Knowledge, Attitudes, and Practices Towards Energy and Climate Change Literacy among Primary and Middle School Teachers

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Abstract:

Energy and climate change literacy is high on the agenda in the education sector, including in the contexts of primary and middle schools. Energy and climate literacy efforts, when combined and ideally infused throughout the curriculum, are believed to address the causes, effects, and risks of climate change and appreciate the range of options to minimize negative impacts and maximize resilience. It is also believed that environmental and climate change education goals cannot be achieved without knowledgeable and committed teachers. With this understanding, the present study sought to assess the energy and climate change literacy among primary and middle school teachers in selected cities in Ethiopia. The primary and middle schools in five cities, namely, Addis Ababa, Bahirdar, Hawassa, Diredawa, and Jimma were the sites of this study. The sampled schools and respondents were selected using a simple random sampling technique. Quantitative survey data were collected using knowledge, attitude, and practice questionnaire items. Collected data were analyzed using descriptive statistics, independent samples t-test, and ANOVA. The findings indicate that while teachers' knowledge of the fundamentals of climate change and climate science is relatively low, their performance on the facts and principles behind the use of energy resources and their utilization is quite promising. It is also found that teachers seemed to have unsatisfactory views about issues related to the production and use of energy resources. On the other hand, the participants of this study reported a great deal of engagement in most of the energy and environmental protection activities. The Ministry of Education should have to work to enhance primary and middle school teachers' awareness and competence on energy and climate change.

Keywords: Climate Change, Energy, Literacy, Primary and Middle School Teachers

Introduction

One of worldwide environmental concern and problem is climate change. Climate change is defined as a slow rise in the average global temperature brought on by the buildup of greenhouse gases in the Earth's atmosphere, mostly because of human activity such as the burning of fossil fuels for energy, deforestation, and industrial operations. The term “climate change” refers to the increasing changes in the measures of climate over a long period – including precipitation, temperature, and wind patterns (Mikhaylov et al., 2020). Global warming is just one aspect of climate change, and it refers to the rise in global temperatures due mainly to the increasing

concentrations of greenhouse gases in the atmosphere. "Greenhouse gases" refers also to those atmospheric gases, both naturally occurring and caused by human activity, that absorb and reemit infrared light (Moiceanu and Dinca., 2021). The Earth's surface emits heat back toward space, which is partially redirected toward the surface by water vapor, carbon dioxide, methane, nitrous oxide, ozone, and other gases in the atmosphere.

Climate change is thought to be primarily caused by greenhouse gases, and this issue has drawn a lot of attention from around the world. One of the main gases thought to be causing global climate change is carbon dioxide (Manabe, 2019). The population and the earth will be impacted by climate change in several ways, both now and in the future. Climate change is already having a negative influence on people's health through increased hunger and poor nutrition in areas where people cannot grow or get enough food, as well as air pollution, disease, extreme weather events, forced displacement, and mental health strains.

In Ethiopia, climate change is widely regarded as having a critical strategic importance with the potential to hold back economic progress or reverse the gains made in the country's development thereby exacerbating the existing social and economic problems. The country emits a very small proportion of global greenhouse gases and yet is highly vulnerable to the impacts of climate change (FDRE, 2020). It has, for instance, been estimated that climate change could reduce Ethiopia's GDP by up to 10% by 2045 compared with a 2011 baseline scenario. Some estimates show that, over the past 50 years, the temperature increased at about 0.2°C per decade whereas precipitation remained fairly stable when averaged over the entire country (Keller, 2009). It is also known that both the spatial and temporal variability of precipitation is high thereby rendering the large-scale trends unrepresentative of the local conditions. What is more, most of the global climate models project an increase in precipitation in both the dry and wet seasons whereas temperature is projected to continue to increase for the next few decades. The projected increases in the interannual variability of precipitation in combination with the warming will likely lead to increases in the occurrence of droughts. On the other hand, heavy rain and floods are projected to increase.

The detrimental impacts of the ongoing and projected climate change and variability include lower agricultural production with corresponding negative effects on food security; shortage of clean drinking water due to the increasing evaporation and variability of rainfall events; incidences of malaria in areas of the highlands where malaria was previously not endemic; increase in cardio-respiratory and infectious diseases; extinction of a large number of plant and animal species; damages to roads and buildings as a result of flooding; etc. (Keller, 2009). In Ethiopia, agriculture is known to contribute 80% of the total greenhouse gas emissions because livestock farming goes together with high methane emissions (Simane et al., 2016; Mulusew & Hong, 2024). In addition to agriculture, the energy sector (heating, cooking, and transport) contributes to the total greenhouse gas emissions with 15% (biomass sources meet 95% of the energy consumption). As the country's greenhouse gas emissions are closely linked to the basic needs of the population like food production (through livestock farming) and heating,

greenhouse gas emissions is likely to increase with the projected increase in population (Keller, 2009).

Dalelo (2011) suggests that the past two decades saw noteworthy efforts in Ethiopia to address, at least at the policy level, issues related to environmental degradation in general and climate change in particular. He specifically mentions some of the key initiatives including efforts to mainstream environment and climate change into what was then called the 'Growth and Transformation Plan'. The document underlines that 'the formulation and implementation of a climate change adaptation program is a dictate of Ethiopia's survival.' Notwithstanding the important steps taken in the policy arena, the level of awareness about the environment in general and climate change in particular remained very low (FDRE, 2001 cited in Dalelo, 2011). Energy and climate change education across the educational levels is believed to narrow this gap.

Review of Literature

The development of human societies is often associated with and traced through parallel developments in people's ability to harness energy from various sources, including the foods they consume, the warmth of the sun, and the combustion of various carbon-rich fuels. The energy-rich sources of fossil fuels are believed to have created the underpinnings of modern society in most of the developed world, enabling unprecedented mobility, industrial growth, domestic comfort, a lavish food supply, and economic prosperity. Understanding the history of human progress hence requires a good deal of energy literacy (Martins et al., 2020; Kellberg et al., 2024).

Energy literacy is conceptualized as understanding the nature and role of energy in the universe and our lives and the ability to apply this understanding to answer questions and solve problems (US Department of Energy, 2017). An energy-literate person is expected to trace energy flows and think in terms of energy systems. Know how much energy he or she uses, for what, and where that energy comes from. Assess the credibility of energy information and communicate about energy and energy use in meaningful ways. Make informed energy and energy use decisions based on an understanding of impacts and consequences. Additionally, she or he continues to learn about energy throughout his or her life (US Department of Energy, 2017). The concept of energy literacy emerges in the more recent pieces of literature (Martins et al., 2020; Kellberg et al., 2024; Białynicki-Birula et al., 2022; Martins et al., 2019; Wang et al., 2021), as a broad concept encompassing three dimensions: knowledge, attitude, and behavior. According to DeWaters et al. (2013):

- Knowledge — is the understanding of basic scientific concepts, rules, and theories, energy transfer, and transformation processes, the influence of energy flows, and the role that energy plays in ecosystems.
- Attitude — assesses the understanding of common energy supply and shutdown situations, the processes of production and use of energy and the consequent environmental impacts, the influence of energy issues on human life, and convictions

and ideologies of each person, based on the energy knowledge, which is inherent in the decision-making process.

