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RESEARCH PAPER

Determining the Energy Literacy among Secondary School Students in Pakistan: A Mixed-Methods Study

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ABSTRACT

Pakistan is facing an energy crisis that has created serious issues for the weak economy and unstable national security. The objectives were to determine the extent of knowledge, attitude, and behavior of secondary school students regarding energy literacy. A total of 400 students and 28 teachers were selected as the sample. The study concluded that students showed better attitudes and behaviors toward energy literacy but poor knowledge. A strong relationship between affective and behavioral dimensions meant that students knew the significance of saving energy. There was a meaningful difference between the views of students in energy literacy on the basis of gender and school location. It recommended that content related to energy literacy may be updated according to the needs of modern era. As Pakistan is suffering from an energy crisis, it is significant to save energy.

KEYWORDS Energy Literacy, Inflation, Pakistan, Energy Crisis, Secondary Level

Introduction

In the era of 21st Century, we are living in a modern society. Now, we are able to move freely for longer distances. Industrial growth can be seen everywhere. Household utilities and top quality fresh foods are available and many of us are enjoying economic prosperity. This all depends mainly on using fossil fuels as energy resources. But it is important to remember that resources of fossil fuels are limited and we are consuming them very fast. The extra ordinary use of these resources has also caused new issues and challenges including global warming and climate change. We are now forced to search for new resources to meet energy demands in near future. We should also focus on consuming energy efficiently (DeWaters & Powers, 2011).

In Pakistan, the situation of energy is not good and we are facing an acute shortage of power supply. There exists a direct link between energy crisis and industrial growth which ultimately results into an economic crisis. But it is a fact that energy crisis is not all of sudden and it has taken a long time to reach in its present form. Power production in Pakistan mainly depends on natural and oil. Our resources of natural gas are exhausting very quickly and we have started importing it from other countries. On the other hand, we use imported oil for power production which is expensive and causes to decrease our reserves. Moreover, power production becomes expensive when we use imported oil and gas for its production. This increase in prices directly causes inflation, too. To cope with this challenge, government should work on saving energy by giving extra weekly holidays,

using daylight commercial centers and reducing government office working hours (Gondal, 2022).

Now, decisions on conservation of energy and other options are to be taken by the government officials and departments and the professionals but every consumer should play an active role in energy conservation. For this purpose, the consumers have to make informed well about losses of energy crisis and its effects on their individual lives. In this way, an understanding about the importance of conservation of energy and effects of reduction of energy resources should be developed among the students. It is the need of time that they should have awareness of linking the content knowledge of science, environment and energy with daily life usage and conservation of energy (Lay at al,2013).

Theoretical Background

During the last two decades, a trend of developing scientific understanding among students has been evolved. This understanding is created by generating a relation between teaching science at school and daily life experiences of the students. This context based approach of teaching science has also given the idea of scientific literacy. It is about focusing such knowledge, awareness and abilities that help them thinking scientifically regarding daily life issues. So, teaching or studying science is not merely a subject, it helps the students to understand effects of scientific developments on their lives as well as lives of others in local, national and global contexts (Bennett, Lubben & Hogarth, 2007). It was recommended by the researchers that teachers

Students are expected to develop comprehension of scientific concepts after studying science at secondary level. It has been seen in many countries of the world during the last two to three decades that the syllabus of science is designed in such a way to promote the concept of scientific literacy. This idea focuses to develop a critical and practical approach among the students through knowledge of science. The change in attitude and behavior towards scientific world is also an important part of this concept. Scientific literacy also makes them able to think and act globally (Bennett, Lubben & Hogarth, 2007). The teachers should enhance understanding and vision of students towards science by connecting it with real world issues (Preczewksi, Mittler & Tillotson, 2009).

