

**Research Project on
Student-Centered and Curriculum
Sequence-based Materials for
Mathematics and Science In-service
Teacher Training
-Based on Kenya's Curriculum-**

December 2009

**Human Development Department
Japan International Cooperation Agency**

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Preface

Japan International Cooperation Agency (JICA) implemented the first and second phase of Strengthening of Mathematics and Science Education (SMASE) Project in the Republic of Kenya from July 1998 to December 2008, aiming to improve mathematics and science education through in-service teacher training. The project has successfully established the in-service teacher training system for whole secondary mathematics and science teachers. Through teachers' leaning of ASEI/PDSI (Activity, Student-centered, Experiment, Improvisation / Plan, Do, See, Improve) approach, which was introduced by the project and aimed to improve teaching skills to realize the student-centered lessons, the project has changed mathematics and science teachers' attitudes towards lessons. Furthermore, such lessons in which students participate actively were realized by those trained teachers.

This approach has been spreading in 33 countries and one region in Sub-Saharan Africa (as of April 2009) . For instance, Kenya started the third phase targeting the primary level, and Malawi, Uganda and Zambia also started the second phase to strengthen mathematics and science education further.

While JICA's education cooperation with ASEI/PDSI approach in Sub-Saharan Africa is spreading, it is necessary to further strengthen teachers' skills to make stronger impact at the classroom level. At the same time, it is also necessary to prepare quality training materials and references which are developed based on the practical student-centered approach and the sequence of curriculum.

In this regard, JICA conducted this Research Project, "Student-Centered and Curriculum Sequence-based Materials for Mathematics and Science In-service Teacher Training: Based on Kenya's Curriculum," to develop materials to which counterparts of the project could refer when they develop training materials with Japanese experts' assistance.

This report introduces the background and structure of the research project, and materials that has been developed by the research project. We hope that these materials would be utilized to improve the quality of mathematics and science education in Sub-Sahara African countries.

Finally, I strongly appreciate the earnest dedication and great contribution of all members of the research project and continuous support to this research project.

December 2009

Nobuko Kayashima
Director General
Human Development Department
Japan International Cooperation Agency

MAP

SMASE-WECSA Association: 33 Countries and 1 Region¹ in Sub-Saharan Africa

(As of April 2009)



Member countries in alphabetical order:

Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Congo, Cote D'Ivoire, Egypt, Ethiopia, Ghana, Gambia, Kenya, Lesotho, Madagascar, Malawi, Mari, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Swaziland, Sudan, Tanzania, Uganda, Zambia, Zanzibar and Zimbabwe

¹ One region indicates Zanzibar Islands which are ones of compositions of United Republic of Tanzania. These islands have the power of Judiciary, legislation and administration and have its own president.

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Preface

Map

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Chapter1 Background of the Research Project

Japan has expanded its educational cooperation in Sub-Saharan Africa since it started the Strengthening of Mathematics and Science Education in Secondary Education (SMASSE) Project of Kenya in 1998. The SMASSE has facilitated SMASE-WECSA network (Strengthening of Mathematics and Science Education in Western, Eastern, Central and Southern Africa network) as one of the project activities and now we can count 33 countries and one region, which are making efforts to improve mathematics and science education in their own countries. The number of technical cooperation projects deploying SMASE-typed approach, which are to strengthen mathematics and science education or in-service training system, has increased up to 10 countries in the SMASE-WECSA network. Like Kenya, Malawi, Uganda and Zambia completed Phase I and are already in the next phase to expand their outputs in other areas of their countries. Moreover, in TICAD IV Yokohama Action Plan (2008) under the “Yokohama Declaration”, Japanese government showed its commitment to provide training to 100,000 in-servicing mathematics and science teachers.

We have two reasons that the Kenya SMASSE project is highly evaluated. First, the project succeeded to create a simple and easily understood model, the “ASEI/PDSI” approach (Activity, Student, Experiment and Improvisation / Plan, Do, See and Improvement)². This approach is an educational movement for realizing student-centered lessons with experimental activities. Secondly, the project could contribute to institutionalizing the in-service training system nationwide by deploying a cascading model. Training materials of the SMASSE project targeting secondary level based on the ASEI/PDSI approach are now assimilated among the SMASE-WECSA member countries.

In order to further enhance the quality of teacher trainings and maximize the impact in the classroom of Kenya and other countries, JICA recognizes that the quality of training materials also play an important role. In terms of quality of teaching materials, Japanese textbooks and teaching guides are well known as highly competitive in the world. Thus, JICA launched a research project to develop teaching materials utilizing Japanese knowledge and experiences. The research project collaborates with a Japanese textbook company and

² ASEI is a key word in the project for lesson innovation. Activities for the students such as practical work, discussion, presentation etc, and should be taken more in the lesson to promote students’ active participation. Not the teacher but the students should be placed at the center of lesson. How the students learn should be given priority over how the teacher teaches. Students should be given opportunities to perform experiments, which enhance understanding of concepts and principles in mathematics and science. When conventional apparatus is not available, teachers should make efforts to give experiments by improvising using locally available resources. However, improvisation is also used for creating interest in the learners. ASEI lesson is made possibly by Plan, Do, See, Improve (PDSI) practice.

Plan: Careful preparation based on learners’ needs and problems

Do: Teach the lesson, using well-chosen and planned activities

See: Evaluate the lesson at all stages of its development

Improve: Feedback the evaluation results to improve lesson instructions and future planning and implementation.

six experienced teachers who had expertise in writing Japanese textbooks.

The project aimed at producing exemplar teaching materials that would be utilized as technical references in developing training materials of INSET. Those teaching materials are produced based on Kenyan syllabi and textbooks (science subjects) under the supervision of Professor Shigekazu TAKEMURA, former academic advisor of SMASSE project. Produced materials are targeted at Kenya Grade 6 to 8 in the units of “Human Body,” “Plants,” “Making Work Easier” and “Energy.”

As these materials extracted the essence of Japanese quality teaching materials, it is expected that other countries such as WECSA members would utilize them when they develop training materials for INSET. However, it would be very important that each country adjusts these materials into local context in each country. If these materials are appreciated, each country is encouraged to develop similar teaching materials that cover the remaining units by a close consultation with Japanese experts.

Chapter 2 Outline of the Research Project

2-1 Goal

(1) Overall Goal

Quality of training modules and materials for mathematics and science education in SMASE-WECSA network are improved.

(2) Purpose of the Research Project

Sixteen science materials for primary grade 6th to 8th, which clearly consider sequence between grades and learning objectives, are developed as reference materials for in-service training, mainly focusing on Kenya.

(3) Outputs (Materials)

The research project developed following materials comprised of twelve units of science materials (four units per 6th, 7th and 8th grade.)

- Training modules (Background information of materials, Learning objectives of each unit, Teaching system, Unit teaching plan, Lesson plan)
- Learning materials (worksheets) for students to promote effective lesson practice by trained teachers
- Evaluation tests and student questionnaires to confirm effectiveness of trainings based on changes of students' learning attitude and students' comprehensions on the topic

2-2 Research Project Team

(1) Process

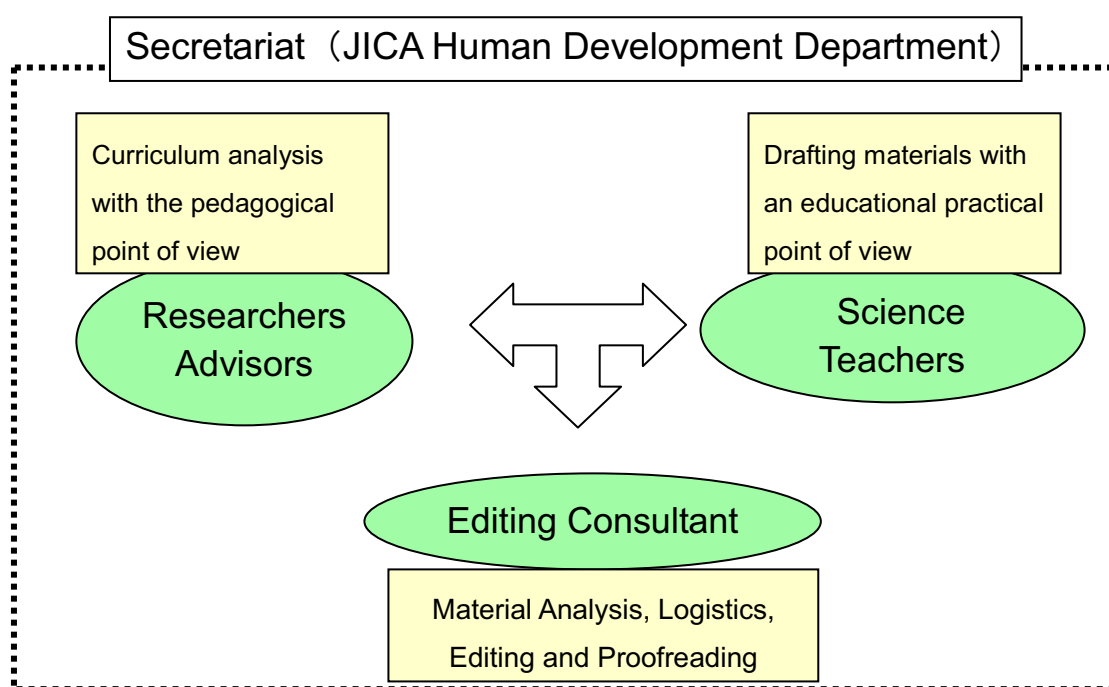
The project consists of researchers or professors in the field of science and practitioners such as teachers who have a plenty of experiences of developing Japanese science textbooks. After researchers wrote materials with a pedagogical point of view and teachers wrote them with the practical point of view, all members gathered to discuss those materials at the meeting held by JICA human development department. JICA recruited Mr. Fukuo as a consulting service consultant to edit and correct materials with his experience in Japanese textbook publishing company, Keirinkan Co Ltd.

(2) Members

* Affiliation is as of October 2009

Science Researcher (Advisor)	Hiroshima University, Professor Emeritus, Former Academic Adviser of SMASSE Project	Professor Shigekazu TAKEMURA
Consultant	Assistant Manager, Corporate Planning	Mr. Hiroshi FUKUO

	Department, SHINKOSHUPPANSHA KEIRINKAN Co. Ltd.	
Practitioners in Science Education Field	Visiting professor, Faculty of Integrated Arts and Social Sciences, Japan Women's University	Ms. Yoko TSUKADA
	Deputy General Manager, School Education & Youth Development Division, Japan Committee for UNICEF	Ms. Hiroko NAGAI
	Chief Teacher, Third Junior High School, Nakano-ku, Tokyo	Mr. Hiroya NAGAHAMA
	Part-time Lecturer, Faculty of Education Human Sciences, University of Yamanashi	Mr. Tadao HATANAKA
	Chief Teacher, Kameido Second Junior High School, Koto-ku, Tokyo	Ms. Junko MAKINO
	Chief Inspector of Schools, School Inspection Division, Education Office, Sumida-ku, Tokyo	Mr. Tetsuya MURAYAMA
Secretariat	Senior Advisor (Education), Human Development Department, JICA	Senior Advisor, Mr. Atsushi MATACHI
	Basic Education Division2, Basic Education Group, Human Development Department, JICA	Director, Mr. Shinichi ISHIHARA
		Mr. Tatsuhiro MITAMURA (as of December 2008)
		Assistant Director, Ms. Minako SUGAWARA
		Associate Expert, Mr. Shinpei TAGUCHI (as of December 2008)
		Associate Expert, Mr. Ken FURUKAWA
		Associate Expert, Ms. Tomoko MATSUMOTO



(3) Writers of Each Section

Professor Shigekazu TAKEMURA wrote Sequence of Teaching Contents, Sequence and Structure of Related Topics, Impact Assessment Survey (NEW SPIAS: SMASE Project Impact Assessment Survey) and proofread whole materials.

