

プロジェクト研究  
「生徒中心の授業の実践と  
カリキュラムの系統性に配慮した  
理数科教材作成」  
(ケニア共和国を事例として)

平成21年6月  
(2009年)

独立行政法人国際協力機構  
人間開発部

人間
JR
09-035



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## 序 文

JICA は、1998 年 7 月から 2008 年 12 月まで、現職教員研修を通じた理数科教育の改善を目標とする中等理数科教育強化計画フェーズ1とフェーズ2をケニア共和国において実施しました。その結果、ケニア全国の中等理数科教員を対象とした現職教員研修が実施され、さらに生徒中心型授業を目指す指導技術の向上を目的とした ASEI/PDSI（活動・生徒中心・実験・創意工夫 - 計画・実施・評価・改善）アプローチを教員が学んだことで、理数科教員の授業に対する態度が変容し、生徒の主体的な学びを促進する授業の実現といった成果が確認されました。

現在、このような理数科教育改善の取り組みは、アフリカ域内 33 カ国 1 地域にも拡大しています（2009 年 4 月現在）。たとえば、ケニアでは初等教育を対象とした理数科教育強化計画（SMASE）が、マラウイ、ウガンダ、ザンビアにおいては全国展開を視野に入れたフェーズ2が開始され、理数科教育の改善が進んでいます。

以上のように拡大を続けるアフリカの理数科教育協力ですが、教室における十分なインパクトを引き出すためには、教員のさらなる能力強化を実施するとともに、生徒中心の授業実践の考え方に基づき、かつ系統性に配慮した質の高い研修教材や参考資料の充実が必要であるとの認識が高まってきています。

このような背景のもと、JICA は、現地カウンターパートが、日本人専門家の支援を受けながら教員研修用教材開発時に参照できる資料を作成するという目的から、プロジェクト研究会を立ち上げました。

本プロジェクト研究報告書は、成果としての教材資料とプロジェクト研究の実施背景や実施体制を取りまとめたものであり、今後の理数科教育協力における質の強化のために活用されることを願うものであります。

最後に、本調査にご協力いただいた内外の関係者の方々に心から感謝の意を表するとともに、引き続き一層のご支援をお願い申し上げます。

平成 21 年 6 月

独立行政法人国際協力機構

人間開発部

部長 西脇 英隆



## 地 図

SMASE-WECSA メンバー国 (2009 年 4 月現在) : 33 カ国と 1 地域<sup>1</sup>



### 33 カ国と 1 地域 (アルファベット順)

アンゴラ、ベナン、ボツワナ、ブルキナファソ、ブルンジ、カメルーン、コンゴ共和国、コートジボワール、エジプト、エチオピア、ガーナ、ガンビア、ケニア、レソト、マダガスカル、マラウイ、マリ、モーリシャス、モザンビーク、ナミビア、ニジェール、ナイジェリア、ルワンダ、セネガル、セイシェル、シエラレオネ、南アフリカ、スワジランド、スーダン、タンザニア、ウガンダ、ザンビア、ザンジバル、ジンバブエ

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<sup>1</sup> 1 地域とはタンザニア連合共和国を構成する島嶼ザンジバルを指す。島嶼ザンジバルには司法・立法・行政自治権があり、独自の大統領を有する。





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## 第1章 本プロジェクト研究の背景

アフリカにおける日本の理数科教育支援は、1998年に開始されたケニア中等理数科教育強化（Strengthening of Mathematics and Science Education in Secondary Education: SMASSE）プロジェクトを中心として拡大し、SMASSE フェーズ2において開始されたアフリカの広域枠組み理数科教育強化—西部・東部・中部・南部アフリカ（Strengthening of Mathematics and Science Education in Western, Eastern, Central and Southern Africa: SMASE-WECSA）ネットワークにおいて、域内33カ国1地域が理数科教育の振興や現職教員研修の制度作りに取り組んでいる。これに伴い、SMASSE 関連の理数科プロジェクトまたは教員研修プロジェクトは域内10カ国に及び、マラウイ、ウガンダ、ザンビアは、ケニアと同様フェーズ1を終え、全国展開を視野に入れたフェーズを開始している。また、サブサハラアフリカの10万人の理数科教員に対する支援を目標として掲げる第4回アフリカ開発会議（Tokyo International Conference on African Development: TICAD IV）横浜行動計画（2008年）も、当該地域における理数科分野の教育改善を後押ししている。

ケニアSMASSE関連プロジェクトが評価される点としては、実験活動を取り入れた授業を通して生徒中心の授業を目指す授業改造運動を、ASEI/PDSI（活動・生徒中心・実験・創意工夫・計画・実施・評価・改善）アプローチ<sup>2</sup>という簡潔で普及しやすいモデルにまとめたことと、カスケード型に見られるような現職教員研修の制度化を行った2点が挙げられる。ケニアでASEI/PDSIに基づいて中等教育レベル向けに開発された研修コンテンツは、アフリカ域内の各国でも活用されている。

しかしながら、ASEI/PDSIアプローチに基づく研修コンテンツの開発は、現在、中等レベルの4年分（4サイクル）にとどまっている。また、すでに実施された4サイクル研修の教室レベルに与えるインパクトを調査した結果からは、教員の授業改造に対する意識変化に影響が見られるものの、授業の質そのもの、または生徒の学習プロセスの変化という観点からは、いまだ十分なインパクトを与えたとは言い難い。つまり、実験活動が授業に取り入れられてはいるものの、生徒に考えさせるための授業に結びついておらず、教材も生徒に考えさせるために活かされている状況にあるとは言い難い。生徒の学習理解度を正確に把握する力や教科知識、カリキュラム分析力といった教員の能力強化の必要性が生じているといえるのである。

2009年1月に開始された初等教育レベルを対象としたケニア SMASE でも、生徒の学習レベルでインパクトを発現させるために、理数科カリキュラムを分析し、ASEI/PDSIアプローチを深化させた質の高い教員研修用教材や生徒用教材の作成が課題となっている。

このような経緯から、JICAは、日本国内における教材編集者、理数科研究者、理数科教育実践者から構成される国内研究会を立ち上げた。本研究会は、アフリカ諸国の理数科カリキュラム分析結果や理数科指導論に基づいた、SMASE-WECSA 域内の実際の教室現場で有効かつ実践的な教材や教員

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<sup>2</sup>ASEI/PDSI（Activity, Student-centered, Experiment, Improvisation / Plan, Do, See, Improve）アプローチとは、身近で入手可能な材料を創意工夫により教材として活用しながら、実験活動を授業に取り入れることで、生徒主体の授業を目指す授業改造プロセスに、計画、実施、評価、改善という一連の行動様式定着を目的としたアプローチのこと。

研修教材の開発のほか、質の高い生徒用教材、生徒の学習評価調査表といった一連の教材パッケージを作成することとなった。

## 第2章 プロジェクト研究の概要

### 2-1 目標

#### (1) 上位目標

SMASE-WECSA ネットワークにおける理数科教育強化のための研修・教材コンテンツの質が強化される。

#### (2) プロジェクト研究の目標

ケニア初等教育 6-8 学年の理数科担当教員を対象とした 4 サイクルの教員研修（毎年 2 週間の研修を 4 年間行うことを想定）で扱う、学年間の系統性とねらい（つけたい力）を明確にした理科 16 教材を立案する。

