

Engineering Students' Opinions on Science Literacy

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Abstract In this study, the aim is to analyze opinions of engineering students on science literacy. Research participants constitute of a total of 143 students attending construction engineering department in a university located in the Eastern Black Sea region of Turkey. In this study in which survey model was adopted, data obtained through a form containing open-ended questions were analyzed using the content analysis method. Engineering students defined science literacy mostly as “knowing, understanding, interpreting science subjects”, “constantly following scientific and technological developments related to science”, “making academic studies, writing articles in fields of physics, chemistry and biology” and “receiving or having received education related to science”. Students indicated that physical sciences had application especially in the field of engineering, they are cornerstone of the engineering profession, and thus physical sciences are important. Students mostly indicated that laboratory applications were important for science literacy since they ensured practical learning, gaining experience, effective and lasting learning, seeing that theoretical knowledge worked in real life, making learning easy, concretization and allowing transformation of theory into practice. In line with research findings, it was seen that engineering students defined science literacy generally in accordance with literature, and in higher years, students’ definitions of science literacy varied.

Keywords Engineering Students, Opinions, Science Literacy

1. Introduction

Societies continuously need scientific and technological flow of ideas, science literacy to ensure enough level of education and to provide social, medical and humanitarian services [1]. Developed countries place emphasis on educate their citizens as science literate to adapt to rapid progress in science and technology and to provide necessary manpower [2, 3]. At this point, science literacy is of critical importance in understanding scientific and technological developments becoming gradually complex and varied, and in using accordingly in today called the age

of science and technology [4, 5].

The term of science literacy was raised by Paul Hurd (1958) and Mc Curdy (1958) [6]. After the Soviet Union launched the satellite called Sputnik into space in 1957, all countries, especially America, realized the strategic role of scientific information, and these countries supported science not to stay back in this scientific race [7]. USA, Canada and European Union countries implemented reforms in this direction [8, 9, 10, 11, 12, 13], and science literacy has become a common vision in educational programs of many countries [14].

In Turkey, the process started with changing courses in universities in 1997. Then, this progress continued with amendments applied in science and technology curriculum in the year 2004, and in physical sciences curriculum in 2013, 2015 and 2017. In Turkey, science literacy was defined firstly by the Higher Education Council as “knowing natural world and knowing both its variety and unity, understanding key concepts and principles of physical sciences, being aware of some important connections binding physical sciences, mathematics and technology, understanding physical sciences, mathematics and technology as the product of human efforts, knowing power and limitations bringing into these fields, having the capacity of scientific thinking, and using science knowledge and scientific thinking ways for individual and social purposes” [15]. Having a very wide scope, science literacy can be defined as a combination of knowledge, skills, attitudes, values and understanding related to science that are necessary for individuals towards examining-questioning, critical thinking, improving problem solving and decision-making skills, being lifelong learners and maintaining the sense of curiosity related to the world around them [16]. According to Çepni, Aycacı and Bacanak (2009), science literacy include knowing science concepts, theory, scientific research methods; understanding relationships between science, technology and society and their effects on themselves; ability to use theoretical information learned from school for solving problems in daily life, explaining social problems related to science and making decisions; ability to write, read and understand articles, journals and books with scientific content; ability to participate in scientific discussions; and having necessary information and skills required to think

neutrally, critically and creatively.

Vision of Science and Technology Course Curriculum and other educational programs in 2004 was to educate all students as science literate regardless of their individual differences. Science literate individuals are those who research-question, make effective decisions, who are self-reliant, who effectively communicate, who are lifelong learners, who have knowledge, skills, positive attitude, perceptions and values related to physical sciences, who have understanding and psychomotor skills towards the relationship between physical sciences and technology-society-environment. In addition, they are individuals who have scientific knowledge skills towards discovery of the natural environment, who understand relationship between social and technological changes, conversions and science and natural environment, who feel responsible for solving problems related to social issues, who can produce alternative solution proposals based on individual or collaborative cooperation with the help of creative and analytical thinking skills, and who have realized with their own intellectual power, creative thinking and studies that information may change in time [17]. Science and technology literate individuals perceive nature of science and scientific information, also understand basic science concepts, principles, laws and theories, and use them accordingly [38]. One of the characteristics of a science literate is ability to use scientific knowledge in making vital and social decisions, making conclusions, solving problems and applying in behaviors [3].