Unit	Grade 6	Grade7	Grade8
Human Body	Mr. Tetsuya MURAYAMA	Ms. Yoko TSUKADA	Mr. Tetsuya MURAYAMA
Plants	Ms. Hiroko NAGAI	Mr. Tadao HATANAKA	Mr. Tadao HATANAKA
Energy	Ms. Junko MAKINO	Ms. Yoko TSUKADA	Mr. Hiroya NAGAHAMA
Making Work Easier	Ms. Junko MAKINO	Mr. Tetsuya MURAYAMAMA	Mr. Hiroya NAGAHAMA

2-3 Schedule

Activity	Agenda
Preparatory meeting with a editor consultant	<ul style="list-style-type: none"> • Basic policy • Exchanging ideas on writers (6 Science Education Practitioners)

Drafting Materials by Professor Takemura and the Consultant	
Meeting with Professor Takemura and the consultant (2008.12.11)	<ul style="list-style-type: none"> • Overview of the research project and basic policy • Introduction of draft materials • Selection of 6 science education practitioners
1 st research project Meeting (2008.12.18)	<ul style="list-style-type: none"> • Introduction of members • Report on Kenyan actual lessons by JICA • Exchanging ideas on draft materials • Fixing writer's section
Materials Writing by Practitioners (1 st Unit)	
2 nd research project meeting (2009.01.22)	Discussion on 1 st drafts
1 st Unit Rewriting and Writing 2 nd Unit by Practitioners	
3rd research project meeting (2009.02.14)	Discussion on 12 units
Submission of Final Materials to the Consultant	
Final meeting (2009.03.27)	Reporting on the materials by the consultant
Submission of Final Materials to JICA	

2-4 References

Kenyan Textbooks below were referred to develop materials.

- Primary Science Pupils' Book for Standard 5-8, Kenya Literature Bureau
- Primary Science Education Foundation Science Pupils' Book 5-8, The Jomo Kenyatta Foundation
- Understanding Science Pupils' Book 5-8, Longhorn
- Primary Science Pupils' Book 5-8, Macmillan
- Science in Action 5-8, Oxford

The textbooks and specific pages that were referred in each material are shown in the table below. Reference pages without particular names of publishers are of textbooks of Kerinkan and Kenya Literature Bureau.

Human Body

Grade 6	Objectives	
	<ul style="list-style-type: none"> • To distinguish the various reproductive organs • To explain the functions of the various male and female reproductive organs • To explain secondary sexual characteristics 	
	Kenya p.1-7	Japan • Health and physical education for Jr. high school, 2006 version, p.5-23,

		<p>Tokyo Shoseki,</p> <ul style="list-style-type: none"> • Textbook Training of health and physical education covered whole textbook, p.64-73
Grade 7	<p>Objectives</p> <ul style="list-style-type: none"> • To distinguish the organs (components) of the circulatory system • To explain components and function of blood • To distinguish types and function of blood vessels • To explain structure and function of the heart 	
	<p>Kenya p.1-12</p>	<p>Japan</p> <ul style="list-style-type: none"> • Jr. high school science grade2 (One), 2001 version, p.98-101,114 • Jr. High school science grade 2(One), 2006 version, p.119-126 • Jr. High school science grade 2 (One), Detail book, 2006 version, p.187-203, 234-241 • Exercise book (Old version) for Jr. high school grade 2, p.40-41 • Textbook Training 2 (One), p.86-93
Grade 8	<p>Objectives</p> <ul style="list-style-type: none"> • To explain human fertilization • To discuss foetal development • To explain the process of birth • To consider main excretory organs relating to waste products 	
	<p>Kenya p.1-19</p>	<p>Japan</p> <ul style="list-style-type: none"> • Primary science grade 5 (One), 2005 version, p.24-29 • Jr. high school science grade 2 (One) 2001 version,p.102-106 • Jr. high school science grade 2 , 2006 version, p.119-126 • Jr. high school health and physical education, 2006 version p.5-23, Tokyo Shoseki • Primary science grade 5 (One), Summary book, p.36-43 • Primary science grade 5 (One), Research book, 2005 version, p.53-66 • Jr. high school science grade 2 (One), Detail book, 2006 version, p.187-203, 234-241 • Exercise book (Old version) for Jr. high school grade 2, p.43-44 • Pittari (Appropriate) Test for primary grade 5, p.18-23 • Textbook Training 2 (One), p.86-93 • Textbook Training of health and physical education covered whole textbook, p.64-73

Plants

Grade 6	<p>Objectives</p> <ul style="list-style-type: none"> • To describe and categorize parts of flowers
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	<ul style="list-style-type: none"> • To explain pollination and fertilization • To describe and categorize seed parts • To research necessary conditions for germination
Kenya p. 21-32	<p>Japan</p> <ul style="list-style-type: none"> • Primary science grade 5 (One), 2005 version, p.4-15 • Primary science grade 5 (One), 2005 version, p.32-43 • Jr. high school science grade 2 (One) , 2001 version, p.9-17, 32-41 • Jr. high school science grade 2 (Second) , 2001 version, p. 48-51 • Primary science grade 5 (One), Summary book2005 version, p.46-59 • Primary science grade 5 (One), Research book, 2005 version, p.67-84 • Jr. high school science grade 2 (One), Detail book, 2001 version, p.41-65, 110-139 • Jr. high school science grade 2 (Second), Detail book, 2001 version, p138-149, 160-161 • Pittari (Appropriate) Test for primary grade 5, p.2-11, 24-31 • Textbook Training 2 (One), p.10-15, 30-39 • Textbook Training 2 (Second), p.38-47
Grade 7	<p>Objectives</p> <ul style="list-style-type: none"> • To explain interdependence between plants • To explain interdependence between plants and animals • To explain the food chain • To explain agriculture crops and pests • To consider various influence of pests on agricultural crops relating to extermination measures
Kenya p. 42-66	<p>Japan</p> <ul style="list-style-type: none"> • Jr. high school science grade 2 (Second), 2006 version, p.100-122 • Jr. high school science grade 2 (Second), Detail book, 2006 version, p.187-233 • Textbook Training 2 (Second), p.76-97
Grade 8	<p>Objectives</p> <ul style="list-style-type: none"> • To explain environmental adaptation of plants • To distinguish indicators of diseased crops • To explain crop diseases and their influences
Kenya p. 32-47	<p>Japan</p> <p>N/A</p>

Energy

Grade 6	<p>Objectives</p> <ul style="list-style-type: none"> • To explain under what conditions light will reach
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	<ul style="list-style-type: none"> • To distinguish transparent, translucent and opaque substances • To show reflection of light • To research reflection of light 		
	<table border="1"> <tr> <td>Kenya p.65-81</td> <td>Japan <ul style="list-style-type: none"> • Jr. high school science grade 1 (One) , 2006 version, p.2-15, 36-37 • Jr. high school science grade 1 (One) , Detail book, 2006 version, p.17-55 • Textbook Training 1 (one), p.4-9,28-31 </td> </tr> </table>	Kenya p.65-81	Japan <ul style="list-style-type: none"> • Jr. high school science grade 1 (One) , 2006 version, p.2-15, 36-37 • Jr. high school science grade 1 (One) , Detail book, 2006 version, p.17-55 • Textbook Training 1 (one), p.4-9,28-31
Kenya p.65-81	Japan <ul style="list-style-type: none"> • Jr. high school science grade 1 (One) , 2006 version, p.2-15, 36-37 • Jr. high school science grade 1 (One) , Detail book, 2006 version, p.17-55 • Textbook Training 1 (one), p.4-9,28-31 		
Grade 7	<p>Objectives</p> <ul style="list-style-type: none"> • To identify sources of electricity • To construct simple circuits • To investigate conductive and non-conductive materials • To explain how to use home electrical appliances • To explain safety measures when electrical appliances are used • To explain safety measures to prevent damage or injury from lightning 		
	<table border="1"> <tr> <td>Kenya p.106-129</td> <td>Japan <ul style="list-style-type: none"> • Primary school grade 3, 2005 version, p.62-71 • Jr. high school science grade 1 (One) , 2006 version, p.87-98 • Primary school grade 3, Summary book, 2005 version, p. 82-93 • Primary school grade 3, Research book, 2005 version, p.115128 • Jr. high school science grade 1 (One) , detail book, 2006 version, p.172-205 • Pittari (Appropriate) Test for primary grade 3, p. 56-65 • Textbook Training 1 (one), p.66-77 </td> </tr> </table>	Kenya p.106-129	Japan <ul style="list-style-type: none"> • Primary school grade 3, 2005 version, p.62-71 • Jr. high school science grade 1 (One) , 2006 version, p.87-98 • Primary school grade 3, Summary book, 2005 version, p. 82-93 • Primary school grade 3, Research book, 2005 version, p.115128 • Jr. high school science grade 1 (One) , detail book, 2006 version, p.172-205 • Pittari (Appropriate) Test for primary grade 3, p. 56-65 • Textbook Training 1 (one), p.66-77
Kenya p.106-129	Japan <ul style="list-style-type: none"> • Primary school grade 3, 2005 version, p.62-71 • Jr. high school science grade 1 (One) , 2006 version, p.87-98 • Primary school grade 3, Summary book, 2005 version, p. 82-93 • Primary school grade 3, Research book, 2005 version, p.115128 • Jr. high school science grade 1 (One) , detail book, 2006 version, p.172-205 • Pittari (Appropriate) Test for primary grade 3, p. 56-65 • Textbook Training 1 (one), p.66-77 		
Grade 8	<p>Objectives</p> <ul style="list-style-type: none"> • To explain meaning of energy • To explain different types of energy • To explain transformation of energy • To explain conserving energy • To recognize necessity of conserving energy 		
	<table border="1"> <tr> <td>Kenya p. 128-159</td> <td>Japan <ul style="list-style-type: none"> • Jr. high school science grade 1 (Second) , 2006 version, p.61-74, 79-89, 97-113 • Jr. high school science grade 1 (Second) , Detail book, 2006 version, p.93-107, 131-155, 157-177, 193-213 • Textbook Training 1 (Second), p.50-61, 66-73, 84-98 </td> </tr> </table>	Kenya p. 128-159	Japan <ul style="list-style-type: none"> • Jr. high school science grade 1 (Second) , 2006 version, p.61-74, 79-89, 97-113 • Jr. high school science grade 1 (Second) , Detail book, 2006 version, p.93-107, 131-155, 157-177, 193-213 • Textbook Training 1 (Second), p.50-61, 66-73, 84-98
Kenya p. 128-159	Japan <ul style="list-style-type: none"> • Jr. high school science grade 1 (Second) , 2006 version, p.61-74, 79-89, 97-113 • Jr. high school science grade 1 (Second) , Detail book, 2006 version, p.93-107, 131-155, 157-177, 193-213 • Textbook Training 1 (Second), p.50-61, 66-73, 84-98 		

Making Work Easier

Grade 6	<p>Objectives</p> <ul style="list-style-type: none"> • To move objects and stop moving objects • To explain meaning of force
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	Kenya p. 88-107	Japan <ul style="list-style-type: none"> • Jr. high school science grade 1 (One) , 2006 version, p.23-34 • Jr. high school science grade 1 (Second) , 2006 version, p.45-60 • Jr. high school science grade 1 (One) , Detail book, 2006 version, p.17-33, 67-88 • Jr. high school science grade 1 (One) , Detail book, 2006 version, p.93-130 • Textbook Training 1 (One), p.16-31 • Textbook Training 1 (Second), p.38-49
Grade 7	Objectives <ul style="list-style-type: none"> • To investigate friction • To explain advantages and disadvantages of the work of friction • To show ways to increase and decrease friction • To explain positioning of a lever’s fulcrum, load and effort 	
	Kenya p.152-174	Japan <ul style="list-style-type: none"> • Primary school grade 5 (One), 2005 version, p.66-77 • Jr. high school science grade 1 (Second) , 2006 version, p.45-67 • Primary school grade 5 (One), Summary book, 2005 version, p.86-99 • Primary school grade 5 (One), Research book, 2005 version, p.111-128 • Jr. high school science grade 1 (One) , Detail book, 2006 version, p.93-141 • Pittari (Appropriate) Test for primary grade 5 (One), p.48-59 • Textbook Training 1 (Second), p.38-55
Grade 8	Objectives <ul style="list-style-type: none"> • To investigate how to incline slopes to make work easier • To investigate how to use one fixed pulley to make work easier 	
	Kenya p.160-181	Japan <ul style="list-style-type: none"> • Jr. high school science grade 1 (Second) , 2001 version, p.95-99 • Jr. high school science grade 1 (Second) , Detail book, 2001 version, p.272-287 • Exercise book (Old version) for Jr. high school grade 3, p.21-27

Chapter 3 Materials

3-1 Sequence of the Kenyan Curriculum

The Kenyan Curriculum consists of the four streams, Human Body, Plants, Energy and Making Work Easier. Its features are as follows:

Human Body	In Kenyan curriculum, several sub units are of health and physical education in Japanese Curriculum. Kenyan curriculum encourages students to memorize the names of organs.
Plants	In Kenya, plants and crops are closer and more important to peoples' daily lives than those in Japan. Therefore, in this unit, pupils learn deeply a relationship between plants and human beings, and the influence of pests.
Energy	Light and Sound are taught in the introduction stage and follow Energy, Reflection and Refraction of Light, Electricity and Conversion of Energy. The Concept of Energy is more deeply taught compared to current Japanese Course of Study. Several points are related to the unit of "Making Work Easier."
Making Work Easier	General concepts are introduced in this unit while quantitative experiments are not included as Japanese curriculum. Examples in textbooks are related to local environments. Several points are related to the unit of "Energy."