Similarly, there is a need not to depend only on content of energy but affective and behavioral dimensions may also be considered when promoting energy literacy among the students. Energy literacy is educating the students about energy and creating affective and behavioral changes among them. In case when students are energy literate, they will have strong conceptual knowledge along with proper usage of energy. In fact, it is a life skill which would help the learners to become better citizens in future (De Waters & Powers, 2007).

Literature Review

Energy Literacy and its Dimensions

It is an effort that prepares students to select the proper way regarding best use of energy in their lives. This concept is based on content, beliefs and behaviors of people about energy and its usage in daily life. It also tells us about the way to conserve energy in order to reduce environmental pollution. It is about to select the energy and environment friendly devices for daily usage (DeWaters & Powers, 2011, 2012; Lay et al., 2013). Energy literacy can be subdivided into three dimensions. These dimensions include cognitive, affective

and behavioral. Cognitive dimension includes syllabus, content and knowledge. Affective dimension consist values and attitudes regarding energy usage whereas behavioral dimension is about actual behaviors of people for energy conservation.

Table 1
Dimensions of Energy Literacy

Type	Description	Measurement
Cognitive	Knowledge and comprehension of basic concepts of energy	Identification and usage of different forms of energy
Affective	Attitudes related to effective usage of energy	Thinking about reducing environmental pollution
Behavioral	Wise decisions and responsibility of energy usage and habits of saving energy	Usage of energy and environment friendly electrical appliances

In the table 1, the dimensions of energy literacy have been briefly described (DeWaters and Powers 2011).

Past Researches

Several types of research related to energy literacy have been conducted in different countries. These included DeWaters & Powers (2011) and Demeo, et al. (2013) in the USA; Yeh, et al. (2017) and Chen, et al (2015) in Taiwan; Cotton, et al (2015) in the UK; Lay et al (2013) in Malaysia; and Pradana, et al (2019) in Indonesia. In the United States of America, researchers have conducted much research to see knowledge of energy among students. They lack knowledge regarding energy literacy (DeWaters & Powers, 2011). Later on, to improve energy literacy, Osbaldiston, and Schmitz (2011) started a program termed Energy Challenge. The results indicated that the program's energy literacy had improved. In Malaysia, Lay et al. (2013) conducted research to assess the comprehension of the students about energy literacy. It explored that the students had a lesser understanding of energy literacy and concluded that the science curriculum should be context-based and may provide foundations for students to build life and decision-making skills for energy literacy.

There are serious issues for a weak economy and unstable national security of Pakistan as the energy crisis increases. This crisis is multifaceted, deep, and complex. It is related to bad governance and a nonprofessional approach. It is due to a lack of financial resources to build/ support energy production projects and infrastructure and the unwillingness of political leadership to take wise steps and perfect decisions for resolving the issues. Moreover, there is a lack of coordination among different departments on power production and distribution. The presence of no complete and combined energy strategy has also inflamed the crisis. To resolve this, international donors may come forward to invest in power generation, supply and recovery. The strong willingness of the government is also significant. Pakistan should also explore renewable energy resources for power production. (Michael, 2013).

Energy is very important to all of us as it has a direct link with financial stability of a country. There is a rapid increase in energy and electricity consumption due to rising temperature, modern developments and expansion in the cities of the world. Pakistan is facing severe energy crisis, now a days. Electricity production and supply is directly connected to industrial growth of the country and the prevailing energy crisis has badly affected the industry due to less power supply. In Pakistan, the electricity is produced mainly using oil and gas. The resources of gas in the country are reducing rapidly and the

cost of imported oil has caused a jump in the prices of electricity. This has also resulted in reducing the foreign exchange reserves. There are many reasons including overuse of petroleum in power generation, nonpayment of electricity bills by institutions and others, lack of interest in installing new power generation plants, lack of usage of renewable resources like water, wind and solar energy in energy/ electricity production. This crisis has now resulted in financial instability in the country. The import bill of petroleum products has surged due to which inflation has surrounded the economy of countries. On the other hand, the short fall in electricity production has resulted in load management due to which people and industries are badly suffering. There is no instant solution of this crisis but we can decrease its intensity by saving and conserving energy (Saba 2022).

