

Exploring The Chemistry Teachers' Perceptions Of Enhancing Awareness Of The Role And Importance Of Chemical Literacy For The Benefit Of School Community During Covid-19

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Abstract:

This study aims to explore how chemistry teachers perceive chemical literacy and the implementation of chemical literacy in the school community to minimize health risks. The study aims to explore the perceptions of Chemistry/Science teachers about the implications of Chemical Literacy to the School Community for their benefits. In this study, 200 Chemistry/Science teachers participated through questionnaire. The 59% male and 41% female science teachers participated from public schools. This study concluded that the majority of secondary school Chemistry/Science teachers were positive about the role and importance of chemical literacy and its implications for the school community are positive. Most of the teachers were aware of the harmful effects of chemicals and are more cautious about safety measures. Also, many of the teachers agreed chemical literacy is helpful to improve health literacy and minimize health issues for students. Most of the teachers read the expiry date before buying a product. Most of the chemistry teachers implicate the knowledge of chemical literacy to solve chemical-based issues. The study recommends that both science and non-science teachers should be trained to enhance the role of Chemical Literacy in their daily consumables. The teachers may arrange science activities about the role of chemical literacy at the school level to improve health literacy after Covid-19.

Key words: Chemical literacy, Implication, Chemical, Science Literacy, Chemistry

Introduction of the Problem and Context:

This research focuses on the role of chemical literacy and its implications for the school community. Though Chemical Literacy is a central point of science education, the need for chemical literacy is essential for every citizen. It has been noticed a dilemma that the role of chemical literacy is ignored by policymakers and curriculum developers in Pakistan. The study aims to explore the level problems of the school community that they faced at the

domestic level during daily routine. A chemically literate person can understand the phenomena of science or chemistry. For example, what ingredients are present in the soap and how does it clean? How much is the expiry date of any product or medicine important? Which household chemicals are dangerous after mixing or safe to use separately? How air pollution or water pollution affects everyday life badly through chemicals. All these questions can be answered by applying chemical

literacy. Chemical literacy is compulsory for understanding chemical ideas because a chemistry-literate person can understand the nature of elements and the combining ability of one element with another element.

A chemically literate person can understand the idea of environmental literacy. Environmental literacy is a global issue. Understanding environmental literacy is very important to decrease environmental problems or issues. Due to the lack of environmental literacy globally, we are facing a lot of problems like global warming, the greenhouse effect, soil erosion, deforestation, ozone depletion, air pollution, water pollution, and so many other environmental issues. The chemists are contributing to the global situation even during COVID-19. The coronavirus pandemic increases the use of chemicals (disinfectants, hand sanitizers, cleaning products, etc.). The pandemic COVID-19 affects the whole world badly. The use of chemical disinfectants is a very essential part of the daily routine of every walk of life. All the disinfectants are chemicals and chemical literacy gives proper awareness of safe usage of these chemicals.

Shwartz et al. (2006) explored the meaning of chemical literacy to scientists and schoolteachers. The study states that the understanding of chemical literacy is needed for everybody and explained the meaning of chemical literacy with respect to different dimensions to scientists and schoolteachers. Interviews were conducted to explore the scientist's perceptions of chemical literacy and workshops were conducted to explore the teacher's perceptions and understanding of chemical literacy. Both scientists and teachers say similar things but hold different views. The teachers say that chemistry directly benefited the students or individuals and scientists focused more on society. Both groups agreed that chemistry has a unique language and explains the microscopic structure of matter. Fadillah et

al. (2018) explained the global awareness of students through chemical literacy and explained the problems and possibilities. The above-mentioned study focused on the problems of global awareness in the context of chemical literacy. The purpose of this study was to discuss both problems and possibilities that exist with chemical education for the improvement of global awareness. The study addressed the interconnection of chemistry and human life.

RESEARCH QUESTIONS:

The research questions of the study are following as:

1. How much Chemistry/Science teachers know the harmful effects of chemicals?
2. Can a chemical literate person be more precautious about safety measures?
3. How much chemical literacy helpful to improve health literacy?
4. Can a chemical literate person implicate the knowledge of chemical literacy to solve chemical based issues?
5. In what extent COVID-19 enlighten the importance of chemical literacy?