*Please refer to "Sequence of Teaching Contents" (p.17) and "Sequence and Structure of Related Topics" (p.32).

3-2 Contents

The contents of the materials were structured as follows:

Rational of this unit	Basic concepts in order to plan and implement lessons such as background information of materials, significance of learning units and what pupils should achieve through units
Objectives: what pupils are expected to achieve in this unit	Objectives of the unit which are indicated mainly in the areas of knowledge and understanding of syllabi
Interrelation of contents of each grade	<ul style="list-style-type: none"> • Contents of Syllabi are indicated in order to tell what pupils learnt in former grades and sequences of following grades. • References to know what pupils learnt in former grades <p>*Please refer to "Sequence of Teaching Contents" (p.17) and "Sequence and Structure of Related Topics" (p.32).</p>
Before starting this unit	Background information before starting the unit such as current learning status of

	the pupils, preparatory notes, common misunderstandings and relations to daily lives
Objectives to be achieved by competency	<ul style="list-style-type: none"> • Competencies are categorized into three groups, such as “Interest, motivation and attitude”, “Scientific thinking and communication activities” and “Knowledge, understanding and skills in observation and experimentation.” (In current Japanese Course of Study, there are 4 groups such as “Interest, motivation and attitude”, “Scientific thinking”, “Knowledge and understanding” and “communication activities and skills in observation and experimentation.”) • Following “Unit teaching plan” and teaching hints and advice of “Lesson Plan” show when teachers can evaluate pupils with objectives of three competency groups. <p>* Evaluations should be done only in the case of necessary.</p>
Ideas behind the structuring the unit	The concept is based on the following “Unit teaching plan.”
Unit teaching plan	<ul style="list-style-type: none"> • A Teaching plan of the whole unit • Names of Sub-units and allotted time are shown in the columns of Sub-unit. (Allotted 35 minutes for 1 period as Kenyan practice) • In the columns of description, practical activities and timing of evaluation. • “Lesson Plan”, “Sub-Unit Review Test” and “Final Unit Evaluation Test” with bold lines can be referred in following pages. <p>**“Unit Teaching Plan” suggests to conduct “Sub-Unit Review Tests” at the end of sub-unites, but time for tests are not allocated because of constraint of annual teaching periods. Tests as homework can be given depending on the progress of the class.</p>
Lesson plan	<ul style="list-style-type: none"> • The top-left columns tell each title of lesson activities such as Introduction, Questions, Experiment and Presentation. They also show rough time allotted. (Allotted 35 minutes for 1 period) • The columns of “Learning flow and activity” show pupils activities. • The columns of “Teaching hints and advice” tell evaluation timings.
Worksheet	<ul style="list-style-type: none"> • Worksheets are used for observations and experiments by pupils. Writing down contents by pupils’ own hands strengthens students’ understanding. • If it is not possible to distribute worksheets by papers, teachers should draw the contents of worksheets on the class boards.
Sub-unit review test	<ul style="list-style-type: none"> • Formative evaluation tests (small quizzes) used at the end of sub-units in order to strengthen basic understanding before starting next sub-unit. <p>* Time for tests are not allocated because of constraint of annual teaching periods.</p>

	Tests as homework can be given depending on the progress of the class.
Final unit evaluation test	<ul style="list-style-type: none"> • Evaluation tests which cover whole unit to confirm students' learning achievement • Those evaluation tests are developed with consideration of certificate examination of primary level and program for International Student Assessment (PISA) by OECD.
Student questionnaire	<ul style="list-style-type: none"> • Questionnaires should be done at the end of unit. • Self-evaluation questionnaires to ask learning activities, interests and motivation. • This questionnaire can be used for units.
References	<ul style="list-style-type: none"> • References for lessons such as backbone knowledge and important points of experiments • Examples of assessment questions of Kenyan text books (complements of unit evaluation tests) • important scientific words of materials of Kenyan text books

3-3 Copyright

Copyright

Readers shall not copy all pages of this material if they need to translate or transfer illustrations and figures of materials for the purpose of training use.

Accuracy of illustrations and figures

Most Illustrations and figures of this material are used for general science subject areas. However, some Kenyan animals and plants have not been confirmed their accuracies.

Appendix (Materials)

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*1 Target units of the research project are parts of Kenyan whole syllabi.

*2 Lesson Plans are only for several sub-units of Teaching Plans.

*3 Some lessons are planned to conduct in 2 consecutive periods.

*4 SMASE Project Impact Assessment Survey (SPIAS) is a name of research survey which the Kenyan SMASSE project began in 2004 in order to assess impact of in-service teacher training. The SPIAS researches a degree of practice of ASEI/PDSI at school and classroom levels by not only achievement tests but also questionnaires for students, teachers and headmasters. The New SPIAS of this material is a revised version proposed by Professor Takemura on parts of student Competence Index, Achievement Index, and student Participation Index.

Sequence of Teaching Contents

Human Body

Standard 5-----

1, Breathing system

By the end of this subtopic, the learner should be able to:
 Define breathing. Distinguish between inspiration and expiration.
 Explain the importance of breathing. Identify the main parts of the breathing system. Draw and label the breathing system.
 Show interest in how the breathing system works.

- ◇ Nose
- ◇ Trachea
- ◇ Bronchus
- ◇ Lungs
- ◇ Diaphragm

2, Function of:

- ◇ Nose
- ◇ Trachea
- ◇ Lungs
- ◇ Diaphragm

By the end of this subtopic, the learner should be able to:
 State the functions of the parts of the breathing system. Show interest in how the breathing system works.

3, Digestive system;

By the end of this subtopic, the learner should be able to:
 Define digestion and explain the importance of digestion. Identify the main parts of the digestive system. Draw and label the digestive system. Show interest in how the digestive system works.

- ◇ Mouth
- ◇ Oesophagus

- ◇ Stomach
- ◇ Small intestine
- ◇ Liver
- ◇ Pancreas
- ◇ Large intestine
- ◇ Rectum
- ◇ Anus

4, Functions of:

- ◇ Teeth
- ◇ Oesophagus
- ◇ Stomach
- ◇ Small intestine
- ◇ Large intestine

By the end of this subtopic, the learner should be able to:
 State the functions of the parts of the digestive system. Show interest in how the digestive system works.

Standard 6-----

Reproduction system and Physical changes during adolescence

1, Parts of the reproductive system

By the end of this subtopic, the learner should be able to:
 Identify some parts of the female and male reproductive system.
 Name some parts of the female and male reproductive systems. Draw and label some parts of the female and male reproductive systems.
 Develop interest in the parts of reproductive system.

Acquire basic scientific knowledge;

- ◇ Female(ovary, oviduct, uterus, vagina)
- ◇ Male (testis, urethra, penis)

2, Functions of some parts of the reproductive system

By the end of this subtopic, the learner should be able to:

State the functions of some parts of the female and male reproductive system. Interest in how the parts relate to their functions. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

Acquire basic scientific knowledge; ovary; part of the female reproductive system that produces the egg. Oviduct; part of the female reproductive system that connects the ovary and the uterus. This is where fertilization takes place. Uterus; part of the female reproductive system where the baby develops. Vagina; part of the female reproductive system where sperm are deposited during sexual intercourse. The baby passes through here during birth. Testis; part of the male reproduction system that produces the sperm. Urethra; part of the male reproductive system through which the sperm pass to the outside. Penis; part of the male reproductive system which deposits sperm into the vagina during sexual intercourse.

3, Changes during adolescence

By the end of this subtopic, the learner should be able to:

Observe and identify some physical changes that take place during adolescence. Describe the physical and emotional changes that take place during adolescence. Develop communication skills by describing the physical changes during adolescence. Behave responsibly in light of the physical and sexual maturation stage that is nearly attained.

✧ Physical change(male and female)

Acquire basic scientific knowledge: Physical changes in girls: Breast grows bigger. Hair grows in armpits and around the sex organs. Hips become broader. Ovaries begin to release eggs. Menstruation usually occurs once a month and may last 4 to 5 days. Pimples may appear on the face. There is rapid increase in weight and height.

Physical changes in boys: chest and shoulders become broader. Voice breaks and becomes deeper. Hair grows on chest, face, armpits and around the sex organs. Sperms begin to mature in the testis. Boys can experience ejaculation. Height and weight

increases and boys become more muscular. Pimples may develop on the face.

Standard 7-----

1, Parts of the circulatory system

By the end of this subtopic, the learner should be able to: Develop curiosity and interest in the circulatory system of the body. Describe the parts of the circulatory system and its function. Draw and label parts of the circulatory system. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

Acquire basic scientific knowledge; the heart receives de-oxygenate blood from the rest of the body and pumps it to the lungs, and also receives oxygenated blood from the lungs and pumps it to the rest of the body.

✧ Heart

✧ Blood

✧ Blood vessels

2, Blood components and functions

By the end of this subtopic, the learner should be able to: Name the components of blood and describe the functions of each. Draw and label the components of blood.

Acquire basic scientific knowledge; Plasma contains substances such as water, salts, digested food and waste products like carbon dioxide. The main function of plasma is transports. Red blood cells carry oxygen from the lungs to the rest of the body. White blood cells help the body to fight germs. Blood platelets help in clotting of blood.

✧ Plasma

✧ Red blood cells

✧ White blood cells

✧ Platelets

3, Types of blood vessels and their functions

By the end of this subtopic, the learner should be able to: Develop interest in identifying blood vessels. Name the blood vessels and describe their functions. Classify blood vessels. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

Acquire basic scientific knowledge; Arteries carry oxygenated blood from the heart to the rest of the body except the pulmonary artery which carries deoxygenated blood from the heart to the lungs. Veins carry de-oxygenated blood to the heart except pulmonary vein which carries oxygenated blood from the lungs to the heart. Capillaries connect arteries to veins.

- ◇ Arteries
- ◇ Veins
- ◇ Capillaries

4, Structure and functions of the heart

By the end of this subtopic, the learner should be able to: Name the structure of the heart and describe its function. Draw and label the structure of the heart. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

Acquire basic scientific knowledge; the heart has four chambers; two auricles which receive blood from veins and two ventricles which pump blood into the arteries. The left part of the heart pumps blood to the body except the lungs. The right part of the heart pumps blood to the lungs at a lower pressure.

- ◇ Auricles
- ◇ Ventricles
- ◇ Vessels (aorta, venacava, valves, pulmonary vein, pulmonary artery)

By the end of this subtopic, the learner should be able to: Develop responsibility for their own safety regarding HIV infection. Self-confidence in discussing about issues related to HIV/AIDS.