Material and Methods

Research Design

To answer the research questions, a mixed-methods research design was adopted. It combines two research methods in a study and uses both of quantitative and qualitative methods. It is helpful in providing complete understanding of the research phenomenon (Creswell, 2013). The mixed-methods sequential explanatory design (QUAN→qual) was deployed in the study. The quantitative data was collected from the secondary school students. Moreover, semi structured interviews of teachers were conducted in the qualitative portion of the research.

Population and Sampling

The study population contained students and teachers of each of eight secondary schools of FGEI (C/G) in Lahore cantonment and City District Government Schools located in Lahore district. A mixed-method sampling was used for selecting the respondents. A simple random sampling technique was deployed to select the students whereas teachers were selected through a purposive sampling technique.

Table 2
Sample of the Study (Students)

Location	Total Students	Male Students	Female Students
Lahore City	200	98	102
Lahore Cantonment	200	82	118
Total	400	180	220

The total sample of the study included 400 students for quantitative data and 28 teachers of these secondary schools for qualitative data. The data of students sample mentioned in table 2.

Instrumentation

An adapted research questionnaire was used as instrument for quantitative data collection from students and qualitative data was collected through semi-structured interviews from teachers

The research questions of the study were regarding the exploration of cognitive, affective and behavioral dimensions of energy literacy among secondary school students. For the purpose of quantitative data collection, an adapted questionnaire of DeWaters and Powers (2008) was used as the research instrument. It contained three dimensions of cognitive, affective and behavior aspects of literacy about energy in daily life. The research

questionnaire consisted of 30 items in total, 10 for each of cognitive, affective and behavior aspects. Moreover, cognitive subscale consisted of multiple choice items, affective subscale contained a 5-point Likert scale items ranging from Strongly Disagree (1) to Strongly Agree (5). For behavioral subscale, again a 5-point Likert scale items ranging from Never (1) to Always (5) was used. This instrument was carefully modified in the light of the most recent literature. It was also refined according to the recommendations of the experts, too. Every possible effort was made to ensure the internal consistency and content validity of the items of the instrument. It was administered to 35 students in a pilot study, to evaluate its internal reliability. The responses of the research questionnaire were transmitted into the computer using SPSS (26.0).

Table 3
Reliability Values of the Research Instrument

Energy Literacy Dimensions s	Cronbach's Alpha R
Cognitive	.66
Affective	.78
Behavioral	.87
Overall	.77

Reliability values for each of the dimensions of energy literacy is mentioned in table 3. It is evident that behavioral dimension has the highest value (.87) of reliability and cognitive dimension has the lowest value (.66). Whereas, the reliability value for affective domain is .78. The overall reliability of the research instrument is .77.

The researchers also used semi-structured interviews as a research instrument of the study. These are helpful in taking useful and optimum information in a short period of time. Moreover, semi-structured interviews are helpful in exploring an in-depth view of the research problem (Cohen et al., 2010). A total of 28 teachers were selected using purposive sampling for the purpose of semi-structured interviews. Open-ended questions, related to cognitive, affective and behavioral dimensions of the energy literacy were included in these interviews. The researchers played a non-judgmental role throughout the interviews. Later on, the obtained data was transcribed and coded. Finally, the interpretation was done in the phase of data analysis.

Results and Discussion

Table 4
Sample of the Study (Teachers)

Variables	Frequency
Age	
21-30 Years	05
31-50 Years	19
Above 50 Years	04
Academic/ Professional Qualification	
M.A./M.Sc./B.Ed.	21
M.Phil./ B.Ed./ M.Ed.	07
Experience	
1-10 Years	13
11-20 Years	12
Above 20 Years	03

The demographic details of respondents are given in the table 4. Here, 5 teachers belonged to age group 21-30 years, 19 teachers were of age between 31-50 years, whereas

only 4 teachers were of 50 years and above. Moreover, 21 teachers had academic/ professional qualification of M.A./M.Sc./B.Ed., and 7 teachers were M.Phil./ B.Ed./ M.Ed. Furthermore, 13 teachers had an experience of 1-10 years, 12 teachers had an experience of 11-20 years and only 3 teachers had an experience of above 20 years.

