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CONTENT ANALYSIS OF LOWER SECONDARY CLASS BIOLOGY TEXTBOOKS OF TELANGANA STATE FOR SCIENTISTS' CONTRIBUTION AND ACADEMIC STANDARD 'APPRECIATION'

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ABSTRACT

Case method, real world or authentic contexts besides laboratory and museum play a significant role in developing scientific appreciation. The principles of field based experiences and nature study can be utilized for scientific understanding, a basis for appreciating the nature as well as the scientist's ingenuity. This study highlighted the academic standards, the content analysis for scientific contributions and teaching-learning strategies to develop scientific appreciation. The content analysis of lower secondary biology textbooks for scientists' contribution revealed bias for the presentation of the concept 'diversity in living organisms' and 'coordination' with the maximum citations. Thus, teachers should have passion for science teaching and scientific inquiry skills for developing them in their students.

KEYWORDS: *Appreciation, Lower Secondary Class, Academic Standard, Scientists' Contribution*

INTRODUCTION

Cooperation of scientists all over the world is one of the secrets of the stupendous progress made by science in recent decades. The purpose of science teaching at upper primary level, among others, is to recognize the relationship of science and technology with society. At the secondary level, the purpose related to science teaching which continues from the upper primary level is aesthetic sensitivity and appreciation. "Appreciation of science" was defined as recognizing the value or excellence of science and therefore choosing the scientific explanation between the clashing worldviews in question (Ebru Z. Mugaloglu & Sibel Erduran, 2012).

The key aspect of science teaching is to make the children understand the thinking process of scientists' and their efforts behind each discovery. The science textbooks prepared on the recommendations of State Curriculum Framework (SCF) –2011, assist children in becoming self-reliant researchers capable of thinking intensely in scientific terms. Thus, the teachers plan teaching-learning strategies given in the textbooks and other resources to inculcate scientific thinking process and inspire scientific approach in children.

The development of scientific appreciation is akin to appreciation in art, music and literature. The student of science should be able to appreciate the contribution of science in the progress of civilization, the adventures of scientists,

natural phenomena, contribution of scientific methods, etc. The scientific content in the opinion of Wheeler & Perkins needs to be developed in an evolutionary manner in the living context of historical development and biographical inspirations and aspirations, and will thus provide for emotional satisfactions and develop emotional depth. The basic aim here is not to teach much of content to the students but to give them a real feel of science.

Some of the Areas for Developing Scientific Appreciations are:

- History of science, scientific discoveries and inventions, special projects like History of Science cases are also included.
- Biographies of Scientists.
- Impact of Modern Science on daily life and its implications for the future of mankind.
- Contributions of science to food, shelter, clothing, health and hygiene, etc.
- Physical environment and environment created by man.

Academic standards are achieved through curriculum transaction. In this process, the various elements of curriculum such as textbooks, experiments, field experiences, assignments, group work are significant. The present study deals with the academic standard–appreciation of scientist's contributions and its content analysis in biology textbooks at lower secondary stage (9th and 10th class) prescribed by the Government of Telangana state. This study also deals with identifying teaching-learning strategies for the development of appreciation in lower secondary school students.

OBJECTIVES

The objectives of the study are:

- To identify academic standards achieved through biology teaching at lower secondary school.
- To analyze the content for appreciation of scientist's contributions in biology textbooks at lower secondary school.
- To suggest teaching -learning strategies (learning experiences) for appreciation of scientist's contributions in biology textbooks at lower secondary school.

Significance of the Study

The new textbooks designed on the recommendations of SCF, 2011 are developed to achieve the desired academic standards. The teachers should develop various teaching-learning strategies to achieve stage-specific academic standards. Of the many academic standards, conceptual understanding is emphasized more than others, and among them the significant one to be overlooked by teachers is the 'appreciation' of scientist's contribution. The appreciation objective has the behaviors of affective domain – 'responding' and 'valuing'. Due importance can be given for 'appreciation' by various strategies, such as, role-play, debates, elocution, art and drama, posters and a host of performance indicators.

The appreciation must come as an outcome of science teaching, and the teacher must make the students conscious of the benefits bestowed by science for the comforts of the mankind. The adventures of scientists in exploring the truth should be told by the teacher.

