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**To cite this article:**

Gebeyehu, D., Dalelo, A., Eshetu, F., Belachew, W., Wodaj, H., Abate, A., & Hagos, M. (2024). Energy-, environmental-, and climate change literacy among primary and middle school students. *International Journal of Research in Education and Science (IJRES), 10*(1), 100-124. https://doi.org/10.46328/ijres.3330

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IJRES International Journal of Research in Education and Science
2024, Vol. 10, No. 1, 100-124 https://doi.org/10.46328/ijres.3330

# Energy-, Environmental-, and Climate Change Literacy among Primary and Middle School Students

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## Article Info

***Article History***

Received:
22 September 2023
Accepted:
25 December 2023

***Keywords***

Climate change,
Energy education,
Environmental education,
Literacy,
Primary and middle schools.

## Abstract

The aim of the present study was to assess the energy- environmental-, and climate change literacy among primary and middle school students in selected cities of Ethiopia. This survey study was conducted in primary and middle schools found in six cities and involved a total of 1589 students. The finding indicate that the participants of the study had a very good awareness about principles underlying generation and use of energy but performed much poorly in items related to awareness about impacts of climate change. The paper also concluded that students' views about issues related to generation and use of energy cannot be considered as favorable. On the other hand, the results on practices related to energy use and environmental protection reveal that participants reported pro-energy and environmental practice. Interestingly, the practice of participants doesn't seem to align with the generally unfavorable attitude towards energy generation and climate change. Therefore, it is advised that primary and middle schools offer a thorough education on energy and environmental education because these levels of instruction have a special role to play in raising awareness of and developing skills and attitudes related to environmental and climate change education.

## Introduction

### Climate Change as the Greatest Policy Issue of our Time

Indeed, there is a growing understanding among scholars and policy makers about the critical role energy plays in today's world as well as the complexity as to how energy issues are intertwined with technical, societal, economic, and environmental aspects of everyday life (DeWaters & Powers, 2011; DeWaters et al, 2013). Historically, the development of human societies is believed to be associated with developments in their ability to harness energy from various sources, including the foods they consumed, the warmth of the sun, and the combustion of various carbon-rich fuels. Reliance on energy-rich sources of fossil fuels has, for instance, enhanced unprecedented mobility, industrial growth, domestic comfort, a lavish food supply and economic prosperity (DeWaters & Powers, 2013).

It is equally true that people across the globe are facing the consequences of the worsening environmental

conditions owing to extensive use of fossil fuels. One of the consequences is the increasing danger posed by climate change which is now widely perceived as "the greatest public policy issue of our time" (Anderson, 2010, p.13). Similarly, Yeh, Huang, and Yu (2017, p.1) present climate change as "one of the most critical challenges that human beings face at this stage of human development". This is because most of the environmental problems currently witnessed in the world, including climate change, are directly or indirectly caused by energy extraction/conversion/utilization thereby necessitating, among other things, designing and application of an appropriate energy and environmental education strategy (Kandpal & Garg, 1999).

In Ethiopia, over the last five decades or so, temperature increased at about 0.2°C per decade. Precipitation, on the other hand, remained fairly stable over the last 50 years when averaged over the country (Keller, 2009). However, the spatial and temporal variability of precipitation is high showing that large-scale trends may not necessarily reflect local conditions. The future changes in precipitation and temperature as projected by various global climate models show an increase in precipitation in both the dry and wet seasons though studies with more detailed regional climate models indicate that the sign of the expected precipitation change is uncertain. It has also been projected that increases in the interannual variability of precipitation in combination with the warming will likely lead to increases in the occurrence of droughts. Furthermore, heavy rains and floods are projected to increase as well. Thereby, the issue of environmental problems in Ethiopia is most severe and complex (Sulaiman et al., 2008; Argado, 2017; Aticho et al., 2019).

Detrimental and beneficial impacts of the ongoing and projected climate change and variability in Ethiopia are widespread in both socio-economic and natural systems (Keller, 2009). For instance, the increasing year-to-year variability and increases in both droughts and heavy precipitation events are believed to lower agricultural production with corresponding negative effects on food security whereas the availability of clean drinking water is likely to decrease due to the increasing evaporation and the increasing variability of rainfall events. There is also a widespread prognosis of incidences of malaria in areas of the highlands where malaria was previously not endemic. What is more, the warming is further expected to cause an increase in cardio-respiratory and infectious diseases. A large number of plant and animal species is threatened by extinction, as climate conditions are changing too quickly for them to adapt. It is also known that heavy rainfall events and floods have the potential for causing damages to roads and buildings.

It is also worth underscoring that, compared to other countries; Ethiopia's emission contribution is negligible and accounts for only 0.53% of global GHG emissions (UNFCCC, 2022). The country's GHG emissions are closely linked to basic needs of the population like food production (through livestock farming) and heating. It can thus be seen that the future GHG emissions will likely increase with the projected increase in population (Keller, 2009).

Sector wise, Ethiopia's GHG emissions are dominated by agriculture, which contributes 80% of the total GHG emissions reflecting the fact that livestock farming goes together with high methane emissions. In addition to agriculture, the energy sector (heating, cooking, and transport) contributes to the total GHG emissions with 15%, 95% of the energy consumption is satisfied by biomass sources (mainly wood); petroleum and electricity are of minor importance.

**Contribution of this Paper to the Literature**

- The purpose of the present study was to investigate the energy- environmental-, and climate change literacy among primary and middle school students in selected cities of Ethiopia.
- In this study, we have demonstrated that primary and middle school students' performance on issues related to energy, the environment, and climate change is generally acceptable but not adequate.
- The findings indicate that all types of primary and middle school teaching in Ethiopia require the development and implementation of well-structured global energy, environmental, and climate change education curricula issues and their local impacts.
- By conducting a literature review, we hope to fill this knowledge vacuum and establish a foundation for future studies on science education that will promote energy, environmental, and climate change literacy.

**Efforts to Address the Problem**

The past three or four decades saw a systematic effort, mainly in the industrially advanced world, to address world energy crises, environmental problems and issues as well as the effects of climate change using diverse strategies. Energy and environmental problems are closely related. Surely the processes of extracting, processing, transporting and utilization of energy resources affect the environment, human health and climate change (Umar & Abubakar, 2014). It is well known that the exhaustive extraction and practice of fossil energy is the main reason and contributor to many severe environmental issues (Mallikarjun et al., 2016). On the other hand, developing renewable energy systems that exploit the sun, the wind, bio, and geothermal energy is critical to addressing concerns about climate change and some environmental issues (Mallikarjun et al., 2016). It is also recognized that the future energy path will be determined not just by professionals and politicians, but by every citizen who participates in society. An informed, energy- and environment literate public is believed to be better equipped to make thoughtful, responsible energy-related decisions and actions. Such a recognition gave energy- and environmental education or literacy its rightful position both in academic discourses and policy debates. It was strongly contended, for instance, that if the international community is to respond to the change posed by climate change, "education has a key role to play in empowering individuals to make informed choices and develop behaviors that reorient society toward enhancing resilience and sustainable practices" (Anderson, 2010, p.13).

Education is widely believed to have a direct contribution to address the issue of energy and climate change as well. Education is conceived, for instance, as "an essential component and a catalyst for responding to global climate change" by raising awareness and promoting knowledge and skills-development (UN, 2013, p.4). Addressing the causes, effects, and risks of climate change and appreciating the range of options to minimize negative impacts and maximize resilience is said to require a combination of all the energy and climate literacy efforts and infusing them throughout the curriculum (McCaffrey, 2015). DeWaters and Powers (2013, p.38) also argue that "an informed, energy-literate public is more likely to be engaged in the decision making process and will be better equipped to make thoughtful, responsible energy-related decisions, choices, and actions".

Energy- and environmental education (literacy) programmes have often been classified in a variety of ways

depending upon the attribute used and age and level of participants involved (Ateş, 2020; Bulut, 2022; Kandpal & Garg, 1999; Samur & Akman, 2023). For example, the energy-education programmes for the general public (i.e. informal education) will, of necessity, be quite different from those targeting schools and institutions of higher education. Similarly, Miléř and Sládeka (2011) rightly underline that climate education can be formal (schools) and informal (media, museums, libraries, zoos). Informal education has the power to engage people of all ages and can achieve quick responses while formal education engages a mostly young generation, which is important for the future development of society. What follows is a concise review of the literature on the state of energy-environmental- and climate change education in formal settings.