Standard 8-----

Reproduction in human beings and excretory system

1, Fertilization

By the end of this subtopic, the learner should be able to: Develop positive attitudes towards human sex organs and reproduction. Identify and state the function of the main parts of the male and female reproduction systems. Explain how fertilization in human beings take place by using key words; fertilization, sperm, ovum, ova, fallopian tubes, testes, ovary, cervix, zygote and fusing. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

Acquire basic scientific knowledge; the process in which a female ovary releases a mature ovum into the oviduct is called ovulation. In human beings, internal fertilization occurs when a sperm penetrates an ovum. Fertilization takes place in the oviduct. Fertilization is the fusion of the sperm and ovum.

2, Foetus development

By the end of this subtopic, the learner should be able to: Discuss the development of the foetus and explain the function of placenta and umbilical cord; amnion and amniotic fluid. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

Acquire basic scientific knowledge; after implantation the mass of cells develops further. At this stage the mass of cells is known as an embryo. From about the eighth week, the embryo develops human features such as feet, arms, lops and ears. At this stage it is known as a foetus. The placenta is the disc-shaped organ that joins the foetus and the uterine wall. Exchange of materials such as gases, food and waste products between the mother and the foetus takes place through the placenta. The umbilical cord connects the foetus at the abdomen to the placenta. The amnion is a sac that surrounds the foetus. It contains amniotic fluid that protects the foetus from shock, movement and accidental injuries.

Standard 5

Classification of plants, Functions of external parts of a plant, Types of roots

1, Classification of plants into:

By the end of this subtopic, the learner should be able to: Collect plants and compare, contrast, classify the plants collected according to colour of the leaves. Find out the non-green plants; algae, mushroom, bread mould, athlete's foot, ringworm. Discuss and group them into green plants into flowering plants e.g. maize, beans, black jack, grass, and parts of flowering plants e.g. Jacaranda and non-flowering plants e.g. pine, fern, and moss. Develop co-operation as pupils classify plants

- ✧ Green and non-green plants
- ✧ Flowering and non-flowering plants

2, Function of external parts of a plant (root, stem, leaf, flower, fruit)

By the end of this subtopic, the learner should be able to: observe and identify the functions of the external parts of a plant. Observe a sizeable plant and draw and label its parts, i. e. roots, stem, leaves, flowers, fruits, etc. Manipulate and draw conclusions. Develop responsibility as pupils identify functions of external parts of a plant.

3, Types of roots (tap roots, fibrous roots)

By the end of this subtopic, the learner should be able to: Develop interest and curiosity about different types of plants roots, Collect and compare as many different types of roots as possible. Draw the different types of roots. Record by drawing fibrous and tap roots. Develop co-operation as pupils classify roots.

- ✧ Zygote
- ✧ Embryo
- ✧ Foetus

3, Process of birth

By the end of this subtopic, the learner should be able to: Develop curiosity about their reproductive organs and the process of birth. Describe the process of birth.

Acquire basic scientific knowledge; Gestation period in human beings is 9 months. After this period, the foetus is fully grown and ready to be born. Contractions of the uterine walls push the body through the cervix and out through the vagina. The removal of waste products from the body is called excretion.

Pupils should be aware of that engaging in sexual intercourse may lead to untimely pregnancy, which may disrupt their education. They should, therefore, abstain from premarital sex. They should know that engaging in sex with infected persons can lead to contraction of AIDS or other sexually transmitted infections such as syphilis and gonorrhoea.

4, Excretory organs and waste products

By the end of this subtopic, the learner should be able to: Identify the excretory organs and their waste products. Draw and label the main excretory organs. Develop interest as he or she identifies the main excretory organs and their waste products. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

Acquire basic scientific knowledge; Excretion is the removal of waste products from the body. The three excretory organs are the skin, the lungs and the kidney. The skin excretes sweat, the lungs excrete carbon dioxide and the kidney excretes urea.

- ✧ Skin (epidermis, dermis, sweat glands, waste product-sweat)
- ✧ Lungs (nose, trachea, waste product-carbon dioxide)
- ✧ Kidney (external appearance of kidney, urethra, bladder, urethra waste product-urine)

Standard 6-----

Growth and reproduction in plants

1, Parts of a flower

By the end of this subtopic, the learner should be able to: Develop interest and curiosity about parts of flowers and their functions. Observe and record the part of flowers.

Acquire basic scientific knowledge; Flowers enable the plants reproduce. There are a great variety of flowers which have different shapes, sized and colours. The parts of a flower are sepals or calyx, petals or corolla, stamen and carpel. The calyx protects the young flower while in the bud stage. The corolla attracts animals to the plant for pollination. The stamens are the male parts of the flower and are made of the filaments and the anthers. The anthers produce the pollen. The carpel or pistil is the female part of the flower that is made of the stigma, the style and the ovary. The stigma receives the pollen. The style supports the stigma. The ovary contains one or more eggs. These eggs are also called ovules.

2, Pollination

By the end of this subtopic, the learner should be able to: Observe and record visitors to flowers. Develop interest and curiosity in reproduction of flowering plants.

Acquire basic scientific knowledge; Pollination, which is the transfer of pollen grains from the anthers to the stigma, can be classified either as self-pollination or cross-pollination. The agents of pollination are animals, mainly some insects and some birds and wind. Flowers pollinated by insects are usually large and brightly coloured. They also have sticky pollen grains, sticky stigma and they offer nectar as a reward to the pollinating animals. Flowers pollinated by wind are often small, dull in colour, odourless, and produce many light pollen grains.

◇ Meaning, types and agents

3, Fertilization

By the end of this subtopic, the learner should be able to: Observe and record fertilization in plants.

Acquire basic scientific knowledge; Fertilization is the fusion of the pollen grains and the ovules in the ovary. After the process, the ovary develops into a fruit and the ovules develops into a seed. The fertilization of flowers is essential in producing seeds which can germinate into new plants. Fertile seeds grow into plants which in turn produce more seeds.

◇ Meaning and fusion

4, Parts of a seed

By the end of this subtopic, the learner should be able to: Observe and record parts of a seed

Acquire basic scientific knowledge; the parts of the seed are micropyle, plumule, radicle, seed coat and hilum. Seed can be classified into two types, monocotyledons and dicotyledons. Monocotyledon seeds have one cotyledon while dicotyledon seeds have two cotyledons. The grass family such as maize, rice, wheat, etc, are all monocotyledons. Examples of dicotyledons are beans, peas, sunflower, castor oil seed and groundnuts.

◇ Monocot seed

◇ Dicot seed

5, Conditions necessary for germination

By the end of this subtopic, the learner should be able to: Observe and record conditions for germination of seeds. Make predictions and experiments, Analyze and see implications and relationships. Pick out causes and effects. Show that air(oxygen) is necessary for germination, Show that water is necessary for germination. Show that warmth is necessary for germination. Draw conclusions. Develop interest and curiosity in conditions necessary for seed germination. Develop integrated skills of identifying, controlling variables, defining operationally, hypothesizing, experimenting, interpreting, concluding and communicating.

Acquire basic scientific knowledge: For seeds to germinate, they must have air (oxygen), water and warmth.

Standard 7-----

Interdependence between plants and animals. Crop pests.

1, Interdependence between plants

By the end of this subtopic, the learner should be able to:
Develop interest and curiosity about interdependence of plants.
Recognize and record examples of dependence of plants on other plants for shade, support and habitat. Identify plants which exhibit specific examples of interdependence.

Acquire basic scientific knowledge: some plants need other plants to survive. The relationship where one organism needs the other for survival is called dependence.

◇ Support

Some plants with weak stems need to twine around other plants with rigid stem in order to reach sunlight.

◇ Plants that use others as habitat

Some plants use others as a home or habitat

◇ Shade

Some plants grow in the shade provided by others to avoid damage from growing in intense sunlight.

2, Interdependence between plants and animals

By the end of this subtopic, the learner should be able to:
Develop interest and curiosity about interdependence of plants and animals. Observe examples of animals depending on plants. Identify plants and animals involved in interdependence. Record some of the examples of interdependence such as drawing and collecting bird nests. Describe examples of interdependence of plants and animals

Acquire basic scientific knowledge;

◇ Food

Some plants are food for animals, e.g. herbivores eat plants; some animals are food for plants, e.g. insectivorous plants eat insects.

◇ Oxygen and Carbon dioxide

Plants release oxygen during photosynthesis, which is used by animals during respiration. On the other hand, animals release carbon dioxide during respiration, which is used by plants during photosynthesis

◇ Shelter

Birds build nests in trees; monkeys also live in trees; in grasslands, when it is too hot, animals take cover from intense sunlight in the shade of trees.

◇ Pollination

Many plants depend on animals for pollination. Insects such as bees and butterflies pollinate flowers as they move from one flower to another. Birds such as the sunbird also pollinate flowers.

◇ Medicines

Herbal medicines are obtained from plants. Extracts or juice from parts can be processed and made into either a liquid, syrup, tablet, capsule or powder for use.

◇ Nutrients

Nutrients are chemical substances which are required for the healthy growth of plants and animals. These nutrients from the soil can be from animal wastes or decomposed dead plants and animals.

◇ Animal waste

When animal wastes decompose they form manure. Soils with manure are fertile. They provide enough nutrients to the plants making them to grow healthy.

◇ Decomposition on death

When plants or animals die, they rot and decompose. During decomposition, nutrients are released into the soil. These nutrients can then be absorbed by the growing plants.

3, Food chain

By the end of this subtopic, the learner should be able to: Observe organisms involved in food chains, Recognize a food chain. Make and explain food chains. Record examples of food chains. Explain and report the implications of a change in a food chain. Constructively criticizing or evaluating a piece of work, a scientific procedure or conclusion. Develop an ability to cooperate in groups when making food chains for the display.

Acquire basic scientific knowledge; A food chain is a relationship which shows who eats what. The arrows give the direction of flow of nutrients. A typical food chain is: green plant(producer) → herbivore(consumer) → carnivore(consumer)

Plant → gazelle → cheetah.

Grass → grasshopper → lizards → snake

Grass → mouse → snake → hawk

Small water plants → small fish → large fish → pelicans

A food chain is a feeding relationship among living things

- ◇ Meaning
- ◇ Examples

4, Crop pests

By the end of this subtopic, the learner should be able to: Recognize and name common crop pests. Observe, identify, classify and record crop pests. Explain the meaning of crop pests. Acquire basic scientific knowledge; A pest is an organism that destroys or damages crops either in the field or in storage. The two types of pest are field pests and storage pests. Examples of field pest are aphids, cutworms, stalk borers, birds such as quelea and weaverbirds. Examples of storage pests are weevils, white ants and rodents such as rats and mice.

◇ Meaning of pest

◇ Types of pest

- Field pest(aphids, cutworms, stalkborers, weaver birds)
- Storage pests(rodents, weevils, white-ants)

5, Effects of pests on crops

By the end of this subtopic, the learner should be able to: Describe the effects of crop pests. Develop an ability to carry out a project on crop pests and their effects and control in their locality. Acquire basic scientific knowledge: the effects of pests on crops are:

- ◇ Lower yields
- ◇ Reduced quality of produce
- ◇ Transmit diseases to crops
- ◇ Cause diseases to consumers

6, Control measures

By the end of this subtopic, the learner should be able to: Develop interest how pests affect crops and how pests can be controlled. Describe how to control crop pests by various methods. Take care of stored grains such as maize, rice, beans, simsim to avoid attack by pests. Develop responsibility towards effective and safe methods of pest control. Develop self-confidence when discussing pest control measures.

Acquire basic scientific knowledge: We can control crop pests by:

- ◇ Scaring
- ◇ Trapping
- ◇ Hand picking
- ◇ Weeding
- ◇ Spraying
- ◇ Pruning

Standard 8-----

Adaptations of plants. Crop diseases

1, Adaptations of plants to their environment

By the end of this subtopic, the learner should be able to:

Observe, identify and describe the various adaptations to their roots, stems and leaves used by plants to allow them to survive in dry and wet environments. Describe how the identified plants are adapted to different habitats.