#### (3) 成果品

初等理科（6-8 学年）を研究対象とし、1 学年につき 4 学習単元を選定し、合計 12 学習単元について以下の教材を作成した。

- ・ 教員研修用教材  
（教材の背景、学習単元のねらい、カリキュラムにおける位置づけ、指導計画、指導案）
- ・ 研修を受けた教員の効果的な授業実践を促進する生徒用教材
- ・ 研修の効果を生徒の態度・学力の変化から測定する評価方法

### 2-2 実施体制

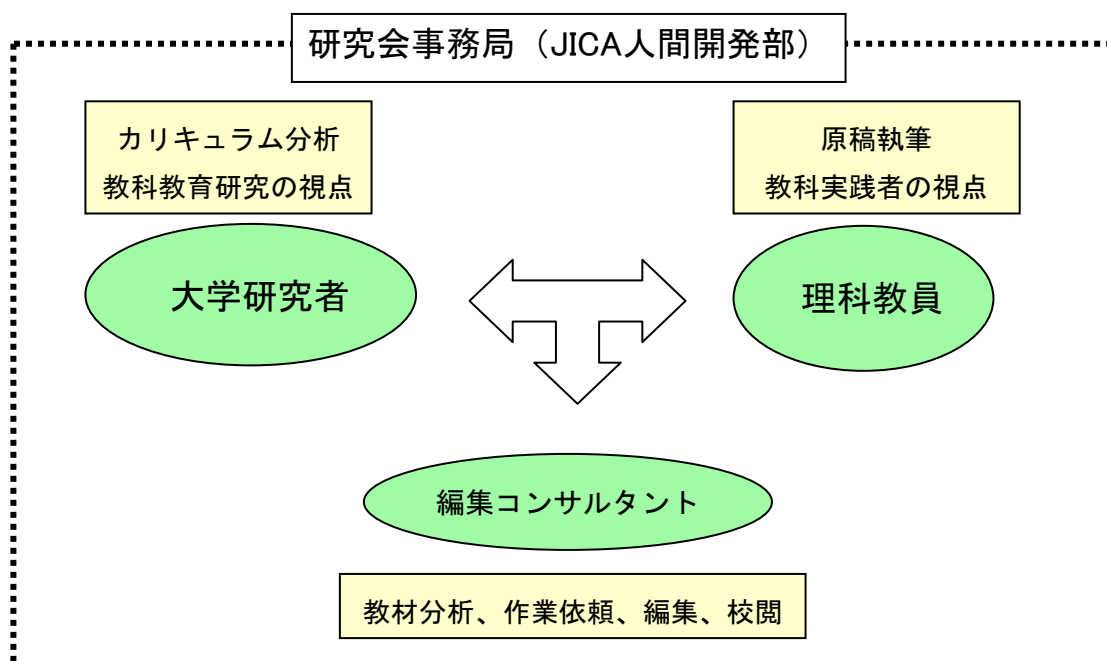
#### (1) 研究会体制

教材作成にあたっては、教科教育研究の視点から理科教育研究者（大学教官）と、理科授業実践者の視点から理科教育実践者（教員や元教員で日本の教科書執筆に関わった経験をお持ちの方等）がそれぞれの分担について原稿を執筆し、JICA 人間開発部主催の研究会において検討を行った。作成された教材の取りまとめ、編集と校閲を行う役務提供コンサルタントとして教科書会社（啓林館）の福尾氏を雇い、日本の教科書会社の知見を活用した。

#### (2) 研究会メンバー（2008 年現在）

理数科教育研究者	広島大学名誉教授（元 SMASSE アカデミックアドバイザー）	武村 重和
編集コンサルタント	株式会社新興出版社啓林館営業企画部副部長	福尾 浩
理数科教育実践者	日本女子大学人間社会学部客員教授	塚田 庸子
	財団法人日本ユニセフ協会学校事業部副部長	永井 洋子
	中野区立第三中学校主幹	長濱 裕也
	山梨大学教育人間科学部非常勤講師	畑中 忠雄
	江東区立第二亀戸中学校主幹	牧野 順子

	東京都墨田区教育委員会統括指導主事	村山 哲哉
事務局	JICA 国際協力専門員	又地 淳
	JICA 人間開発部基礎教育グループ基礎教育第二課課長	石原 伸一
	JICA 人間開発部基礎教育グループ基礎教育第二課	三田村 達宏
	JICA 人間開発部基礎教育グループ基礎教育第二課	菅原 美奈子
	JICA 人間開発部基礎教育グループ基礎教育第二課 Jr 専門員	田口 晋平
	JICA 人間開発部基礎教育グループ基礎教育第二課 Jr 専門員	古川 顕
	JICA 人間開発部基礎教育グループ基礎教育第二課 Jr 専門員	松本 知子



### (3) 執筆分担(敬称略)

武村重和 学習についての質問・指導内容の系統・関連単元の系統と構造・追加評価問題・インパクト調査問題・全単元内容校閲

分野	第6学年	第7学年	第8学年
Human Body	村山 哲哉	塚田 庸子	村山 哲哉
Plants	永井 洋子	畑中 忠雄	畑中 忠雄
Energy	牧野 順子	塚田 庸子	長濱 裕也
Making Work Easier	牧野 順子	村山 哲哉	長濱 裕也

## 2-3 研究のプロセス

活動名	内容
事前準備	編集コンサルタントとの打ち合わせ <ul style="list-style-type: none"> <li>・基本方針の確認</li> <li>・執筆者（理科教育実践者 6 名）の選考依頼</li> </ul>
研究者とコンサルタントによる成果品ひな形の作成	
打ち合わせ (2008.12.11)	編集コンサルタントと研究者との打ち合わせ <ul style="list-style-type: none"> <li>・概要・基本方針の確認</li> <li>・成果品ひな形の確認</li> <li>・執筆担当者の決定</li> </ul>
第 1 回国内研究会 (2008.12.18)	<ul style="list-style-type: none"> <li>・ 参会者の紹介（JICA、理科教育研究者、理科教育実践者）</li> <li>・ ケニアの授業の様子等に関する実態報告（JICA）</li> <li>・ 成果品ひな形の紹介（研究者）</li> <li>・ 成果品ひな形についての意見交換（理科教育実践者）</li> <li>・ 原稿依頼（コンサルタント）</li> </ul>
実践者による初稿原稿（1 単元）執筆	
第 2 回国内研究会 (2009.01.22)	初稿執筆を受け、成果品ひな形のコンセプト等の問題点を再協議
実践者による初稿修正と 2 単元目執筆	
第 3 回国内研究会 (2009.02.14)	全単元（12 単元）の原稿についての協議 <ul style="list-style-type: none"> <li>・ 内容の過不足、問題点、新たなアイデアに関する意見交換</li> </ul>
最終原稿を編集コンサルタントへ提出	
成果品報告会 (2009.03.27)	編集コンサルタントによる報告 <ul style="list-style-type: none"> <li>・ 追加資料の差し込み、語句・記述方法の統一、その他調整</li> </ul>
最終成果品の提出	