- Behavior/practice — evaluates the personal awareness of the impact of day-to-day actions, the production and use of energy, the responsibility of each one as a citizen of the world, and the commitment to effective and truly committed actions in saving energy.

It is also argued that the future energy path will be determined not just by professionals and politicians, but by every citizen who participates in society—through the energy choices that are integral to decisions of daily life. Energy literacy is therefore considered an important life skill with which to empower today's students as well as the public (DeWaters & Powers, 2011). Energy-literate public is, for instance, hoped to be more likely to be engaged in the decision-making process and be better equipped to make thoughtful, responsible energy-related decisions, choices, and actions (DeWaters & Powers, 2013).

Those who advocate energy literacy also claim that the greatest potential resource for meeting our national energy crisis is energy literacy. For instance, Saul Griffith, co-founding partner of the engineering design and technology innovation company Squid Labs, had the following to say: "if we are to make a big change in the way energy is produced and consumed we need an 'energy literacy' that gives people a tangible sense of their energy consumption, and of what it takes to meet that" (Griffith, 2008 cited in DeWaters, et al, 2013, p.p.56). What is more, energy literacy plays a crucial role because well-informed citizens can support the design and implementation of smart and forward-looking policies.

The selection of energy sources and technologies determines not only the extent of threat to the planet because of anthropogenic carbon emissions but also the health and sustainability of the economy and even national security (Yeh et al., 2017). Similarly, Akitsu et al. (2017, p.1067) concludes that energy literacy is "indispensable for a sustainable society". Climate change is believed to be one of the most significant socio-scientific challenges hindering efforts aimed at creating sustainable societies (Mittenzwei et al, 2019). The scientific consensus on climate change is clear: it is real, primarily caused by human activities, and demands immediate attention and action to mitigate its harmful effects on our planet and its inhabitants. Knowledge regarding climate change helps young people to understand and tackle the consequences of global warming, encourages them to change their behavior, and helps them to adapt to what is already a global emergency. Education will be a key tool in the fight against climate change in the coming years. To address this challenge, people need to be empowered to assess information about climate change and make informed decisions. This in turn requires a good background on energy-related issues as most of the phenomena in the context of climate change, such as the greenhouse effect, are based on energy-related processes.

For people to respond to the effects of climate change and global warming, they must become more climate literate and knowledgeable. The basis for educated adaptation and mitigation strategies is climate literacy. A climate literate person is widely expected to understand the

essential principles of the Earth system governing climate patterns; know how to gather information about climate and weather, and how to distinguish credible from non-credible scientific sources on the subject; communicate about climate and climate change in a meaningful way; and make scientifically informed and responsible decisions regarding climate (NOAA, 2007 cited in Miléř & Sládeka, 2011). On the other hand, dealing with energy and climate change in education requires a good deal of understanding of the energy concept which cannot be achieved without a formal education on energy and climate change.

Climate change education (CCE) is believed to promote learning about the causes and effects of climate change as well as possible responses, providing a cross-curricular and multidisciplinary perspective (UNITAR, 2013). It develops competencies in the field of climate change mitigation and adaptation, to promote climate-resilient development and reduce the vulnerability of communities in the face of an uncertain future. CCE helps individuals to make informed decisions; and contributes to efforts geared towards disaster risk reduction.

The role of educators

Educators are considered powerful agents for change, delivering the educational response required to achieve sustainable development in general and the Sustainable Development Goals (we known as SDGs) in particular (UNESCO 2017 cited in Rieckmann & Barth, 2020). It is thus strongly argued that the chance for education processes and educational institutions to become more sustainable is determined by the knowledge, competencies, attitudes, and values of educators. Educators have long traditions of promoting social change and can use their expertise on knowledge, skills, and attitude and behavior change to help reduce greenhouse gas emissions (Anderson, 2010). In addition to education's integral role in change in behavior, schools have a role to play in mitigation in terms of becoming carbon neutral and reducing their ecological footprint.

Teachers' beliefs, practices, and attitudes are believed to be essential for understanding and improving educational processes (OECD, 2009). Teachers' beliefs shape students' learning environment and influence student motivation and achievement. However, empirical studies indicate a mixed result about the relationship between teachers' knowledge, beliefs, and practice.

The link between climate change knowledge, attitude, and practice

An empirical study that assessed the knowledge, attitudes, and practices (KAP) of climate change education (CCE) among lower secondary teachers in Tehran, Iran, used a cross-sectional survey design (Karami et al., 2017). To determine the status of teachers' knowledge, attitudes, and practices, the data was classified into three categories on a scale of 100%: good status (more than 75%), moderate status (50-75%), and weak status (less than 50%). The findings revealed that the teachers were equipped with appropriate knowledge, i.e. 22.2% good and 52.8% moderate levels of knowledge. Teachers' attitude was found to be moderate, and their practice was weak.

A study from Israel assessed beliefs among in-service teachers about the existence and the anthropogenic origin of climate change, their knowledge about the causes and consequences of climate change and the actions which can be taken to remediate it. The study also assessed teachers' level of concern about it and their readiness to act and teach in a climate-friendly way (Serouss et al., 2019). The results show gaps in knowledge, especially regarding the consequences of climate change, and misconceptions about the causes of climate change. On the other hand, the anthropogenic nature of climate change is found to be well-admitted. The study also indicates that the percentage of teachers ready to take action to slow down climate change is smaller than the percentage of teachers understanding climate change. The result also showed a significant correlation between knowledge about the consequences of climate change and concern about it and readiness to act.

A more recent study conducted in Nigeria, which examined how teacher's climate change belief influences classroom management practices for students' climate change awareness, revealed that a teacher's perception of climate change is a significant predictor of students' perception of climate change (Igu, et al., 2023). Another survey conducted by UCL's Centre for Climate Change and Sustainability Education (CCCSE) on the current state of climate change and sustainability education in England (in 2022-23) indicates a difference in teachers' integration of climate change and sustainability education in their classroom practices (Greer et al, 2023). It was specifically noted that "teaching related to climate change and sustainability continues to align with the National Curriculum by who completed the survey". For instance, a greater number of those who integrated climate change and sustainability taught geography (41.3%) and science (37.2%). Whilst in principle the National Curriculum affords teachers flexibility to incorporate climate change and sustainability across their teaching, the results indicate such flexibility is not flowing through to practice.