### The Problem and Rationale

Though it is widely recognized that education can enable individuals and communities to make informed decisions and take action for climate resilient sustainable development, policymakers often fail to engage the education sector (Anderson, 2010). The international community and particularly those within the climate change arena are strongly criticized for having overlooked the role of education in bringing about behavior change for mitigation. On the other hand, it is strongly argued that addressing the ever increasing threat posed by climate change cannot be achieved without engaging schools and educators (Anderson, 2010). Educators have, for instance, a track record in educating for social change and can use their expertise on knowledge, skills, and attitude and behavior change to help reduce greenhouse gas emissions.

In addition to education's integral role in behavior change, schools have a role to play in mitigation in terms of becoming carbon neutral and reducing their own ecological footprint. Education is also a critical component of adaptive capacity, along with health, assets and governance. It is hence argued that an informed, energy literate public will be better equipped to make thoughtful, responsible energy-related decisions and actions (DeWaters & Powers, 2011). There are also some encouraging reports that "young people are increasingly well-informed and aware of environmental issues and the impact of increases in greenhouse gases in the atmosphere" (Oliver & Adkins, 2020). If such an awareness and activism deepens and spreads across wider cities of a country, its impact on policy and practice would really be significant. Akitsu (2017, p.1067) rightly underscores that "energy literacy is indispensable for a sustainable society, which is fostered and improved by formal and informal energy education". The aim of the present study was to assess the energy- environmental-, and climate change literacy among primary and middle school students in selected cities of Ethiopia. The study sought to answer the following research question: What is the level of energy- environmental-, and climate change literacy among students in primary and middle school of selected cities of Ethiopia?

## Theoretical Background

### Energy-, Environmental- and Climate Change Education in a Formal Setting

Schools, through their energy-, environmental- and climate change education programs, could teach about how natural environments function and how individuals can manage their behavior and ecosystems to live sustainably thereby fostering the effective integration of environmental stewardship and climate change education into

educational programs and school curricula (Anderson, 2010; Gebeyehu, 2008, 2018). Such programs are hoped to promote not only knowledge about energy, environment, climate change and the associated challenges but also foster attitudes and motivations to make informed decisions and take responsible action. Besides, while offering energy-, environmental- and climate change education or literacy in an integrated fashion, schools could run age- and grade level specific education focusing on each of these components as suggested below. Because, energy-, environmental-, and climate change literacy that can empower people to make thoughtful decisions and take responsible actions is more important as energy shortages, environmental problems and issues as well as impacts of climate change have become pressing issues in Ethiopia (Nigatu et al., 2014) as well as in the world.

**The Operationalization of Energy Literacy**

Energy literacy, which encompasses broad content knowledge as well as affective and behavioral characteristics, is hoped to empower people to make appropriate energy-related choices and embrace changes in the way we harness and consume energy (DeWaters & Powers, 2011; Chen et al., 2015; Bamisile et al., 2016; Öykün & Abbasoğlu, 2017). Therefore, since energy is all about making decisions, energy literacy is essential because informed and educated citizens serve as the foundation for the development and implementation of wise and progressive policies. An energy literate individual is one who understands 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 with respect to low-carbon renewable energy resource development and energy consumption, and is equipped with the necessary skills to do so (DeWaters & Powers, 2013; Zyadin et al., 2012).

Programs aimed at creating energy literacy are expected to cover four core dimensions of energy education: energy concepts, reasoning on energy issues, low-carbon lifestyle, and civic responsibility for a sustainable society. It has been strongly suggested that primary-school level energy-education programmes should aim at creating awareness about all energy sources and should also make the students conscious of the various environmental implications of energy extraction, conversion and utilization (Kandpal & Garg, 1999; Gebeyehu, 2008, 2018). On the other hand, the objective of secondary-school level energy-education programmes should be to develop basic preparatory knowledge and skills for undertaking advanced studies in the field of energy at higher levels. The university-level energy-education programmes must provide in-depth theoretical knowledge of various energy technologies and systems, besides providing practical hands-on skills, training in design, fabrication, installation and maintenance of the same.

**The Operationalization of Environmental Literacy**

Environmental education encompasses approaches, tools, and programs that develop and support environmentally related attitudes, values, awareness, knowledge, and skills that prepare people to take informed action on behalf of the environment (Monroe and Krasny, 2016; UNESCO, 1978; Lee et al., 2015; Edsand & Broich, 2019;

Zachariou et al., 2020). As an evolving concept, environmental literacy has been conceived as the major outcome of environmental education. Furthermore, environmental literacy is conceptualized, by UNESCO, as a "basic functional education for all people, which provides them with the elementary knowledge, skills, and motives to cope with environmental needs and contribute to sustainable development," (UNESCO, 1989, cited in DeWaters & Powers, 2013, p.42). It has been rightly underlined that energy education, vital though it is, remains incomplete if it doesn't explicitly address the impacts of human activities, specifically the combustion of buried solar energy/fossil fuels, on the environment in general and climate system in particular (McCaffrey, 2015).

**The Operationalization of Climate Change Literacy**

Climate Literacy is short for ***Climate Science Literacy***, which is an understanding of human impacts on climate and the impacts of climate on human systems. One of the first attempts to define climate literacy was made in 2007 at a workshop on "Climate & Weather Literacy" where a group of scientists and educators developed an initial framework for weather and climate education (Miléř & Sládeka, 2011; Mittenzwei, et al., 2019). According to this group, climate literacy refers to an understanding of the climate's influence "on you and society and your influence on climate." More specifically, a climate literate person is presented as the one who understands the essential principles of all aspects of the Earth system governing climate patterns; knows how to gather information about climate and weather, and how to distinguish credible from non-credible scientific sources on the subject; communicates about climate and climate change in a meaningful way; and makes scientifically informed and responsible decisions regarding climate. Climate literacy thus describes "not only knowledge of climate change, but also the ability to analyze climate data and to evaluate and reflect on behavior' (Mittenzwei, et al., 2019, p.3).

**The Knowledge-Attitude-Practice Relationship**

It is noted that, more generally, increased knowledge tends to improve feelings of self-confidence in one's ability to ask intelligent questions and think critically about a subject, and as that confidence grows the individual is more likely to participate in decision making (Pearson & Young, 2002 cited in DeWaters & Powers, 2013,). However, the link between knowledge, attitude and action is not always clear as can be seen from the results of empirical studies reported briefly hereunder.

**Factors Affecting Pro-Energy, Environmental- and -Climate Change Actions**

Some empirical studies show that children exhibit a high level of awareness and concern about climate change and this, in turn, affects their visions of – and anxieties about – their own future and that of the world in general. A survey conducted in the UK found that 24 per cent of the 10-18 year-olds questioned "believed climate change presented the greatest threat to the world's future" (UNICEF, 2008, p.28). Another study conducted in the UK found that around 50 per cent of children aged 7-11 "are anxious about global warming and "often lose sleep" over it". A cross-national study, based on secondary data from the Programme of International Student Assessment (PISA) and involving more than half a million students in 72 OECD and partner countries, investigated the extent to which students are informed on the issue of climate change (Oliver & Adkins, 2020).

The researchers claim that their analysis of these data provides unparalleled insight into fifteen-year-old students' self-reported awareness about greenhouse gases and how this varies by achievement, enjoyment of and interest in science, students' socio-economic status and country of origin. The results indicate that there are substantial global variations in students' awareness of greenhouse gases, which is independent of the international ranking of PISA scores; and measures of scientific literacy are found to have the greatest association with students' awareness about greenhouse gases, although enjoyment of science and interest in broad scientific topics suggests that school science courses that are rigorous in content and enjoyable for students prepare them to be well informed citizens about climate change.