REVIEW OF RELATED STUDIES

According to Ministry of Education and Culture of Cyprus (1996) science education must help pupils "to develop attitudes for proper appreciation of their environment, in order to actively participate in activities that promote its preservation and improvement" among other objectives (N Valanides, M Papageorgiou, R Pavlovs, 2013).

Margaret H. Delagato (2009) recommended the clarification of the definition of science within multicultural science education frameworks. The changes in the textbooks for environmental education are often a reflection of the nation's changing consciousness (Wilson AH, 2000).

Science educators unanimously agree that textbooks play an important role in teaching learning process (Clement, 2008). However, around 90% of students learn science in some form of texts, but important conclusions are that science texts do not significantly contribute to quality learning in science education (Iztok Devetok & Janez Vogrinc, 2013).

Science textbooks to a high extent paid attention to achievement motivation construct (Shah Mohammadi, N, 2013). While Pingel (2010) found that the criteria for textbook analysis include types of texts and mode of presentations such as the use of illustrations, photos, maps, tables and exercises to practice the knowledge that students just learned. Much of the research of textbooks is content analysis of textual nature.

The quantitative approach employed for evaluation contrasts with a more interpretative approach, and has the potential in depicting textbook profiles in a more reliable way complementing the commonly employed qualitative procedures. Implications suggest that further work in the teacher preparation is needed on calibrating the analysis procedures with science textbooks used in different international settings (Ajda Kahveci, 2009).

Y. Lin & D.F. Treagust (2013) found that the textbook authors tend to use more iconic diagrams in the junior secondary year textbooks. The frequency of portrayal of science as a process of inquiry was higher in introductory chapters of the textbooks and in chapter dealing with the topic of genetics and lower in chapters dealing with leaf structure. The frequency of portrayal of science as a process of inquiry was also higher at the beginning of chapters and at the beginning of paragraphs (Elizabeth M. Eltinge & Carl W. Roberts, 1993).

The chief implication of study by H. Wang (1998) is that the current science textbooks need major 'surgery' to keep only the essential content for effective science instruction and learning. Reconstruction of science textbooks needs to be guided by clear vision of scientific literacy. The history of science shall be used to present the science, society and technology in an integrated fashion for effective learning and understanding.

The five recently published biology textbooks in USA devoted more text to engaging students in finding out answers, gathering information and learning how scientists go about their work. Further, they presented an authentic view of the scientific enterprise (Eugene L. Chiapetta & David A. Fillman, 2007).

The reviews indicate that most of the studies are related to content analysis of textbooks in science for instructional processes, process skills, conceptual understanding, modes of presentation and authentic views. So, the researcher has conducted a study of content analysis of biology textbooks of lower secondary classes of Telangana state for 'appreciation' of scientist's contribution.

METHOD OF STUDY

Objectives of the study are fulfilled first by identifying the academic standards from the biology textbooks. Next, the academic standard – 'appreciation' content in the form of scientific contributions is referred from the 9th and 10th Biology textbooks using the method of 'content analyses. Lastly, the teaching-learning strategies for achieving the purpose of 'appreciation' are suggested.

Identifying Academic Standards of Biology at Lower Secondary School

Academic standards identify what students should know and be able to do in the classroom within a given subject or content area. These standards serve as goals for student learning, guideposts for classroom instruction, and a framework for assessment. They also provide a critical foundation or starting point for the development of curriculum (https://www.kimberly.k12.wi.us/departments/academics/academic-standards). Further, they focus on what the students will need to learn in order to be college & career ready and to be competitive in the job market.

These Academic Standards of Biology Prescribed by SCERT, Government of Telangana, are Listed from the Textbooks, they are:

- **Conceptual Understanding:** Students can explain the process of given concepts, cite examples, give reasons, states comparison & differences, and develop their own mind maps.
- **Asking Questions & Making Hypotheses:** Students can ask questions to understand, to clarify the concepts and to participate in discussions. They make hypotheses in each situation.
- **Experimentation & Field Investigation:** Students understand the given concepts and can experiment on their own. They participate in field investigation and prepare reports.
- **Information Skills and Projects:** Students can collect information (interviews, internet, etc.) and analyze systematically. They conduct own project works.
- **Communication through Drawing and Model Making:** Students can explain their conceptual understanding by drawing figures and making models. They plot graphs by using given information or collected data.
- **Appreciation and Aesthetic Values:** Students can appreciate manpower and nature and have aesthetic sense towards nature. They follow constitutional values.
- **Application to Daily Life and Concern to Biodiversity:** Students can utilize scientific concept in their daily life situations. They show concern towards biodiversity.