## 2-4 参考資料

### (1) ケニアの理科教科書

教材作成にあたり、以下のケニア理科教科書を参照した。

- ・ 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

### (2) 各分野作成のための資料参照個所

以下は、4 分野を開発するにあたって参照した教科書類の該当個所一覧である。ケニアについては

Kenya Literature Bureau 出版の教科書を参照した。日本については、特に断りがないものは啓林館の教科書を参照している。

## 人体 (Human Body)

6年	内容 <ul style="list-style-type: none"> <li>・ いくつかの生殖器系の器官を見分けることができる。</li> <li>・ いくつかの生殖器系の働きを述べることができる。</li> <li>・ 青年期の体の変化を述べることができる。</li> </ul>	
	ケニア p.1～7	日本 <ul style="list-style-type: none"> <li>・ 東京書籍中学校保健体育 平成18年度用 p.5～23</li> <li>・ 教科書トレーニング 保健体育全教科書版 p.64～73</li> </ul>
7年	内容 <ul style="list-style-type: none"> <li>・ 循環器系の各器官（要素）を見分けることができる。</li> <li>・ 血液の構成要素とそれらの働きを説明できる。</li> <li>・ 血管の種類とそれらの働きを見分けることができる。</li> <li>・ 心臓の構造と働きを説明できる。</li> </ul>	
	ケニア p.1～12	日本 <ul style="list-style-type: none"> <li>・ 平成13年度用 中理2上 p.98～101、114</li> <li>・ 平成18年度用 中理2上 p.119～126</li> <li>・ 平成18年度用 中理2上詳説 p.187～203、234～241</li> <li>・ 旧問題集2年 p.40～41</li> <li>・ 教科書トレーニング2上 p.86～93</li> </ul>
8年	内容 <ul style="list-style-type: none"> <li>・ 人間の受精について説明できる。</li> <li>・ 胎児の成長について討議できる。</li> <li>・ 生命誕生の過程について述べることができる。</li> <li>・ 主な排泄器官と老廃物について関連付けて考えることができる。</li> </ul>	
	ケニア p.1～19	日本 <ul style="list-style-type: none"> <li>・ 平成17年度用 小理5上 p.24～29</li> <li>・ 平成13年度用 中理2上 p.102～106</li> <li>・ 平成18年度用 中理2上 p.119～126</li> <li>・ 東京書籍中学校保健体育 平成18年度用 p.5～23</li> <li>・ 平成17年度用 小理5上要点編 p.36～43</li> <li>・ 平成17年度用 小理5上研究編 p.53～66</li> <li>・ 平成18年度用 中理2上詳説 p.187～203、234～241</li> <li>・ 旧問題集2年 p.43～44</li> <li>・ ぴったりテスト5年 p.18～23</li> </ul>



		<ul style="list-style-type: none"> <li>教科書トレーニング 2 上 p.86～93</li> <li>教科書トレーニング 保健体育全教科書版 p.64～73</li> </ul>
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## 植物 (Plants)

6 年	内容	
	ケニア p.21～32	日本
7 年	内容	
	ケニア p.42～66	日本
8 年	内容	
	ケニア p.32～47	日本 なし

## エネルギー (ENERGY)

6年	内容 <ul style="list-style-type: none"> <li>・ どのようにして光はとどくかを説明できる。</li> <li>・ 透明な物質、半透明な物質、不透明な物質。</li> <li>・ 光の反射を証明できる。</li> <li>・ 光の反射の調査研究ができる。</li> </ul>	
	ケニア p.65～81	日本 <ul style="list-style-type: none"> <li>・ 平成 18 年度用 中理 1 上 p.2～15、36～37</li> <li>・ 平成 18 年度用 中理 1 上詳説 p.17～55</li> <li>・ 教科書トレーニング 1 上 p.4～9、28～31</li> </ul>
7年	内容 <ul style="list-style-type: none"> <li>・ 電気の源の名前を挙げられる。</li> <li>・ 簡単な回路を作ることができる。</li> <li>・ 電気を通すものと通さないものを調べることができる。</li> <li>・ 家庭の電気器具とその使い方を説明できる。</li> <li>・ 電気器具を扱うときの安全対策について述べるができる。</li> <li>・ 雷で稲妻が発生した時の安全対策を説明できる。</li> </ul>	
	ケニア p.106～129	日本 <ul style="list-style-type: none"> <li>・ 平成 17 年度用 小理 3 年 p.62～71</li> <li>・ 平成 18 年度用 中理 1 上 p.87～98</li> <li>・ 平成 17 年度用 小理 3 年要点編 p.～82～93</li> <li>・ 平成 17 年度用 小理 3 年研究編 p.115～128</li> <li>・ 平成 18 年度用 中理 1 上詳説 p.172～205</li> <li>・ ぴったりテスト 3 年 p.56～65</li> <li>・ 教科書トレーニング 1 上 p.66～77</li> </ul>
8年	内容 <ul style="list-style-type: none"> <li>・ エネルギーとは何かを説明できる。</li> <li>・ 異なる種類のエネルギーについて述べるができる。</li> <li>・ エネルギーの変換について述べるができる。</li> <li>・ エネルギーを大切にすることの方法について述べるができる。</li> <li>・ エネルギーを大切にすることの必要性について認識する。</li> </ul>	
	ケニア p.128～159	日本 <ul style="list-style-type: none"> <li>・ 平成 18 年度用 中理 1 下 p.61～74、79～89、97～113</li> <li>・ 平成 18 年度用 中理 1 下詳説 p.93～107、131～155、157～177、193～213</li> <li>・ 教科書トレーニング 1 下 p.50～61、66～73、84～98</li> </ul>

## 仕事 (Making Work Easier)

	<p>内容</p> <ul style="list-style-type: none"> <li>物体を動かすこと、動いている物体を止めることができる。</li> <li>力とは何かを述べることができる。</li> </ul>	
6年	ケニア p.88～107	<p>日本</p> <ul style="list-style-type: none"> <li>平成18年度用 中理1上 p.23～34</li> <li>平成18年度用 中理1下 p.45～60</li> <li>平成18年度用 中理1上詳説 p.17～33、67～88</li> <li>平成18年度用 中理1下詳説 p.93～130</li> <li>教科書トレーニング 1上 p.16～31</li> <li>教科書トレーニング 1下 p.38～49</li> </ul>
7年	<p>内容</p> <ul style="list-style-type: none"> <li>摩擦について調べることができる。</li> <li>摩擦の働きの利点と不利な点について述べるができる。</li> <li>摩擦を減らす方法や増やす方法について示すことができる。</li> <li>異なるてこにおいて、支点、力点、作用点について述べるができる。</li> </ul>	
	ケニア p.152～174	<p>日本</p> <ul style="list-style-type: none"> <li>平成17年度用 小理5上 p.66～77</li> <li>平成18年度用 中理1下 p.45～67</li> <li>平成17年度用 小理5上要点編 p.86～99</li> <li>平成17年度用 小理5上研究編 p.111～128</li> <li>平成18年度用 中理1下詳説 p.93～141</li> <li>ぴったりテスト 5上 p.48～59</li> <li>教科書トレーニング 1下 p.38～55</li> </ul>
8年	<p>内容</p> <ul style="list-style-type: none"> <li>どのように板(斜面)を傾けると簡単に仕事ができるかを調べることができる。</li> <li>どのように一つの固定された滑車を使うと簡単に仕事ができるかを調べることができる。</li> </ul>	
	ケニア p.160～181	<p>日本</p> <ul style="list-style-type: none"> <li>平成13年度用 中理1下 p.95～99</li> <li>平成13年度用 中理1下詳説 p.272～287</li> <li>旧問題集 3年 p.21～27</li> </ul>