Acquire basic scientific knowledge; Plants have special adaptations that enable them to survive in different environment. Adaptations for dry areas include- having deep root systems, reduced size of leaves, sunken stomata, covering with waxy material and shedding leaves during the dry season. Adaptations for wet areas include- plants having leafy shoots, broad leaves, hair on leaves, shallow root system and breathing roots.

- ◇ Dry areas
- ◇ Wet areas

2, Signs of unhealthy crops

By the end of this subtopic, the learner should be able to:

Observe, identify and describe the signs of diseased crops. Differentiate between a healthy and a diseased plant. Understand and describe the effects of crop disease on yield, quality of produce and profit. Evaluate and recognize good and poor features, knowing how to improve grades. Be aware of the practical and economic consequences of crop disease.

Acquire basic scientific knowledge; Healthy crops grow fast and are strong, and produce high yields. Signs of unhealthy crops include- stunted growth, curled leaves, wilting, spots and streaks and discolouration on growing leaves, ears and stems.

- ◇ Stunted growth
- ◇ Descolouration on growing leaves, ears, stem
- ◇ Curled leaves
- ◇ Wilting

◇ Spot/streaks

3, Effects of crop diseases

By the end of this subtopic, the learner should be able to:

State signs of unhealthy crops. Record signs of unhealthy crops. Develop interest as he or she identifies signs of unhealthy crops. State effects of crop diseases. Record effects of crop diseases. Develop interest as he or she records effects of crop diseases.

Acquire basic scientific knowledge; Effects of crop diseases include- lower yields and reduce quality of produce

◇ Lower yields

When the crop is stunted, some may not grow to maturity and there may be reduced or yields. When the leaves are diseased, the photosynthesis process is affected. The plant cannot adequately make food for the plant. The crops become weak. The quality of the final product is also affected. The yields may also be reduced. Diseased seeds may not germinate. This also reduces the amount of produce.

◇ Reduced quality produce

If a crop suffers from stunted growth, it cannot give good quality of yields. If we are harvesting leaves, flowers, fruits, seed, stems, or roots they will be smaller in size compared to those of normal good quality. If the disease causes curled leaves, discolouration, spot and streaks the quality of the harvested leaves, flowers, fruits and seeds will be poorer. Poor quality farm produce are not attractive to customers. Thus they do not fetch good prices. Buyers pay less for such farm produce.

Making work easier

Standard 5

Balancing

1, Balancing on a see-saw

By the end of this subtopic, the learner should be able to:

Repeat the balancing activity in pairs until the heaviest pupils is identified. Discuss with the pupils how the lightest pupils can balance the heaviest pupil in the class on the see-saw. Observe and record different balance situations on a see-saw. Measure to locate balance positions. Predict balance positions on a see-saw. Develop practical skills to problem solving.

2, Making and using a simple beam balance to compare mass of different materials

By the end of this subtopic, the learner should be able to:

Manipulate when making a beam balance. Develop skills of observation, manipulation, measuring, simple construction and comparing. Develop interest when finding balance points and co-operation when working in pairs. Develop curiosity about finding out how a balance works.

Standard 6

Movement and force

1, Movement

By the end of this subtopic, the learner should be able to:

Develop the following skills: Identification of what forces can do, manipulation as pupils handle different apparatus and objects to investigate movement and force, measurement as they measure

forces used to move things and recording as pupils write down forces required to push or pull objects. Develop attitude of longing to know and to understand, respect for logic and demand for verification. Develop curiosity and interest in forces and movements. Develop co-operate in groups to do activities and increase self-confidence and communication skills.

Acquire basic scientific knowledge: Stationary objects do not move on their own. A force is a pull or push. A force is needed to move an object. A force is needed stop a moving object. A force can be produced by gravity. A force can be produced by wind. A force can be produced by springs. Frictional force opposes sliding motion and increases work. Gravitational force pull objects towards the ground.

- ◇ Moving objects
- ◇ Stopping objects from moving

2, Force

By the end of this subtopic, the learner should be able to:

Explain how pupils feel when they pull the spring. Push and compress the spring and describe how they feel in their hands. Identify and name the parts of a spring balance. Describe and name the unit of measuring force. Measure forces in newtons and predict patterns in forces. Develop manual and mental skills. Develop responsibility in co-operative work.

Acquire basic scientific knowledge: A force is a push or a pull. A force can make objects that are at rest start moving, or it can stop moving objects. Force is measured in units called newtons.

- 1 kilogram(kg) = approximately 10 newtons(N)
- ◇ Meaning of force
- ◇ Units of force(Newton)

Standard 7-----

Friction and parts of lever

1, Meaning of friction

By the end of this subtopic, the learner should be able to: Investigate friction as a force that opposes the movement of one surface over another. Apply friction in walking, moving of vehicles on tarmac, braking, lighting matches, writing on the board, rubbing/erasing and skating. Find out friction as a nuisance in wearing out of objects or machine parts and also making work difficult.

Acquire basic scientific knowledge; Meaning of friction.

2, Advantages and disadvantages of friction

By the end of this subtopic, the learner should be able to: Develop an interest and curiosity in friction and how it changes in different situations. Develop an ability to co-operate by working in group doing various activities. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

Acquire basic scientific knowledge; One main advantage of friction is that it helps us to bring moving objects to stop. Find out the main disadvantage is that it causes unwanted resistance and increases our work.

3, Increasing and reducing friction

By the end of this subtopic, the learner should be able to: Compare the force of friction between surfaces as the weight, surface and lubricant change. Investigate ways of reducing friction such as using rollers, smoothening/polishing surfaces, using lubricants and streamlining. Search; locating sources, using several sources, Inquire; asking, interviewing, corresponding. Gather data; tabulating, organizing and recording.

Acquire basic scientific knowledge and increase friction by making surfaces rough. Reduce friction by smoothening surfaces

and applying oil or grease on the moving parts.

4, Position of the fulcrum, load and effort in the following levers when in use

By the end of this subtopic, the learner should be able to: Explain the meaning of a lever. Describe and give everyday examples of the three classes of lever. Demonstrate activities and point at the position of the load, effort and fulcrum. Draw the various levers and label the positions of the load, effort and fulcrum. Demonstrate; setting up levers, making them work, describing parts and functions, illustrating scientific principles. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

Acquire basic scientific knowledge; The effect of changing distance between effort and fulcrum. If the fulcrum is near to the load, a small effort can lift a big load. The fulcrum is the axle of the wheel-barrow; the load is placed as close as possible to the axle, and the lifting effort is put on the ends of the handles. Use the different types of levers to make work easier.

- ◇ Claw hammer
◇ Crowbar
◇ Wheelbarrow, spade

Standard 8-----

Simple machine

1, Inclined planes

By the end of this subtopic, the learner should be able to: Observe slopes of different gradients. Identify which gradient of a slope is easier to work with. Carry out investigation to find out the amount of effort needed to raise a load along slopes of different gradients. Develop curiosity and interest about inclined planes and their usefulness in making work easier. Develop

practical attitudes in problem solving as pupils design experiments and investigate the amount of effort required to raise a load slopes of different gradients. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

Acquire basic scientific knowledge; Effort needed to push or pull a load along an inclined plane, is less than one needed to raise it straight up. Find out that the ladder is another example of inclined planes. It is a structure for climbing up and down a high place. It is easier to climb a hill along a winding road than going straight up the hill.

- ◇ Ladder
- ◇ Staircase
- ◇ A road winding up a hill

2, Single fixed pulley

By the end of this subtopic, the learner should be able to:

Observe how a single fixed pulley is used to raise loads e.g. a flag. Work with pulleys to raise the flag and other loads. Know the pulley's parts, how it works, how to adjust it, its proper use for a given task, its limitations. Discuss how people raise water from wells and loads in a construction site, and convenience of using a pulley. Investigate how single fixed pulleys make work easier.

Acquire basic scientific knowledge; The effort force is the same as the load force. The distance moved by both effort and the load are equal. In a single fixed pulley the load distance is equal to the effort distance, i. e. when the load moves 1m the effort distance is 1m. The direction of the load is opposite to that of the effort. When the load moves up the effort moves down.

- ◇ Uses of single fixed pulleys such as on the flag post

Standard 5-----

1, Types of sound

- ◇ Load and soft

By the end of this subtopic, the learner should be able to: Manipulate apparatus when making different sounds by the following methods: scratching, striking, blowing, brushing, plucking. Interest in how sounds are made. Co-operate to work together in the activity. Point out that in all these situations, sound is produced by the vibration of objects. Group the sounds into: soft, loud, and low, high.

2, Pollution from sound

By the end of this subtopic, the learner should be able to:

- ◇ Effects such as damaging the ear drum and irritation
- Identify the main effects of sound pollution. Responsible for not making sound pollution.

3, Heat transfer

- ◇ Conduction

By the end of this subtopic, the learner should be able to:

Investigate transfer of heat in solids. Observe and record what happens. Appreciate the fact that heat travels along the metal bar. This movement of heat through the solid is called conduction.

- ◇ Convection

By the end of this subtopic, the learner should be able to:

Set up an experiment and demonstrate the flow of heat in water. Use a candle to demonstrate how hot air rises. The warm air at the bottom rises and cold air comes in to replace it. Be curious about heat and how it travels. Describe convection of heat in water and air.

- ◇ Radiation

By the end of this subtopic, the learner should be able to:

Use a source of heat such as the sun, a heater, and wood fire. Sit outside where the air is calm or around the fire. Know the method of heat transfer by which heat reaches as being mainly radiation.

4, Good and poor conduction

By the end of this subtopic, the learner should be able to:
Observe and record good and bad conductors of heat. Classify good and poor conduction of heat.

5, Uses of good and poor conductors of heat

By the end of this subtopic, the learner should be able to:
Say how the conductors and non-conductors are used in daily life: cooking utensils, iron for pressing clothes and hot water pipes, worm clothes.

Standard 6-----

1, How light travels

By the end of this subtopic, the learner should be able to:
Design an experiment to how light travels. Observe that light travels in a straight line. Show interest as they investigate how light travels.

Acquire basic scientific knowledge; Light is a form of energy. Light travels in straight lines from its source.

2, Transparent, translucent and opaque materials

By the end of this subtopic, the learner should be able to:
Set out experiments to investigate how light behaves when it falls on transparent, translucent and opaque materials. Gather data, organize, sort and classify materials into transparent, translucent and opaque and record their uses in everyday life. Predict the suitable use of a material for a particular situation. Be curious about materials and light. Work co-operatively in groups.

Acquire basic scientific knowledge; Some materials are transparent, some translucent, others opaque. Houses use transparent materials on windows and sometimes on doors. Walls are made of opaque materials.

3, Reflection of light

By the end of this subtopic, the learner should be able to:
Demonstrate reflection of light and compare reflection from smooth shiny surfaces and reflection from rough and dull surfaces. Observe reflection. Describe how reflection of light takes place.

4, Reflection light using a source of light and a smooth shiny surface

By the end of this subtopic, the learner should be able to:
Reflect letters and words in the mirror and write how they appear. Explain that the word is reflected in the mirror it appears turned about sideways.

Acquire basic scientific knowledge; Shiny surfaces reflect light in one direction; non-shiny surfaces scatter light in all direction.

5, Refraction of light

By the end of this subtopic, the learner should be able to:
Observe refraction of light. Record what happens by drawing the effects of refraction of light. Describe how refraction takes place. Develop interest about refraction of light. Locate a problem, learn background, set up experiments, analyze data, draw conclusion.

6, Apparent bending of light in air and water

By the end of this subtopic, the learner should be able to:
Discuss why the light bends. Discuss what is meant by apparent bending of the ruler in water. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

Acquire basic scientific knowledge; Light rays are refracted when they travel from one medium to another. The refraction of

light makes the bottom of pools of water or coin appear closer to the surface than they really are.