From among these 7 academic standards, the present authors focused on the study of 6th academic standard – Appreciation and aesthetic values of biology 9th and 10th classes.

Content Analysis for Appreciation–'Scientists Contributions'

Content analysis technique is adopted for analyzing the textbooks of lower secondary stage (9 & 10 classes). This technique comes under the descriptive survey method, the purpose of which is to describe the status of academic standard – 'appreciation' as revealed through incorporation of scientist's contributions in the textbooks.

In this study, content analysis answers to define data, its source, its context, its measurement, its analysis and its scope (Klaus Krippendoff, 2004). The data is a written text in the biology textbooks. Further, use of content analysis is made according to Holsti (1969). The purpose of content analysis is to describe & make inferences about the scientist's contribution and achievement of 'appreciation'. The element here is message pertaining to the questions starting with 'what'. The procedure adopted is to:

- Compare scientist's contribution content to appreciation
- Describe trends in scientist's contribution content
- Relate known sources of scientist's contribution to messages they produce.

The unit of coding is a single word to phrase(s). Constructing the relationships between codes by sorting out them within specific categories / themes is taken up as per Bruce B. Frey (2018).

The source of data is all lessons in Biology textbooks of 9th & 10th class of Telangana state. A checklist is prepared to identify the scientist's contribution. The checklist composed of five components related to the academic standard 'appreciation'. The components covered are–name of the chapter/ lesson/ topic, scientist name & nationality, year of contribution and the contribution itself. Researcher browsed through the content of the textbooks for these components and prepared tables–one for 9th class and another for 10th class. It is depicted in tables 1 and 2.

Teaching-Learning Strategies for Achieving–'Appreciation'

Next, authors gleaned through the possible teaching-learning strategies (learning experiences) matching to the appreciation of scientist's contributions in biology textbooks at lower secondary school.

Illustrations, narrations, dramatizations, mock-ups, field trips and other activities at the science corner are some of the factors which will create sufficient experiential background. This can be later on, exploited to develop scientific appreciation because the requisite material has been first created before it has been moulded. Real feel of science, scientific attitude and appreciation can be effectively demonstrated and developed among pupils by unfolding the real story of great discoveries in a concrete and lively manner. Thus, the main curriculum sites and learning resources are among others laboratories and local sites such as museums and other institutions.

Teachers are advised to conduct activities such as – display in wall magazine, participate in Theatre day, do field observation, and organize special days. Plan and execute activities like science club and elocution.

A Discussion of the Various Teaching-Learning Strategies is given below

Laboratory Teaching

It assumes that first-hand experience in observation and manipulation of the materials of science is superior to other methods of developing understanding and appreciation. Laboratory training is also frequently used to develop skills necessary for more advanced study or research. (Gage, 1962).

Laboratories provide students with opportunities to think about, discuss, and solve real problems. The purpose of laboratory work is to achieve the process objectives of science teaching such as development of scientific skills (communication–abstract and concrete), attitude, interest and appreciation. Thus, laboratories are wonderful settings for teaching and learning science.

Field-Based Learning

In field-based learning, teaching is extended to a site outside of the classroom or laboratory, exposing students to a real-world setting. Students learn through direct interaction with an environment that reflects taught concepts. Field-based learning is generally chosen because the experience stimulates an appreciation for, concern or valuing of the visited environment (Lonergan, N. & Andresen, L.W (1988) Field-based education: Some theoretical considerations. Higher Education Research & Development, 7 (1) 63–77).

The students should occasionally be taken for outings (field trips) so as to appreciate the beauty of nature. To get the full benefit of experiential learning, you would want the students to experience that world firsthand. In most cases this is done in some kind of field experience.

Games and Simulations

Students must make decisions, solve problems, and react to the results of their decisions which practiced through games and simulations. Incorporating games and simulations into courses can provide many benefits, including: Allowing students to learn by doing: Interactive simulations provide a way for students to become active participants in the learning process and learn from their mistakes in a low-stakes, safe environment(https://resources.depaul.edu/teaching-commons/teaching-guides/technology/other-teaching-tools/Pages/games-simulations.aspx).