## 第3章 成果品（教材）

### 3-1 ケニアのカリキュラムの系統

ケニアの後期初等教育のカリキュラムは、**Human Body, Plants, Energy, Making Work Easier** の4つの系統から成る。生徒が習得すべき内容は、日本のカリキュラムに類似する点も多い。以下に、ケニアのカリキュラムの特徴を述べる。

Human Body	日本の保健体育領域の内容が含まれている。名称を覚える内容が多い。
Plants	日本に比べ、農作物をはじめ植物がより身近で重要な役割を占めているため、人間との関係や農作物や収穫物を荒らす害虫などについても詳しく学習している。
Energy	光・音を導入として、熱エネルギー、光の反射・屈折、電気、エネルギー変換へとつながっている。日本の現行学習指導要領に比べて、エネルギーの概念を理解させることに力を入れている。仕事領域との関連も多い。
Making Work Easier	日本のように実験は定量的ではないが、ひとつおりの概念は教えている。教科書で紹介されている例が、ケニア現地での身近な例が多い。エネルギー領域との関連も多い。

（注）付属資料 p.15【指導内容の系統】（縦のつながり）と p.30【関連単元の系統と構造】（横のつながり）を参照。

### 3-2 成果品（教材）の内容

作成した教材の各項目は、次のような考え方で作成した（掲載順）。

単元設定の趣旨	「教材の背景」や「学習する意味」、「児童生徒につけたい力」など授業を計画し行うために前提となる考え方。
単元の目標	シラバスで示された知識理解を中心としたその単元で学習する目標。
指導内容の系統	<ul style="list-style-type: none"> <li>下位学年での既習内容や上位学年へのつながりがわかるように、<b>Human Body, Plants, Energy, Making Work Easier</b> の4系統に分けてシラバスの内容を示している。</li> <li>同系統の既習内容の確認に有用である。</li> <li>本単元が該当する部分については太枠けいで表示。</li> </ul> （注）付属資料 p.15【指導内容の系統】（縦のつながり）と p.30【関連単元の系統と構造】（横のつながり）を参照。
学習を始める前に	学習を始める前の事前情報。児童生徒の実態や準備面での留意点。誤概念、日常生活との関連なども含む。
観点別達成目標	<ul style="list-style-type: none"> <li>「関心・意欲・態度」、「科学的な思考・表現」、「知識・理解、観察・</li> </ul>

	<p>実験の技能」の3観点に分けて表記（現在の日本は、これらから表現と実験の技能の2つをセットで独立させた4観点）。</p> <ul style="list-style-type: none"> <li>ここで示された観点別達成目標は、この後に掲載する【指導計画】の内容欄、【授業案】の教師の指導・助言のポイント欄において、この目標が達成できたかどうかの場面で評価可能かを示している。</li> </ul> <p>（注）ここで示した観点別達成目標について、授業案で示したすべての場面で評価しなければならないというものではなく、評価可能な場面として示している。</p>
単元構成の考え方	指導計画を提案するベースとなる考え。
指導計画	<ul style="list-style-type: none"> <li>単元全体の指導計画。</li> <li>学習単位欄には、小単元名と小単元ごとの配当単位時間（ケニアの実態に合わせて1単位時間＝35分）を示している。</li> <li>内容欄には具体的な活動内容を示し、観点別達成目標について評価可能な場面を（評価／知・技3）のようなスタイルで示している。</li> <li>【授業案】、【小単元の振り返り問題】、【単元末評価問題】を提案している部分は、太枠けいで表示している。</li> </ul> <p>（注）各小単元末には、ここまでの振り返りとして【各小単元の振り返り問題】を行う指導計画にしているが、年間授業時数との関連から配当時間としては確保していない。ゆとりがなければ、家庭学習で行うことを前提としている。</p>
授業案	<ul style="list-style-type: none"> <li>表の一番左の欄には、学習内容を表す言葉（導入、問題、実験、発表）と併せて、目安となる時間を示している（1単位時間＝35分として配分）。</li> <li>学習の流れと活動欄には生徒の活動を示している。</li> <li>教師の指導・助言のポイント欄には、評価可能な観点別達成目標を示している。ワークシートの提案がある場面では、ワークシートが何ページに掲載されているかを示している。</li> </ul>
ワークシート	<ul style="list-style-type: none"> <li>生徒が授業で活用するワークシート。スケッチを書き込むもの、実験のためのものなど、手を使って書き込むことで学習の定着を図る。</li> <li>ページの右上には、指導計画の何時間目で使用するかを示している。</li> </ul> <p>（注）ケニアでは紙媒体にコピーして配布することは困難という意見も聞いている。その場合は、板書例としての活用が考えられる。</p>
小単元の振り返り問題	<ul style="list-style-type: none"> <li>小単元ごとの形成的な評価問題（小テスト）。次の小単元に入る前に、現小単元の基礎的な学習内容の定着を図るためのもの。</li> <li>ページの右上には、指導計画の何時間目で使用するかを示している。</li> </ul> <p>（注）年間授業時数との関連から配当時間としては確保していない。ゆとりがなければ、家庭学習で行うことを前提としている。</p>

<p>単元末評価問題</p>	<ul style="list-style-type: none"> <li>・ 単元全体を網羅する評価問題（練習問題）。</li> <li>・ 単元の最後に理解度を確認するためのもの。</li> <li>・ 卒業認定試験、経済協力開発機構（Organisation for Economic Co-operation and Development: OECD）の生徒の学習到達度調査（Programme for International Student Assessment: PISA）も意識して出題。</li> </ul>
<p>学習についての質問</p>	<ul style="list-style-type: none"> <li>・ 単元末に実施する。</li> <li>・ 学習活動や関心・意欲を問う自己評価問題。</li> <li>・ 全単元共通の内容。</li> </ul>
<p>参考資料</p>	<p>以下の3種類により、構成されている。</p> <ol style="list-style-type: none"> <li>① 授業を進めるうえで参考になる資料。バックボーンとなる知識、実験のポイントなど。</li> <li>② ケニアの教科書に掲載されている評価問題の一例。今回提案した評価問題を補う。</li> <li>③ ケニアの教科書に掲載されている資料の一例。重要な用語の確認と今回提案した参考資料等を補う。</li> </ol>

### 3-3 著作権

この成果品の翻訳または図版の描き起こしを行う場合は、全くのトレースではなく参考として扱うこと。また、今回紹介した図版の中に特殊なものはほとんど含まれず、一般的な理科で使われるものが多いが、一部、ケニア現地の動植物を紹介したものについては、その表現の正確性などは確認できていない点にご留意いただきたい。

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注1. 本研究会で扱う単元は、ケニアの当該学年における全単元の一部である。