On the other hand, together with science literacy, studies based on interdisciplinary approaches began to emerge in science education [3]. This is because it is necessary to possess the 21st century skills listed as creativeness, critical and analytical thinking, research, questioning, making decisions and solving problems and collaborative studies together with the facts that science and technology progress rapidly, individual differences come into prominence [18]. In this context, these skills can be realized STEM (science, technology, engineering and mathematics) teaching system that contained interdisciplinary and application-oriented approach [18]. In this regard, 2017 physical sciences curriculum bearing the vision of science literacy was prepared within the framework of STEM training, and engineering and design skills were added to course acquisitions. It is of great importance for students to experience science and engineering applications to increase scientific research and technological development capacity, socioeconomic development and competitive power of Turkey [19]. In this context, "Science and Engineering Applications" unit has been added to the end of each year from 4th year to 8th year in which students are aimed to answer a daily problem practically with a product they design [19]. STEM education, by guiding collaboration among different disciplines like an engineer, aims at educating individuals who are open to communication, who can think

systematically, who are creative, have ethical values and who can find the most appropriate solution to the problems [20, 21, 22, 23]. In addition, developed by National Research Council (NRC) based on K-12 Science Education Standards updated in 2012 in USA, Framework for K-12 Science Education gives wide coverage to engineering education in both application and scope. In this context, the aim of emphasized engineering education is the necessity for nesting these applications rather than adding extra engineering applications to intensive sciences programs or transforming science courses into engineering courses. To do this; the first way is to place engineering learning objectives into objective of other learning fields, and the second way is to fuse basic engineering applications into other learning fields [24].

As is known, with educational programs aiming at educating all individuals as science literate, the aim is to ensure that educated students view the world with the eyes of a scientist. Although the scope of science literacy concept is wide, it is thought that a qualified science literate should first understand the definition and nature of science literacy concept better. In this context, in this study, the objective is to analyze opinions of engineering students on science literacy who are from the field of engineering that is closely associated with physical sciences and that is one of field of application of physical sciences. It is seen that many studies have been conducted on science literacy, and these studies mostly concentrate on levels of science literacy among teachers, prospective teachers or students [5, 25, 26, 27, 28, 29, 30, 31, 32] and on teachers' or prospective teachers' opinions on science literacy [30, 33, 34, 35]. Within the scope of this research, engineering students' opinions on science literacy may provide general information about their perspectives, perceptions or attitudes related to physical sciences. Therefore, a period when an interdisciplinary understanding is aimed, how much engineering students need to associate their field of study with physical sciences, and information about applications in the faculty of engineering.

2. Materials and Methods

2.1. Model of Research

This work was conducted according to survey model that aims at describing a situation existing in the past or existing currently as it is [36]. An event, individual or object is tried to be described under its own conditions and as it is in a survey model study [37].

2.2. Participants

Research participants constitute of a total of 143 students attending construction engineering department in a university located in the Eastern Black Sea region of Turkey. Characteristics of participants are presented in Table 1.

Table 1. Characteristics of Participants

	1st year		2nd year		3rd year		4th year		Total	
	f	%	f	%	f	%	f	%	f	%
Girls	10	35,7	3	9,7	11	30,6	8	16,7	32	22,4
Boys	18	64,3	28	90,3	25	69,4	40	83,3	111	77,6
Total	28	100	31	100	36	100	48	100	143	100

Participants have ranged in age between 18 and 22. The years of completing secondary education of participants vary between 2013 and 2017. The university entrance examination is made in Turkey after completing secondary education. The scores of participants' entrance examination to engineering department are almost equivalent. Participants have similar qualifications on a class basis.

2.3. Data Collection Tools

Research data was collected by form containing open-ended questions developed by the researcher. There are the form containing open-ended questions related to definition of science literacy, characteristics of science literate individuals, self-assessment as science literate, importance of science literacy for engineering, importance of laboratory practices in science literacy and adequacy of laboratory practices in terms of science literacy. In preparation of open-ended questions, principles were considered such as easily understanding questions, not being multidimensional, and being router responder. Opinions of two field experts were taken with a view to control how much the open-ended questions served for its purposes, its lucidity and practicality, and the form took its final form in accordance with expert suggestions.

Additionally, the form containing open-ended questions was applied 3 students before applying. The students were given a class hour to be able to write their opinions comfortably.