A study conducted to establish what elementary students knew about sources of energy, climate change, and renewable and nonrenewable energy sources while attending an energy learning event revealed that students' ideas about the types of energy were still developing (Boylan, 2008). Up to half of the elementary students held specific misunderstandings about renewable and non-renewable energy sources. Besides, many students were not clear about how the key environmental concepts of climate change, greenhouse emissions and global warming are different from each other.

Zerinou et al *(*2020) examined the attitudes and views of fifth- and sixth-grade students and their parents about energy and water saving as well as environmental protection in the municipality of Orestiada, Greece. They reported that both parents and students had similar energy saving habits (turning the tap off during brushing teeth or shaving, taking baths without filling the bathtub with water, turning off the shower while lathering up, pulling down the shutters at night, and switching off the lights when leaving a room). Besides, both students and parents expressed similar practices regarding watering plants in the garden or on the balcony (most of them preferring to water plants in the afternoon or at night, that is, the time that some quantity of water can be saved) (Zerinou et al., 2020).

A Malaysian study that investigated the levels of energy literacy among Grade 8 students found that levels were relatively low suggesting that the implemented curriculum had failed to meet the specifications of the intended curriculum that emphasizes the relevance of energy-related issues to students' everyday life experiences (Lay et al, 2013). The authors suggest that there is a need to emphasize the importance of a "context-based curriculum specifying criteria that embrace broad energy literacy with benchmarks related not just to science-related energy content but also recognizing the importance of practical energy-related knowledge, decision making skills, value judgments, ethical and moral dimensions, and issues of personal responsibility related to energy resource development and consumption".

A quantitative study that examined the effectiveness of a geospatial curriculum approach (geospatial technologies (GT)) to promote energy literacy among eighth-grade students (ages 13–15) in an urban school district in Pennsylvania, found a statistically significant gains from pretest to posttest on knowledge of energy resource acquisition, energy generation, storage and transport, and energy consumption and conservation (Bodzin, 2013). The GT students had year-end energy content knowledge scores significantly higher than those who learned with the business as usual (BAU) curriculum. The findings support that the implementation of a geospatial curriculum

approach that employs learning activities that focus on the spatial nature of energy resources can improve the energy literacy of urban middle-level education students.

A study by (Akitsu, 2017) that investigated energy literacy and its structural model for lower secondary (ages 13–15) students in Japan found that female students and students who have family discussions about energy-related issues scored higher than their counterparts. The energy literacy structure model was described by six predictors by structure equation modeling, where energy-saving behavior was predicted by both the awareness of consequences and the ascription of responsibility (Akitsu, 2017). Both the awareness of consequences and the ascription of responsibility were predicted by basic energy knowledge through the cognition of environmental issues. The prediction of energy-saving behavior by the awareness of consequences indicates the role of bonding between the relevant knowledge on energy and the environmental issues and energy-saving behavior.

## Method

### Research Design and Method

The various components of energy literacy discussed in the foregoing sections are strongly influenced by the geographic and cultural context for which they are intended. The implication is that efforts to measure and promote energy literacy need 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 (DeWaters & Powers, 2011; Chen et al., 2015). The present study therefore employed descriptive survey design as it is believed to suit this situation better. Pinsonneault and Kraemer (1993, p.77) defined a survey as a "means for gathering information about the characteristics, actions, or opinions of a large group of people". Surveys can also be used to assess needs, evaluate demand, and examine impact (Salant & Dillman, 1994).

### Participants of the Study and Sampling Techniques

This study was conducted in primary and middle schools found in six cities (i.e., Addis Ababa, Diredawa, Bahr dar, Hawassa and Jimma). The samples were thus selected from nine primary and middle schools found in Addis Ababa city and six primary and middle schools found in each of the remaining cities. The selected schools as well as the sampled respondents were selected randomly. Table 1 shows the number of respondents included in each of the regions/cities.

Table 1. Sample Respondents by City

| S/N | City | Sampled respondents |
|---|---|---|
| 1 | Addis Ababa | 436 |
| 2 | Bahr dar | 294 |
| 3 | Diredawa | 295 |
| 4 | Hawassa | 283 |
| 5 | Jimma | 281 |
| Total | | 1,589 |

**Data Collection Instruments**

Survey questionnaires were used to collect students' knowledge, attitudes and practices related to energy and climate change education. For the knowledge part, the survey questionnaire consists of thirty questions prepared on a three rating scale (1= no idea, 2 = wrong and 3 = correct). The practice part consists of eleven items prepared on a five point likert-scale ranging from 1 = not always to 5 = always. Similarly, the fifteen attitude items were prepared based on a five point likert-scale ranging from 1 = strongly disagree to 5 = strongly agree. All the instruments were prepared by the thematic research team.

**Validity and Reliability**

All the instruments were distributed to professionals for their comments and were presented in a validation workshop to get them commented and determine their validity. The instruments were further reviewed based on the comments of professionals for the face and content validity. Moreover, pilot study was conducted on students who were not included in the main study to determine the validity and reliability of the instruments. Cronbach alpha was calculated and the result is presented in Table 2.

Table 2. Cronbach Alpha Values for the Energy and Climate Change Education Instruments

| S. No | Components | Cronbach alpha |
|---|---|---|
| 1 | Knowledge | 0.79 |
| 2 | Practice | 0.74 |
| 3 | Attitude | 0.83 |

The alpha coefficients of Cronbach in Table 2 yielded greater than 0.7 for the pilot and the main study thereby indicating that the instruments have acceptable internal-consistency and, thus, are reliable.

**Data Analysis**

In this study, descriptive statistics such as frequency tables and percentages, mean and standard deviation were used. In addition, some inferential statistics of comparison such as independent sample t-test, chi-square and ANOVA were used for the data analysis to see variations with respect to different categories.

## Results and Discussion

**Awareness about Issues Related to Energy and Climate Change**

Previous studies have shown that people hold misconceptions about energy, and for young students these may persist into adulthood (Yeh et al., 2017). Similarly, Mittenzwei et al. (2019) suggest that, although curricula across the globe have strengthened efforts to support teaching the energy concept, most learners struggle to develop a deep understanding of energy. Nine of the questions in the awareness test prepared for the current study were related to basic principles underpinning energy production and use (Table 3). Respondents' performance seems

quite impressive in three of the nine questions. A large majority of the respondents had a correct answer pertaining conversion of electrical energy to light (Q3 = 85.5%); the factors that determine the amount of electrical energy an electrical appliance consumes (Q1 = 83%); and the source of electricity produced in Ethiopia (Q9 = 84.6%). Close to half of the respondents had a correct response with regard to energy resource currently in use in Ethiopia (Q6 = 49.3%). On the other hand, 27.1% of the respondents got the question wrong. Close to three-fourth (Q7 = 70.9%) had a correct answer related to the benefit of energy conservation. Almost an equal proportion of the respondents had the right answer to the question related to the type of activity that consumes the most electricity in an average Ethiopian urban household (Q8 = 69.6%). Table 3 indicates the basic principles of energy.

Table 3. Energy: Basic Principles

| Item No. | Question | Performance (%) | | |
|---|---|---|---|---|
| | | N | W | C |
| Q1 | 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. | 7.7 | 9.3 | *83* |
| Q2 | Electrical energy is converted to light and heat when you turn on an incandescent bulb. | 3.8 | 10.4 | *85.8* |
| Q3 | It is impossible to build a machine that produces more energy than it uses. | 20.1 | 42.9 | 37 |
| Q4 | Renewable energy resources are those resources replenished by nature in a short time. | 17.1 | 28.2 | *54.8* |
| Q5 | Fossil fuels provide about 85% of the energy used in developed countries like the United States and Europe. | *38.6* | 27.1 | 34.3 |
| Q6 | Coal is the most abundant of the fossil fuels currently under use in Ethiopia. | 23.6 | 27.1 | 49.3 |
| Q7 | Energy conservation is the single fastest and most cost-effective way to address our energy needs. | 11.1 | 18.1 | *70.9* |
| Q8 | Baking and cooking consume the most electricity in the average Ethiopian urban households. | 8.3 | 22.1 | 69.6 |
| Q9 | Most of the electricity produced in Ethiopia comes from water. | 6.6 | 8.8 | 84.6 |

[N= No idea, W= wrong, C=correct]

Only one third of the respondents had a correct answer to the question related to the contribution of fossil fuels to the energy mix in developed countries (Q5 = 34.3%), 38.6% expressing that they had no idea. This makes sense as the question relates to students' knowledge about energy generation in industrially advanced countries. With regard to the conception of renewable energy resources, a little more than half (Q4 = 54.8%) had a correct answer, 45.3% had it wrong or had no idea at all (Table 3). In this category, the only question that challenged the respondents was the one related to energy efficiency (Q3 = 37%), wrongly answered by 42.9% of the respondents. In general, however, the respondents had a very good awareness about principles underlying generation and use of energy. If one considers 50% as a passing mark, this is really an astonishing performance on the part of primary

and middle school students in Ethiopia. The impacts related to energy generation is shown in Table 4.