LITERATURE REVIEW:

The main ideas of chemistry are a major concern of every citizen like understanding of careful use of chemicals, how chemistry or chemical literacy implements our social concerns, how to avoid hazards or harms of chemicals (pollution), and the awareness of the role of chemicals or disinfectants of the recent global issue in COVID-19 situation. Understanding of chemistry or chemical literacy improves the safe use of chemicals, hygiene level, health and environmental literacy, the yield of agricultural crops, and awareness level of local and global concerns. Chemical literacy is the central concern of chemical and science education. Kohen (2019) expressed chemical literacy consists of the knowledge of chemistry, skills of chemistry, and chemistry-based of socio-

scientific issues or problems. Chemical literacy is comprised of three components: 1) Basic chemistry (elements, symbols, and processes). 2) Professional misperceptions and understanding in academia and how industries work. 3) Societal context-related chemistry in the real world.

It is argued that the students and everybody in society need to gain chemical literacy so that the students and the general public understand the role of chemistry in their lives and society effectively. Ina et al. (2019) stated chemical literacy is an ability or understanding and its role is positive and very essential for students in the current and modern educational needs. The study results show that high school students only memorize without knowing. They did not know how to conceptualize the understanding of real knowledge. The learners had trouble at sub-microscopic levels.

Shwartz et al. (2005) described the attainment of scientific literacy and ongoing reforms in science education as the main goals in many countries. In this context, the study involved high school chemistry teachers to explain the term chemical literacy and chemistry teachers' perception of chemical literacy. The chemistry teachers discussed the importance, need, and operational meaning of chemical literacy. According to the study, chemical literacy involves several components which are mentioned: a) Understanding the chemically based information and reactions of matter, the procedure of chemical methods, and how chemistry work is acknowledged as scientific work. b) Understand and explain the definitions, concepts, theories, laws, and applications of chemistry. c) Understand that chemistry technology and chemical technology seek to change the world itself. d) Understand the nature of chemistry-based phenomena and appreciate the chemical technology associated with the community. Secondary school-level chemistry provides the basic information about chemicals

for further learning of chemical literacy. The gap showed that the curriculum developers and teachers need to highlight the chemistry and chemical related issues of society to develop chemical literacy through curriculum.

Nuraisyah et al. (2019) explained that 78.43% of students stated that the guided discovery-based chemistry module helped them to think more critically, logically and enhanced their chemical literacy approach. Through guided discovery, learning activities are easier to learn and the students easily understand the lesson. The study results revealed that the stages of guided discovery trained students to develop critical thinking and improved chemical literacy ability. Sumarni et al. (2017) stated the average chemical literacy achievement content aspect of students is 31.8% and included in the low category. The explicitly integrated learning aspects are necessary to improve students' chemical literacy. Yustin et al. (2019) the study indicated that the learners' chemical literacy ability was badly low, and students need to develop chemical literacy skills in connecting and analyzing scientific information. Shah et al. (2013) expressed the levels of chemical literacy of lower secondary school teachers through their professional practice with chemical management in schools were found very low. The low levels of chemical literacy fail to develop the personal and societal needs of learners.

Heavy metals and toxic chemicals are used in the laboratories of research-based institutions. Laboratory chemicals are participating to enhance chemical content in the environment which is unknown. Arbanah et al. (2012), explained heavy metals used in the laboratory are hazards to human health and environment and that liquid laboratory chemicals waste should be removed from the laboratory. The researchers need to reject or discourage the conventional methods to remove heavy metals and use modern techniques or encourage searching for alternative treatment

methods. Bio sorption method is one of the methods to remove heavy metal ions. The study states that Pleurotus (mushroom) has potential as bio sorbent for liquid laboratory chemical waste treatment. Nascimento et al. (2010) stated educational research institutions' laboratory and non-laboratory activities contribute to chemical waste in small quantities but many of them chemicals are highly toxic. The study states that research institutions need to use waste minimization procedures such as reuse and recycling of chemicals. Environmental pollution agencies of government made pertinent laws, directives and guidelines for research institutions for safe use of laboratory chemicals. Moreover, hospital waste is an important issue in developing countries. Arshad et al. (2011) stated hospital waste is a risk to the public and to the environment. Clinical and non-clinical waste are collected and thrown together which are highly unsafe. The safety measures dealing with hospital waste are inadequate and toxic pollutants emit when hospital waste is incinerated. It was suggested that proper waste management is required to ensure health and environmental issues. Institutions such as Shaukat Khanum and Shalamar have proper hospital waste management practices for the science students. This study explores that gaps on the role of chemical literacy in enhancing literacy on the hazards and risk to daily life of the school community, science students and teachers, parents, and school based stakeholders.