Museum Visits

Museums are great places to support classroom teaching, visiting a museum can really bring curriculum content to life. They are informal learning environments which can spark student interest in science and provide opportunities to broaden & deepen students' engagement. They can reinforce scientific concepts & practices, while developing an appreciation for and interact in the pursuit of science in school & in daily life.

Museums provide an opportunity to handle real objects, solve problems, and interact with others – and potentially all at the same time, too. They are perfect places to ask our own questions and try to discover the answer. Thus, museums offer experiences that are tough for schools to present; and includes effective learning through a lot of interactive activities, stations for children to play and field trips (https://www.slideshare.net/AngelaMwSabu/role-of-science-museums-in-teaching-science).

For example, Wonder lab of the museum is great because it's all about getting hands-on and using science skills like curiosity and creativity, plus there are some amazing things to see! You can stick your head inside a cloud, play with magnetic liquid and listen to music through your teeth. Modern World gallery is full of weird and wonderful objects that have changed our lives, from the world's oldest steam engine, to a jumper made from the wool of a cloned sheep. (https://explorify.wellcome.ac.uk/blog/top-5-activities-science-museum)

Role-Plays

It is a spontaneous dramatization of a situation without any prior released or structured dialogue. This technique is used to show emotional reactions and behaviors of people to a particular situation and discuss values. Enacting in this strategy gives student a few minutes to set stage and discuss roles. The actors in the play project their feelings as naturally as possible and this feature can be utilized for scientists contribution. Role playing is like a drama in which each participant is assigned a character to portray, but no lines are learned.

Case-Based Approach / Case Study Method / History of Science Cases

This approach engages students in discussion of specific scenarios that resemble or typically are real-world examples. It is learner-centered with intense interaction between participants as they build their knowledge and work together as a group to examine the case. The instructor's role is that of a facilitator, while the students collaboratively analyze and address problems and resolve questions that have no single right answer.

Opportunities in abundance are available for solving evasive scientific problems through simple and cheap equipment as used by the world famous scientists as well as for experiencing firsthand the various aspects of scientific attitude and appreciation when a case study method is used in the classroom.

Case study method in science teaching not only enlivens day to day classroom teaching but also dramatizes the way science is built piece by piece, brick on brick and a scientist following a scientist. Howard B. Baumel & J. Joel Berger developed a set of sample questions from research papers which would help in Historical approach to science. They are:

- What problem was the scientist studying?
- What information did the scientist have at hand when he investigated the problem?
- What hypotheses did the scientist probably have at hand as he planned his investigation?
- What was the outcome of the experiments: observationally and in relation to the objectives?
- What conclusion was reached?
- Is the conclusion justified?
- What simple experiment could you plan to verify the conclusion?
- What have you used in the plan that was not available to the scientist?

HOSC method's aim is not primarily to teach scientific content but to give students the real feel of science, the way the scientists worked in past, to share with them part of their excitement and even frustration.

The Basic Aims of These Case Histories are to Know as Much as Possible through the Various Means About

- The methods used by scientists.
- The means by which science advances.
- The personalities and human qualities of the scientists.
- The interplay of social, economic, technological and psychological factors with the progress of science.
- The importance of science of accurate and accessible records, constantly improved instruments and free communication between scientists.

Thus, case methods are intended to develop student ability to solve problems using knowledge, concepts, and skills relevant to a course. Cases provide contextualized learning. Usually, cases are presented in writing, but you can use a videotape or you can role play a problem situation.

- **Real World or Authentic Contexts:** These contexts expose students to viewpoints from multiple sources, and see why people may want different outcomes.
- **Science Club:** Science clubs can become a nucleus of science teaching and link classroom and laboratory with the community. The purpose of the science clubs are: to study the lives and the influence of great scientists; and to stimulate interest in and interpret science to others. Thus, science clubs keep the students in touch with the recent advances of science and their effect on human life.
- **Studio Instruction:** St. Edwards University (Austin, Texas) set aside the traditional class structure and uses two four–hour lab periods so that students are able to "act as scientists and learn as a scientist learns".
- **Discussion Method:** Critical questions examine the validity of an author's arguments or discussion. For example, "An eminent authority states thus and so. Under what conditions might that not be true?" It is appropriate method for building on others' ideas in such a way as to increase their motivation rather than make them feel punished or forgotten.