2.4. Data Analysis

Data obtained in this study was analyzed using content analysis method. In content analysis, data similar to each other is collected within the framework of specific concepts and themes, and these are interpreted in a way that reader can understand [43]. The main objective in

content analysis is to attain the concepts and relationships that can explain the collected data. Findings from this study were provided as frequency and percentage. Since there were students who gave more than one answer to each question or did not give any answers, percentage calculations in findings were calculated over the total number of answers given rather than the figure in the sample. In addition, students attending the 1st year were coded as S₁-1, S₁-2, S₁-3, ..., S₁-28; those attending the 2nd year were coded as S₂-1, S₂-2, S₂-3, ..., S₂-31; those attending the 3rd year were coded as S₃-1, S₃-2, S₃-3, ..., S₃-36; and those attending the 4th year were coded as S₄-1, S₄-2, S₄-3, ..., S₄-48.

At the stage of data analysis, categories related to science literacy were determined by the researcher within the scope of reliability studies, and opinions of an academician giving course of qualitative data analysis at postgraduate level were consulted. Differing categories were classified and revised again by the academician and researcher. To ensure validity of results achieved in the study, in the findings section, the raw data was presented as much as possible, and in the method section, data analysis process was tried to be explained in detail.

3. Findings

As a result of analyses, engineering students' opinions were gathered under 6 categories including "definition of science literacy", "characteristics of science literate individuals", "self-assessment as science literate", "importance of science literacy for engineering", "importance of laboratory practices in science literacy" and "adequacy of laboratory practices in terms of science literacy". Students' opinions on the definition of science literacy are presented in Table 2.

Table 2. Students' Definitions for Science Literacy

Categories	1st year		2nd year		3rd year		4th year		Quotes
	f	%	f	%	f	%	f	%	
Knowing, understanding, interpreting science subjects	2	7,1	5	16,1	5	13,9	9	18,8	Science literacy is the ability to find solution to issues and events we see and face in daily life. S1-13
Constantly following scientific and technological developments related to science	3	10,7	5	16,1	5	13,9	7	14,6	
Making academic studies or writing articles in fields of science	2	7,1	2	6,5	5	13,9	6	12,5	Science literacy is to be interested in and study science-related documentaries, books, magazines etc. S1-17
Receiving or having received education related to science	3	10,7	5	16,1	3	8,3	3	6,3	
Teach or ability to teach science topics	3	10,7	3	9,7	3	8,3	2	4,2	Science literacy is to understand positive sciences (physics, chemistry, biology) and to be at a level to create theories and hypotheses making use of these fields. S3-1
Ability to find solution	1	3,6	2	6,5	3	8,3	3	6,3	
Aiming at personal development and guiding his/her life thanks to science	1	3,6	2	6,5	2	5,6	3	6,3	Science literacy is the ability to understand and interpret terminological or content, text and visual concepts related to physical sciences. S3-28
Understanding and applying subjects of science	1	3,6	1	3,2	1	2,8	4	8,3	
Having different or scientific perspective, ability of versatile thinking	-	-	1	3,2	2	5,6	3	6,3	Science literacy is to ability to read nature and make sense of events in nature. S4-20
Understanding and interpreting the nature or surrounding	-	-	-	-	2	5,6	3	6,3	
Analytical thinking	-	-	-	-	2	5,6	1	2,1	Science literacy is the combination that improves individuals' skills of research, questioning, problem-solving and decision making, and ensure that they be lifelong learning individuals. S4-46
Knowing formulas, units etc. related to science	-	-	1	3,2	1	2,8	-	-	
Knowing/interpreting numerical and verbal data	1	3,6	1	3,2	-	-	-	-	Science literacy is to ability to read nature and make sense of events in nature. S4-20
Developing scientific process skills and ensuring lifelong learning	-	-	-	-	-	-	2	4,2	
Ability to solve numerical problems	-	-	-	-	1	2,8	-	-	Science literacy is the combination that improves individuals' skills of research, questioning, problem-solving and decision making, and ensure that they be lifelong learning individuals. S4-46
Ability to use measurement tools	-	-	1	3,2	-	-	-	-	
Observing and elicitation from observations	-	-	-	-	-	-	1	2,1	

Table 2 shows that engineering students define science literacy in seventeen different ways and that the diversity of their definitions varies according to year level. Engineering students defined science literacy mostly as “knowing, understanding, interpreting science subjects”, “constantly following scientific and technological developments related to science”, “making academic studies, writing articles in fields of physics, chemistry and biology” and “receiving or having received education related to science” in all of years level. The higher the students' year is, students tended to give definitions such as “understanding and applying subjects of science”, “having different or scientific perspective, ability of versatile thinking” and “understanding and interpreting the nature or surrounding”, but it is seen that frequency of these definitions is small. Students' opinions on characteristics of science literate individual are presented in Table 3.