Table 4. Impacts Related to Energy Generation

| Item No. | Question | Performance (%) | | |
|---|---|---|---|---|
| | | N | W | C |
| Q11 | Generating electricity with photovoltaic (solar) cells is the least harmful to human health and the environment. | 18.6 | 33.1 | 48.3 |
| Q10 | People who live in countries that have large amounts of fossil fuel resources generally have a high standard of living. | 21.6 | 25.7 | 52.7 |
| Q22 | Wind, solar and water power generation schemes cause severe air pollution. | 12.6 | 45.9 | 41.5 |

The second category of questions relate to impacts of generation of energy (Table 4). A little more than half of the respondents (Q10 = 52.7%) responded correctly about the relation between amounts of fossil fuel resources a country has and the standard of living therein. It is important to note that one-fourth of the respondents got it wrong. Close to half of the respondents had a correct response with regard to the impact of generating electricity using photovoltaic (Q11 = 48.3%). On the other hand, 33.1% of the respondents got the question wrong. Interestingly, almost equal proportion of the respondents gave correct (41.5%) and wrong (45.9%) answers to the question related to the effect of wind, solar and water power generation schemes on air quality (Q22). Compared to the first category (Table 3), respondents performed much poorly showing that respondent's awareness about impacts of generation of energy leaves much to be desired. Table 5 provides an explanation of the significance, causes, and effects of climate change.

Table 5. Climate Change: Meaning, Causes and Consequences

| Item No. | Question | Performance (%) | | |
|---|---|---|---|---|
| | | N | W | C |
| Q12 | Climate refers to the day-to-day fluctuations in the conditions of the earth's lower surface atmosphere at a specific location. | 13.1 | 25 | 61.9 |
| Q13 | Greenhouse effect is caused by gases that trap heat radiated from the Sun. | 26.1 | 21.5 | 52.4 |
| Q15 | Climate change could result in a big warming in some places and big freeze in others. | 6.8 | 9.8 | 83.4 |
| Q17 | Average global temperature had risen by about 0.6$^{o}$C since 1900. | 44.2 | 20.3 | 35.5 |
| Q18 | Global warming in some localities could reduce the number of deaths and illnesses resulting from extremely cold weather. | 17.3 | 35.6 | 47.1 |
| Q21 | The Ozone hole was created due mostly to man-made chemicals. | 17.5 | 17.4 | 65.1 |
| Q24 | Climate change is likely to reduce crop growing season thereby forcing some cities to abandon production altogether. | 11.5 | 19.4 | 69.1 |

At school level, climate change education (CCE) is believed to promote learning about the causes and effects of

climate change as well as possible responses; and to develop competences in the field of climate change mitigation and adaptation, with the aim to promote climate-resilient development and reduce the vulnerability of communities in the face of an uncertain future (UN, 2013). Questions in this category therefore address issues related to meaning, causes and consequences of climate change. Less than two-third of the respondents had a correct response to the question related to definition of climate (Q12 = 61.9%), 25% got this wrong. This is worrisome because having the right understanding about climate is a precondition to any discussion on its causes and effects. Even lower proportion of the respondents (52.4%) had a correct answer to the question related to the process underlying the greenhouse effect (Q13). Close to half of the respondents either got it wrong or had no idea at all. The highest performance (83.4%) in this category of questions (Table 5) goes to the question related to the impacts of extreme climatic conditions. However, with regard to the apparently positive localized impact of global warming (Q18), respondents' performance doesn't seem encouraging (47.1% got it correct and 35.6% wrong). This indicates that students' awareness about impacts of climate change lacks depth. Close to 70% of the respondents had a correct answer to the question related to the impact of climate change on crop production (Q24), one fifth got it wrong. Two third of the participants gave a correct answer to the question on causes of the formation of Ozone hole (Q21). The rate of global temperature rise (Q17) is the area where the least performance was seen in this category of questions, with a little more than one third (35.5%) of the respondents providing the right answer and 44.2% expressing having no idea. As this is one of the fundamental issues in climate change science and politics alike, such a depressed performance calls for concern and possible intervention.

The overall performance in this category of the instrument (dealing with meaning, causes and consequences of climate change) is not at all bad as all questions, except two, received more than 50% correct responses. On the other hand, close to one-third of the respondents gave a wrong answer or had no idea in all the cases, except one (Table 5). The effect of climate change on developing countries is depicted in Table 6 below.

Table 6. The Impact of Climate Change in Developing Countries

| Item No. | Question | Performance (%) | | |
|---|---|---|---|---|
| | | N | W | C |
| Q14 | The African Continent has the highest capacity to adapt to climate change. | 19.7 | 20.9 | 59.4 |
| Q19 | In Ethiopia, rainfall declined significantly when averaged for the whole country over the last fifty years. | 29.1 | 22.9 | 48 |
| Q20 | Africa is responsible for about one fourth of global emissions of greenhouse gases. | 33.9 | 24.8 | 41.3 |
| Q26 | Almost all deaths in the world due to weather-related disasters take place in developing counties. | 12.4 | 22.9 | 64.7 |
| Q27 | Ethiopia is extremely vulnerable to climate change mainly because of high dependence on rain-fed agriculture. | 12.2 | 24.6 | 63.2 |

It is evident that developing countries, though they don't contribute much to global warming, suffer more from the consequences of climate change. For instance, weather-related death occurs more in developing counties than

developed (Q26). A little more than two-third of the respondents got this correct and 22.9% got it wrong (Table 6). To the question on Africa's capacity to adapt to climate change (Q14), less than two-third (59.4%) got it right, and 20.9% wrong. Surprisingly, one third of the respondents had no idea as to the degree to which the African continent contributes to emission of greenhouse gases (Q20). Only 41.3% got this right. A similar trend is to be seen in performance specifically related to the issue in Ethiopia. On Ethiopia's vulnerability to climate change (Q27), one-fourth of the respondents had a wrong answer, less than two-third had a correct one. Similarly, more than half of the respondents either got it wrong or had no idea to the question on the pattern of distribution of rainfall in Ethiopia over the recent decades (Q19). Only 48% had a correct answer to such a basic question. In general, performance on issues pertaining to the impact of climate change in Africa as a continent and Ethiopia as a country appears to be less than satisfactory. This is therefore another area that requires a targeted intervention. Measures for mitigating and adapting to climate change are shown in Table 7.