The Other Methods Available with the Teacher are

- **Documentation Method:** A student who is consulting a dictionary, map, supplementary material and interviewing important people from all walks of life (relevant to the problem under study) is documenting himself. He, is thus, face to face in a true-to-life situation and, is in his own way and at his own level, he is trying hard to assemble documentary material which he studies and collates in order to show the inter-dependent links.
- **Debates:** It develops integrity in research work, confidence in expressing well-founded convictions and courtesy in discussion. Thus, the educational value of debate is "a constructive summing-up of conclusions".
- **Coordinative Methods (Field of Interest Method):** These methods awaken student's interest in science and enable him to discover hidden relationships, make and apply judgments to see the phenomena 'in their true inter-relations rather than presenting them in the form of artificial analysis and to clarify theoretical ideas through firmly grounded analogies'.

Few such strategies for appreciation of scientist's contribution along with the textbook questions are given for 9th class and 10th class is shown in tables 3 and 4 respectively, and is appended at the end.

RESULTS

Theme -Wise Analysis for Scientist's Contributions

Analysis is made according to the theme / concept and the scientist's contribution in terms of frequency. It revealed that in 9th class; ten scientist's contributions are quoted in the chapter–Diversity in living Organisms; it is followed by seven scientists in Cell–its structure and functions; while only one scientist's contribution is mentioned in the chapters–Plant Tissues; Animal Tissues; Challenges in improving agriculture; and Adaptations in Ecosystems. The theme-wise analysis for 10th class shows that thirteen scientists contribution is for the chapter–Coordination–the linking system; twelve scientists for Reproduction-the generating system; while the chapters Excretion; Coordination in life processes; and Natural resources have only one scientist.

This finding is in tune with the study of Wilson, A H (2000).

Theme-Wise Teaching-Learning Strategies

Generally, the scientific contributions can be appreciated through case method & real world / authentic contexts. However, with little tuning of the content, other methods can be also be used.

Teaching-Learning Strategies for the Concepts Dealt in 9th Class are Summarized Below:

Cell–its structure & function–Discussion; Plant tissues–Laboratory; Animal Tissues–Studio Instruction; Movement of materials across cell membrane & Animal behavior–Real World / Authentic Contexts; Diversity in living organisms, Challenges in improving Agricultural products, & Adaptations in different Ecosystems–Field based; Sense organs–Games & Simulations.

10th class concepts and the corresponding teaching learning strategies are given below:

Nutrition–Coordinate method; Respiration–Debate: Transportation–Case method; Excretion–Real World / Authentic Contexts; Coordination–Field based; Reproduction–Laboratory & Museum; Coordination in life processes–Science club; Heredity - Museum / Science club; Our Environment–Field based.

This finding is similar to that of Wang H (1998) who found that the science instruction should needs to be taught in an integrated manner. Another study of Eugene L. Chiapetta & David A. Fillman (2007) had reported that 'authentic view of the scientific enterprise need be given to students'.

DISCUSSIONS

Theme-wise analysis of 9th class textbook showed that the concept 'Diversity in living organisms' has many contributions such as Origin of Species; Classification of plants; Binomial nomenclature and Classification - five - kingdom, three-kingdom, two empires, four –kingdoms, three domains & six – kingdoms. Whereas, the concept 'Coordination – the linking system' has many scientists contributions like Difference between motor & sensory nerves; Spinal cord; Peripheral Nervous System; Islets of Langerhans; Discovery of Insulin; Hormones; & Phototropism for 10th class biology textbook. Perhaps, this may be due to the importance of content held by the Textbook authors and the scope of content devised by the editors.

The teaching-learning strategies adopted for the concepts of 9th class were Real world / authentic contexts, Case method, Studio instruction, Discussion, Laboratory, Field based, and Games & Simulation. While that for 10th class, teaching-learning strategies covered were Real world / authentic contexts, Case method, Museum, Coordinate method, Debate, Laboratory, Field based, and Science club. The teacher's competencies are considered while dealing with the science concept.