注2. 掲載した授業案は、指導計画の一部の学習単位（小単元）のみを対象としている。

注3. 授業案には、2単位時間続きで実施することを想定して作成されているものもある。

注4. SMASE Project Impact Assessment Survey (SPIAS)とは、SMASE プロジェクトが現職教員研修のインパクトを図ることを目的として2004年に開始した調査の名称である。ASEI/PDSIの原則の学校や教室における実践度合いを、学力調査のみならず、生徒、教員、校長といった様々な観点から調査している。本報告書に掲載されているNew SPIASは、執筆者の一人である武村重和氏による、生徒質問紙（Student Competence Index）、学力テスト（Achievement Index）及び理科学習参加指標（Student Participation Index）部分の改善に関する試案である。





## 指導内容の系統

### 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, good 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
- ◇ Discolouration 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

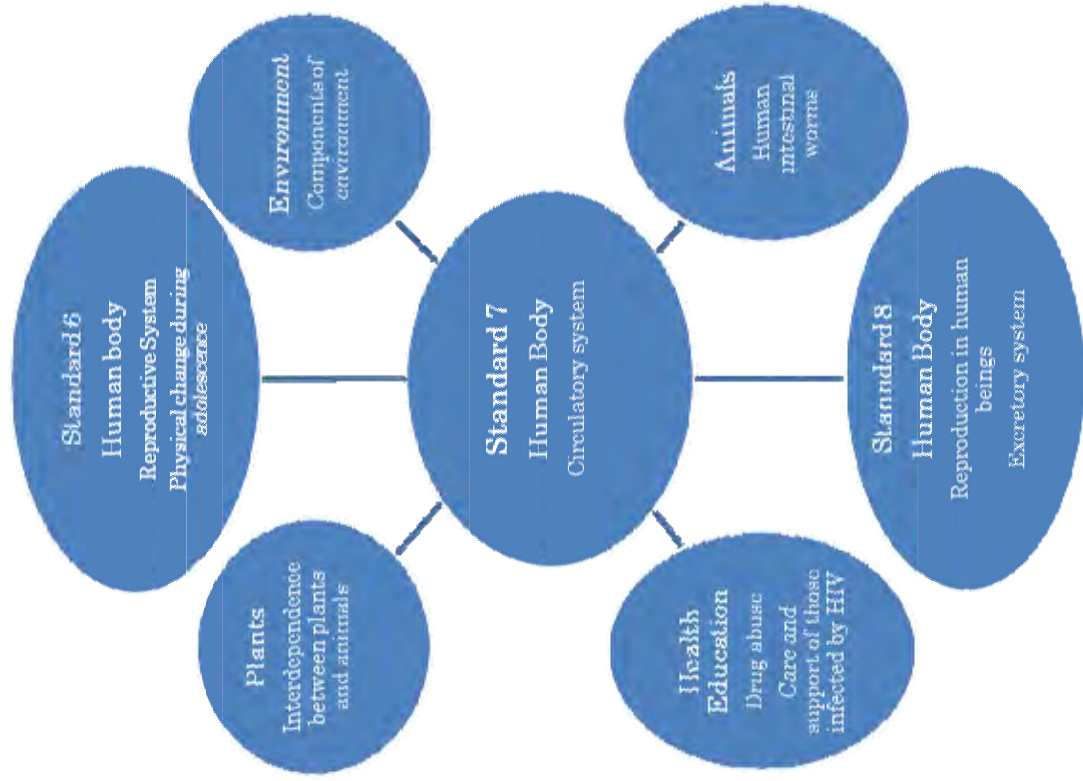
By the end of this subtopic, the learner should be able to:

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;

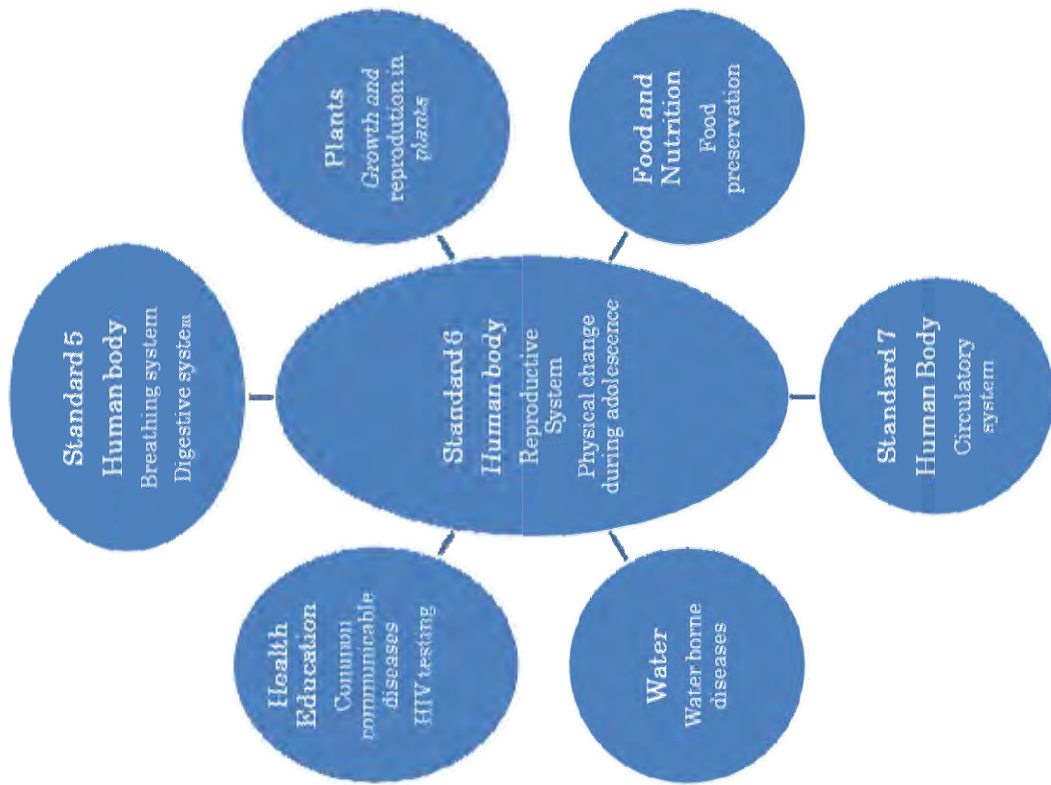
- ✧ Using energy sparingly
- ✧ Using energy efficient devices
- ✧ Using renewable energy (wind, sun, biogas, planting trees)