Triangulation of data

In the process of triangulation of data different theories, techniques, researchers and data sets are deployed to find a real picture of the research problem. It is helpful in optimizing the validity and credibility of the findings of research. It has three types. Different research methods are used by the researchers in methodological triangulation of data. More than one theories are using in theoretical triangulation of data. Whereas, in triangulation of data sets, different population/ sample, times and places are used by the researchers in data collection and analysis process (Bhandari, 2022). In the present study, quantitative data was collected by from students using the research questionnaire and qualitative data form teachers through semi-structured interviews. It helped the researchers to obtain a complete picture of the research phenomenon.

Data Collection

The researchers made visits of the selected schools and sought permission from principals to conduct the study. Students were briefed through their teachers about the objective, language and content of the research questionnaires. Their willingness to participate in the study was also confirmed. They were given freedom to response the items according to their knowledge, comprehension and perception. Due time and consideration was given by the researchers in this process of data collection. Similarly, in case of semi-structured interviews, only willing teachers were included. They were briefed well about the research. Their interviews were audio taped with their permission, which were later transcribed and coded for the sake of data analysis.

Data Analysis Procedures

The collected data was transmitted into computer using SPSS (26.0). It was analyzed for percentage, mean and standard deviation. Furthermore, independent samples t-test and Pearson correlation r were also deployed for inferential statistics. Below are the detailed descriptions of data analysis.

Table 5
Mean and Standard Deviations for Energy Literacy Dimensions

	N	Minimum	Maximum	M	SD
Cognitive	400	23.00	35.00	34.00	5.59
Affective	400	22.00	49.00	35.50	5.94
Behavioral	400	25.00	47.00	36.34	5.25

The calculated values of mean and standard deviation for cognitive, affective and behavioral dimensions of energy literacy have been shown in the table 5. It is clear that cognitive domain has *M* =34.00, *SD*=5.59, affective domain has *M* =35.50, *SD*=5.94 and behavioral domain has *M* =36.34, *SD*=5.25.

Views of students on cognitive dimension

Table 6
Views of Students on Cognitive Dimension in Energy Literacy

Cognitive Dimension	M	SD
1. Energy is defined as . . .	3.33	1.36
2. The unit used for the measuring the quantity of consumed electricity is	3.88	1.04
3. The total energy consumed by an electrical appliance is. . .	3.67	1.08
4. A machine which may generate more energy than it takes …	3.77	1.08
5. The largest amount of energy for almost all living things is obtained from . . .	4.17	.85
6. The term renewable energy resources means…	3.03	1.40
7. Coal is not a renewable energy resource…	2.92	1.35
8. A large number of useful products is manufactured from …	3.61	1.25
9. Major source of producing electricity using renewable energy in Pakistan is…	3.72	1.12
10. Fossil fuels provide about 65% of the energy used in Pakistan.	3.34	1.28

Table 6 shows the views of students regarding cognitive dimensions in energy literacy. Descriptive statistics (mean and standard deviation) of the respondents is stated as, Energy is defined as . . . (*M* = 3.33, *SD*=1.36), the unit used for the measuring the quantity of consumed electricity is . . (*M* =3.88, *SD*=1.04), the total energy consumed by an electrical appliance is . . . (*M* =3.67, *SD*=1.08), a machine which may generate more energy than it takes is… (*M* =3.77, *SD*=1.08), the largest amount of energy for almost all living things is obtained from . . . (*M* =4.17, *SD*=0.85), the term renewable energy resources means…(*M* =3.03, *SD*=1.40), coal is not a renewable energy resource… (*M* =2.92, *SD*=1.35), a large number of useful products is manufactured from…(*M* =3.61, *SD*=1.25), major source of producing electricity using renewable energy in Pakistan is…(*M* =3.72, *SD*=1.12), fossil fuels provide about 65% of the energy used in Pakistan…(*M* =3.34, *SD*=1.28).