CONCLUSIONS

Academic standard–'Appreciation' is considered very crucial to develop scientific temper among the youth. They need to be taught stage relevant concepts with appropriate teaching-learning strategies. Real world / authentic contexts method and the Case methods give students opportunities to work like the scientists. That is, think, persevere, collaborate, theorize and publish the way scientists do. A lot of interest needs to be generated among children by teachers with their acumen and passion for science as well as to children.

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APPENDIX

Table 1: Contribution of Scientists in the Class 9 Biology Textbook

S.No	Chapter	Scientist	Nationality & Field	Year	Contribution	Page No.
1	Cell: Its structure and functions	Robert Brown	Scotland Botanist	1831	Nucleus	4
2		M J Schleiden	Germany Botanist	1831	Cell theory	4
3		Camillo Golgi	Italy Biologist	1898	Golgi bodies	6
4		M J Schleiden & Theodor Schwann	Germany-Botanist Germany-Physician	1838	Cell theory	9
5		Robert Hooke	English-Natural Philosopher		Cell observation	9
6		Rudolf van Virchow	Germany-Physician	1855	Cell division	9
7	Plant tissues	Nehemiah Grew	English-Physician	1664	Parenchyma	19
8	Animal tissues	Land Steiner	Austria-Physician		Blood groups	32
9	Movement of material across their cell membrane	Freddie Mercury & David Bowie			De-salination	45
10		Thomas Graham	Scotland-chemist		Diffusion of gases	46
11		William Kolff	Dutch-physician	1947	Dialysis	48
12	Diversity in Living organisms	Charles Darwin	English-naturalist	1859	The Origin of species	56
13		Charak	Indian-physician	1st Century AD	Classification of plants	56
14		Sushruth	Indian-Physician	2nd Century AD	Classification of plants	56
15		Carl Linnaeus	Swedish-botanist	1758	Binomial Nomenclature	57
16		Thomas Whittaker	English-Metaphysician	1969	Five-kingdom classification	57
17		Ernst Haeckel	German-zoologist	1866	Three-kingdom	57
18		Eduard Chatton	French-biologist	1925	Two empires	57
19		Herbert F. Copeland	American-biologist	1938	Four-kingdoms	57
20		Carl Woese	American-microbiologist	1990	Three domains	57
21		Thomas Cavalier Smith	English-biologist	1998	6 Kingdoms	57
22	Sense organs	Albertus Magnus	German-Bishop	1220	Role of senses	77
23		Johannes Kepler	German-astronomer	1600	Role of eye	77
24	Animal behaviour	Konrad Lorenz	Austrian-zoologist	1903–1989	Animal Behaviour	96
25		Ivan Pavlov	Russian-	1849–	Conditioning	96

			physiologist	1936		
26		Irene Pepperberg	American-Animal psychologist	1977	Animal cognition	102
27		Nikolas Tinbergen; Konrad Lorenz & Karl Von Frisch	Dutch-Biologist Austrian-zoologist Austrian-ethologist	1973	Animal Behaviour	103
28	Challenges in improving agricultural products	Dr. G P Hector	Indian-economic botanist	1911	High yield Rice varieties	126
29	Adaptations in different ecosystems	Charles Darwin	English-naturalist	1885	Adaptive radiation in Galapagos Finches	145