Standard 7; Human Body



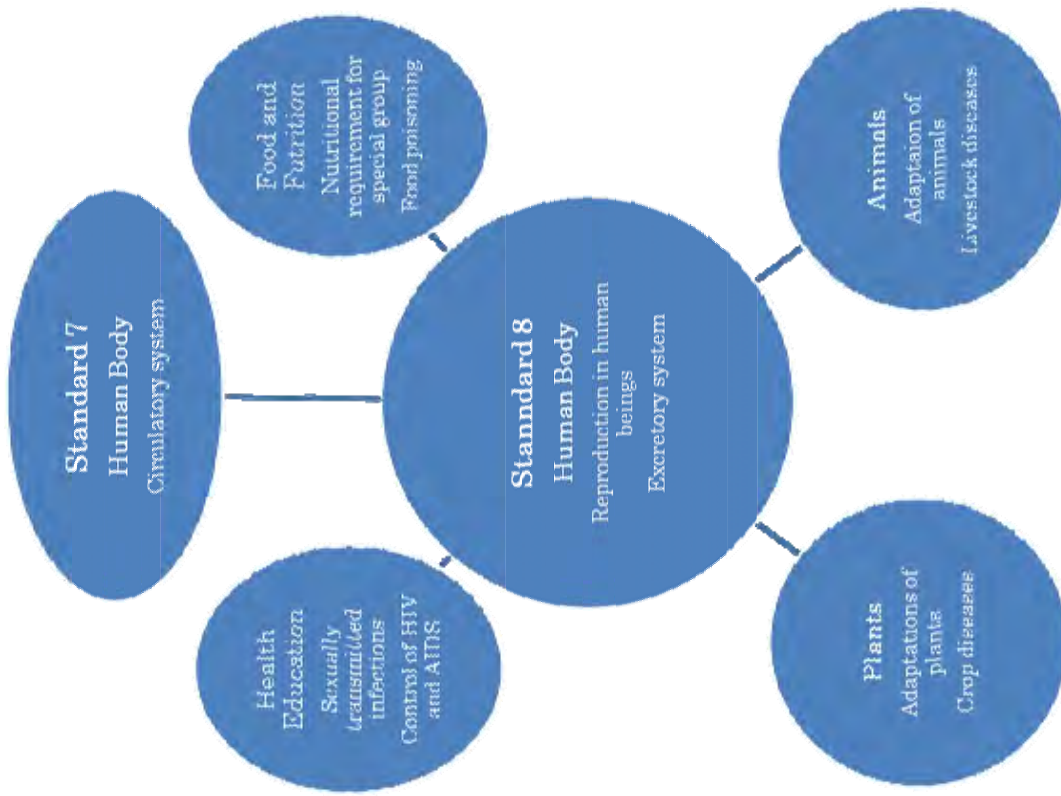
関連単元の系統と構造

Standard 6; Human Body

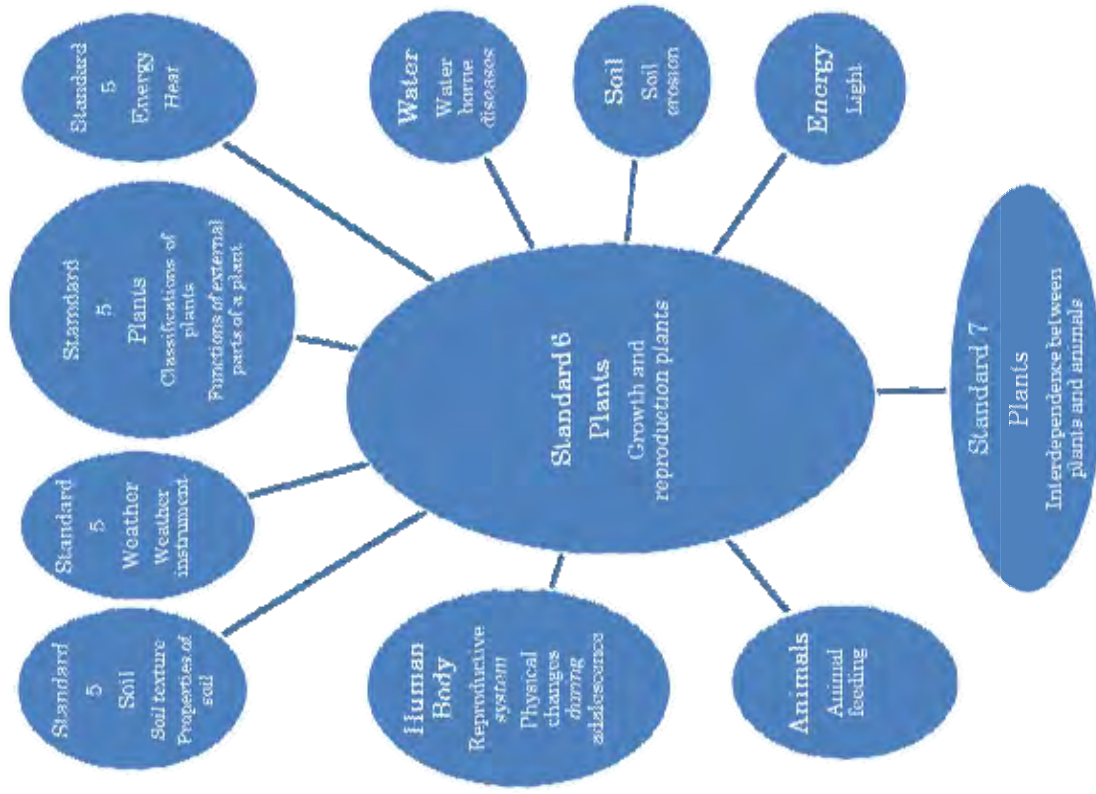




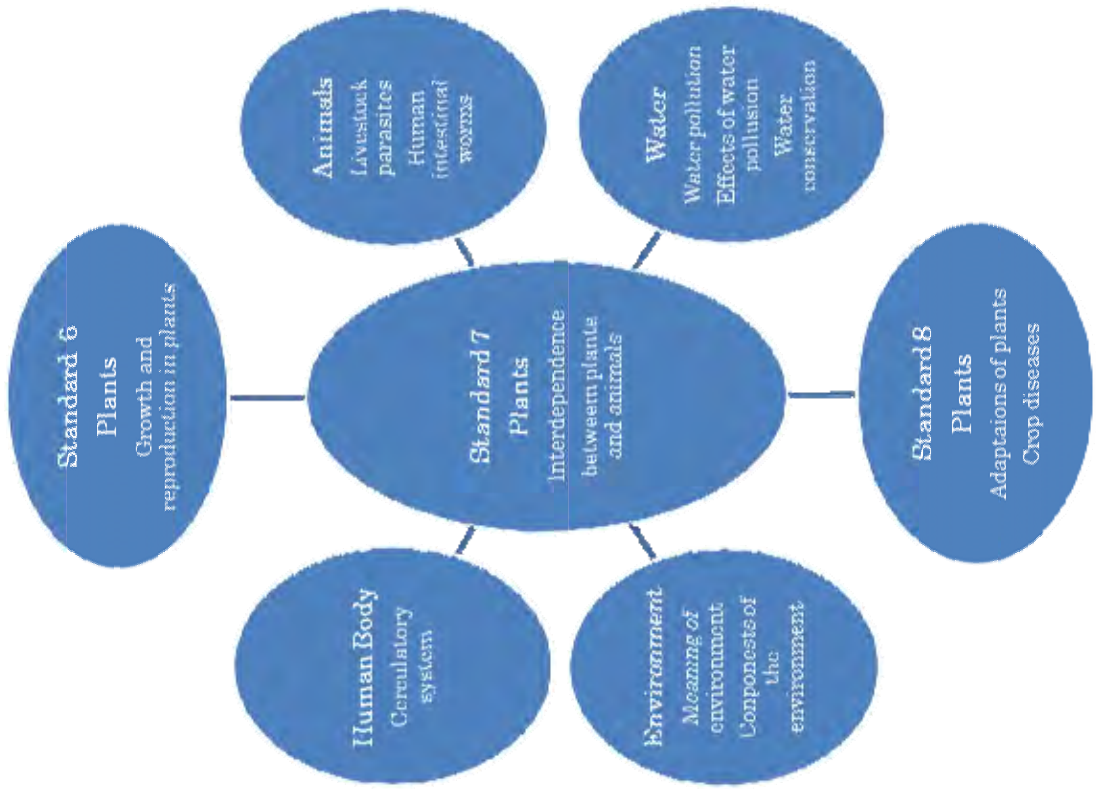