RESEARCH METHODS

The list of number male and female secondary school teachers were obtained from District Education Officer (Secondary) Kasur. The researcher visited the secondary schools personally and took permission from Headmaster/ Principal to conduct survey study and administered the tool to the secondary

school Chemistry/Science teachers. During tool administration and data collection, the use of mask, the use of hand sanitizer and social distance were maintained. The data was collected by researcher visiting each public secondary school to meet male and female Chemistry/Science teachers and spent number of days to collect. The total male and female secondary school chemistry/science teachers were 800 in District Kasur 25% of that population was 200 which was the sample of the study. The 200 secondary school teachers were selected randomly from urban and rural areas schools. Random sampling was used for sample selection. The tool was based on a theoretical framework that was formed with the help of existing knowledge and theories within the limits of critical bounding assumptions. It holds a theory of a research study; it explains the problems under the study that exists and defines the whole study. It is based on the role of chemical literacy and its implications to the school community and contains the understanding of chemical literacy, implications of chemical literacy, hazards if there is no chemical literacy, and chemical literacy in the COVID-19 situation. It is based on four sections and 25 items. Each section in the questionnaire contained 6 items and the first section contained 7 items.

CHARACTERISTICS OF TEACHERS

In this study, 200 secondary school Chemistry teachers from district Kasur participated through questionnaire items response. The respondents included 59% male and 41% female from public schools. The demographic statistics of gender, age, posting of school locality, qualification, chemistry major, experience and training of chemical literacy are given below in the form of percentages. The tables are presented in academic format.

Table 1 Demographic makeup of Gender

Demographic Variable	Percentage
Gender	
Male	59%
Female	41%
Age (Years)	
20-30	25%
30-40	61%
40+	14%
Locality of School	
Rural	69%
Urban	31%
Qualification	
BSc	11%
BS(Hons.)/MSc	52%
MPhil	37%
Chemistry as a Major Subject	
Yes	33%
No	67%
Teaching Experience (Years)	
0-5	22%
5-10	57%
10+	21%

The experienced and senior secondary school Chemistry/Science teachers are less interested in becoming part of the study. The 5-10 years of teaching experience teachers are more motivated to become part of the study. The pie chart of the demographic makeup of experienced

Chemistry/Science teachers who did not receive training in chemical literacy. The concept of chemical literacy is ignored in Pakistan that's why we are facing serious social and environmental issues.

Table 2 Responses of Teachers regarding Chemical Literacy (Percentage)

Items	SA	A	N	DA	SDA
1. I think chemical literacy is spread of knowledge to avoid harmful effects of Chemicals	40	44	11	3	2
2. I think chemical literate people use more precautions of safety	34	46	15	3	2
3. I think chemical literate people are careful to avoid X-Rays effects	39	37	20	2	2
4. I understand chemical literacy needs to every citizen	34	32	23	8	3
5. I understand chemical literacy is the focal point of scientific literacy	21	46	23	9	1
6. I understand chemical literacy is helpful to improve health literacy	23	50	22	5	0

7. I understand chemical literacy improves environmental literacy	30	44	20	4	2
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The responses of secondary school teachers of Chemistry are mainly positive. The participants will perceive an understanding of chemical literacy. The understanding of chemical literacy is knowledge, safety and is needed by every citizen. To know about chemical literacy is just like knowing about avoiding the harmful effects of chemicals. 46% of participants agree that chemically literate persons use more precautions for safety. However, it was noticed that the

focus of the set of items related to health and environmental literacy. Most of the participants agreed that understanding chemical literacy improves health literacy and environmental literacy. Environmental literacy is related to a number of environmental issues like different types of pollution, solid waste, the greenhouse effect, ozone depletion, soil erosion, global warming, etc.