7, Demonstration on making a rainbow

By the end of this subtopic, the learner should be able to:

Observe and draw rainbow. Make a rainbow. Name the colours of the rainbow.

Acquire basic scientific knowledge; a spectrum can be made by refracting sunlight through glass or water. A rainbow is formed by the refraction of light by water drops in the air. The colours in the spectrum or rainbow are red, orange, yellow, green, blue, indigo and violet.

Standard 7-----

Electricity

1, Sources of electricity

By the end of this subtopic, the learner should be able to:
Develop an interest and curiosity about electrical energy sources.
Observe, record and discuss a variety of sources of electricity.

Acquire basic scientific knowledge; Name sources of electricity.

- ◇ Batteries
- ◇ Bicycle dynamos
- ◇ Hydro-electric generators
- ◇ Petro and diesel-driven generators
- ◇ Geothermal generators
- ◇ Wind-driven turbines
- ◇ Solar energy

2, Simple electric circuit

By the end of this subtopic, the learner should be able to:

Construct; making simple equipment for demonstrations and experimentation. Describe how a simple circuit is made. Manipulate equipment to make a simple circuit. Co-operate with others as he/she makes a simple circuit.

Acquire basic scientific knowledge; A simple electric circuit is formed when electricity follows a complete loop from its source. A simple electric circuit can be made from a dry cell, a bulb and connecting wires. A switch can be added to a circuit to control the flow of electricity.

3, Good and bad conductors of electricity

By the end of this subtopic, the learner should be able to:
Experiment; recognizing a problem, planning a procedure, collecting data, recording data, analyzing data, drawing conclusions. Manipulate circuits to identify good and poor conductors of electricity. State the good and poor conductors of electricity. Show confidence as he or she investigates good and poor conductors of electricity. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

Acquire basic scientific knowledge; Some materials conduct electricity while others do not. Metals like copper, aluminium and silver are good conductors of electricity. Substances like wood, air, plastic, and rubber are poor conductors of electricity and are called insulators.

4, Electrical appliances at home and their uses

By the end of this subtopic, the learner should be able to:
Observe and record how electricity is used in domestic appliances and explain how different electrical appliances perform different tasks. Organize; putting items in labeling and arranging. Develop creativity and use appropriate skills and technologies for solving problems for productive work. Create a method, device, or technique.

- ◇ An iron
- ◇ Radio
- ◇ Television

Standard 8-----

1, Different types of energy
By the end of this subtopic, the learner should be able to:

Explain what energy is. Demonstrate the presence of energy in the local environment. Show curiosity about forms of energy. Outline; employ major headings and subheading, using logical organization.

Acquire basic scientific knowledge; The different types of energy.

- ◇ Chemical
- ◇ Name substances that contain chemical energy
- ◇ Heat
- ◇ Identify heat as a form of energy
- ◇ Light
- ◇ Describe light as a type of energy
- ◇ Magnetic

By the end of this subtopic, the learner should be able to:
Predict, experiment and collect data of magnetic energy. Find out which things can be attracted by a magnet and where the magnetic force is strongest. Find out how the poles behave towards each other. Make magnets by stroking. Make magnets by the electrical method. Make toys by using magnets. Construct simple toys for demonstrations. Describe how a simple toy is made. Manipulate them to move effectively. Co-operate with others as he or she makes a simple toy.

- ◇ Sound
- ◇ Demonstrate sound energy

3, Transformation of energy
By the end of this subtopic, the learner should be able to:

Develop analytical skills in identifying energy transformations in real life examples. Describe transformation of energy. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

- ◇ Cooker
- ◇ Electric kettle
- ◇ Handcraft toys making

5, Safety when dealing with electricity
By the end of this subtopic, the learner should be able to:

State the dangers posed by electricity. Explain how to handle electricity and electric devices carefully.

- ◇ Not touching switches with wet hands
- ◇ Not putting sticks, pencils and wires in sockets
- ◇ Not overloading sockets

6, Lighting and safety measures
By the end of this subtopic, the learner should be able to:

Describe how lighting is made. State the precautions that should be taken against lighting. Develop attitude of longing to know and to understand, respect for logic and demand for verification.

Acquire basic scientific knowledge; When we rub pieces of plastic with a cloth, they get the power to move light objects. The plastic picks up an electric charge and becomes charged with electricity. The electric charge on each piece of plastic gives it energy. This energy is stored on the plastic for a while and so is called electric potential energy. The two kinds of charge which produce opposite effects are called negative charge and positive charge. Like charges always repel each other. Unlike charge always attract each other. Static electricity is caused by friction and only flows when it is discharged from its source, e.g. a cloud in the case of lightning. Lightning is a discharge of static electricity from clouds to earth or another cloud.

- ◇ Fitting lighting arresters
- ◇ Avoid walking in open fields when it is raining
- ◇ Not sheltering under trees when raining

Acquire basic scientific knowledge; Energy can neither be destroyed nor created, but can be changed from one form to another. This is called energy transformation.

- ✧ Electric circuit to other forms of energy
 - ✧ Food to other forms of energy
 - ✧ Burning fuels to other forms of energy
 - ✧ Burning changes the fuel into heat and light energy
 - ✧ Radio to another form of energy
 - ✧ Simple electromagnet to another form of energy
- Manipulate various apparatus on transformation of energy such as making electromagnets.
Energy can be transformed in the following ways.

Energy in a torch; Chemical → electrical → heat → light.

Food; Chemical → heat and mechanical.

Burning fuel; Chemical → heat and light.

Radio using torch cells; Chemical → electrical → sound.

Magnets; Electrical → electrical → magnetic.

4, Methods of conserving energy

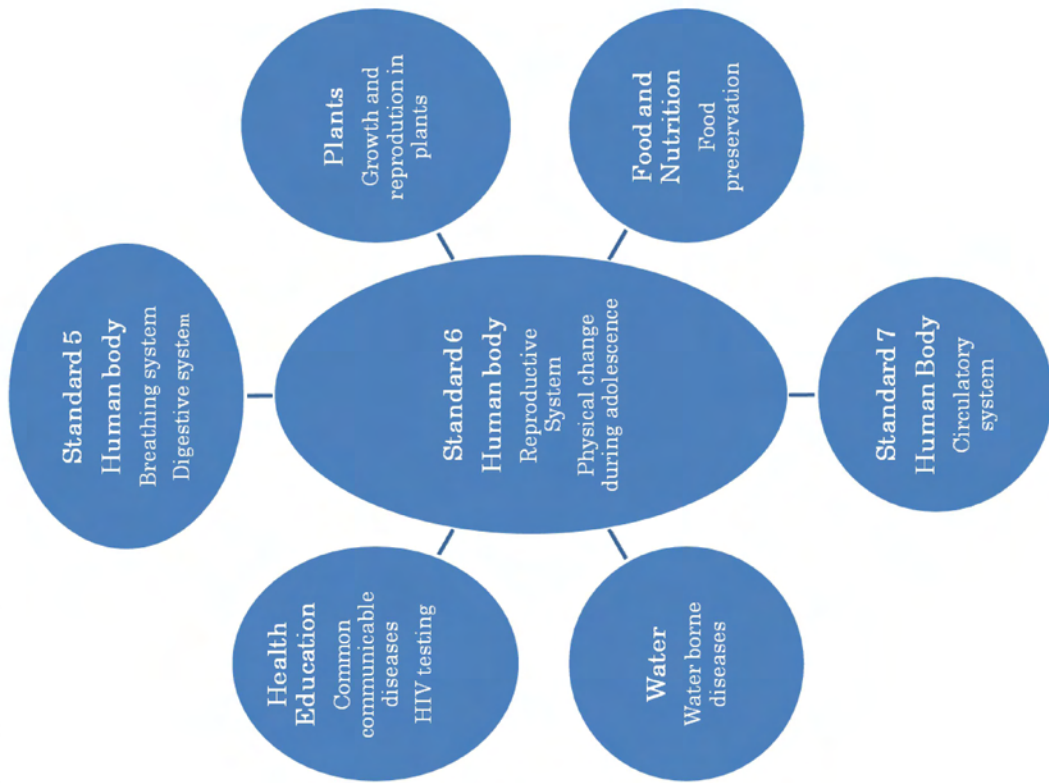
By the end of this subtopic, the learner should be able to:

State the methods of conserving energy. Manipulate materials as they demonstrate conservation of energy. Develop a practical approach to problem solving as he/she appreciates the need to conserve energy. Develop and use appropriate skills and attitude for conserving energy by using renewable energy, that is sun, wind, biogas and trees.

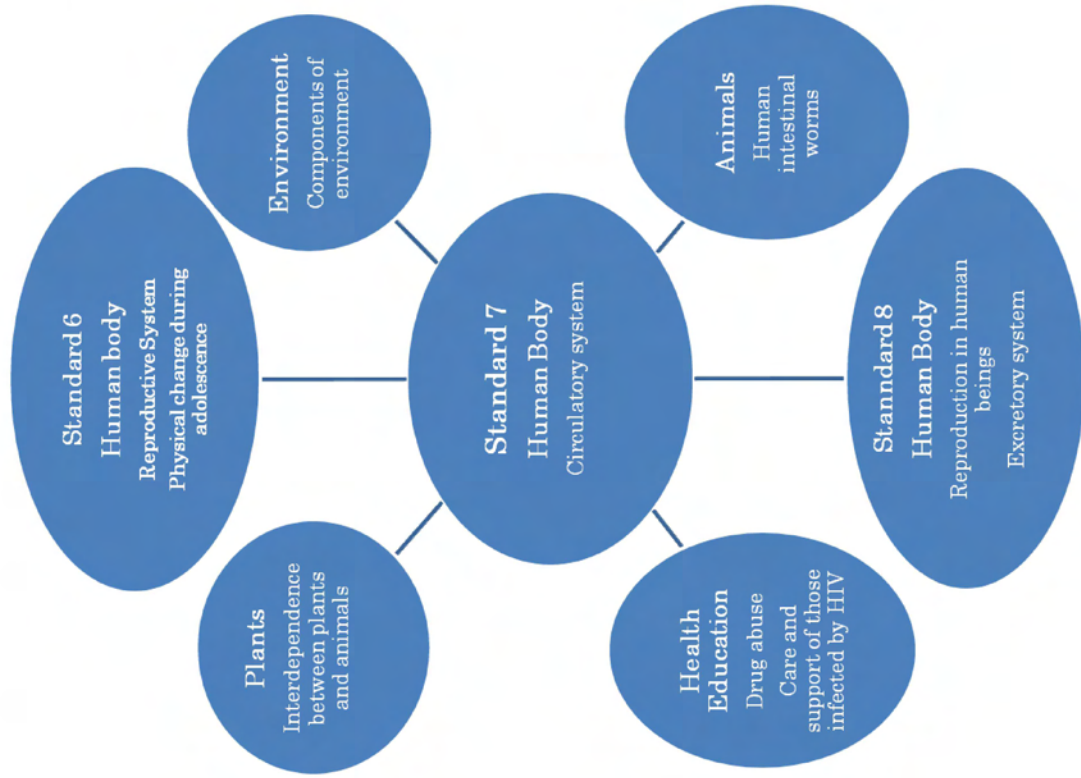
Acquire basic scientific knowledge;

- ✧ Using energy sparingly
- ✧ Using energy efficient devices
- ✧ Using renewable energy (wind, sun, biogas, planting trees)