Table 3. Students' Opinions on Characteristics of Science Literate Individual

Categories	1st year		2nd year		3rd year		4th year		Quotes
	f	%	f	%	f	%	f	%	
Producer solutions to problems in daily life	2	6,3	4	7,8	6	8,1	13	9,5	
Researcher	3	9,4	4	7,8	6	8,1	11	8,0	
Eager to learn, and questioner constantly	3	9,4	4	7,8	6	8,1	9	6,6	
Interested in subjects of science	4	12,5	5	9,8	5	6,7	7	5,1	Science literate people have more different perspectives of the world, and they are more aware of innovations. S1-Ö10
Sensible	3	9,4	4	7,8	4	5,4	10	7,3	
Reader scientific journals, watcher documentaries, follower up-to-date information	3	9,4	5	9,8	5	6,7	8	5,8	They are individuals open to innovation, researcher-spirited, who follow developments in the world. S2-3
Analytical thinker, examiner outcomes, an observer	-	-	4	7,8	5	6,7	8	5,8	
Have different perspective, producer different ways of solution	1	3,1	3	5,9	4	5,4	9	6,6	These are people with different points of view and searching for different ways of solution. S2-19
Practical	3	9,4	3	5,9	4	5,4	6	4,4	
Knowledgeable on his/her surroundings and the nature	-	-	1	2,0	4	5,4	9	6,6	These are people who can associate events occurring around them with physical sciences, and who can produce the solution easily. S3-14
Innovative	1	3,1	2	3,9	3	4,0	8	5,8	They have more information about their surroundings and the nature. I think that they are more qualified in terms of technology, and they know use of technology better. S4-11
Know science subjects	1	3,1	3	5,9	3	4,0	5	3,6	
Follow technology and scientific developments	1	3,1	2	3,9	3	4,0	5	3,6	They may think of events they face in a multidimensional way, they create practical solutions against problems. S4-27
Can use the technology	1	3,1	1	2,0	2	2,7	5	3,6	
Curious for numeric operations, with mathematical intelligence	2	6,3	2	3,9	1	1,4	4	2,9	
Apply in life what he/she learns	1	3,1	-	-	2	2,7	5	3,6	
Person is enjoying scientific studies	1	3,1	1	2	1	1,4	3	2,2	
Open to criticism	1	3,1	-	-	2	2,7	2	1,5	
Think quickly and produce solution	-	-	1	2	1	1,4	3	2,2	
Curious about everything in nature, and investigate	-	-	1	2	2	2,7	2	1,5	
Self-disciplined	-	-	-	-	1	1,4	3	2,2	
Experimenter	1	3,1	-	-	1	1,4	1	0,8	
Designer	-	-	1	2	-	-	1	0,8	
Can communicate well and can transfer what they think	-	-	-	-	1	1,4	-	-	
Have received education in science fields with science and technology weight	-	-	-	-	1	1,4	-	-	
Successful in science courses	-	-	-	-	1	1,4	-	-	

Table 3 shows that students define characteristics of science literate individual in twenty-six different ways and that the diversity of their definitions varies according to year level. Students indicated that science literate individuals generally have characteristics such as “producer solutions to problems in daily life”, “researcher”, “eager to learn and questioner constantly”, “interested in fields of physics, chemistry and biology”, “sensible”, “reader scientific journals, watcher documentaries, follower up-to-date information”, “analytical thinker, examiner outcomes, observer”, “have different perspective, producer different ways of solution”, “practical”, “knowledgeable on his/her surroundings and the nature” and “innovative” in all of years level. The higher the students’ year is, students tended to give definitions such as “know science subjects” , “follow technology and scientific developments”, “can use the technology”, “think quickly and produce solution”, “curious about everything in nature, and investigate” and “self-disciplined”, but it is seen that frequency of these definitions is small. Engineering students’ opinions on self-assessments of their science literacy are presented in Table 4.