A Kenyan study that assessed teachers' and students' perceptions of integrated environmental education in the curriculum found that both teachers' and students' perceptions were weak leading to little attention to adequate integration of Environmental Education in the school curriculum. The study also claims that such a low perception negatively impacted teachers' and students' involvement in and commitment to the implementation of Environmental Education in the school curriculum thereby contributing to the persistence of environmental degradation in the region (Chikati & Okendo, 2018). Another study assessing the extent to which environmental education was implemented in the curriculum by Grade 8-10 Geography educators in a region of Namibia revealed that while educators had sufficient knowledge and understanding of environmental concepts and issues, they lacked the required environment-related skills and attitudes. Additionally, they did not employ a variety of teaching approaches or alternative assessment methods (Loubser & Simalumba, 2016). Concerning practice, the study shows that, though educators understand the significance of Indigenous knowledge in geography education, their participation in school environmental education initiatives needs to be strengthened.

Rationale and Research Questions

McCaffrey (2015) strongly argues that any effort to avoid or minimize the connection between human energy consumption and changing climate amounts to a form of science denial through omission. He hence suggests that energy and climate literacy efforts should be combined and ideally infused throughout the curriculum to address the causes, effects, and risks of climate change. Further he appreciates the range of options to minimize negative impacts and maximize resilience. Besides, the long traditions educators have in educating for social change led some to hope that they can use such expertise to help reduce greenhouse gas emissions (Anderson, 2010).

Environmental and climate change education is believed to "promote not only knowledge of the environment, climate change and the associated challenges, but also fosters attitudes and motivations to make informed decisions and take responsible action" (Anderson, 2010, p.6). In addition to education's integral role in behavior change, schools could play an important role in mitigation by becoming carbon neutral and reducing their ecological footprint. For all this to materialize, there should be a high level of awareness and commitment on the part of teachers. It is also increasingly recognized that most of the environmental problems presently being faced by humankind are directly or indirectly caused by energy extraction/conversion/utilization. Climate change concern, being a global phenomenon, has already motivated educational planners and administrators to develop courses focusing on a variety of environmental issues. Thus, it makes sense to benefit from the synergy between efforts towards mitigating environmental problems and efforts towards meeting the increasing energy demand in a sustainable manner (Kandpal & Garg, 1999).

Energy and climate change literacy are top priorities in the educational field, particularly in the context of primary and middle schools at the local, national, and worldwide levels. The goals of energy, environmental, and climate change education cannot be achieved without knowledgeable and committed teachers. However, environmental and climate change education promotes not only knowledge of the environment, climate change, and the associated challenges but also fosters attitudes and motivations to make informed decisions and take responsible action (Anderson, 2010). This is because knowledge serves as a foundation, attitudes reveal how students feel about energy and climate challenges, and practices show how they apply what they have learned in real-world situations.

While there is a growing emphasis on energy and climate change education, the effectiveness of current efforts in equipping primary and middle school teachers with the necessary knowledge, attitudes, and practices for energy and climate change literacy remains uncertain (Białynicki-Birula et al., 2022; Leve et al., 2023; Martins et al., 2019; Nepraš et al., 2022; Wang et al., 2021). With this understanding, this study aims to address this gap by examining the current state of energy and climate literacy knowledge, attitudes, and practices among primary and middle school teachers in selected cities in Ethiopia. In addition to this, it is good to explore the existence of such differences based on their cities, gender, educational level, fields of study, and experience. Thus, the study sought to answer the following research questions:

1. What is the level of energy- environmental-, and climate change literacy knowledge, attitudes, and practices among teachers in primary and middle schools of selected cities of Ethiopia?
2. Are there statistically significant differences in teachers' knowledge, attitudes, and practices of energy and climate change literacy because of their cities, gender, educational level, fields of study, and experience?

The findings of this study hold implications for policymakers, educators, and educational institutions, indicating areas for targeted interventions to enhance energy and climate change literacy among future teachers.

Methodology

Research design

The present study employed descriptive survey research to collect data from Primary and Middle School Teachers. Survey design is preferable when observations or data are needed from large samples on not sufficiently studied (Dillman et al., 2014; Pinsonneault & Kraemer, 1993). Teacher-related knowledge, attitude, and practice of energy and climate change literacy are not sufficiently studied area in the Ethiopian Context.

Participants of the study and sampling techniques

The primary and middle schools in five cities, namely, Addis Ababa, Bahirdar, Hawassa, Diredawa, and Jimma were the sites of this study. These cities were purposively selected as the study focused on areas that are vulnerable to environmental and climate change-related issues and problems. The study population includes 299 Primary and Middle School Teachers in these study areas. The teachers were those who had graduated in any field of study and those who taught in Primary level school grades (grades 1-6) and Middle-level school grades (grades 7-8). For this survey, the numbers of schools selected from each of the cities to participate in the study were approximately based on the number of schools found in the cities. As Addis Ababa city has many schools, 9 schools were selected from Addis Ababa and 6 schools from each of the cities of Bahir Dar, Dire Dawa, Hawassa, and Jimma as these cities are approximately comparable with the number of schools that they have. The selection of both the sample schools and respondents was done randomly. Table 1 shows the number of respondents in each of these cities.

Table 1: *Sample respondents by location*

S/No	Region or city	Sampled respondents
1	Addis Ababa	81
2	Bahirdar	60
3	Diredawa	60
4	Hawassa	46
5	Jimma	52
Total		299

Data collection instruments

Researchers often apply four core dimensions for the assessment of energy literacy: energy concepts, reasoning on energy issues, low-carbon lifestyle, and civic responsibility for a sustainable society (Chen et al., 2015). This study utilizes a comprehensive questionnaire designed to measure three distinct variables: knowledge, behaviors/practice, and attitudes related to energy as well as climate change adaptation and mitigation. The questionnaire items were developed by the study team members. The items were to judge or assess Primary and Middle School teachers' knowledge, attitude, and practices of energy literacy. Thirty questions made up the knowledge portion of the questionnaire; the questions were constructed using a three-point rating system: correct, wrong, and no idea. Additionally, the fifteen attitude items were constructed using a five-point Likert scale: strongly agree, agree, undecided, disagree, and strongly disagree. Conversely, the practice section consists of eleven items that are produced using a five-point Likert scale: always, frequently, sometimes, rarely, and Not at all.

Validity and reliability of the instruments

Professional feedback on the face and content validity of the instruments guided additional review. To collect feedback and ascertain the validity of each instrument, it was given to experts for review, and the feedback was then presented at a validation workshop. To further assess the validity and reliability of the instruments, a pilot research was carried out on students who were not part of the main study. Cronbach alpha was computed, and the outcome is shown in Table 2 below.

Table 2: *Cronbach Alpha values for the energy and climate change education instruments*

S/No	Components	Cronbach alpha
1	Knowledge	0.798
2	Attitudes	0.731
3	Practices	0.847

For both the pilot and the primary investigation, Cronbach's alpha coefficient values were larger than 0.7 (Table 2). These show that the instruments have acceptable internal consistency and, thus, are reliable.

Analysis of data

Descriptive statistics, including mean, standard deviation, and frequency tables and percentages, have been employed in this investigation. Furthermore, inferential statistical comparisons including the independent sample t-test and ANOVA have been employed in the data analysis to observe differences between distinct categories.

