.888	.000
	Rural	1485	3.676	.795		
Mitigation behaviors	Urban	838	3.935	.814	6.721	.000
	Rural	1485	3.703	.786		
Adaptation behaviors	Urban	838	3.596	.819	4.510	.000
	Rural	1485	3.424	.74		

$p<.05$

According to these results, students'skills to acquire and process information about climate change, think critically, solve problems, communicate and exchange ideas, as well as their cognitive, emotional, and behavioral attitudes toward mitigating and adapting to climate change, showed that the average performance of urban students was higher than that of rural students, with statistically significant differences.

The analysis of students' skills, attitudes, and behaviors regarding climate change in relation to green travel reveals the following results.

Table 7. Differences in students' skills, attitudes, and behaviors toward climate change in relation to green travel

	Green travel	N	Mean	Standard deviation	t	p
Climate change skills	Yes	2020	3.534	.769	8.151	.000
	No	303	3.166	.727		
Skills to acquire and process information	Yes	2020	3.479	.832	8.275	.000
	No	303	3.067	.804		
Critical thinking skills	Yes	2020	3.435	.837	7.374	.000
	No	303	3.057	.832		
Problem solving skills	Yes	2020	3.601	.806	7.25	.000
	No	303	3.237	.816		
Communication and exchange skills	Yes	2020	3.621	.8	6.618	.000
	No	303	3.305	.774		
Climate change attitudes	Yes	2020	3.939	.639	6.791	.000
	No	303	3.673	.617		
Cognitive component	Yes	2020	4.033	.801	5.177	.000
	No	303	3.777	.814		
Affective component	Yes	2020	3.811	.715	5.678	.000
	No	303	3.563	.667		
Behavioral component	Yes	2020	3.972	.709	6.711	.000
	No	303	3.678	.724		
Climate change behaviors	Yes	2020	3.815	.797	10.161	.000
	No	303	3.317	.784		
Mitigation behaviors	Yes	2020	3.85	.788	10.125	.000
	No	303	3.363	.78		
Adaptation behaviors	Yes	2020	3.769	.869	9.56	.000
	No	303	3.257	.864		

$p<.05$

Based on the above results, students' skills to acquire and process information about climate change, think critically, solve problems, and communicate effectively—as well as their cognitive, emotional, and behavioral attitudes toward reducing and adapting to climate change—show that the average scores of students who engage in green travel in their daily lives are higher and statistically different from those of students who do not. This highlights the importance of green travel.

5. CONCLUSION

Previous studies have focused on assessing students' understanding and knowledge of climate change, as well as identifying their attitudes and behaviors. However, there is a lack of research that comprehensively covers students' knowledge, skills, attitudes, and behaviors regarding climate change.

Regarding students' knowledge of climate change literacy, 32% were rated as high and 35.5% as above average, while 23.9% were rated below average, and 8.1% were rated as

low. The general scores for skills, attitudes, and behaviors related to climate change literacy were 3.49, 3.91, and 3.75, respectively, on a 5-point Likert scale. These results highlight the need for actions to deepen students' understanding of climate change, enhance their skills to engage with it, and promote their active participation and response.

The average score of boys was higher than that of girls in terms of students' skills, while girls scored higher than boys regarding their attitudes. Therefore, it is advisable to implement programs and methods tailored to their interests to engage boys' attitudes in this area and enhance girls' abilities.

There is a need to focus specifically on climate change literacy for rural students and to enhance the equitable distribution of educational resources between urban and rural areas.

Green travel in everyday life plays a crucial role in developing students' climate change literacy. Therefore, schools should actively promote the concept of green travel and foster these habits in students through hands-on activities, ultimately encouraging action against climate change aimed at enhancing awareness and skills.

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