Views of students on affective dimension

Table 7
Views of Students on Affective Dimensions in Energy Literacy

Affective Dimensions	M	SD
11. It is necessary to include energy education in the secondary-level curriculum.	2.67	1.36
12. I can do more to save energy if I know more about it.	3.61	1.25
13. Saving energy is necessary.	3.72	1.12
14. Energy requirements and operating costs should have labeled on all electrical appliances.	3.34	1.28
15. Pakistan should focus on producing a maximum of electricity using renewable resources.	3.55	1.22
16. We, as a nation, should conserve energy.	3.51	1.26
17. It is better to develop renewable energy technologies instead developing new sources of fossil fuels.	3.73	1.13
18. We save energy that makes a difference to the energy crisis.	3.93	0.97
19. I can contribute to solving energy problems if we plan/ work to do so.	3.70	1.30
20. I believe that appropriate energy-related choices and actions may cause to reduce energy problems.	2.87	1.48

Table 7 shows the views of students regarding affective dimensions in energy literacy. Descriptive statistics (mean and standard deviation) of the respondents is stated below. It is necessary to include energy education in the secondary-level curriculum (*M* = 2.67, *SD*=1.36), I can do more to save energy if I know more about it (*M* =3.61, *SD*=1.25), saving energy is necessary (*M* =3.72, *SD*=1.12), energy requirements and operating costs should have labeled on all electrical appliances (*M* =3.34, *SD*=1.28), Pakistan should focus on producing a maximum of electricity using renewable resources (*M* =3.55, *SD*=1.22), we,

as a nation, should conserve energy (*M* =3.51, *SD*=1.26), it is better to develop renewable energy technologies instead developing new sources of fossil fuels (*M* =3.73, *SD*=1.13), we save energy that makes a difference to the energy crisis (*M* =3.93, *SD*=0.97), I can contribute to solving energy problems if we plan/ work to do so (*M* =3.70, *SD*=1.30), I believe that appropriate energy-related choices and actions may cause to reduce energy problems (*M* =2.87, *SD*=1.48).

Views of students on behavioral dimension

Table 8
Views of Students on Behavioral Dimension in Energy Literacy

Behavioral Dimension	M	SD
21. I prefer to save water/ energy.	2.89	1.33
22. I walk instead of riding a bike.	3.34	1.33
23. I turn off the lights while leaving the room.	3.91	1.05
24. I shut down the computer when not used.	3.53	1.22
25. I keep thoughts on energy saving and apply those to my daily decisions.	3.73	1.16
26. I usually turn off gas heaters/ fans/ television/ bulbs when not used.	3.99	1.10
27. I keep encouraging others to turn off extra appliances when not used.	3.54	1.22
28. We use energy-efficient and environment-friendly devices at home to save energy.	3.51	1.26
29. I believe that saving energy cause to increase foreign exchange reserves and strengthen our economy.	3.73	1.13
30. I am willing to buy fewer things for the sake of saving electricity.	3.93	.97

Table 8 shows the views of students regarding behavioral dimensions in energy literacy. Descriptive statistics (mean and standard deviation) of the respondents is stated below.