Table 3 Responses regarding Importance of Chemical Literacy (Percentage)

Items	SA	A	N	DA	SDA
1. I think chemical literacy minimizes health issues and increase safety	32	54	10	2	2
2. I think chemical literacy is essential with respect to hygiene	16	60	20	3	1
3. I think everybody reads the expiry date before buying a product	35	25	15	15	10
4. I think chemically literate people grow more yields of agriculture crops	34	40	16	9	1
5. I know acid rain causes skin problems	45	40	10	3	2
6. I know town and housing societies are planned far away from industrial units	36	44	10	5	5

Most of the participants feel the implications of chemical literacy minimize chemical-based issues and increase safety. From the questionnaire, the third section asked the opinions or perceptions about hazards/harms if

there is no chemical literacy. Table 4 interprets hazards/harms if there is no chemical literacy. The third section included 6 items in table 5 and the percentage of each item's interpretation is given below.

Table 4 Responses of Teachers Regarding Chemical Literacy and Pollution (Percentage)

Items	SA	A	N	DA	SDA
1. I know all types of pollution are increasing due to lack of chemical literacy	28	45	17	8	2
2. I know carbon dioxide gas is environmental friendly	21	28	23	13	15
3. I know environmental problems are increasing due to overuse of chemical resources	35	50	13	2	0

4. I know plastic bags are affecting the fertility of Soil	53	30	9	4	4
5. I know the spread of environmental education minimize environmental problems	37	49	12	2	0
6. I know to drink cold drinks (carbonated) are harmful for health	55	32	7	3	3

There are a lot of harms of pollution in our environment if there is no chemical literacy. All over the world, not in Pakistan pollution (air, water, and soil) is increasing day by day. 45% of participants agreed all types of pollution are increasing due to a lack of chemical literacy. Section three data showed that the participants are confused about whether carbon dioxide gas is environmentally friendly or not even 15% of

participants strongly disagreed. The use of chemicals is increasing because of our social needs, hygiene, sanitation, glimmering world, packed food processing and production, and overpopulation of the world. The drastic use of chemicals all over the world and overuse of chemicals resources increased the number of environmental issues.

Table 5 Responses of Teachers regarding Chemical Literacy and Fighting the Pandemics (Percentage)

Items	SA	A	N	DA	SDA
1. I think chemical literacy is the first aid of every Pandemic	29	42	20	6	3
2. I think I avoid crowds with respect to COVID-19 Situation	57	33	7	2	1
3. I think the use of mask is the first safety measure of COVID-19	64	27	6	2	1
4. I think hand sanitizing is the use of chemical literacy	51	42	6	1	0
5. I think the use of disinfectants minimizes the effects of COVID-19	40	40	14	3	3
6. I think COVID-19 enlightens the importance of chemical literacy	26	48	22	3	1

The data indicates that chemically literate societies can fight better against these types of pandemics or situations. The survey also determines the gender difference, age in years, school locality, qualification, chemistry as a major subject, and experience in years. Moreover, data shows that those males' opinion is higher on the role of chemical literacy and its implications for the school community. More male participants agreed that chemically literate people use more precautions for safety and avoid

X-Rays harmful effects. The understanding and implementation ratio of male participants are also higher than female participants because male participants are present more in numbers in our data set. The male participants understand better of harmful effects of chemicals if there is no chemical literacy. In the COVID-19 situation, the male participants strongly agree as compared to female participants to avoid crowd and use masks as a first safety measure.