### Standard 8; Human body



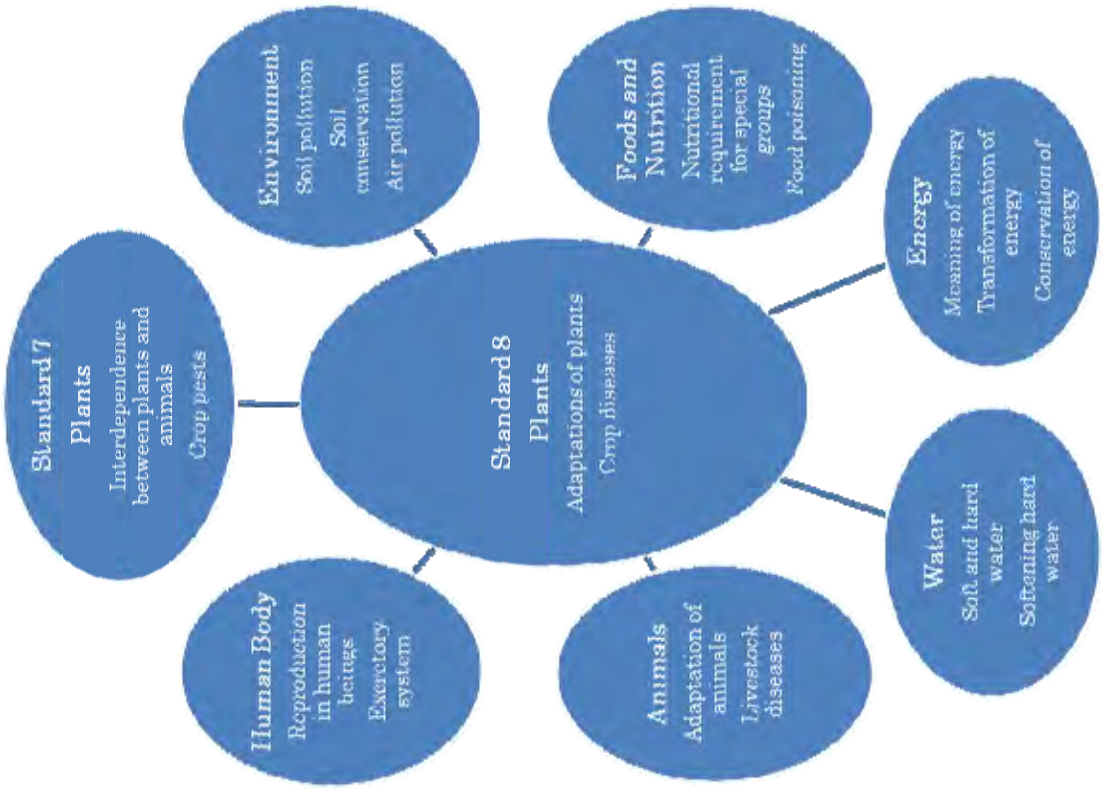
### Standard 6; Plants



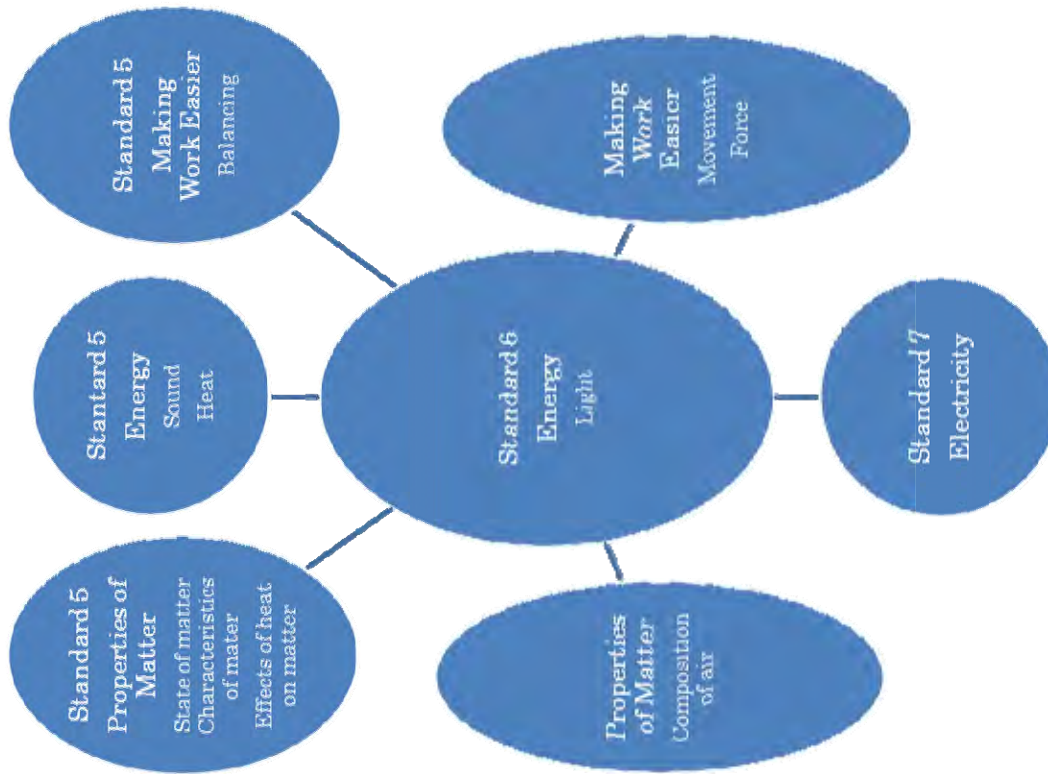
### Standard 7; Plants



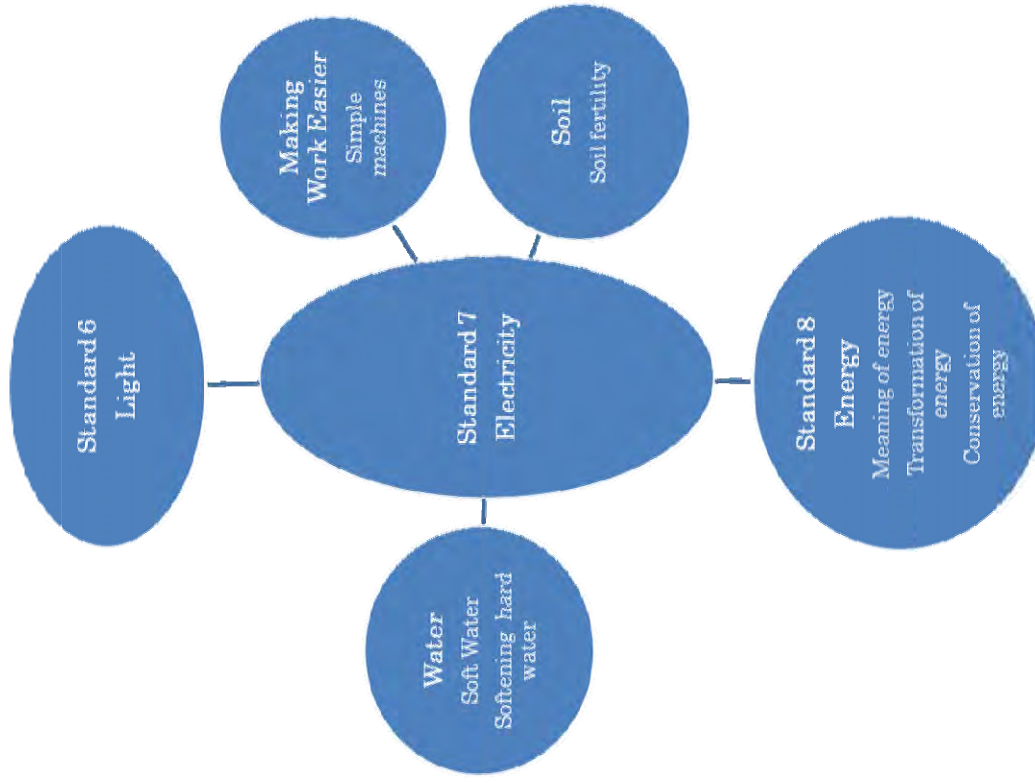