I prefer to save water/ energy (*M* = 2.89, *SD*=1.33), I walk instead of riding a bike (*M* =3.34, *SD*=1.33), I turn off the lights while leaving the room (*M* =3.91, *SD*=1.05), I shut down the computer when not used (*M* =3.53, *SD*=1.22), I keep thoughts on energy saving and apply those to my daily decisions (*M* =3.73, *SD*=1.16), I usually turn off gas heaters/ fans/ television/ bulbs when not used (*M* =3.99, *SD*=1.10), I keep encouraging others to turn off extra appliances when not used (*M* =3.54, *SD*=1.22), We use energy-efficient and environment-friendly devices at home to save energy (*M* =3.51, *SD*=1.26), I believe that saving energy cause to increase foreign exchange reserves and strengthen our economy (*M* =3.73, *SD*=1.13), I am willing to buy fewer things for the sake of saving electricity (*M* =3.93, *SD*=0.97).

Table 9
Pearson Correlation among Dimensions of Energy Literacy

Energy Literacy Dimension		Cognitive	Affective	Behavioral
Cognitive	Pearson Correlation	1	.923	.937
	Sig. (2-tailed)		.002	.003
	N	400	400	400
Affective	Pearson Correlation	.923	1	.960
	Sig. (2-tailed)	.002		.001
	N	400	400	400
Behavioral	Pearson Correlation	.937	.960	1

	Sig. (2-tailed)	.003	.001	
	N	400	400	400

Table 9 provides an analysis of the relationship among different dimensions of energy literacy using Pearson Correlation r. It is evident that a positive correlation is present among cognitive, affective and behavioral dimensions of energy literacy. Although it has a low value, but still the relationship is significant. It can be analyzed that the behavioral dimensions of energy literacy among students is more closely related to affective dimension as compared to cognitive dimension.

Table 10
Differences among Views of Students on Energy Literacy Dimensions, based on Gender

Dimension	Gender	N	M	SD	Df	M.D	t	Sig
Cognitive	Male	180	38.81	5.16				
					398	5.65	8.10	.002
	Female	220	33.16	4.56				
Affective	Male	180	32.28	4.91				
					398	-5.88	7.88	.001
	Female	220	38.16	5.49				
Behavioral	Male	180	38.56	5.19				
					398	4.04	5.77	.004
	Female	220	34.52	4.59				

Table 10 presents the differences among views of students upon different energy literacy dimensions, based on gender. For cognitive dimension, values of mean for male and female are 38.81 and 33.16 respectively with a mean difference of 5.65 and t is 8.10. As sig. value is .002 ($p<.005$), so it can be concluded that there exists significant difference among the views of students upon cognitive dimension of energy literacy based on gender. The male students have better knowledge and comprehension of energy. Similarly, the values of mean for male and female are 32.28 and 38.16 and respectively with a mean difference of -5.88 and t is 7.88, for affective dimension. As sig. value is .001 ($p<.005$), so it can be concluded that there exists significant difference among the views of male and female students upon affective dimension of energy literacy. The female students showed better attitudes towards energy literacy than male students. Moreover, for behavioral dimension, the values of mean for male and female are 38.56 and 34.52 respectively with a mean difference of 4.04 and t is 5.77. As sig. value is .004 ($p<.005$), so it can be concluded that there exists significant difference among the views of male and female students upon behavioral dimension of energy literacy based on gender. The male students showed better energy literacy behaviors. It can be further deduced that there exists significant difference among the views of male and female students upon energy literacy.

Table 11
Differences among Views of Students on Energy Literacy Dimensions, based on location

Dimension	**Location**	**N**	**Mean**	**Std. D**	**Df**	**M.D**	**t**	**Sig**
Cognitive	City	200	34.25	5.22				
					398	-2.94	-3.80	.003
	Cantt	200	37.19	5.59				
Affective	City	200	36.56	5.41				
					398	3.23	-3.86	.002
	Cantt	200	33.33	5.04				
Behavioral	City	200	37.88	4.56				
					398	3.04	-3.71	.004
	Cantt	200	34.84	5.49				