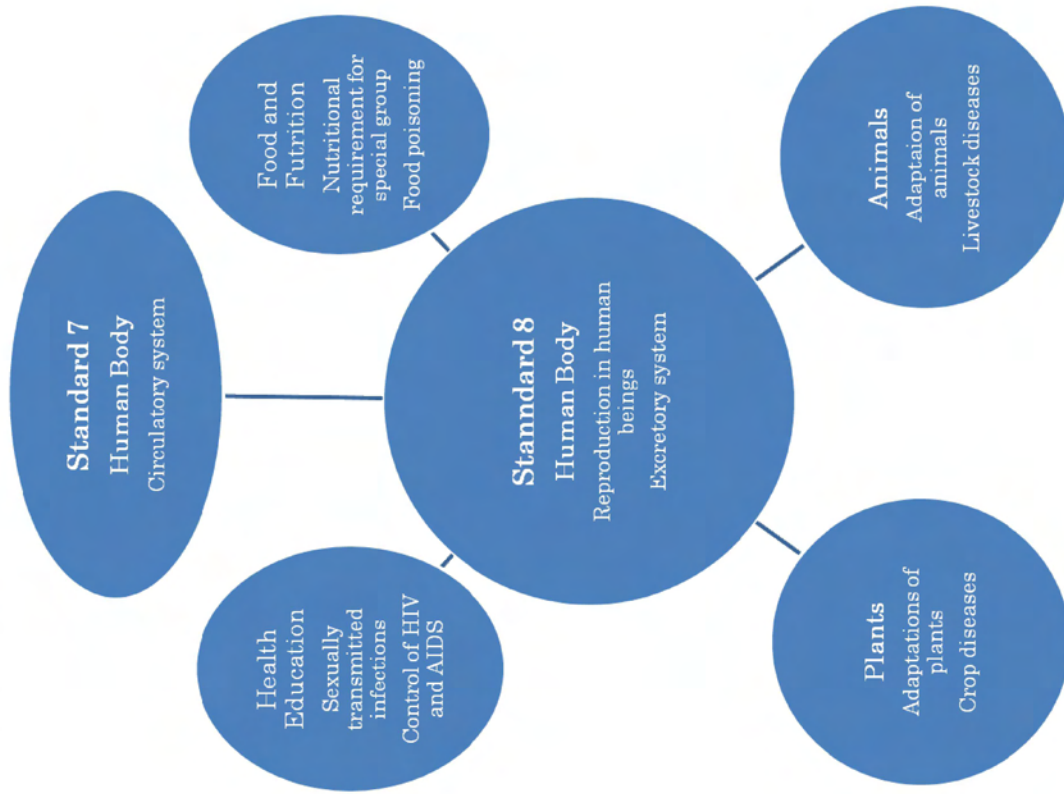
Sequence and Structure of Related Topics
Standard 6; Human Body