Ethical considerations

The study adheres to ethical guidelines, ensuring participant confidentiality, anonymity, and voluntary participation. Informed consent is obtained, and participants are informed about the purpose of the study.

Results and Discussion

Background characteristics of respondents

The following table shows the teachers respondents background information.

Table 3: *Respondents Characteristics of teachers for all Regions*

		AA		Bahir Dar		Dire Dawa		Hawassa		Jimma		Over all Total	
Characteristics		N	%	N	%	N	%	N	%	N	%	N	%
Education level	Certificate	22	27.2	3	5.0	0	0	8	17.4	0	0	33	11.0
	Diploma	28	34.6	56	93.3	26	43.3	12	26.1	23	44.2	145	48.5
	Degree	28	34.6	1	1.7	34	56.7	26	56.5	25	48.1	114	38.1
	Masters	3	3.7	0	0	0	0	0	0	4	7.7	7	2.3
	Total	81	100	60	100	60	100	46	100	52	100	299	100
Specialization	General Science	34	42.0	25	41.7	30	50.0	25	54.3	30	57.7	144	48.2
	Social studies	10	12.3	25	41.7	8	13.3	11	23.9	13	25.0	67	22.4
	Others	37	45.7	10	16.7	22	36.7	10	21.7	9	17.3	88	29.4
	Total	81	100	60	100	60	100	46	100	52	100	299	100
Teaching Experience	1−5 years	15	18.5	3	5.0	2	3.3	16	34.8	13	25.0	49	16.4
	6−10 years	33	40.7	1	1.7	8	13.3	13	28.3	4	7.7	59	19.7
	11−15 years	18	22.2	8	13.3	29	48.3	10	21.7	9	17.3	74	24.7
	16 − 20 years	7	8.6	16	26.7	15	25.0	4	8.7	6	11.5	48	16.1
	20 years	8	9.9	32	53.3	6	10.0	3	6.5	20	38.5	69	23.1
	Total	81	100	60	100	60	100	46	100	52	100	299	100
Gender	Male	46	56.8	28	46.7	39	65.0	29	63.0	11	21.2	153	51.2
	Female	35	43.2	32	53.3	21	35.0	17	37.0	41	78.8	146	48.8
	Total	81	100	60	100	60	100	46	100	52	100	299	100

Results

Results have been presented and discussed under three categories: Teachers' awareness about issues related to energy and climate change; their views about production and use of energy resources; and teachers' practices related to energy use and environmental protection. This is followed by presentation of results of comparison between teachers' attitude and practice against such factors as gender and geographical location.

Teachers' awareness about issues related to energy and climate change

The performance on items related to basic facts and principles underlying energy sources and their unitization seems to be quite encouraging. Respondents demonstrated the highest performance (correct responses ranging from 63-91%) in five of the nine items: the condition in

which electrical energy is converted to light and heat (CEC2, 91.2%); the source of most of the electricity produced in Ethiopia (CEC9, 89.9%); factors that determine the amount of electrical energy used by an electrical appliance (CEC1, 86.8%); the fact that energy conservation is the fastest and most cost-effective way to address our energy needs (CEC7, 72.9%); and the conception about renewable energy resources (CEC4, 62.6%) (Table 4). The item that states that it 'is impossible to build a machine that produces more energy than it uses got a correct response from 49.1% of the respondents with 32.8% having it wrong (CEC3). Two of the items related to energy use in Ethiopia seem to be difficult for the respondents. More than one-third (38%) of the respondents wrongly indicated that coal "is the most abundant of the fossil fuels currently under use in Ethiopia" (CEC6) whereas one-third (33%) of the respondents wrongly indicated that baking and cooking "consume the most electricity in the average Ethiopian urban households" (CEC8). The only item where a significant proportion of the respondents (33%) had no idea relates to the contribution of fossil fuel to the energy mix of developed countries (CEC5).

The analysis of data on basic facts and principles underlying energy resources and their utilization shows a very good overall performance though there are areas, particularly related to the situation in Ethiopia, where the performance is quite unsatisfactory. Awareness about the role played by fossil fuel in the energy mix of developed countries is found to be less than expected of a teacher (this could have a major implication for respondents' views on issues related to climate change).

The second category of items related to teachers' awareness are those related to the socio-economic and environmental impacts of energy generation (Table 5). Interestingly, 60% of the respondents hold the wrong information that people "who live in countries that have large amounts of fossil fuel resources generally have a high standard of living" (CEC10), only one-fifth go it right. Close to 70% of the respondents rightly indicated that generating electricity with photovoltaic (solar) cells is least harmful to human health and the environment (CEC11), more than four-fifths got this wrong. The fact that wind, solar, and waterpower generation schemes cause relatively lesser air pollution is known to 60.1% of the respondents, and more than one-fourth got it wrong.

One can thus see that performance in this category of items is generally good but not adequate. A similar observation was made by Liarakou et al. (2009) based on their study that investigated the knowledge and attitudes of secondary school teachers in Greece towards renewable energy sources. Their study revealed that although teachers were informed about renewable energy sources and well disposed towards these sources, they hardly expressed clear positions regarding several issues about wind and solar energy technologies and farms. Consequently, the practice of integrating such themes into teaching and extracurricular educational programs was found to be limited.

Table 4: *Energy: Basic facts and principles*

Item No.	Question		Performance N	W	C
CEC1	The amount of electrical energy an electrical appliance will consume depends on the power rating of the appliance and the length of time it is turned on.	n	13	26	257
		%	4.4	8.8	*86.8*
CEC2	Electrical energy is converted to light and heat when you turn on an incandescent bulb.	n	10	16	271
		%	3.4	5.4	*91.2*
CEC3	It is impossible to build a machine that produces more energy than it uses.	n	55	92	142
		%	19.0	31.8	*49.1*
CEC4	Renewable energy resources are those resources replenished by nature in a short time.	n	33	78	186
		%	11.1	26.3	*62.6*
CEC5	Fossil fuels provide about 85% of the energy used in developed countries like the United States and Europe.	n	98	73	126
		%	33.0	24.6	*42.4*
CEC6	Coal is the most abundant of the fossil fuels currently under use in Ethiopia.	n	64	113	120
		%	21.5	*38.0*	40.4
CEC7	Energy conservation is the fastest and most cost-effective way to address our energy needs.	n	18	62	215
		%	6.1	21.0	*72.9*
CEC8	Baking and cooking consume the most electricity in the average Ethiopian urban household.	n	22	98	177
		%	7.4	*33.0*	59.6
CEC9	Most of the electricity produced in Ethiopia comes from water.	n	7	23	266
		%	2.4	7.8	*89.9*

[N= No idea, W= Wrong, C= Correct]

Table 5: *Impacts related to energy generation*

Item No.	Question		Performance		
			N	W	C
CEC11	Generating electricity with photovoltaic (solar) cells is the least harmful to human health and the environment.	n	24	66	206
		%	8.1	22.3	69.6
CEC10	People who live in countries that have large amounts of fossil fuel resources generally have a high standard of living.	n	57	61	179
		%	19.2	20.5	60.3
CEC22	Wind, solar and water power generation schemes cause severe air pollution.	n	38	179	81
		%	12.8	60.1	27.2

Seven items of the instrument relate to the meaning, causes, and consequences of climate change. More than half of the respondents (57.6%) wrongly considered the climate as "the day-to-day fluctuations in the conditions of the earth's lower surface atmosphere at a specific location" (CEC12), one-third had it right. A higher proportion (60.2%) wrongly indicated that the greenhouse effect "is caused by gases that trap heat radiated from the Sun" (CEC13), a little more than one-fourth had this right. Responses to these items underscore that respondents' awareness about issues related to energy generation is very low. This is quite worrisome as the respondents are teachers who are expected not to have the kinds of misconceptions students have about the meaning, causes, and consequences of climate change.