Table 7. Climate Change: Adaptation and Mitigation Measures

| Item No. | Question | Performance | | |
|---|---|---|---|---|
| | | N | W | C |
| Q16 | Adaptation to climate change refers to an adjustment in natural or human system in response to actual or expected climatic change. | 12 | 14.8 | *73.2* |
| Q23 | There are technological alternatives developed over the last five years that could replace fossil fuels quickly or cheaply. | 34.4 | 27.4 | 38.2 |
| Q25 | Adaptation measures are aimed at moderating harm caused by climate change. | 10.1 | 13.6 | 76.3 |
| Q28 | Adaptation measures are aimed at exploiting beneficial opportunities that result from climate change. | 14.5 | 21.9 | 63.6 |
| Q29 | Climate change mitigation measures target the causes of climate change, seeking to reduce the emission of greenhouse gases. | 20.2 | 19.1 | 60.8 |
| Q30 | Most renewable sources generate energy only intermittently; when the sun is shining or the wind is blowing. | 21.8 | 44.3 | 33.9 |

The forth category deals with measures often suggested to reduce the impacts of climate change (Table 7). Close to three-fourth (73.2%) of the respondents had a correct response to the question related to the meaning of adaptation (Q16) whereas a little more than three-forth (76.3%) gave a correct answer to the question on aim of adaptation (Q25) as one of the measures used to reduce the negative impacts of climate change. The rate of a correct response got a bit lower in the case of a related question which states that adaptation measures "are aimed at exploiting beneficial opportunities that result from climate change" (Q28). In this case, 63.6% got it correct and 21.9% had a wrong answer. With regard to mitigation, respondents seemed to have a much lower awareness. Less than two-third (60.8%) had a correct response to the question on definition (Q29), the remaining had it wrong or no idea. On the technological solutions to climate change, the performance went even lower. For instance, on the technological alternatives that "replace fossil fuels quickly or cheaply", respondents had 38.2% correct answer, with a substantial proportion providing a wrong answer (27.4%) and even higher proportion (34.4%) having no idea. This is probably because of the widely prevailing view that technology could fix all environmental problems.

The lowest performance (33.9%) in this category is related to the question that raises the apparent limitation of renewable sources of energy (Q30). In this case, 44.3% got it wrong and one-fifth had no idea (Table 7). The overall performance of students in questions rated to measures against climate change is fairly good except in two cases. It is also interesting to note that performance in questions related to adaptation measures is far better than that of mitigation measures. This is perhaps because of the overall situation Ethiopia is in. As a developing country, Ethiopia has a better chance with respect to adaptation than mitigation.

In general, energy and environmental issues have already proved to be among the major issues threatening the socio-economic fabric of the whole globe. Report by UNICEF argues, for instance, that children, particularly those in Africa and Asia, are already facing a future in which it appears likely that disasters will increase in number and become more intense, where economic growth will falter and incomes fall, where disease outbreaks will be more frequent, clean water and good sanitation harder to secure, and habitats and communities less stable (UNICEF, 2008). A similar argument is made by Anderson (2010, p.3) that people and "particularly children living in poverty in underdeveloped countries with weak governance and poor education systems are the hardest hit by climate change". The implication of all this is that children will have to cope with higher levels of conflict and other pressures which keep them out of school and force them into work too soon.

There is also a consensus around the fact that addressing energy and environmental issues facing the contemporary world calls for learning to change consumption patterns, such as using renewable forms of energy and designing greener technologies. Here comes the potential role of schools and educators. Mitigation of the impacts of climate change, for instance, requires education geared toward learning how to change lifestyles, economies and social structures that are based on excessive greenhouse gas production (Anderson, 2010, p.4). Energy and environmental literacy plays a crucial role as well-informed and well-educated citizens are the basis for the design and implementation of smart and forward-looking policies (Yeh et al., 2017). Likewise, DeWaters and Powers, (2011, p.1699) regard energy literacy as "an important life skill with which to empower today's students as well as the general public".

The students who took part in this study had a very good awareness about principles underlying generation and use of energy. If one considers 50% as a passing mark, this is really an astonishing performance on the part of primary school students in Ethiopia. The literature clearly indicates that a higher degree of energy literacy greatly empowers people to make appropriate energy-related choices and embrace changes in the way people harness and consume energy: "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.56).

Similarly, the overall performance of students in questions related to meaning, causes and consequences of climate change is not at all bad as all questions, except two, received more than 50% correct responses. On the other hand, close to one-third of the respondents gave a wrong answer or had no idea in all the cases, except one. The participants of this research performed much poorly in questions related to awareness about the impacts of generation of energy.

Students' performance in issues pertaining to the impact of climate change in Africa as a continent and Ethiopia as a country appears to be less than satisfactory. This is therefore another area that requires targeted intervention. On the contrary, the overall performance of students in questions related to measures against climate change is found to be fairly good except in two cases. It is also interesting to note that performance in questions related to adaptation measures is far better than that related to mitigation measures. This is perhaps Pause of the overall situation Ethiopia is in. As a developing country, Ethiopia has a better chance in adaptation than mitigation.

**Views about Production and Use of Energy Resources**

One of the goals of energy education is believed to be developing "a well-informed public with positive attitudes toward energy conservation and the ability to make appropriate decisions regarding future energy choices" (Akitsu, 2017, p.1067). The tool used by the present study to measure students' views has two parts. The first part deals with views about production and use of energy resources (Table 8) while the second relates to views about causes, consequences and efforts to control climate change (Table 9). Students seemed to have divided views on most of the statements related to the first category (Table 8). For instance, 48% of the respondents disagree with the view that one doesn't have to "worry about conserving energy, because new technologies will be developed to solve the energy problems for future generations" (A1). Interestingly, less than half of the respondents (39.4%) agree to the same statement. The later view goes in line with the respondents' tendency to trust technological fixes to environmental problem as discussed in the preceding section (Table 7, Q23). Only 10.7% of the respondents endorsed the need for labelling all electrical appliances (A2) so as to show the resources used for making them, their energy requirements, and operating costs. Even a greater proportion of the respondents (81.8%) did not agree to the statement that calls for making "more of our electricity from renewable resources" (A4). Expectedly, more than one-fourth (27%) of the respondents were not ready to take a position on the statement that compares developing renewable energy technologies with new sources of fossil fuels: "Efforts to develop renewable energy technologies are more important than efforts to develop new sources of fossil fuels" (A5). Yet, more than half (59%) disagree to the statement which clearly favors development of new sources of fossil fuels.

Understandably, respondents expressed a highly divided view about the need for making laws aimed at protecting the natural environment "less strict in order to allow more energy to be produced" (A6). Quite interestingly, equal proportion of students (42%) supported and rejected the view, the remaining not being able to decide (Table 8). This is another evidence of the persistent competition between the goal of economic development and environmental protection. With regard to the need for generation of wind energy, environmental concerns are not made a priority at all. Close to three-fourth of the respondents (71.7%) 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" (A7). Such a practice is already happening in Ethiopia (e.g. Adama Wind Park built in a scenic valley). Though the proportion is lower, responders seem to support the view that calls for development of more oil fields "even if they are located in areas protected by environmental laws) (A8). Only one-fourth disagree with this apparently highly anthropocentric view (one-fifth could not decide). Even more strikingly, a little more than half of the respondents (53.2%) rejected the statement that reflects a careless attitude on the part of some students: "I don't need to worry about turning lights and computers off in the classroom, because the school pays for the electricity".

In fact more than one-third (35.4%) agree to it (A9). On the whole, students views about issues related to generation and use of energy cannot be considered as favorable.

Table 8. Views about Production and Use of Energy Resources

| Item no. | Question | Response | | | | |
|---|---|---|---|---|---|---|
| | | SA | A | U | D | SD |
| A1 | We don't have to worry about conserving energy, because new technologies will be developed to solve the energy problems for future generations. | 27.5 | 12.9 | 11.5 | 17.8 | 30.3 |
| A2 | All electrical appliances should have a label that shows the resources used in making them, their energy requirements, and operating costs. | 4.7 | 6 | 13.3 | 28.6 | 47.4 |
| A4 | We should make more of our electricity from renewable resources. | 3.9 | 5 | 9.2 | 24 | 57.8 |
| A5 | Efforts to develop renewable energy technologies are more important than efforts to develop new sources of fossil fuels. | 5.7 | 8.3 | 27 | 27.4 | 31.6 |
| A6 | Laws protecting the natural environment should be made less strict in order to allow more energy to be produced. | 24.3 | 17.7 | 16.1 | 20.6 | 21.3 |
| A7 | More wind farms should be built to generate electricity, even if the wind farms are located in scenic valleys, farmlands, and wildlife areas. | 40.9 | 30.8 | 15.4 | 7.7 | 5.2 |
| A8 | More oil fields should be developed as they are discovered, even if they are located in areas protected by environmental laws. | 31.3 | 22.9 | 19.5 | 15.2 | 11.1 |
| A9 | I don't need to worry about turning lights and computers off in the classroom, because the school pays for the electricity. | 22.1 | 13.3 | 11.4 | 18.8 | 34.4 |

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

Table 9 shows the views of respondents about causes, consequences and efforts to control climate change. Close to two-third of the respondents (61.9%) disagree that climate change has "the potential to reverse the gains made in Ethiopia's development" (A10); and a bit more (70.4%) rejected the view that climate change "could exacerbate/accelerate social and economic problems currently facing Ethiopia" (A11). With regard to the potential of climate change "to destabilize the Horn of Africa" thereby bringing more fierce competition for water (A12), close to one-fourth expressed their hesitation to endorse the view while 57.9% disagreed. It is therefore interesting to see that respondents seem to disagree with the popular views regarding the negative impacts of climate change in Ethiopia and the Horn of Africa at large. Equally interestingly, the respondents don't seem to appreciate the positive impacts of climate change often associated with increased rainfall. Close to two-third (61.1%) disagreed with the view that climate change "brings opportunities for Ethiopia as it brings more rather than less rainfall"

(A13) while one-fifth hesitated to decide either way.