Table 2: Contribution of Scientists in the Class 10 Biology Textbook

S.No	Chapter	Scientist	Nationality and Field	Year	Contribution	Page No.
1	Nutrition-Food supplying system	C.B Van Neil	Dutch American–microbiologist	1931	Equation for Photosynthesis	2
2		C.B Van Neil	Dutch American–Microbiologist	1931	Role of light in photosynthesis	3
3		Robert Hill	British-plant biochemist	1939	Release of oxygen in photosynthesis	3
4		Joseph Priestley	English-Natural philosopher	1770	Role of air in the growth of green plants	4
5		Joseph Priestley	English-Natural philosopher	1774	Discovered oxygen	5
6		Antoine Lavoisier	French-chemist	1775	Coined the term 'Oxygen'	5
7		Jan Ingenhousz	Dutch-Physiologist	1779	Formation of oxygen during photosynthesis	7
8		Theodor Wilhelm Engelmann	German-Botanist	1882	Effects of different colors of light on photosynthetic activity	7
9		Pierre Joseph Pelletier & Joseph Bienaime Caventou	French-chemist and French-pharmacist	1817	Extracted green pigment and named it 'Chlorophyll'	9
10		Julius Von Sachs	German-botanist	1883	Discovered Chloroplasts	9
11		Daniel I. Arnon	Polish-plant physiologist	1954	Extracted Chloroplasts	10
12	Respiration-the energy producing system	Antoine Lavoisier & Joseph Priestley	French-chemist & English-natural philosopher	1772	Gaseous exchange in respiration	24
13	Transportation-the circulatory system	Rene Laennec	French-physician	1816	Invented Stethoscope	50
14		Girolamo Fabrici	Italian-surgeon	1574	Noticed small valves in Leg	54
15		William Harvey	English-physician	1628	Circulation of blood	54
16		Marcello Malpighi	Italian-biologist	1661	Discovered Capillaries	55
17		Jan Baptist Van Helmont	Dutch-chemist		Transportation of materials within the plant	64
18	Excretion-the	Dr. Charles	American-surgeon	1954	First Kidney	84

	wastage disposing system	Hufnagel			transplantation	
19	Coordination-the linking system	Aelius Galenus	Greek-physiologist	200 AD	Explained the difference between motor nerves and sensory nerves	96
20		Leonardo Da Vinci & Stephen Hales	Italian-polymath English-physiologist	Mid-16th century Mid-18th century	Role of spinal cord in nervous control	102
21		Charles Bell & Francois Magendie	Scottish-Surgeon French-physiologist	1822	Peripheral Nervous system	103
22		Paul Langerhans	German-pathologist	1868	Discovered the cells that secrete insulin (Islets of Langerhans)	105
23		Frederic Grant Banting & Charles Best & John James Rickard Macleod	Canadian-physician Canadian-scientist Scottish-biochemist	1922	Discovered insulin	106
24		Ernest Starling	British-physiologist	1905	Coined the term 'Hormone'	106
25		Charles Darwin & Francis Darwin	English-naturalist English-botanist	1880	Experiments on phototropism	111
26		Frits Warmolt Went	Dutch-biologist	1926	Discovered auxins in plants	111
27	Reproduction-the generating system	Charles Darwin	English-naturalist	1876	Self-fertilization	128
28		Rudolf van Virchow	Germany-Physician	1855	Cell theory	132
29		Robert Remak	German-embryologist	1852	Observations on cell division	132
30		Walther Fleming	German-biologist	1879	Cytogenetics, Mitosis, Chromosomes, Chromatin	132
31		Wilhelm Roux	German-zoologist	1888	Mosaic theory of epigenesis	132
32		Gregor Johann Mendel	Austrian-scientist	1866	Role of chromosomes in heredity	132
33		August Weismann	German-biologist	1882-1895	Germ plasm theory	133
34		Theodor Boveri	German-biologist	1904	Mitotic cell division	133
35		James Watson & Francis Harry Compton crick	American-molecular biologist British-biophysicist	1953	Structure of DNA	134
36		Dr. Potu Narasimha Rao & Dr. Johnson	Indian-cytologist	1970	Functional relationship between the phases of mitosis and cell-fusion technique	135 & 143
37	Coordination in life processes	Dr. William Beaumont	American-surgeon	1822	Gastric Physiology	164
38	Heredity-from parent to	Gregor Johann Mendel	Austrian-scientist	1857	Heredity	168

39	progeny	James Watson & Francis Harry Compton crick	American-molecular biologist British-biophysicist	1953	Structure of DNA	177
40	Heredity-from parent to progeny	Walter Sutton & Thomas Hunt Morgan	American-geneticist American-geneticist	1911	Sex-linked inheritance	178
41		Jean Baptist Lamarck	French-naturalist	1809	Theory of evolution, inheritance of acquired characteristics	181
42		Charles Darwin	English-naturalist	1859	Theory of evolution by natural selection	182
43		Charles Lyell	Scottish-geologist	1830	Uniformitarianism-constancy of cause and effect throughout space and time	182
44		Thomas Robert Malthus	English-cleric	1798	Malthusian growth model	182
45		Alfred Russell Wallace	British-naturalist	1858	Natural selection contributed to origin of new species and Wallace effect.	183
46	Our environment-our concern	Charles Sutherland Elton	English-ecologist	1927	Ecological pyramid	196

Table 3: Teaching Learning Strategies In 9th Class To Achieve Appreciation.