A great majority of the respondents (85%) correctly indicated that climate change "could result in a big warming in some places and big freeze in others" (Table 6, CEC15). However, only one-third know global warming in some localities could reduce the number of deaths and illnesses resulting from extremely cold weather (CEC18), 42% got this wrong. Yet another consequence of climate change, i.e., its contribution to re-education of crop growing season "thereby forcing some localities to abandon production altogether" (CEC24) is known to 70% of the respondents, more than one-fifth had it wrong.

The other item in this category related to the rate of increase in global temperature since 1900 (CEC17) put a large number of respondents in a state of uncertainty, 40% indicating that they had no idea. Regarding the causes of the Ozone hole (CEC21), four-fifths of the respondents had the right answer making it one of the areas where respondents displayed the highest degree of climate change literacy. In general, however, performance in this category of items seems to range from low to moderate.

Table 6: *Climate change: meaning, causes and consequences*

Item No.	Question		Performance		
			N	**W**	**C**
CEC12	Climate refers to the day-to-day fluctuations in the conditions of the earth's lower surface atmosphere at a specific location.	n	25	101	171
		%	8.4	*34.0*	57.6
CEC13	Greenhouse effect is caused by gases that trap heat radiated from the Sun.	n	40	77	177
		%	13.6	*26.2*	60.2
CEC15	Climate change could result in a big warming in some places and a big freeze in others.	n	9	33	256
		%	3.0	11.1	*85.9*
CEC17	Average global temperature had risen by about 0.6^{o}C since 1900.	n	116	54	120
		%	40.0	18.6	*41.4*
CEC18	Global warming in some localities could reduce the number of deaths and illnesses resulting from extremely cold weather.	n	73	124	100
		%	24.6	41.8	*33.7*
CEC21	The Ozone hole was created due mostly to man-made chemicals.	n	23	37	238
		%	7.7	12.4	*79.9*
CEC24	Climate change is likely to reduce crop growing season thereby forcing some localities to abandon production altogether.	n	23	67	209
		%	7.7	22.4	*69.9*

Table 7 shows the results on items related to the impacts of climate change on developing countries. Respondents' awareness about the capacity of the African continent to adapt to climate change is very low with less than one-third able to respond correctly (CEC14). More than half of the respondents were either unsure about the contribution of Africa to the global emission of greenhouse gases or had it wrong (CEC20). Even a lower proportion of the respondents (23.8%) had the right information about the pattern of rainfall in Ethiopia over the past decades (CEC19). One can see that there is a clear cause for concern.

On the other hand, three-fourths of the respondents had a correct understanding of the extent and specific localities of casualties in the world "due to weather-related disasters" (CEC26); and an equal proportion about the extent of Ethiopia's vulnerability "to climate change mainly because of high dependence on rain-fed agriculture" (CEC27). One can thus see that there is a mixed performance concerning the impacts of climate change in developing countries (very poor performance on issues related to the African continent).

Table 7: *The impact of climate change in developing countries*

Item No.	Question		Performance N	W	C
CEC14	The African Continent has the highest capacity to adapt to climate change.	n	38	91	163
		%	13.0	***31.2***	55.8
CEC19	In Ethiopia, rainfall declined significantly when averaged for the whole country over the last fifty years.	n	41	71	186
		%	13.8	***23.8***	62.4
CEC20	Africa is responsible for about one-fourth of global emissions of greenhouse gases.	n	61	108	129
		%	20.5	***36.2***	43.3
CEC26	Almost all deaths in the world due to weather-related disasters take place in developing countries.	n	15	57	225
		%	5.1	19.2	***75.8***
CEC27	Ethiopia is extremely vulnerable to climate change mainly because of high dependence on rain-fed agriculture.	n	10	65	223
		%	3.4	21.8	***74.8***

The last category of the section on awareness deals with adaptation to and mitigation of climate change. Close to four-fifths of the respondents understood the meaning of adaptation as "an adjustment in the natural or human system in response to actual or expected climatic change" (CEC16); and a bit higher proportion rightly considered the aim of adaptation measures as "moderating harm caused by climate change" (CEC27). When it comes to another aim of adaptation measures, i.e. "exploiting beneficial opportunities that result from climate change", the proportion of correct responses went a bit down with 74.2% getting it right (CEC28).

The areas in this category which challenged the respondents are related to renewable energy sources and technologies. For instance, close to four-fifths of the respondents have no idea or have a piece of wrong information about the possibility of replacing fossil fuel in the future shortly (CEC23). Similarly, less than half of the respondents know that most "renewable sources generate energy only intermittently; when the sun is shining, or the wind is blowing" (CEC30). Given the promise of renewable energy sources and technologies to address most of the problems related to climate change, the low awareness in this area should be taken as a serious cause for concern.

Table 8: *Climate change: Adaptation and mitigation measures*

Item No.	Question		Performance N	W	C
CEC16	Adaptation to climate change refers to an adjustment in natural or human systems in response to actual or expected climatic change.	n	16	44	237
		%	5.4	14.8	*79.8*
CEC23	There are technological alternatives developed over the last five years that could replace fossil fuels quickly or cheaply.	n	69	81	148
		%	23.2	*27.2*	49.7
CEC25	Adaptation measures are aimed at moderating harm caused by climate change.	n	14	41	244
		%	4.7	13.7	*81.6*
CEC28	Adaptation measures are aimed at exploiting beneficial opportunities that result from climate change.	n	25	52	222
		%	8.4	17.4	*74.2*
CEC29	Climate change mitigation measures target the causes of climate change, seeking to reduce the emission of greenhouse gases.	n	30	49	218
		%	10.1	16.5	*73.4*
CEC30	Most renewable sources generate energy only intermittently; when the sun is shining or the wind is blowing.	n	42	128	125
		%	14.2	43.4	*42.4*

Teachers' views about the production and use of energy resources

A previous study conducted in Kenya to assess climate change awareness among primary school teachers reported that teachers registered a medium level of awareness albeit gaps in their knowledge owing to such factors as age, gender, level of education, and school location (Ochieng, 2014). Results further show that primary school teachers in Kisumu City perceive climate change as a threat and support its inclusion into Kenya's primary school curriculum. The present study attempted to assess the views of respondents using nine statements related to the production and use of energy resources. The findings indicate that respondents hold mixed views, some positive and some negative, about the issues raised (Table 9). Less than one-third (29.4%) of the respondents disagree with the view that there is no need to "worry about conserving energy" as new technologies "will be developed to solve the energy problems for future generations" (AEC1). It should also be noted that more than half (59.4%) of the respondents support the view. There is a view that calls for labeling all electrical appliances to show "the resources used in making them, their energy requirements, and operating costs". Interestingly, 78.7% of the respondents supported this view (AEC2). The fact that such a practice is nowadays commonly advocated in Ethiopia might have led to such a view. The need to make use of "more of our electricity from renewable resources" is one of the views that received the strongest support (90.2%) (AEC4).