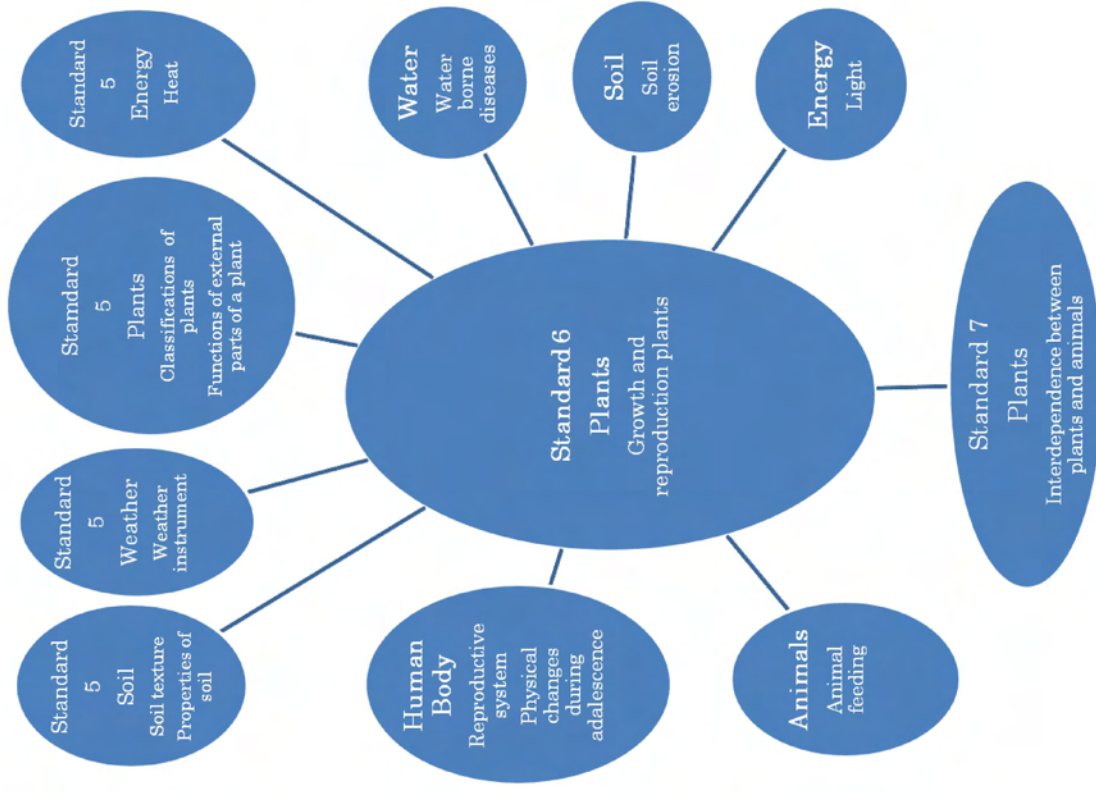
Standard 7; Human Body



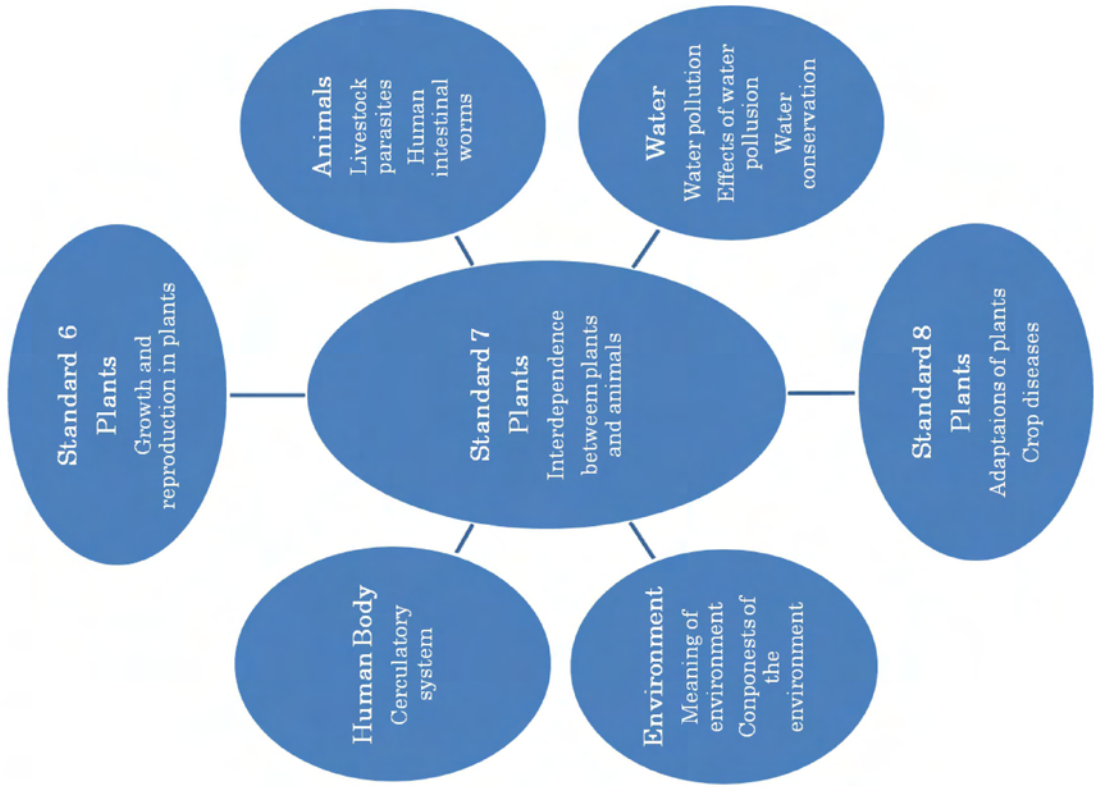
Standard 8; Human body



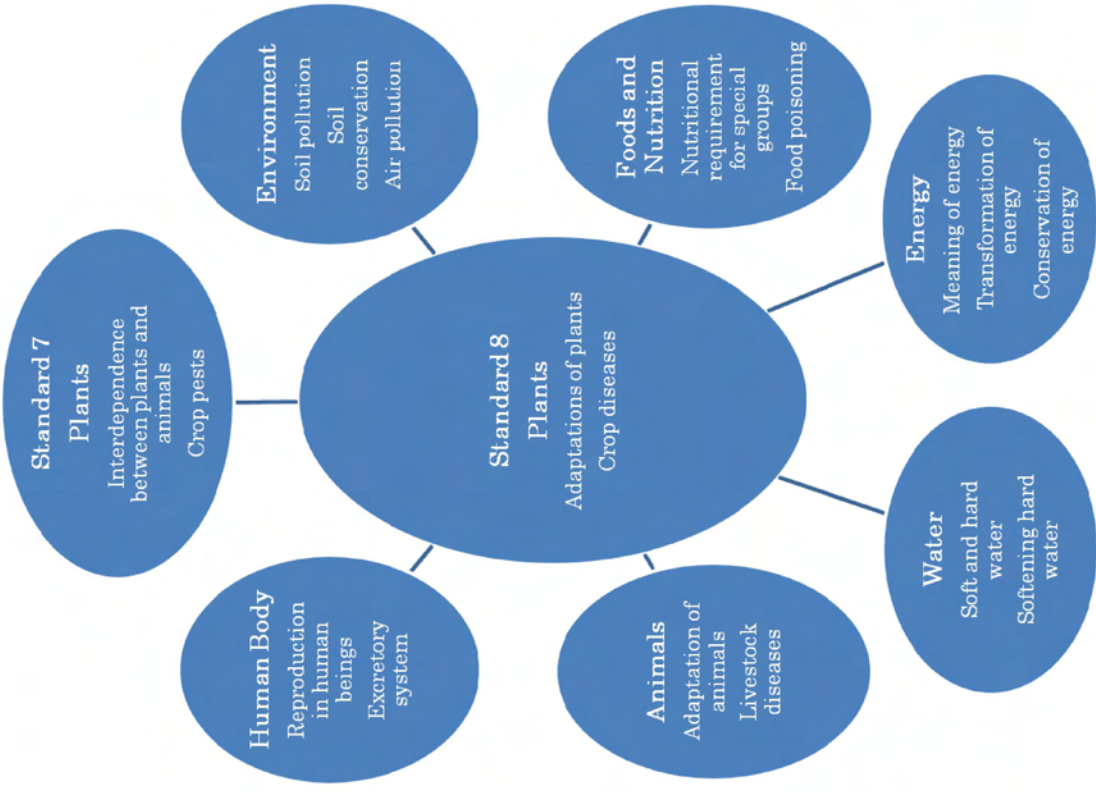
Standard 6; Plants



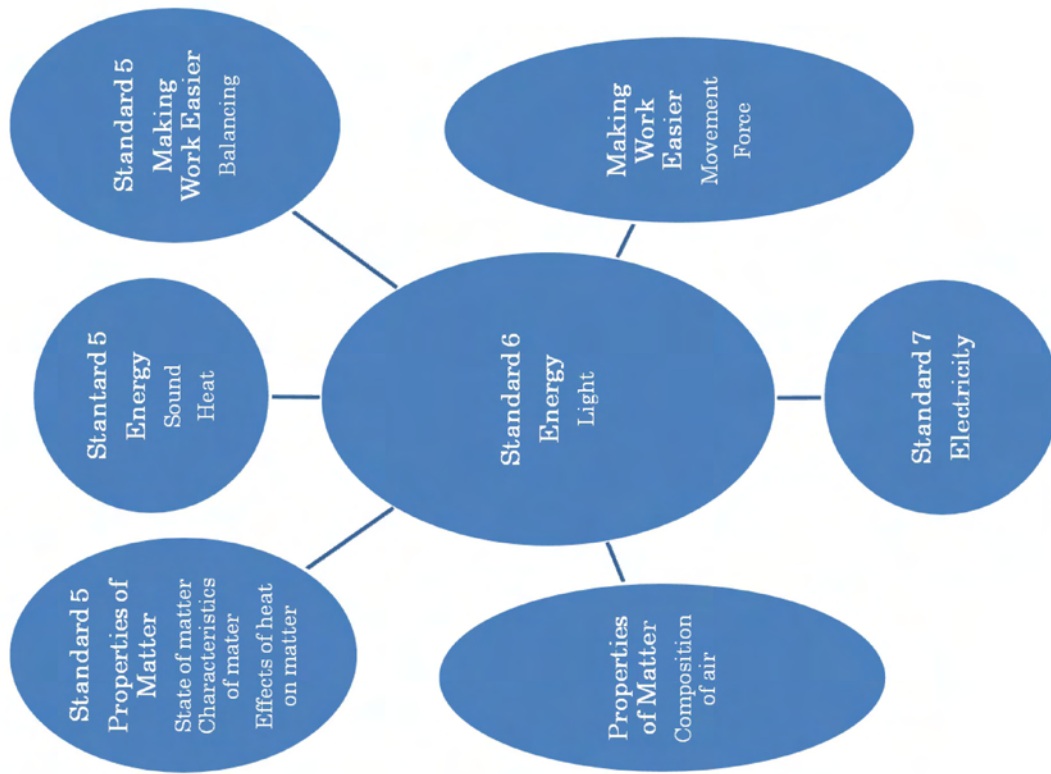
Standard 7; Plants



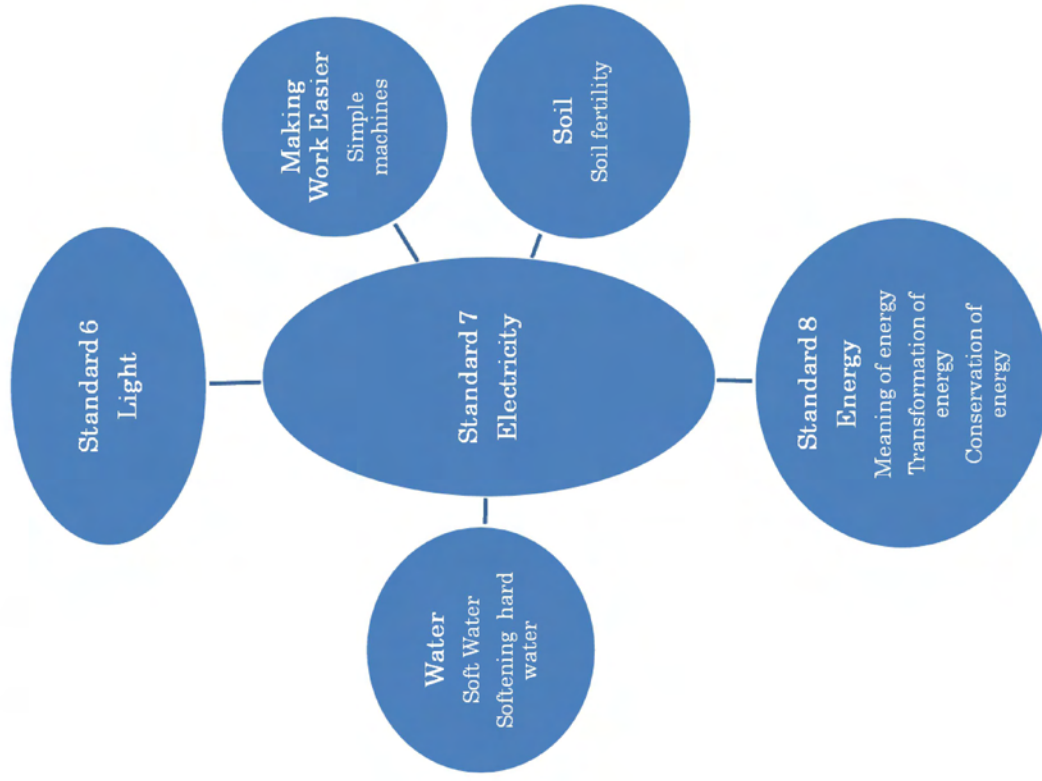
Standard 8; Plants



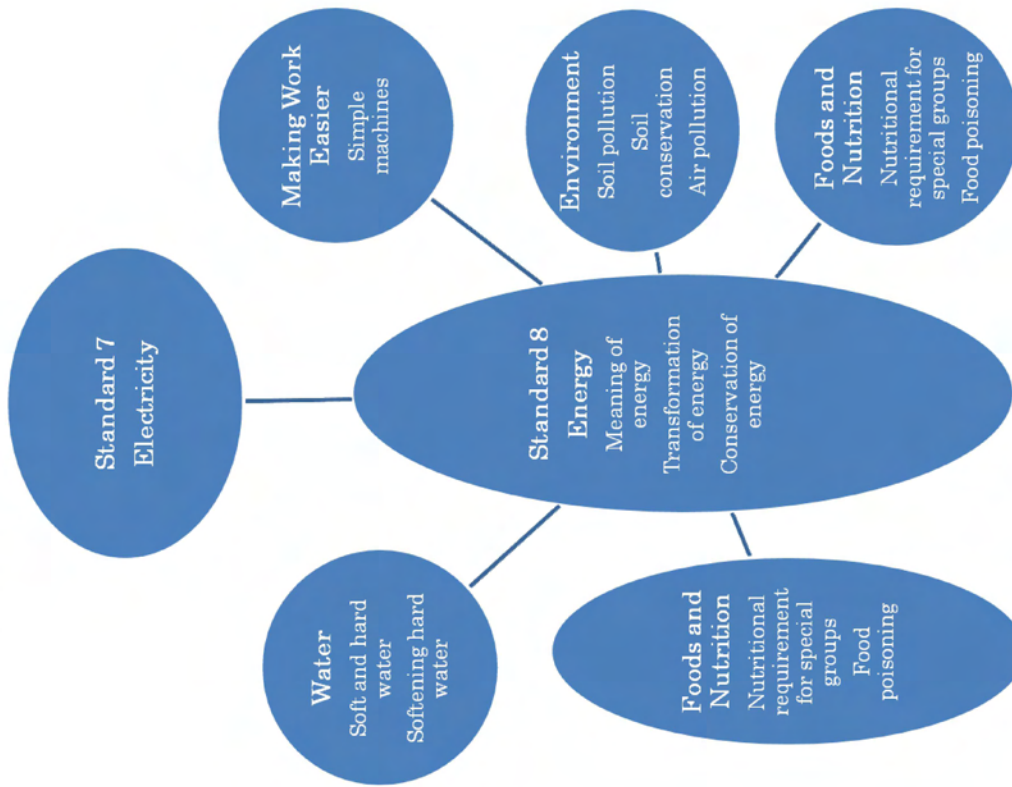
Standard 6; Energy



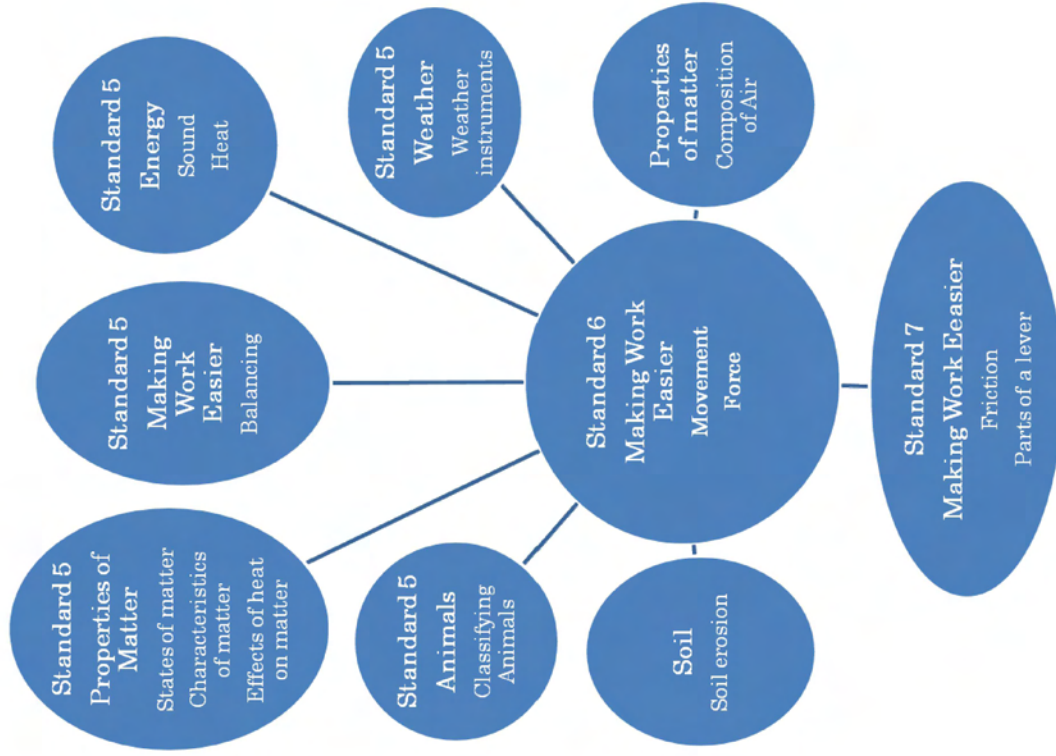
Standard 7; Energy



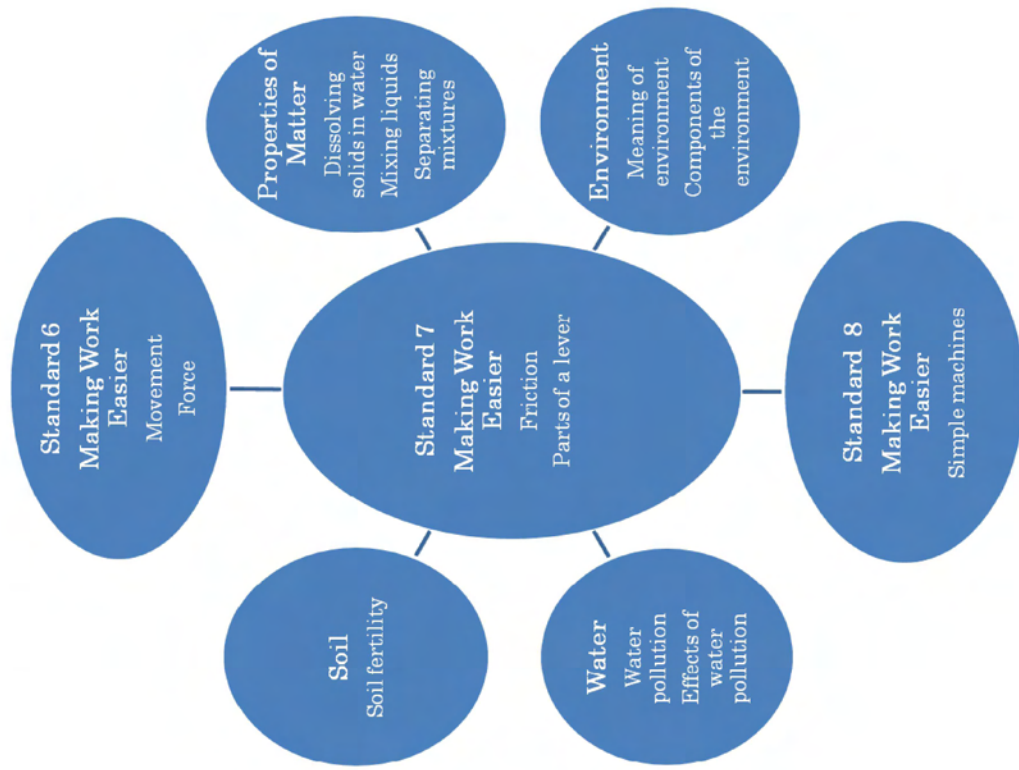
Standard 8; Energy



Standard 6; Making Work Easier



Standard 7; Making Work Easier



Standard 8; Making Work Easier