Following a similar line of think, half of the respondents support the view that Ethiopia "should not be forced to compromise future economic growth and wellbeing by restricting emissions of greenhouse gases" (A14), with one-fourth undecided. Similarly, more than three-fourth of the responds (76.4%) disagree that the Ethiopian government "should have stronger restrictions about the gas mileage of new cars" (A3). Finally, 27.4% of the respondents couldn't take a position on the view that Ethiopia is "well positioned to become a regional leader in low carbon growth" (A15), while 56.1% agreed. In general, participants of this study seem to have a view that could be considered more unfavorable than favorable about causes, consequents and controlling climate change in Ethiopia.

Table 9. Views about Cause, Consequences and Controlling Climate Change

| | | Response | | | | |
|---|---|---|---|---|---|---|
| Item no | Statement | SA | A | U | D | SD |
| A3 | The government should have stronger restrictions about the gas mileage of new cars. | 3.4 | 7 | 13.1 | 25.4 | 51 |
| A10 | Climate change has the potential to reverse the gains made in Ethiopia's development. | 7.8 | 10.2 | 20 | 28 | 33.9 |
| A11 | Climate change could exacerbate/accelerate social and economic problems currently facing Ethiopia. | 7.3 | 8.8 | 13.5 | 30 | 40.4 |
| A12 | Climate change has the potential to destabilize the Horn of Africa by bringing more fierce competition for water. | 9.8 | 8.8 | 23.5 | 27.2 | 30.7 |
| A13 | Climate change brings opportunities for Ethiopia as it brings more rather than less rainfall. | 8.1 | 10.1 | 20.6 | 24.3 | 36.8 |
| A14 | Ethiopia should not be forced to compromise future economic growth and wellbeing by restricting emissions of greenhouse gases. | 28.9 | 20.1 | 25.9 | 12.2 | 13 |
| A15 | Ethiopia is well positioned to become a regional leader in low carbon growth. | 6.6 | 10 | 27.4 | 23.9 | 32.2 |

**Practice Related to Use of Energy and Environmental Protection**

Eleven statements have been provided for respondents to report frequencies of engagement in activities related to use of energy and environmental protection (Table 10). Close to two-third (63.7% and 66.4%) of the respondents reported that they frequently or always encourage neighbors/relatives (P1) and family members (P2) to use energy saving cooking stoves, respectively. A little more than half (53.2%) indicated that they intentionally buy power saving lumps, frequently or always. One-fifth reported that they never buy such lumps intentionally (P3). Close to two-third (62.1%) of the respondents reported that they, frequently or always, walk "short distances, instead of taking a taxi or Bajaj to save energy" (P4) whereas 54.5% reported that they "ride a bicycle, instead of taking a

taxi or Bajaj to save energy" (P11). On the other hand, 29.3% said that they rarely or never ride a bicycle with an intention to save energy. Nearly two-third of the respondents (62%) indicated that they "mobilize communities to engage in environmental protection activities" (P5).

Table 10. Practices Related to Energy Use and Environmental Protection

| Item no | | Response | | | | |
|---|---|---|---|---|---|---|
| | Statement | NA | R | S | F | A |
| P1 | I encourage neighbors/relatives to use improved cooking stoves (stoves that save fuel wood). | 8.7 | 12.1 | 15.5 | 16 | 47.7 |
| P2 | I encourage family to use improved cooking stoves (stoves that save fuel wood). | 6.7 | 10.5 | 16.4 | 20.4 | 46 |
| P3 | I intentionally buy power saving lamps. | 20.2 | 12.1 | 14.5 | 16.6 | 36.6 |
| P4 | I walk short distances, instead of taking a taxi or Bajaj to save energy. | 9.1 | 12.7 | 16.1 | 17.9 | 44.2 |
| P5 | I mobilize communities to engage in environmental protection activities. | 9.1 | 11.2 | 17.7 | 23.2 | 38.8 |
| P6 | I plant trees based on my own initiative. | 5.8 | 8.5 | 17.9 | 19.5 | 48.3 |
| P7 | I plant trees in response to government's/NGO's call. | 11.7 | 9.7 | 15.6 | 20.8 | 42.1 |
| P8 | I teach/train/preach about environmental protection. | 19 | 12.3 | 15.3 | 17.5 | 36 |
| P9 | I turn off electric devices whenever they are off use. | 7.8 | 8.1 | 12.7 | 17.3 | 54.1 |
| P10 | I turn off the lights whenever leaving a room. | 11.2 | 8.9 | 14.4 | 17.5 | 48 |
| P11 | I ride a bicycle, instead of taking a taxi or Bajaj to save energy. | 19.2 | 10.1 | 16.2 | 18.6 | 35.9 |

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

Two of the statements relate to tree planting practices (Table 10). More than two-third (67.8%) of the respondents reported that they planted trees based on their own initiative (P6) whereas 62.9% said that they planted trees in response to governments/NGO's call (P7). A little more than half of the respondents (53.5%) expressed that they taught/trained/preached, frequently or always, about environmental protection whereas 31.3% engaged in this activities only rarely or not at all (P8). A vast majority of the responds reported a favorable behavior regarding use of electric energy. Close to three-forth (71.4%) reported that they, frequently or always, "turn off electric devices whenever they are off use' (P9) whereas 65.5% said they do this "whenever leaving a room" (P10).

The results on practices related to energy use and environmental protection reveal that participants reported pro-energy and environmental practice. More than half, in some cases up to three-fourth, of the participants reported that they engage in activities that save energy and protect the environment. One should note here that the practice

of participants doesn't seem to align with the generally unfavorable attitude towards energy generation (Table 8).

**Variations by Place**

As discussed earlier, the various components of energy literacy are strongly influenced by the geographic and cultural context for which they are intended. Thus, comparisons were made in order to explore whether differences are there between cities on students' knowledge, practice and attitudes of energy and climate change education. The following Table 11 and 12 show the descriptive statistics for the knowledge, practice and attitudes of energy and climate change education, respectively.

Table 11. Mean Frequency Percentage of Students' Response on Knowledge, Attitude and Practice

| Cities | Knowledge | | | Attitude | | | | | Practice | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | W | C | SA | A | U | D | SD | NA | R | S | F | A |
| Addis Ababa | 10.05 | 12.75 | 27.15 | 7.55 | 6.75 | 10.15 | 10.1 | 15.45 | 5.3 | 4.65 | 8.65 | 9.85 | 21.5 |
| Bahr dar | 10.05 | 11.2 | 28.75 | 6.55 | 6.55 | 8.65 | 12.15 | 16.15 | 8.95 | 6.95 | 8.05 | 9.25 | 16.85 |
| Diredawa | 9.35 | 10.5 | 30.15 | 7.8 | 6.4 | 8.65 | 11.5 | 15.7 | 4.45 | 4.1 | 7.25 | 9.65 | 24.55 |
| Hawassa | 9.45 | 10.45 | 30.15 | 6.55 | 9.15 | 8.55 | 12.95 | 15.8 | 6.6 | 6.7 | 7.7 | 8.15 | 20.8 |
| Jimma | 6.05 | 13.4 | 30.55 | 9.85 | 6.15 | 7.95 | 9.2 | 16.85 | 4.05 | 4.25 | 7.05 | 9.4 | 25.2 |

As it is indicated in table 11, no that much differences is to be seen between student's responses across the different cities. To undertake a further scrutiny on this issue, ANOVA were conducted to check the existence of statistically significant differences among each of the cities with respect to the attitude and practice variables. The result is indicated in Table 12.