Table 9: *Views about production and use of energy resources*

Item No.	Question		Response*				
			SD	**D**	**U**	**A**	**SA**
AEC1	We don't have to worry about conserving energy because new technologies will be developed to solve the energy problems for future generations.	N	55	32	33	69	107
		%	18.6	10.8	11.1	***23.3***	***36.1***
AEC2	All electrical appliances should have a label that shows the resources used in making them, their energy requirements, and operating costs.	N	9	25	29	74	159
		%	3.0	8.4	9.8 %	***25.0***	***53.7***
AEC4	We should make more of our electricity from renewable resources.	N	8	5	16	69	197
		%	2.7	1.7	5.4	***23.4***	***66.8***
AEC5	Efforts to develop renewable energy technologies are more important than efforts to develop new sources of fossil fuels.	N	12	14	39	91	139
		%	4.1	4.7	13.2	***30.8***	***47.1***
AEC6	Laws protecting the natural environment should be made less strict in order to allow more energy to be produced.	N	59	54	28	70	84
		%	***20.0***	***18.3***	9.5	***23.7***	***28.5***
AEC7	More wind farms should be built to generate electricity, even if the wind farms are located in scenic valleys, farmlands, and wildlife areas.	N	125	95	33	28	15
		%	***42.2***	***32.1***	11.1	9.5	5.1
AEC8	More oil fields should be developed as they are discovered, even if they are located in areas protected by environmental laws.	N	83	79	50	54	29
		%	***28.1***	***26.8***	16.9	18.3	9.8
AEC9	I don't need to worry about turning lights and computers off in the classroom, because the school pays for the electricity.	N	53	37	23	57	126
		%	17.9	12.5	7.8	***19.3***	***42.6***

** D= Disagree, SD= Strongly disagree, U=Undecided, agree, A= Agree, SA= Strongly*

The view that attaches more importance to efforts to develop renewable energy technologies than developing new sources of fossil fuels has been rejected by a few (8.8%) respondents (AEC5). On the other hand, respondents held a mixed view about the laws related to the protection of the natural environment. More than one-third (38.3%) rejected the view that environmental laws should be made less strict "to allow more energy to be produced' whereas more than half (52.2%) agreed that such laws be relaxed (AEC6). Nearly one-seventh of the respondents agree that more "wind farms should be built to generate electricity, even if the wind farms are located in scenic valleys, farmlands, and wildlife areas" (AEC7); more than one-fourth (28.1%) agree that more oil fields should be developed "even if they are located in areas protected by environmental laws" (AEC8). Ethiopia's current level of deep and widespread poverty could be one reason why those teachers held such views that go against environmental care and protection. On the other hand, close to one-third (30.4%) of the respondents rejected the statement "I don't need to worry about turning lights and computers off in the classroom because the school pays for the electricity" (AEC9) while 61.9% of the respondents agreed to such a view that could exemplify an extreme form of negligence in use of resources (in this case

energy). In general, a significant number of teachers who took part in this study seem to have an unfavorable view of issues related to the production and use of energy resources.

Table 10: *Views about the cause and consequences of and controlling climate change*

Item No.	Statement		Response SD	D	U	A	SA
AEC3	The government should have stronger restrictions about the gas mileage of new cars.	N	7	10	36	78	165
		%	2.4	3.4	12.2	***26.4***	***55.7***
AEC10	Climate change has the potential to reverse the gains made in Ethiopia's development.	N	23	25	27	87	133
		%	7.8	8.5	9.2	***29.5***	***45.1***
AEC11	Climate change could exacerbate/accelerate social and economic problems currently facing Ethiopia.	N	10	19	17	87	163
		%	3.4	6.4	5.7	***29.4***	***55.1***
AEC12	Climate change has the potential to destabilize the Horn of Africa by bringing more fierce competition for water.	N	10	25	43	109	108
		%	3.4	8.5	14.6	***36.9***	***36.6***
AEC13	Climate change brings opportunities for Ethiopia as it brings more rather than less rainfall.	N	13	18	55	85	124
		%	4.4	6.1	18.6	***28.8***	***42.0***
AEC14	Ethiopia should not be forced to compromise future economic growth and well-being by restricting emissions of greenhouse gases.	N	74	50	72	50	47
		%	***25.3***	***17.1***	24.6	17.1	16.0
AEC15	Ethiopia is well positioned to become a regional leader in low-carbon growth.	N	8	17	54	105	109
		%	2.7	5.8	18.4	***35.8***	***37.2***

The instrument used seven statements to assess the views of the respondents about the causes and consequences of and controlling climate change (table 10). It is important to note from the outset that, to some extent, the respondents had a positive view of most of the statements about the causes and consequences of climate change in Ethiopia. For instance, three-fourths of the respondents share the concern that "climate change has the potential to reverse the gains made in Ethiopia's development" (AEC10). Similarly, a much higher proportion (84.5%) agrees that climate change "could exacerbate/accelerate social and economic problems currently facing Ethiopia" (AEC11). There is a growing concern that climate change "has the potential to destabilize the Horn of Africa by bringing more fierce competition for water" (AEC12). Interestingly, close to three-fourths (73.5%) of the respondents share this concern, and only 11.9% disagree.

The view that climate change "brings opportunities for Ethiopia as it brings more rather than less rainfall" (AEC13) is shared by about 70.8% of the respondents (10.5% disagree). Ethiopia is often presented as "well positioned to become a regional leader in low carbon growth" (ACE15). Close to three-forth agree whereas less than ten percent of the respondents disagree to the view thereby rejecting one of the most popular views often portrayed by official sources. More than four-fifths (82.1%) of the respondents agree that the Ethiopian government "should have stronger restrictions on the gas mileage of new cars" (AEC3). In line with this, 42.4% of the respondents disagree with one of the most anthropocentric views that Ethiopia "should not be forced to compromise future economic growth and wellbeing by restricting emissions of greenhouse gases" (AEC14).