Table 6 Differences in Teachers Responses regarding Role of Chemical Literacy by Age

Items	AGE	SA	A	N	DA	DA	χ^2	df	p
1. I think chemical literacy minimizes health issues and increase safety.	20-30	13	1	4	32	0	23.4	8	0.00
	30-40	41	4	15	62	0			
	40+	10	0	1	14	3			
2. I think everybody reads the expiry date before buying a product.	20-30	25	1	6	14	4	31.9	8	0.00
	30-40	46	24	17	21	14			
	40+	2	4	6	15	1			
3. I know all types of pollution are increasing due to lack of chemical literacy.	20-30	18	5	6	21	0	15.6	8	0.04
	30-40	30	10	26	54	2			
	40+	8	1	2	14	3			
4. I know environmental problems are increasing due to over-use of chemical resources.	20-30	20	3	3	24	0	12.7	6	0.04
	30-40	43	0	16	63	0			
	40+	7	2	6	13	0			
5. I think the use of mask is the first safety measure of COVID-19.	20-30	35	2	5	6	2	25.4	10	0.00
	30-40	80	2	4	36	0			
	40+	13	0	3	11	0			
6. I think use of disinfectants minimizes the effects of COVID-19.	20-30	22	4	6	16	2	16.2	8	0.03
	30-40	52	1	19	49	1			
	40+	6	0	6	15	1			

The chi-square was on all the 25 items in this section, and 6 show age differences in years in response patterns. In general, real differences might be expected. The 4.13 data showed that the age group of 30-40 years participants' feelings about the role of chemical literacy and its implications to the school community are higher than the age group of 20-

30 years and more than 40 years. The age group 30-40 years responses are more likely positive than other age groups because 30-40 years age groups are present more in numbers in our data set. The understanding of the age group of 30-40 years about chemical literacy is better than other age groups.

Table 7 Difference of opinion regarding the role of Chemical Literacy by Locale

Name of Items	Locale	SA	A	N	DA	SDA	χ^2	df	p
1. I understand chemical literacy needs to every citizen.	Rural	44	48	31	8	6	9.0	4	0.05
	Urban	23	16	14	10	0			
2. I understand chemical literacy is the focal point of scientific literacy.	Rural	34	54	36	13	0	13.6	4	0.00
	Urban	8	38	10	5	2			
3. I understand chemical literacy	Rural	37	58	35	7	0			

	is helpful to improve health literacy.	Urban	9	41	8	5	0	11.4	3	0.01
4.	I understand chemical literacy improves the environmental literacy.	Rural	45	50	32	10	0			
		Urban	14	37	7	2	3	17.6	4	0.00
5.	I think chemically literate people grow more yields of agriculture crops.	Rural	57	46	20	14	0			
		Urban	13	33	12	4	1	12.7	4	0.01
6.	I know all types of pollution are increasing due to lack of Chemical literacy.	Rural	35	61	26	14	1			
		Urban	21	28	8	2	4	10.0	4	0.03
7.	I know plastic bags are affecting the fertility of soil.	Rural	80	30	12	5	10	12.6	4	0.01
		Urban	25	29	5	2	2			
8.	I think chemical literacy is the first aid of every pandemic.	Rural	29	64	29	10	5			
		Urban	29	20	11	2	1	13.6	4	0.00
9.	I think use of disinfectants minimizing the effects of COVID-19.	Rural	48	61	22	5	1			
		Urban	32	19	9	0	3	10.8	4	0.02
10.	I think COVID-19 enlighten the importance of chemical literacy.	Rural	31	63	34	9	0			
		Urban	20	32	9	0	2	12.3	4	0.01

The chi-square was on all the 25 items in this section, the data of table 7 show 10 posting of school locality differences in response patterns. In general, these real differences might

be expected. The rural responses are more likely positive than urban participants because rural school locality participants are presents more in numbers in our data set.

Table 8 The Difference of Opinion of the Role of Chemical Literacy by Educational Qualification

Items	Educational Qualification	SA	A	N	DA	SDA	χ^2	df	p	
1.	I understand chemical literacy is needed for every citizen.	B.Sc.	8	10	2	1	2			
		BS/M.Sc.	26	40	25	10	2	16.9	8	0.03
		M.Phil.	33	14	18	7	2			
2.	I understand chemical literacy is the focal point of scientific literacy.	B.Sc.	7	6	7	2	1			
		BS/M.Sc.	26	40	25	11	1	17.1	8	0.02
		M.Phils.	9	46	14	5	0			
3.	I think everybody reads the expiry date before buying a product.	B.Sc.	5	10	3	2	3			
		BS/M.Sc.	25	29	20	17	12	28.4	8	0.00
		M.Phil.	43	11	6	10	4			
4.	I think chemically literate person grow	B.Sc.	9	6	2	5	1			
		BS/M.Sc.	30	43	21	9	0	18.9	8	0.01

more yields of agriculture crops.	M.Phil.	31	30	9	4	0			
5. I think use of mask is the first safety measure of COVID-19.	B.Sc.	16	5	0	1	0			
	BS/M.Sc.	58	29	12	3	1	24.1	10	0.00
	M.Phil.	54	19	0	0	1			