S.No	Chapter	Question	Strategy	Page No.
1	Cell: its structure and functions	How do you appreciate about the organization of cell in the living body?	Discussion (Significance of cell, different shapes, sizes & functions at different places in organism)	11
2	Plant Tissues	While observing internal parts of plants how do you feel about its structure and functions?	Laboratory (observe T.S. root, stem & leaf – structure & functions)	22
3	Animal Tissues	The blood test report of a patient says that he/she does not have the required levels of hemoglobin. What are its ill effects?	Studio instruction (Blood test report-dialogue of Doctor & patient)	37
4	Movement of materials across the cell membrane	Can you fill the coconut with water without making a hole to the coconut?	Real world / Authentic contexts (Observe if the fallen coconut absorbs water – look for osmosis)	48
5	Diversity in living organisms	Can you appreciate the efforts of scientists in classifying a wide range of organisms?	Field based (observe diversity – very large, small, microscopic, different habitat, life processes in plants & animals)	72
6	Sense organs	How do you appreciate the functions of sense organs which help us to enjoy the beauty of nature?	Games & simulations (Coordination of sense organs during Games – eye, hand, ear, etc., for achieving goal)	93
7	Animal behaviour	"Understanding of animal behaviour creates positive attitude towards animals". How do you support this statement? Explain with suitable examples.	Real world / Authentic contexts (Observe animals being eaten and eating in the food chain, food web and practically in nature)	104
8	Challenges in	What threats to nature do	Field based (Visit to the Farm & observe	123

	improving agricultural products	chemical fertilizers, pesticides and herbicides pose?	effects of different fertilizers)	
		Organic manure is helpful to biodiversity. How do you support this statement?	Field based (Visit to the Farm & observe vast diversity in living organisms)	124
9	Adaptations in different ecosystems	Amphibians are wonderful creatures on earth. How do you appreciate their adaptation?	Field based (Visit a pond & observe the webbed feet of a toad)	147

Table 4: Teaching Learning Strategies in 10th Class to Achieve Appreciation

S. No	Chapter	Question	Strategies	Page No.
1	Nutrition–food supplying system	Almost all living world depend on plants for food materials. How do you appreciate the process of making food by the green plants?	Coordinated or Field of interest method (Discover hidden relationships, see phenomena in their true-interrelations; photosynthesis)	22
2	Respiration–energy producing system	How do you appreciate the mechanism of respiration in our body?	Debate (Expressing convictions & courtesy in discussion about inhalation, exhalation; expansion & contraction of lungs; chest activity)	46
3	Transportation–the circulatory system	What do you want to compare the transportation in blood vessels in man?	Case method (Contributions of G. Fabric, William Harvey & Marcello Malpighi)	71
		How do you feel about transportation of water in huge trees?	Laboratory (Set apparatus for Root pressure)	71
4	Excretion–the waste disposing system	List out the things that make you amaze in excretory system of human being.	Real world/ Authentic contexts (Visit to a Hospital; Dialysis Ward – Machine functioning as a Kidney)	91
5	Coordination–the linking system	It is very interesting to watch a creeper entwining its tendrils to the support. Isn't it? How do you express your feelings in this situation?	Field based (Visit to a Farm; Thigmotropism – observe tendrils of Cucumber & Bitter gourd climb the support)	115
6	Reproduction–the generating system	How will you appreciate cell division that helps in perpetuation of life?	Museum / Laboratory (Observe Mitosis in a Laboratory; Watch a video or working model of Cell division in Museum)	142
7	Coordination in life processes	Prepare a cartoon on Pavlov's experiment with a suitable caption.	Science club (Cartoon preparation of conditioning of Dog)	162
8	Heredity–from parent to progeny	Nature selects only desirable characters. Prepare a cartoon.	Museum / Science club (Video or Model of Evolution in Museum; Cartoon preparation of survival of the fittest)	191
9	Our environment–our concern	How do you appreciate ecological pyramids?	Field based (Visit a Farm; Observe the number of green plants, animals – human beings, birds, insects, etc., & place it in a unit area – to form a pyramid)	196