Teachers' practices related to energy use and environmental protection

The participants of the study reported active participation in pro-energy and environmental activities (Table 11). Close to three-fourths (74.2%) of the respondents reported that they encouraged "neighbors/relatives to use improved cooking stoves (stoves that save fuel wood)" (BEC1) whereas even a higher proportion (82.2%) said that they encouraged "family to use improved cooking stoves" (BEC2). Similarly, three-fourths and more than half (55.2%) of the respondents reported intentionally buying "power saving lamps" (BEC3); and walking "short distances, instead of taking a taxi or Bajaj to save energy" (BEC4); respectively.

Table 11: *Practices related to energy use and environmental protection*

Item no	Statement		Response				
			NA	**R**	**S**	**F**	**A**
BEC1	I encourage neighbors/relatives to use improved cooking stoves (stoves that save fuelwood).	n	8	18	50	59	159
		%	2.7	6.1	17.0	***20.1***	***54.1***
BEC2	I encourage the family to use improved cooking stoves (stoves that save fuel wood).	n	9	7	39	64	174
		%	3.1	2.4	13.3	***21.8***	***59.4***
BEC3	I intentionally buy power-saving lamps.	n	12	27	36	69	148
		%	4.1	9.2	12.3	***23.6***	***50.7***
BEC4	I walk short distances, instead of taking a taxi or Bajaj to save energy.	n	30	34	67	69	93
		%	10.2	11.6	22.9	***23.5***	***31.7***
BEC5	I mobilize communities to engage in environmental protection activities.	n	14	27	72	69	114
		%	4.7	9.1	24.3	***23.3***	***38.5***
BEC6	I plant trees based on my own initiative.	n	13	22	68	60	130
		%	4.4	7.5	23.2	***20.5***	***44.4***
BEC7	I plant trees in response to the government's/NGO's call.	n	14	22	33	84	143
		%	4.7	7.4	11.1	***28.4***	***48.3***
BEC8	I teach/train/preach about environmental protection.	n	18	31	46	73	127
		%	6.1	10.5	15.6	***24.7***	***43.1***
BEC9	I turn off electric devices whenever they are off use.	n	3	8	31	58	196
		%	1.0	2.7	10.5	***19.6***	***66.2***
BEC10	I turn off the lights whenever leaving a room.	n	6	17	27	63	181
		%	2.0	5.8	9.2	***21.4***	***61.6***
BEC11	I ride a bicycle, instead of taking a taxi or Bajaj to save energy.	n	77	37	58	49	74
		%	26.1	12.5	19.7	***16.6***	***25.1***

NA= Not at all, R= rarely, S=Sometimes, F= frequently, A= Always

Close to two-thirds (61.8%) of the respondents reported having mobilized "communities to engage in environmental protection activities" (BEC5) whereas more than two-thirds (67.8%) indicated that they taught, trained, or preached "about environmental protection" (BEC8). About tree planting, a little less than two-thirds (64.9%) of the respondents said that they planted trees "based on my initiative" (BEC6) while a much greater proportion (76.7%) reported that they took part in tree planting activity "in response to government's/NGO's call" (BEC7).

A great majority (85.6% and 83%) of respondents reported that they "turn off electric devices" (BEC9) whenever such devices are off use; and "turn off the lights whenever leaving a room" (BEC10), respectively. The only action in the questionnaire that was reported to have not been

practiced frequently enough was riding a bicycle, "instead of taking a taxi or Bajaj to save energy" (BEC11). A nearly equal proportion of the respondents reported that they practice this frequently/always (41.7%) and rarely/not at all (38.8%).

In general, the respondents reported a great deal of engagement in all the activities related to energy and environmental protection except riding a cycle, which was exercised by less than half of the respondents. Such a strong engagement in pro-energy and environmental activities is not expected given the largely unfavorable attitude toward issues related to the causes and consequences of climate change.

Variations in teachers' attitudes and practice concerning different variables

In this research, primary school teachers' mean score in attitude and practice was compared with respect to cities, gender, educational level, the field of study, and experience.

Variations between cities

ANOVA can be used to check the significance of the differences between the scores of teachers' attitudes towards climate change. Since Levene's test is statistically significant (p=0.021), it is not possible to interpret the F-test value indicated in Table 12.

Table 12: *Results of ANOVA for comparison of cities*

Variable		Sum of Squares	df	Mean Square	F	P
Attitude	Between Groups	7.034	4	1.759	3.892	.004
	Within Groups	132.834	294	.452		
	Total	139.868	298			

In such cases, a good alternative is to run an ANOVA with the Welch statistic. To test for a robust equality of mean among the five cities, a Welch test was conducted and it was found that $F_{Welch}(4,132.7)=3.049$; P=0.019. Therefore it was found that there is a significant violation of homogeneity of means.

To spot the place where a statistically significant difference was detected in the attitude variable, a post hoc test was conducted. Since the assumptions of homogeneity of variance were not assumed for the attitude variable, Tamhane's T2 was run. This is because Tamhane's T2 is an appropriate post hoc test when variances are unequal and/or sample sizes are different (De Muth & Bruskiewitz, 2006). Tamhane's T2 test showed that the difference between the mean scores of Jimma and Bahirdar cities which was M=0.485 at P=0.014 was significant. Hence, it can be concluded that the attitude of teachers towards energy and climate change shows the existence of differences between cities.

On the other hand, ANOVA was used to check the significance of the differences between the scores of teachers' practice in addressing energy and climate change-related issues as the assumptions of normality were not violated for this variable.

Table 13: *Results of ANOVAs between cities for practice variable*

Variable		Sum of Squares	df	Mean Square	F	P
Practice	Between Groups	3.784	4	.946	1.353	.250
	Within Groups	205.493	294	.699		
	Total	209.277	298			

The results of the analysis of variance between cities do not show the existence of statistically significant differences for the practice (F(4, 298)=1.353; P=0.250).

Variations by gender

An independent sample t-test was used to evaluate the significance of the differences between male and female teachers in the attitude and practice components of the instrument. The result is indicated in Table 14.

Table 14: *Independent sample t-test results*

		N	M	SD	t	df	P
Attitude	Male	153	3.713	.5650	1.145	296	.253
	Female	145	3.622	.7937			
Practice	Male	153	4.024	.8531	2.260	296	.025
	Female	145	3.806	.8094			

It is to be seen in Table 14 that there is a significant difference between male and female teachers' scores on the practice aspects ($t(296) = 2.260$, $P < 0.05$) but no significant differences in attitudes between male and female teachers ($t(296) = 1.145$, $P > 0.05$). Although the overall result shows the existence of statistical significance, the separate t-test analysis does not show the existence of a statistically significant difference between male and female teachers found in each of the cities.

Variations by educational level, field of study and experience

ANOVA was conducted to determine the statistical differences between the groups concerning the three variables: educational level, field of study, and experience for each of the two components: attitude and practice (Table 15) as the assumptions of normality were not violated.