The chi-square was on all 25 items and the data of table 8 show qualification differences in response patterns. In general, these real differences might be expected. The secondary school teachers of BS(Hons.)/M.Sc.

qualification responses are more likely positive than B.Sc. and M.Phil. Qualification participants because BS (Hons.)/M.Sc. qualification secondary school teachers are presents more in numbers in our data set.

Table 9 The Difference of Opinion of the Role of Chemical Literacy by Major

Item	Chemistry Major	SA	A	N	DA	SDA	χ^2	df	p
1. I understand chemical literacy improves the environmental literacy.	Yes	26	25	7	6	2	11.0	4	0.03
	No	33	62	32	6	1			
2. I know acid rain causes skin problems.	Yes	39	19	5	1	2	9.9	4	0.04
	No	50	63	14	5	2			
3. I know town and housing societies are planned far away from industrial units.	Yes	30	20	9	2	5	10.9	4	0.02
	No	42	67	10	10	5			
4. I know carbon dioxide gas is environmental friendly.	Yes	12	25	11	12	6	9.3	4	0.05
	No	29	31	35	15	24			
5. I know environmental problems are increasing due to over-use of chemical resources.	Yes	35	23	7	1	0	4.3	4	0.00
	No	35	77	18	4	0			
6. I think chemical literacy is the first aid of every pandemic.	Yes	12	36	14	4	0	10.6	4	0.03
	No	46	48	26	8	6			

The chi-square was calculated on all 25 items in this section, the data of table 9 show 6 chemistry teachers as a major subject difference in response patterns. The secondary school teachers without chemistry major responses are

more likely positive than chemistry major teachers because without chemistry major secondary school teachers are present more in numbers in our data set.

Table 10 Difference of Opinion regarding the role of Chemical Literacy by Teaching Experience

Teaching	SA	A	N	DA	SDA
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Items	experience						χ^2	df	p
1. I think everybody reads the expiry date before buying a product.	0-5	22	12	7	2	3	21.5	8	0.00
	5-10	44	21	13	21	14			
	10+	7	17	9	6	2			
2. I think the use of a mask is the first safety measure of COVID-19.	0-5	25	9	7	3	2	28.4	10	0.00
	5-10	77	33	3	0	0			
	10+	27	11	2	1	0			

The chi-square was on all the 25 items in this section, the data of table 10 show 2 teaching experience differences in response patterns. In general, these real differences might be expected. Secondary school teachers' experience 5-10 years responses are more likely positive than 0-5 and more than 10 years teaching experience because 5-10 years teaching experience of secondary school teachers are presented more in numbers in our data set.

DISCUSSION

This study aimed to explore secondary school teachers' perceptions of the role of chemical literacy and its implications to the school community. The first two research questions inquired about the Chemistry/Science teachers' views or perceptions of the understanding of harmful effects of chemicals and precautions about safety measures of chemicals. The responses from questionnaire data indicated key findings is that secondary school Chemistry/Science teachers perceived well of the understanding of chemical literacy. The research's data about the teachers' perceptions of the understanding of chemical literacy is similar to Shwartz et al. (2005) with respect to the usability of chemistry. The above-mentioned study explored the definition of chemical literacy and explained that a chemically literate person uses his/her understanding of chemistry in his daily life. The awareness and understanding of chemical literacy are very

important. The study explored the meaning of chemical literacy to scientists and schoolteachers. The study states that the understanding of chemical literacy is needed by everybody and explained the meaning of chemical literacy with respect to different dimensions to scientists and schoolteachers. As compared to scientists, the teachers' perceptions of Chemical Literacy are more comprehensible.