Table 4. Students' Opinions on Self-Assessment for Science Literacy

	Categories	1st year		2nd year		3rd year		4th year		Quotes
		f	%	f	%	f	%	f	%	
Seeing oneself as science literate	Doing research, being curious	1	3,6	3	9,7	3	8,3	5	10,4	When I face a problem in real life, I can bring scientific reviews rather than conventional daily comments. S1-18 I think I can be literate when I master many subjects related to my field. S1-25 I see myself as a science literate. Because I comprehend physical sciences. S2-7 I especially follow natural events, astronomy and geology branches. S2-18 I see myself as a science literate. Because one of the characteristics of prospective engineer is to produce practical solutions to problems, to be curious and researcher. S3-29 I follow science and technology. I am interest in department I attend, I like finding solutions to people's needs, nature and problems. S4-4
	Reading science magazine	2	7,2	2	6,5	1	2,8	5	10,4	
	Following science-related branches	1	3,6	1	3,2	4	11,1	4	8,3	
	Following scientific developments, applying what they learn in life	1	3,6	1	3,2	3	8,3	4	8,3	
	Ability to make scientific comments	1	3,6	1	3,2	3	8,3	4	8,3	
	Understanding science topics	-	-	2	6,5	1	2,8	4	8,3	
	Following the developing technology	1	3,6	1	3,2	1	2,8	3	6,3	
	Ability to produce practical solutions	-	-	1	3,2	1	2,8	4	8,3	
	Taking lessons associated with science (Physics)	-	-	3	9,7	1	2,8	1	2,1	
	Completing what is missing/learning new things	1	3,6	1	3,2	-	-	2	4,2	
Not seeing oneself as science literate	Knowing all units	-	-	2	6,5	-	-	-	-	
	Not being able to master science subjects	1	3,6	2	6,5	2	5,6	4	8,3	
	Not receiving enough courses of science	-	-	2	6,5	1	2,8	3	6,3	
	Not being a researcher, not doing research	1	3,6	-	-	1	2,8	4	8,3	
	Disliking the department attended, not being interested	1	3,6	-	-	2	5,6	1	2,1	
	Not following scientific journals or programs	1	3,6	1	3,2	1	2,8	-	-	
	Dealing with science courses since they are mandatory in engineering	2	7,2	-	-	1	2,8	-	-	
	Not follow science and scientific developments enough	2	7,2	-	-	-	-	-	-	
	Inability to produce practical information	-	-	1	3,2	1	2,8	-	-	
	Inability to make different interpretations	-	-	1	3,2	-	-	-	-	
Not knowing units	-	-	1	3,2	-	-	-	-		

Table 4 shows that more than half of the students reported that they saw themselves as science literate, because they were prone to doing research in the field of science and technology, they read science journals, followed scientific developments and tried to practice what they have learned into their lives, and they were able to make science comments. Students not considering themselves as science literate attributed it to the fact that they did not master science subjects enough, they did not receive enough courses of science, did not make research and not like their departments. Engineering students' opinions on the importance of science literacy for the field of engineering are presented in Table 5.

Table 5. Students' Opinions on the Importance of Science Literacy for the Field of Engineering

Categories	1st year		2nd year		3rd year		4th year		Quotes
	f	%	f	%	f	%	f	%	
Since science have application in the field of engineering	6	23,1	6	19,4	7	17,1	9	14,5	Science literacy is important to catch scientific levels of scientific and industrialist countries. S1-21
Since science are foundation of engineering or associated with engineering	6	23,1	6	19,4	9	22,0	13	21,0	Analysis of substances, examination of movements and analysis of body movements etc. It is important to be science literate since science is in all fields of our lives. S2-1
To understand or explain all kinds of events occurring around us	2	7,7	3	9,7	4	9,8	7	11,3	Science is especially the assistant science in calculation of development and strength of roads, bridges and hospitals. Therefore, science literacy is important. S2-15
Since science cover almost all of the life and are included in every aspect of life	2	7,7	2	6,5	4	9,8	5	8,1	Science is cornerstones of engineering. For instance, while building a building, we accomplish it based on calculations we learn from laws of physics and ensure that it becomes a solid structure. Therefore, science literacy is important. S3-22
Not to stay behind under today's conditions and in improving technology/ To ensure development and improvement of science and technology	2	7,7	3	9,7	4	9,8	3	4,8	They are used to find solution for problems faced in daily life. Safety, economy and aesthetics of the work done can be adjusted fine with science. S4-15
To produce solutions to problems encountered/to make our lives more convenient	-	-	2	6,5	2	4,9	7	11,3	Engineering means science. Engineer gets help from science. For example, for a building to stay in balance, we should have information in the field of static, so we can calculate this. Therefore, science literacy is important. S4-39
To be a good engineer	3	11,5	3	9,7	1	2,4	2	3,2	
To use in accordance with our needs in business life	1	3,8	1	3,2	3	7,3	4	6,5	
Since science allow being more knowledgeable, creative and innovative	1	3,8	2	6,5	3	7,3	3	4,8	
Since studies facilitating our lives are conducted under the leadership of science	2	7,7	1	3,2	1	2,4	3	4,8	
Since materials used in the field of engineering are outcomes of research and development by science	1	3,8	1	3,2	2	4,9	3	4,8	
To understand universe or nature	-	-	1	3,2	1	2,4	3	4,8	