Concerning the education level and experience, no statistically significant difference was observed between the groups for the attitude (F(3, 298)=2.104; P=0.100 and F(2, 298)=1.732; P=0.179, respectively) and practice component (F(3, 298)=0.581; P=0.628 and F(2, 298)=0.312; P=0.732, respectively). Concerning the field of study as well, there were no statistically significant differences between the groups concerning the practice (F(4, 298)=0.195; P = 0.941), though a slightly significant difference was observed for those from Hawassa city (F(2.819)=3.243, P=0.049). However, there were no such differences concerning attitude (F(4, 298)=0.834; P = 0.505).

Table 15: *ANOVA results showing the variations between groups concerning educational level, field of study, and practice*

			Sum of Squares	df	Mean Square	F	P
Educational level	Attitude	Between Groups	2.930	3	.977	2.104	.100
		Within Groups	136.938	295	.464		
		Total	139.868	298			
	Practice	Between Groups	1.228	3	.409	.581	.628
		Within Groups	208.049	295	.705		
		Total	209.277	298			
Field of study	Attitude	Between Groups	1.618	2	.809	1.732	.179
		Within Groups	138.250	296	.467		
		Total	139.868	298			
	Practice	Between Groups	.440	2	.220	.312	.732
		Within Groups	208.837	296	.706		
		Total	209.277	298			
Experience	Attitude	Between Groups	1.569	4	.392	.834	.505
		Within Groups	138.299	294	.470		
		Total	139.868	298			
	Practice	Between Groups	.553	4	.138	.195	.941
		Within Groups	208.725	294	.710		
		Total	209.277	298			

Conclusion and Implications

This paper presented the results of a study that assessed energy and climate change literacy among primary and middle school teachers in selected cities in Ethiopia. Energy literacy is understood as a broad term encompassing content knowledge as well as affective and behavioral aspects (DeWaters & Powers, 2013). In other words, energy literacy extends to include not just knowledge about and attitudes/values toward energy but also to encompass actions and behaviors. Efforts to measure and promote energy literacy are, therefore, expected to take a similarly broad approach, "emphasizing knowledge of traditional, scientific and technical energy content as well as of energy issues framed within a societal context". On the other hand, the specific aspects of these various components of energy literacy will be strongly influenced by the geographic and cultural context for which they are intended. Similarly, climate literacy is believed to include both knowledge about climate change and the ability to analyze climate data and evaluate and reflect on behavior (Mittenzwei, et al.,). With this background, this presented study tried to assess the awareness, attitude, and practice related to energy and climate change education among teachers in Ethiopia.

DeWaters and Powers (2013) argue that an energy-literate individual is expected to understand the impacts that energy production and consumption have on all spheres of environment and

society; is cognizant of the impacts of individual, collective, and corporate energy-related decisions and actions on the global community; is aware of the need for energy conservation and the need to develop alternatives to fossil fuel-based energy resources; and strives to make choices, decisions, and take actions that reflect these understandings and attitudes concerning energy resource development and energy consumption, and is equipped with the necessary skills to do so. Getting citizens who meet such expectations is highly desirable to ensure a sustainable future. It is even more desirable to have teachers with such a profile as they have a double responsibility: one related to their own lives and another to the lives of students under their care.

It is, for instance, widely recognized that teachers are 'the key stakeholders in the climate change discourse' (Hung, 2023, p.118). It is also true that teachers to be effective in promoting energy and climate change literacy, they have to meet the minimum expectation in the area. Previous studies warn that teachers themselves could have low levels of energy and climate change literacy and even serious misconceptions about concepts related therewith. Some of such studies indicate that prospective teachers held the same erroneous understanding as that of secondary students. Hung (2023, p.118) thus warns that if "teachers themselves have misconceptions, then they are more likely to pass on these same erroneous understandings to their students". This paper reports the results of a study that attempted to assess energy- and climate-change literacy among primary and middle school teachers in selected cities in Ethiopia. The following are the key findings of the study.

First, teachers' performance on basic facts and principles underlying energy resources and their utilization is found to be quite promising except in some cases particularly related to the situation in Ethiopia. The areas in this category which challenged the respondents are related to renewable energy sources and technologies. For instance, close to four-fifth of the responders had no idea or a piece of wrong information about the possibility of replacing fossil fuel shortly. Similarly only less than half of the respondents knew that most "renewable sources generate energy only intermittently; when the sun is shining or the wind is blowing". Given the promise of renewable energy sources and technologies to address most of the problems related to climate change, the low awareness in this area should be taken as a serious cause for concern.

Second, teachers' awareness of the basic facts related to climate and climate change is very low. This is quite worrisome as the respondents are teachers who are expected not to have the kinds of misconceptions their students have about the meaning, causes, and consequences of climate change. With respect to the impacts of climate change in developing countries, the study showed a mixed performance (very poor performance on issues related to the African continent).

Third, teachers who took part in this study seem to have an unfavorable view about issues related to production and use of energy resources. A significant number of participants had a generally negative view on some of the statements pertaining to causes and consequences of climate change in Ethiopia. For instance, more than half of the respondents supported the statement "I don't worry about turning lights and computers off in the classroom, because the school pays for the electricity".

Fourth, the participants of this study reported a great deal of engagement in all the activities related to energy and environmental protection except riding a cycle which was exercised by less than half of the respondents. Such a strong engagement in pro-energy and environmental activities is not expected given the largely unfavorable attitude toward issues related to the causes and consequences of climate change.

Fifth, the analysis of variance between groups shows that there was a statistically significant difference among teachers from different cities concerning their attitude and practice. Similarly, a statistically significant difference was observed between male and female teachers' scores on the practice aspects but no significant differences in attitude. About the level of education and experience, the results indicate no statistically significant difference in attitude. Likewise, no statistically significant difference was found based on differences in fields of study.

According to the results, implications and recommendations emerge for educators, teachers, researchers, curriculum developers, and policymakers. Education on energy and climate change ought to be seen as a vital subject for both classroom instruction and teacher preparation programs in the future. Primary and middle school teachers play a critical role as agents of energy and climate change knowledge transfer within the classroom yet this study revealed gaps in their knowledge of the same. This direction could be helped by adopting curricula that are in line with global trends in energy and climate change education, or by better integrating concepts and issues related to energy and climate change into curricula holistically and critically. Due to its complexity, energy and climate change may be difficult for elementary and middle school teachers to understand. Therefore, when creating energy and climate change curricula for elementary and middle schools, curriculum designers should collaborate with teachers to ensure that the material is clear and concise, taking into account the complexity of these subjects. The government should, through the Ministry of Education, develop comprehensive programs for primary and middle school teachers that emphasize energy and climate change awareness, as well as strategies for strengthening their competence. Further research is needed to determine the factors that influence the knowledge, attitudes, and behaviors of elementary and middle school teachers about energy and climate change. The fast-growing number of scientific papers reflects the growing significance of effective education on energy and climate change concerns

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