Table 11 presents the differences among views of students upon different energy literacy dimensions, based on location of school. For cognitive dimension, the values of mean for students of city and cantonment are 34.25 and 37.19 respectively with a mean difference of -2.94 and t is -3.80. As sig. value is .003 ($p<.005$), so it can be concluded that there exists significant difference among the views of students of city and cantonment upon cognitive dimension of energy literacy. Similarly, the values of mean for male and female are 36.56 and 33.33 respectively with a mean difference of 3.23 and t is -3.86, for affective dimension. As sig. value is .002 ($p<.005$), so it can be concluded that there exists significant difference among the views of students of city and cantonment upon affective dimension of energy literacy. Moreover, for behavioral dimension, the values of mean for students of city and cantonment are 37.88 and 34.84 respectively with a mean difference of -3.04 and t is -3.71. As sig. value is .004 ($p<.005$), so it can be concluded that there exists significant difference among the views of students upon behavioral dimension of energy literacy based on school location.

Semi-structured interviews of teachers were conducted to confirm the views of students and to find the way to improve energy literacy among the secondary school students. Extracts form these interviews of teachers have been stated in the following paragraphs.

My students believe in saving energy and think using renewable energy technologies may help decrease the expense of electricity and reduce load management. The clear majority of those turn off the lights while leaving the room. He emphasized that cognitive dimension of energy literacy among students may be improved by introducing a complete unit of energy education in the syllabus. [Teacher 'C']

Given my students, content knowledge of energy, in the secondary-level curriculum is insufficient. An additional syllabus with a detailed description may include. They possess strong thoughts on energy saving and apply those in their daily decisions and usually turn off gas heaters/ fans/ television/ bulbs when not used. He viewed for improvement, that students should be provided with effective coaching and awareness about energy literacy to improve more.[Teacher 'G']

The students in my secondary-level Physics, have strong beliefs about saving and conserving energy. They think it is better to use wind, water, solar and nuclear power to produce electricity. They prefer using energy-efficient and environment-friendly devices at home to save energy. According to them, to save energy is to increase valuable foreign exchange and strengthen the national economy. She viewed that content knowledge about energy literacy is inappropriate and do not match with latest trends.[Teacher 'P']

Student view we can do more to save energy if we know more about it. They believe that saving energy is necessary. They think that energy requirements and operating costs should be on all electrical appliances. They know well about the significance of renewable energy resources and convince Pakistan should focus on producing maximum electricity using renewable resources. My students usually turn off gas heaters/ fans/ television/ bulbs when not used and encourage others to turn off extra appliances when not used. Students know about socio-economic issues related to the energy crisis, financial crisis, and load management of electricity and other utilities in Pakistan. She argued that energy crisis may be controlled by applying an effective management of resources.[Teacher 'S']

According to my students, electricity wastage can be shorter using energy-efficient and environment-friendly devices at home. They believe that saving energy makes a difference in the energy crisis. They think the energy crisis may shorten using better planning and effective management of available resources. She stated that teachers should brief the students about

importance of energy conservation, moving beyond the boundaries of course outlines and curriculum. [Teacher 'U']

Students in my class view that appropriate energy-related choices and actions may cause to reduce energy problems. Many of them prefer to save water/ energy. We walk instead of riding a bike while going to nearby shops/markets. We also know about saving energy and turning off the lights while leaving the room. [Teacher 'X']

My students tell me they usually turn off gas heaters/ fans/ television/ bulbs when not used. They also keep encouraging others to turn off extra appliances when not used. They prefer using energy-efficient and environment-friendly devices at home to save energy. They believe that saving electricity cause them to save precious foreign exchange reserves. They think that energy literacy may cause reducing problems like inflation, poverty, and energy crisis [Teacher 'AB'].

The students in my class view they can do more to save energy if they know more about it. We, as a nation, should conserve energy. The government should focus on producing more electricity using renewable resources. They view that they can contribute to solving energy problems if they have a better plan to act upon. A responsible behavior of saving energy should be encouraged by teachers. [Teacher 'AC']

The present study explored energy literacy among secondary school students. Data was collected using research questionnaires and semi-structured interviews. In total, 400 students participated in the quantitative portion of the research, and teachers of secondary schools took part in the qualitative portion of the study. The analyses of data for descriptive and inferential statistics were done using SPSS (26.)