The third research question inquires about how much chemical literacy is helpful to improve health literacy and the fourth research question delves into to what extent a chemical literate person knows about health issues. Both second and third research questions are explored through section 2 of the questionnaire to think about the implications of chemical literacy. In section 2 of the questionnaire, the responses of participants are mainly positive. Many of the participants feel the implications of chemical literacy minimize chemical-based issues, increase safety, and improve health literacy. The findings from data about the teachers' perceptions of the implications of chemical literacy are similar to Arshad et al. (2011). Hospital waste is an important issue in developing countries. The previous study stated hospital waste is a risk to the public and to the environment. The clinical and non-clinical waste is collected and thrown together which is highly unsafe. The safety measures dealing with hospital waste are inadequate and toxic pollutants are emitted when hospital waste is incinerated. This study said proper waste

management is required to ensure the health and environmental issues. Institutions such as Shaukat Khanum and Shalamar have proper hospital waste management practices.

Moreover, it is found that understanding and awareness of chemical literacy are not enough to overcome general health issues and hygiene problems. The implications of chemical literacy are very necessary otherwise chemical literacy is just information and not fruitful to societal needs. The fifth research question is about reading the expiry date before buying a product. The nature of chemicals changes any product with respect to time, temperature, and physical conditions of the place of storage so that is why chemical literacy is essential. The sixth research question inquired about the knowledge of chemical literacy to solve chemical-based issues. The implications of chemical literacy are very important with respect to the agriculture sector like agricultural crops more yield production, proper growth of crops and seed preservation, etc. All over the world plastic bags affected the fertility of the soil badly. Due to this reason, Pakistan bans plastic bags like another international world but still used in Pakistan.

The seventh research question inquired about to what extent pollution increased due to the lack of chemical literacy. Fadillah et al. (2017) study addressed the interconnection of chemistry and human life. This study recommended introducing global environmental issues into the basic science or chemical curriculum for all students in order to develop global awareness. The above-mentioned study is similar to the findings; the spread of environmental education minimizes environmental problems or issues. Today industry is an essential part of modern society. Hazardous industrial waste has a serious impact on health and the environment. All over the world, not in Pakistan pollution (air, water, soil, etc.) is increasing day by day. The majority of

participants agreed that all types of pollution are increasing due to the lack of chemical literacy. The findings are similar to Misra et al. (2005). The literature suggested every discarded material from the industry is called industrial waste and hazardous to human health and pollutes the environment (soil, air, and water) when disposed of waste improperly. Solid industrial waste contributed the main share toward environmental degradation. Thus, the waste-generating industries needed to develop environment-friendly cost-effective planning for waste in future. If there is no chemical literacy, all types of pollution, environmental issues and pandemic like diseases are increased according to above mentioned studies.

The recent situation of COVID-19 is one of the global examples that the awareness or understanding and implementation of chemical literacy are the social responsibility of both science and non-science graduate students and teachers. The researcher data explored the same to Hazen et al. (1991) the chemically literate societies can fight better against COVID-19 type pandemic situation. Similar to Hazen et al. (1991), non-science students need to understand public or society-related environmental issues, medical issues and problems, and novel materials and technologies in a scientific context. They need to build up learning on the universal laws of physics, chemistry, geology, and biology that work every day. It is the need of the time; the non-science students should also be scientifically literate to fight against the COVID-19 situation. Hence this study emphasized that the science and non-science departments induct programs together and developed an integrated content of scientific knowledge and communicate about the chemicals and their hazards can affect school community to wider level.

CONCLUSION:

This study concluded that the majority of the Chemistry/Science teachers were positive and have good understanding of the role and importance of chemical literacy and its implications for the school community are positive. Hence, based on the findings of the study, the following conclusions can be drawn:

- Most of the teachers were aware the harmful effects of chemicals and are more precautious about safety measures.
- Most of the teachers agreed chemical literacy is helpful to improve health literacy and minimize health issues.
- Most of the teachers implicate the knowledge of chemical literacy to solve the chemical-based issues.
- Many of the teachers measure the harmful effects of carbonated drinks on health or are aware of the harmful effects of carbonated drinks on health.
- Most of the teachers give positive responses about the role of chemical literacy in the pandemic of COVID-19 situation.

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