Table 5 shows that the diversity of students' explanations on the importance of science literacy for the field of engineering varies according to year level. Students often indicated that science had application especially in the field of engineering, and thus science literacy is important. In addition, students reported that science literacy was significant in terms of "explaining all kinds of events occurring around us" and "not to stay behind under in today's conditions and in improving technology". The higher the students' year is, students tended to give explanations such as "to produce solutions to problems encountered/to make our lives more convenient" and "to understand universe or nature", but it is seen that frequency of these explanations is small. Engineering students' opinions on the importance of laboratory applications in science literacy are presented in Table 6.

Table 6. Students' Opinions on Importance of Laboratory Applications in Science Literacy

Categories	1st year		2nd year		3rd year		4th year		Quotes
	f	%	f	%	f	%	f	%	
Laboratory applications provide hands-on learning (ensure learning based on observation and experiment)	6	13,0	9	19,6	9	18,4	11	13,9	When we make application, learning phase occurs faster. S1-2
Ensure gaining experience	6	13,0	6	13,0	9	18,4	12	15,2	Practical training facilitates understanding and grasping. S1-12
Provide effective and lasting learning	4	8,7	6	13,0	7	14,3	10	12,7	Theoretical knowledge is forgotten fast unless this knowledge is taken into practice. S1-18
Allows us to see what theoretical knowledge works in real life	5	10,9	4	8,7	5	10,2	6	7,6	We can experience simply situations that we may face in our daily lives or work lives in physics laboratory. These small experiences may be our guide. S2-4
Allow facilitation of learning/visualization and concretization	6	13,0	4	8,7	2	4,1	5	6,3	Engineers cannot acquire professional experience in classroom environment. S2-29
Allow transforming theory into practice	3	6,5	3	6,5	5	10,2	6	7,6	It is important in terms of being sure and not to hesitate in terms of reliability of results we obtain in formulas. S3-10
Allow practicing	5	10,9	2	4,3	3	6,1	3	3,8	It is important in terms of knowing how to make designs facilitating people's lives and how to use them. S3-33
Allow analysis or testing	-	-	3	6,5	4	8,2	4	5,1	It is necessary for individuals to visualize better for understanding events and in future studies. S4-38
Allow for carrying out real applications	3	6,5	1	2,2	-	-	5	6,3	Engineering is practicality, ability to produce quick and lasting solutions. It is impossible for a person not knowing practice to achieve this. S4-43
Allow for consolidating that are learned	2	4,3	1	2,2	2	4,1	3	3,8	
Facilitate understanding and grasping	3	6,5	1	2,2	-	-	4	5,1	
Allow for finding solutions to problems that we face	2	4,3	1	2,2	2	4,1	3	3,8	
Allow to bring explanations to scientific events	-	-	1	2,2	1	2,0	4	5,1	
Allow consolidating with experiments	-	-	4	8,7	-	-	2	2,5	
Allow for comparing obtained results with real values	-	-	-	-	-	-	1	1,3	
Allow for faster learning	1	2,2	-	-	-	-	-	-	

Table 6 shows that students explain on importance of laboratory applications in science literacy in sixteen different ways and that the diversity of their explanations varies according to year level. Students mostly indicated that laboratory applications were important for science literacy since they ensured practical learning, gaining experience, effective and lasting learning, seeing that theoretical knowledge worked in real life, making learning easy, and allowing transformation of theory into practice. The higher the students' year is, students tended to give explanations such as "allow bringing explanations to scientific events" and "allow for comparing obtained results with real values", but it is seen that frequency of these definitions is small. Engineering students' opinions on adequacy of laboratory applications they carry out in terms of science literacy are presented in Table 7.