The mean values for cognitive, affective, and behavioral dimensions were 34.00, 35.50, and 36.34 whereas standard deviations for cognitive, affective, and behavioral dimensions of energy literacy were 5.59, 5.94, and 5.25 respectively. The majority of students answered the questions based on the cognitive dimension. Students' views on the affective dimension of energy literacy contained the following.

The students believe: saving energy is necessary, energy requirements and operating costs should have labeled on all electrical appliances, Pakistan should focus on producing electricity using renewable resources, we should conserve energy, and it is better to develop renewable energy technologies instead developing new sources of fossil fuels, we save energy that makes a difference to the energy crisis, we can contribute to solving energy problems if we plan to do so.

Similarly, students' views on the behavioral dimension of energy literacy included the following.

The students believe: in walking instead of riding a bike, turning off the lights while leaving the room and shutting down the computer when not used, keeping thoughts on energy saving and applying those to their daily decisions, usually turning off gas heaters/ fans/ television/ bulbs when not used, keep encouraging others to turn off extra appliances when not used, use energy-efficient and environment-friendly devices at home to save energy, saving energy cause to increase foreign exchange reserves and strengthen our economy.

The Pearson correlation r showed a positive correlation among cognitive, affective, and behavioral dimensions of energy literacy. But this relationship is stronger between behavioral and affective dimensions than the cognitive dimension.

An independent sample t-test was applied to explore the difference among the views of students on energy literacy dimensions based on gender. It showed that male students have better knowledge and comprehension of energy than female students. On the other hand, female students showed better attitudes toward energy literacy than male students. Male students showed better energy literacy behaviors than female students. Hence, there is a significant difference between the views of male and female students on energy literacy.

An independent sample t-test was also applied to explore any significant difference among the views of students on energy literacy dimensions based on location. It showed that students of the cantonment have better knowledge and comprehension of energy than students of the city. On the other hand, students of Lahore city showed better attitudes towards energy literacy than students of the cantonment.

Conclusion

The results of the present study showed that mean values are higher for affective and behavioral dimensions as compared to cognitive. It meant that students have better attitudes and behaviors toward energy literacy than knowledge. So there is a need to focus on content and energy literacy pedagogies at the secondary level. These results are similar to those of Lay et al. (2012) and Zografakis *et al*. (2008). A positive relationship was explored among cognitive, affective, and behavioral dimensions of energy literacy. But it was stronger between behavioral and affective dimensions than the cognitive dimension. Similarly, a significant difference was determined between secondary students based on gender location. Similar results were found in the studies conducted by DeWaters and Powers (2011) and Lay et al. (2012).

The study concluded that students showed better attitudes and behaviors toward energy literacy. However, they showed poor knowledge, indicating that content regarding energy literacy is insufficient. Moreover, a strong relationship between affective and behavioral dimensions meant that secondary school students have a better awareness of the importance of saving energy. It is either due to social media or issues like load management of electricity and inflation. A significant difference was explored between male and female students in energy literacy. The male students have better knowledge and comprehension of energy than female students. On the other hand, female students showed better attitudes toward energy literacy than male students. Students of the cantonment had better knowledge and comprehension of energy than students of the city. Moreover, students of Lahore city showed better attitudes towards energy literacy, than those of the Lahore cantonment.

Recommendations

The study recommended that content related to energy literacy may be added/ updated according to the needs of the modern era. As Pakistan is suffering from an energy crisis and other related issues like inflation, reduced foreign exchange reserves, and load management of electricity, it is significant to save energy. Teachers' training is required. Modern pedagogical practices may be adopted to deliver concepts of energy literacy and conservation. The government may also consider using alternative renewable energy resources for power generation.

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