Table 12. Results of ANOVA

| DV | Source | df | Mean square | F | P |
|---|---|---|---|---|---|
| Attitude | Corrected Model | 4 | 2.832 | 17.040 | .000 |
| | Intercept | 1 | 16396.677 | 98660.187 | .000 |
| | Region | 4 | 2.832 | 17.040 | .000 |
| | Error | 1584 | .166 | | |
| | Total | 1589 | | | |
| | Corrected Total | 1588 | | | |
| Practice | Corrected Model | 4 | 16.840 | 25.497 | .000 |
| | Intercept | 1 | 21323.593 | 32285.953 | .000 |
| | Region | 4 | 16.840 | 25.497 | .000 |
| | Error | 1584 | .660 | | |
| | Total | 1589 | | | |
| | Corrected Total | 1588 | | | |

Table 12 shows the existence of statistically significant differences between the groups for both variables: attitude and practice. The follow up test conducted to spot the place where the differences exist shows that the mean difference was higher for Addis Ababa, Diredawa and Hawassa cities followed by Bahr Dar and Jimma for each of the two variables.

**Variation by Gender and Grade Level**

Since it is important to study the effect gender and grade level have on students' knowledge, practice and attitude of energy and climate change education, chi square was conducted for the knowledge part. Table 13 shows the frequency of students' responses and the chi-square result with respect to gender and grade level for the knowledge part.

Table 13. Descriptive Statistics and Chi-Square Result for the Students' Knowledge

| | | Frequency of students responses | | | | Chi-square |
|---|---|---|---|---|---|---|
| | | No idea | Wrong | Correct | Total | |
| Gender | Male | 3373 | 4665 | 11251 | 19289 | 15.98 |
| | Female | 5270 | 6485 | 16416 | 28171 | |
| | Total | 8643 | 11150 | 27667 | 47460 | |
| Grade level | G6 | 4507 | 5515 | 13325 | 23347 | 42.04 |
| | G8 | 4131 | 5632 | 14321 | 24084 | |
| | Total | 8638 | 11147 | 27646 | 47431 | |

As can be seen from Table 13, gender has a significant effect on students' responses to questions related to energy and climate change. This is clearly evident in the frequency of the respondents in each category of the responses. However, it looks that grade level does not have much effect on students' knowledge about energy and climate change even though the chi-square result shows the existence of a statistically significant differences between the groups.

In order to examine the effect of gender and grade level on students practice and attitude towards energy and climate change, an independent samples t-test was conducted after checking for the assumptions of independence, normality of the data and homogeneity of variances. Table 14 and 15 show the descriptive statistics and independent samples t-test for students' practices and attitude towards energy and climate change with respect to gender and grade level.

Table 14. Descriptive Statistics and t-Test Result for the Students Practices

| Component | Variable | | N | M | SD | t | df | P |
|---|---|---|---|---|---|---|---|---|
| Practice | Gender | Male | 645 | 3.77 | 0.79 | 2.152 | 1587 | 0.032 |
| | | Female | 944 | 3.68 | 0.86 | | | |
| | Grade level | Grade 6 | 782 | 3.73 | 0.43 | 0.966 | 1587.72 | 0.334 |
| | | Grade 8 | 806 | 3.69 | 0.40 | | | |

The descriptive statistics in Table 14 shows that the mean responses of students on practice were higher for male than female students and grade 6 than grade 8 students in their practice to energy and climate change education. This difference was statistically significant ($P < 0.05$) for gender while it was not statistically significant ($P > 0.05$) between grade levels. This implies that students grade level does not have that much significant impact on the students practice towards energy and climate change while gender has an impact. So males were relatively better with respect to self-reported practice.

Table 15. Descriptive Statistics and t-Test for the Responses Of Students'

| Component | Variable | | N | M | SD | t | df | P |
|---|---|---|---|---|---|---|---|---|
| Attitude | Gender | Male | 645 | 3.24 | 0.39 | -0.764 | 1587 | 0.445 |
| | | Female | 944 | 3.26 | 0.43 | | | |
| | Grade level | Grade 6 | 782 | 3.27 | 0.43 | 1.46 | 1586 | 0.144 |
| | | Grade 8 | 806 | 3.24 | 0.40 | | | |

Table 15 shows that results for the independent samples t-test do not reveal any statistically significant difference ($P > 0.05$) between male and female students as well as grade 6 and 8 students. The implication is that students' gender and increment in grade level did not play a major role in their attitudes towards energy and climate change.

In general, the analysis of variance showed a statistically significant difference in students' attitude and practice by cities (those from Addis Ababa, Diredawa and Hawassa having shown better performance). Gender is also found to have a significant effect on students' responses related to energy and climate change whereas grade level having no much effect on students' knowledge about energy and climate change. It is also found that the mean responses of students on practice were higher for male than female students and those in grade 6 than in grade 8. In both cases, the difference was statistically significant ($P < 0.05$). The results for the independent samples t-test do not reveal any statistically significant difference ($P > 0.05$) between male and female students as well as grade 6 and 8 students. This implies that students' gender and increment in grade level did not change their attitudes towards energy and climate change.

## Conclusion and Recommendations

According to the finding of the study, very good awareness was achieved among those students who took part in the study regarding principles relating to generation and energy use but they were extremely poor at answering questions related to climate change impacts. Moreover, the paper found that it was not possible to take student opinions on energy generation and use as favorable. On the other hand, the results of the activities related to energy use and the protection of the environment show that the participants reported pro-energy and environmental practices. The participants' attitude to energy generation and climate change, however, doesn't appear to be aligned with the usual negative view on these issues. The performance of primary and middle school students on issues related to energy, the environment and climate change is generally okay but in no way sufficient. In this regard, the findings of this study could serve as an in-depth source of information for national curriculum revisions, particularly on the integration of all the components of energy-, environmental-, and climate change

literacy sufficiently. The findings of the study also demonstrated that there is a need of developing and implementing well-structured global energy, environmental and climate change education curricula issues and their local impacts for all types of primary and middle school teaching in Ethiopia. Moreover, concerted efforts should be made by all stakeholders to improve students' knowledge, practices, values and attitudes needed about energy-, environmental- and climate change literacy. It is therefore recommended that a comprehensive education on energy, environmental and climate change education has to be provided in primary and middle schools as this level of education has a special role to play in creating awareness about and development of skills and attitude pertaining to environmental and climate change education. This goes in line with a global call to take a climate change education as an urgent need. It is specifically suggested that climate change education has to be interdisciplinary and holistic; integrating scientific, social, gender, economic, cultural and ethical dimensions, and incorporating local, traditional and indigenous knowledge perspectives and practices (UNESCO, 2009). It is also important to consider the level of fear and anxiety felt by children in relation to climate change and to reassure them that it "is a threat that can be addressed" (UNICEF, 2008, p.28).

## Acknowledgments

We particularly thank all the participants in selected cities of Ethiopia that shared their time with us during data collection.

## References

Akitsu, Y. (2017). Investigating energy literacy and its structural model for lower secondary students in Japan. *International Journal of Environmental & Science Education, 12* (5), 1067-1095. http://creativecommons.org/licenses/by/4.0/

Anderson, A. (2010). *Combating Climate Change through Quality Education*. Washington, DC 20036: The Brookings Institution.

Argado, Z. S. (2017). Environmental Education for all: Ethiopian Context. *International Journal of Environment, Agriculture and Biotechnology (IJEAB), 2*(3), 1262-1280. http://dx.doi.org/10.22161/ijeab/2.3.32

Ateş, H. (2020). Pre-Service Science Teachers' Perceptual Biases Regarding Sustainable Food Consumption: Negative Footprint Illusion. *International Journal of Research in Education and Science (IJRES), 6*(4), 599-612.