Table 7. Students' Opinions on Adequacy of Laboratory Applications in terms of Science Literacy

Categories	1st year		2nd year		3rd year		4th year		Quotes
	f	%	f	%	f	%	f	%	
Experiment or application are not made	6	22,2	11	35,5	9	25,0	15	31,3	I think more useful application will be more beneficial. S1-3
Adequacy experiment or application are not made	8	29,6	6	19,4	10	27,8	5	10,4	Not enough, where will I use titration in real life? S1-17
What are seen in laboratory cannot be used in real life	1	3,7	5	16,1	6	16,7	13	27,1	It allows us to put into practice the subjects we learn in courses. S2-1
Applications in the field of engineering are insufficient and at simple level	1	3,7	4	12,9	6	16,7	7	14,6	When we start to work after graduation, there is a possibility to meet a foreign world. To say the least, even though we build a wall by ourselves, this strangeness may be avoided. S3-19
Application is not made about how theoretical knowledge learned is used in daily life	2	7,4	3	9,7	1	2,8	5	10,4	We do not receive enough laboratory courses to understand how theoretical knowledge is used in real life. S4-44
Applications applied are not focused on construction site	2	7,4	1	3,2	-	-	2	4,2	Experiment applications describing the basics of the work by discussing events as a whole, that are more complex and lead to think will be better. S4-45
Since number of students is high, applications are not made	3	11,1	-	-	1	2,8	1	2,1	
Applications cannot be made with missing equipment and material	2	7,4	1	3,2	1	2,8	-	-	
We are usually passive in applications made	1	3,7	-	-	2	5,6	-	-	
Applications do not have any objectives	1	3,7	-	-	-	-	-	-	

Table 7 shows that students generally reported that laboratory practices they made were insufficient, applications they made were not usable in real life or their work lives and they did not experience at the simplest level in laboratory environment how theoretical knowledge they learned were used in daily life. Especially students indicated that laboratory course they received was not provided based on practice and application. Students generally indicate towards conducting laboratory courses or increasing laboratory hours, making applications usable in real life and making more comprehensive experiments.

4. Conclusions and Discussion

In this study in which opinions of engineering students on science literacy that are from the field of engineering that is closely associated with physical sciences and that is one of field of application of physical sciences, it was revealed that engineering students had information in accordance with literature about science literacy. It is seen that engineering students mainly defined science literacy as “knowing, understanding, interpreting subjects of physical sciences”, “constantly following scientific and technological developments related to science”, “making research, academic studies, writing articles in fields of physical sciences” and “attending a department, receiving or having received education related to science”. The higher the students’ year is, students tended to give definitions such as “understanding and applying subjects of physical sciences”, “having different or scientific perspective, ability of versatile thinking”, “ability to find solution” and “understanding and interpreting the nature or surrounding”. When definitions were analyzed, it was seen that engineering students defined science literacy generally in accordance with literature, and in higher years, students’ definitions of science literacy varied. The reason for this may be attributed to the fact that students have gained the professional experience in upper years. Another reason for this may be attributed to the fact that their department (civil engineering) was one of application areas of physical sciences. Because the department of civil engineering is a field based on physics and mathematics education, and giving education on operation and construction of all kinds of structures that people directly use in daily life. Aldan-Karademir (2012), in their study, concluded that classroom teachers could not define science literacy completely, and they defined science literacy with meanings they attributed.

Engineering students have reported that science literate individuals generally have characteristics such as “producing solutions to problems in daily life or examine problems faced”, “being a researcher”, “eager to learn, questioning constantly”, “being interested in fields of physical sciences, curious in subjects of physical sciences”, “being sensible”, “reading scientific journals, watching

documentaries, following up-to-date information or aware of innovation”, “thinking analytically, examining outcomes, being an observer”, “having different perspective, producing different ways of solution”, “being practical”, “having knowledge on his/her surroundings and the nature” and “being innovative”. It was determined that engineering students had information about basic characteristics that science literate individuals should have. As is known, science literate individual is someone who researches-question, who can solve problems, who are lifelong learners, who have information, skills, positive attitude, perceptions and values related to physical sciences, who understand the relationship between social and technological changes-transformations and science and nature, who can produce alternative solution suggestions based on individual or collaborative cooperation with the help of creative and analytical thinking skills, and who can realize with his/her mind power, creative thinking and studies that knowledge may change in time [17]. Within the scope of this study, it was observed that, the higher students’ year was, engineering students also made definitions towards a science literate individual “who can use technology” and “who applies in real life what is learned”. Anyway, the main goal of the civil engineering department is to educate engineers who follow rapidly developing science and technology, who have knowledge of developing science and technology, and who are equipped with the skills to transfer this information to practice. Duban (2010), in her study, determined that prospective teachers considered science and technology literate individuals as people who had scientific awareness, who understood scientific subjects, who followed technological developments and used them in their lives and who were sensitive to nature. Ability to adapt rapid changes and development in science and technology requires individuals to have abilities of physical sciences and technology use [39]. At this point, science literate individuals have ability to understand and explain some scientific concepts and phenomenon and to follow technological developments and use them in their lives. Engineering students’ opinions on science literate individuals as knowing subjects of physical sciences, eager to learn and continuously questioning/being skeptical, being interest in the fields of physical sciences or being curious, ability to use technology and applying in their lives what they learn show similarities with statements by Miller (1983), Bybee (1995) and National Science Teachers Association [29] on science literate individuals who should be curious and skeptical, who can grasp science and technology-oriented processes and concepts and who can use them in daily life.

More than half of engineering students reported that they saw themselves as science literate, because they were prone to doing research in the field of science and technology, they read science journals, followed scientific developments and tried to practice what they have learned

into their lives, and they were able to make science comments. Erbaş (2005), in a study, detected a positive relationship between science literacy and number of books at home, Internet use and basic computer sciences. Keskin (2008) determined a significant relationship between students' state of reading scientific journals and their scientific literacy. Students not considering themselves as science literate attributed it to the fact that they did not master physical sciences enough, they did not receive enough courses of physical sciences, did not make research and not like their departments. Yakar (2010), in a study, found out a significant relationship between levels of science literacy and owning a computer, frequency of benefiting from Internet and library, shape of benefiting from television, ability to write names of domestic and foreign periodicals. In addition to students who considered themselves as science literate, it was observed that students not considering themselves as science literate were also not strangers to the concept of science literacy and gave a general information about concepts. In descriptions made by students who considered themselves as science literate, it was observed that some characteristics of a "functional" or "conceptual and procedural" science literate individual (e.g. making research, reading science journals, closely following scientific developments and evolving technology, applying what they learn in life etc.) were mentioned. However, engineering students' explanations do not give clear information about how much they are science literate. Therefore, in addition to receiving engineering students' opinions regarding science literacy concept, determining their levels of science literacy may reveal the current situation more clearly.

Engineering students stated that physical sciences had application especially in the field of engineering and they were significant for understanding and explaining every event occurring in our surrounding, not staying behind in today's conditions and improving technology, producing solution to problems faced and facilitating our lives. However, students generally indicated that physical sciences course they received was not provided based on practice and application. A good science education aims at educating science literate individuals who understand the interaction between science-technology and society, who can use knowledge they learn in daily life [40]. Furthermore, students mostly indicated that laboratory applications were important for science literacy since they ensured practical learning, gaining experience, effective and lasting learning, seeing that theoretical knowledge worked in real life, making learning easy, picturing at mind, concretization and allowing transformation of theory into practice. Students mostly reported that laboratory practices they made were insufficient, applications they made were not usable in real life and they did not experience at the simplest level in laboratory environment how theoretical knowledge they learned were used in daily life. However, laboratories have important functions in terms of teaching

science subjects more efficiently to students [41]. Kaya and Bacanak (2013), in their study, determined that students reached consensus in the laboratory method while analyzing methods and techniques that should be used by teachers to increase science literacy. It is considered that methods such as direct instruction, taking notes and verification type laboratory activities are not effective in improving students' literacy, educational process should have a quality towards increasing students' self-confidence and motivation, for this purpose, students should be guided in a way to become individuals who research and question rather than who always need to receive [34]. In the study, it was also observed that almost all of the engineering students had positive perceptions about science literacy. In addition to engineering students' positive perceptions on science literacy and being science literate individuals, academic staff working in the engineering faculty should also have high level of science literacy. For this reason, in accordance with research findings, it is necessary to take into account how much science literacy can be taught to students who have been educated with new educational programs aiming at bringing in interdisciplinary understanding since 2004, and adequacy of applications in engineering faculty should also be analyzed. In this sense, instructors can be informed in detail about the importance of science literacy, it can be discussed what can be done to ensure instructors carry out their courses and laboratory practices in a different way. Besides, laboratory practices may be emphasized to support development of scientific process skills and scientific attitudes that are crucial in engineering students' science literacy.

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