Aticho, A. et al. (2019). Assessment of community knowledge and perception on environmental issues in Jimma Zone, Southwest Ethiopia. *Journal of Degraded and Mining Lands Management, 6*(2), 1635-1644. DOI: 10.15243/jdmlm. 2019.062.1635

Bamisile, O. O. et al. (2016). Evaluation of Energy Literacy among Nigerian Senior Secondary Students. Research & Reviews: *Journal of Educational Studies*, 3 (1), 11-18. https://www.rroij.com/

Bodzin, A. M. et al. (2013). Developing Energy Literacy in US Middle-Level Students Using the Geospatial Curriculum Approach. *International Journal of Science Education, 35(9)*, 1561–1589. https://doi.org/10.1080/09500693.2013.769139

Boylan, C. (2008). Exploring elementary students' understanding of energy and climate change. *International*

*Electronic Journal of Elementary Education*, 1(1), 1-15. https://iejee.com/

Bulut, A. (2022). Evaluation of the Place of Nature and Environment in Educational Life in Accordance with the Opinions of Teachers. In O. Noroozi & I. Sahin (Eds.), *Proceedings of IHSES 2022-- International Conference on Humanities, Social and Education Sciences* (pp. 182-187), Los Angeles, USA. ISTES Organization.

Chen, K., Liu, S. & Chen, P. (2015). Assessing Multidimensional Energy Literacy of Secondary Students Using Contextualized Assessment. *International Journal of Environmental & Science Education, 10*(2), 201-218. https://doi.org/10.12973/ijese.2015.241a

DeWaters, J. E. & Powers, S E. (2011). Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior. *Energy Policy, 39,* 1699–1710. https://doi.org/10.1016/j.enpol.2010.12.049

DeWaters, J. & Powers, S. (2013). Establishing Measurement Criteria for an Energy Literacy Questionnaire. *The Journal of Environmental Education, 44*(1), 38–55. https://doi.org/10.1080/00958964.2012.711378

DeWaters, J. et al (2013). Designing an Energy Literacy Questionnaire for Middle and High School Youth. *The Journal of Environmental Education, 44*(1), 56–78. https://doi.org/10.1080/00958964.2012.682615

Edsand, H. & Broich, T. (2019). The Impact of Environmental Education on Environmental and Renewable Energy Technology Awareness: Empirical Evidence from Colombia. *International Journal of Science and Mathematics Education, 18,* 611–634. https://doi.org/10.1007/s10763-019-09988-x

Gebeyehu, D. (2008). Energy & Environmental Education: Prospects and Challenges for a Sustainable Global Future, *Proceedings of the 3rd Annual National Conference on "Teacher Education in Ethiopia: Prospects and Challenges"*, 263-287.

Gebeyehu, D. (2018). The Role of Renewable Energy Education in Climate Change Mitigation and Sustainable Development: A Review. *The Ethiopian Journal of Education, XXXVIII* (2), 1-50.

Kandpal, T.C. & Garg H.P. (1999). Energy Education. *Applied Energy, 64 (1-4),* 71-78. https://doi.org/10.1016/S0306-2619 (99)00076-8

Keller, M. (2009). Climate Risks and Development Projects Assessment Report for a Community-Level Project in Guduru, Oromiya, Ethiopia. Bread for all.

Lay, F. et al (2013). Assessing secondary school students' understanding of the relevance of energy in their daily lives. *International Journal of Environmental & Science Education,* 8(1), 199-215. http://www.ijese.com/

Lee, L. et al (2015). Energy literacy: Evaluating knowledge, affect, and behavior of students in Taiwan. *Energy Policy,* 76, 98–106. http://dx.doi.org/10.1016/j.enpol.2014.11.012

Mallikarjun, G. et al. (2016). *Impacts of energy generation on environment, 3rd international conference on science, technology and management* (ICSTM-16), 690-697.

McCaffrey, M. S. (2015). The Energy-Climate Literacy Imperative: Why Energy Education Must Close the Loop on Changing Climate. *Journal of Sustainability Education, 8,* January 2015. http://www.susted.org/

Miléř, T. and Sládeka, P. (2011). The climate literacy challenge. *Procedia Social and Behavioral Sciences, 12,* 150–156.

Mittenzwei, D. et al. (2019). The Energy Concept and its Relation to Climate Literacy. *EURASIA Journal of Mathematics, Science and Technology Education, 15*(6), 1-18. https://doi.org/10.29333/ejmste/105637

Monroe, M.C., Krasny, M.E., (2016). *Across the spectrum: Resources for environmental education* (3rd ed.). North American Association for environmental education, Washington, DC.

Nigatu, A. S. et al. (2014). Knowledge and perceptions about the health impact of climate change among health sciences students in Ethiopia: a cross-sectional study. *BMC Public Health,* 14:587. http://www.biomedcentral.com/1471-2458/14/587

Oliver, M. C. & Adkins, M. J. (2020). "Hot-headed" students? Scientific literacy, perceptions and awareness of climate change in 15-year olds across 54 countries. *Energy Research & Social Science,* 70, 1-9. https://doi.org/10.1016/j.erss.2020.101641

Öykün, T. Abbasoğlu, S. (2017). Energy Literacy Survey at High Schools in Northern Cyprus. *International Journal of New Trends in Arts, Sports &Science Education, 6(2),* 1-16. www.ijtase.net

Pinsonneault, A., & Kraemer, K. L. (1993). Survey research methodology in management information systems: An assessment. *Journal of Management Information Systems*, *10*(2), 75-105. https://www.jstor.org/stable/40398056

Salant, P., & Dillman, D. A. (1994). *How to conduct your own survey*. New York: John Wiley and Sons.

Samur, H. & Akman, O. (2023). Analysis of Environmental Literacy Levels of Social Studies Pre-Service Teachers. *International Journal on Social and Education Sciences (IJonSES), 5*(3), 605-625. https://doi.org/10.46328/ijonses.588

Sulaiman, H. et al. (2008). A Study on the Environmental Education in the Metropolis Schools of Addis Ababa, Ethiopia. *Journal of Environmental Extension, 7*, 22-30. https://www.researchgate.net/

Umar, D A & Abubakar, M. M. (2014). Effects of energy utilization on the environment. *Discovery, 25* (90), 93-99. http://www.discovery.org.in/ d.htm

UN (2013). *Resource Guide for Advanced Learning on Integrating Climate Change in Education at Primary and Secondary Level.* United Nations Institute for Training and Research (UNITAR).

UNESCO, 1978. *The Tbilisi Declaration: Final Report: Intergovernmental Conference on Environmental Education.* USSR 14-26 October 1977.

UNESCO (2009). *REPORT: UNESCO*. International Seminar on Climate Change Education 27–29, July 2009 at UNESCO. Paris.

UNFCCC (2022). *Ethiopia's Third National Communication to the United Nations Framework Convention on Climate Change (UNFCCC), December 2022*.

UNICEF (2008). *Our climate, our children, and our responsibility: The implications of climate change for the world's children.* UNICEF UK Climate Change Report 2008

Yeh, S., Huang, J. & Yu, H. (2017). Analysis of Energy Literacy and Misconceptions of Junior High Students in Taiwan. *Sustainability*, 9, 423: 1-29. https://doi.org/10.3390/su9030423

Zachariou, F. et al. (2020). Exploring the Attitudes of Secondary Education Students on Environmental Education in Relation to their Perceptions on Environmental Problems: The Case of the Prefecture of Viotia. *Interdisciplinary Journal of Environmental and Science Education 2020, 16*(1), e02208, 1-13. https://doi.org/10.29333/ijese/6442

Zerinou, I. *et al* (2020). Energy Saving: Views and Attitudes among Primary School Students and Their Parents. *Sustainability, 12*, 6206: 1-23. http://dx.doi.org/10.3390/su12156206

Zyadin, A. et al (2012). School students' knowledge, perceptions, and attitudes toward renewable energy in Jordan. *Renewable Energy*, 45, 78-85. https://doi.org/10.1016/j.renene.2012.02.002

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