### Standard 8; Plants



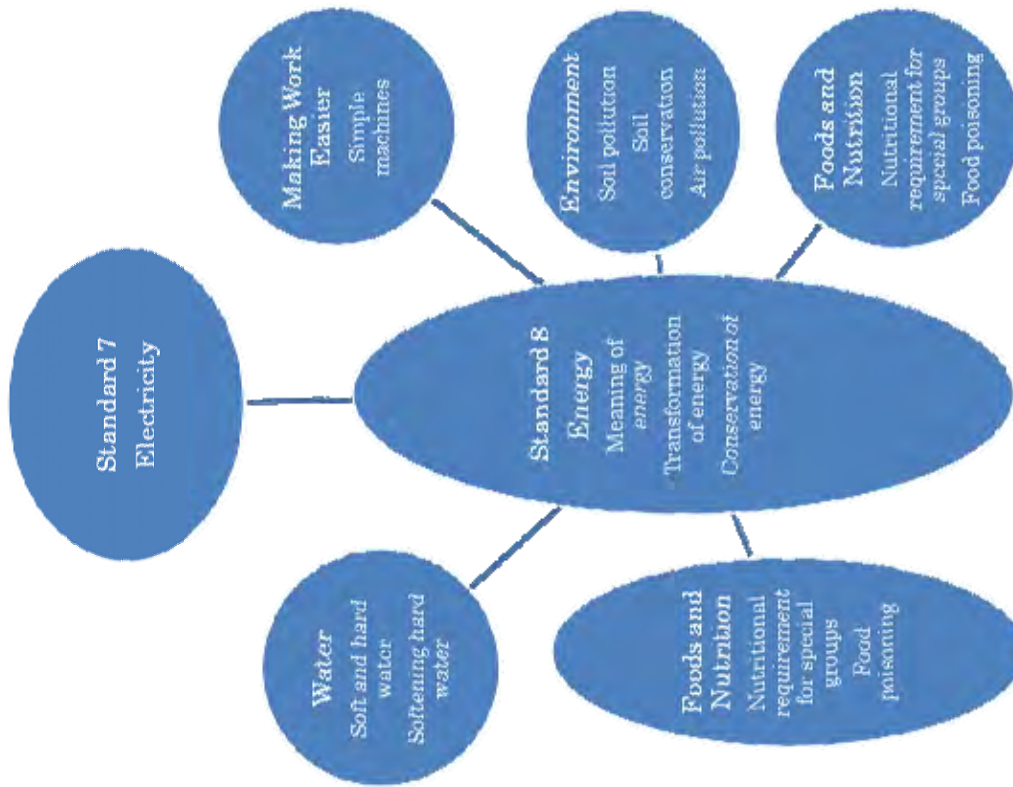
### Standard 6; Energy



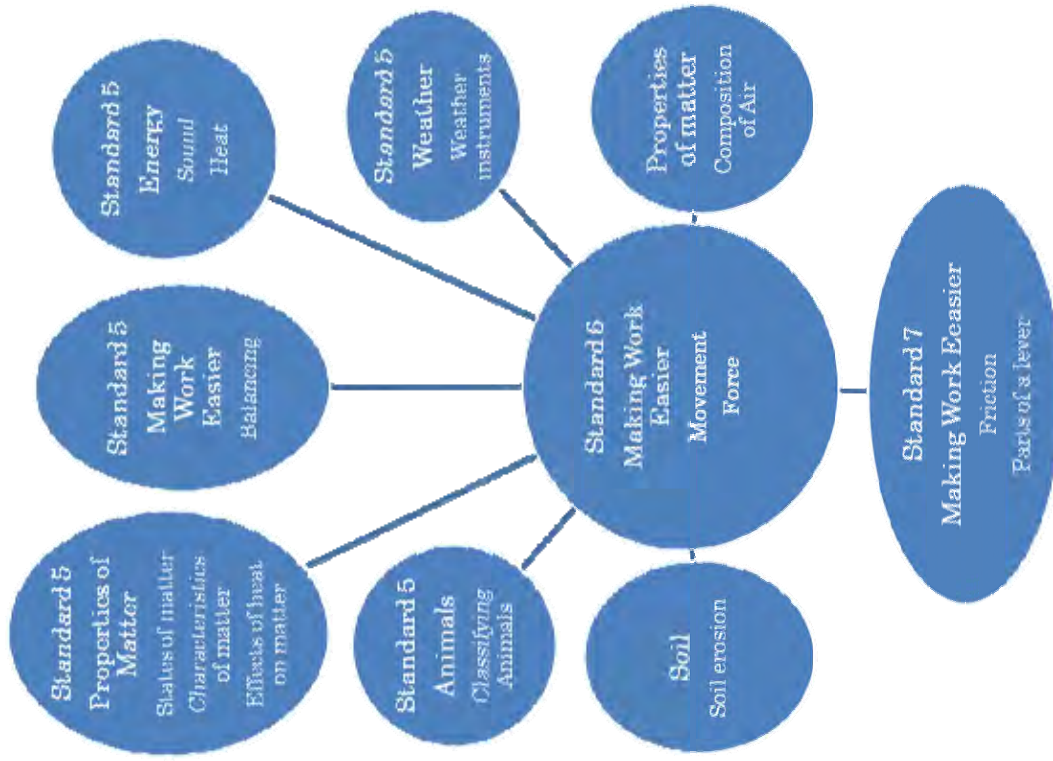
### Standard 7; Energy



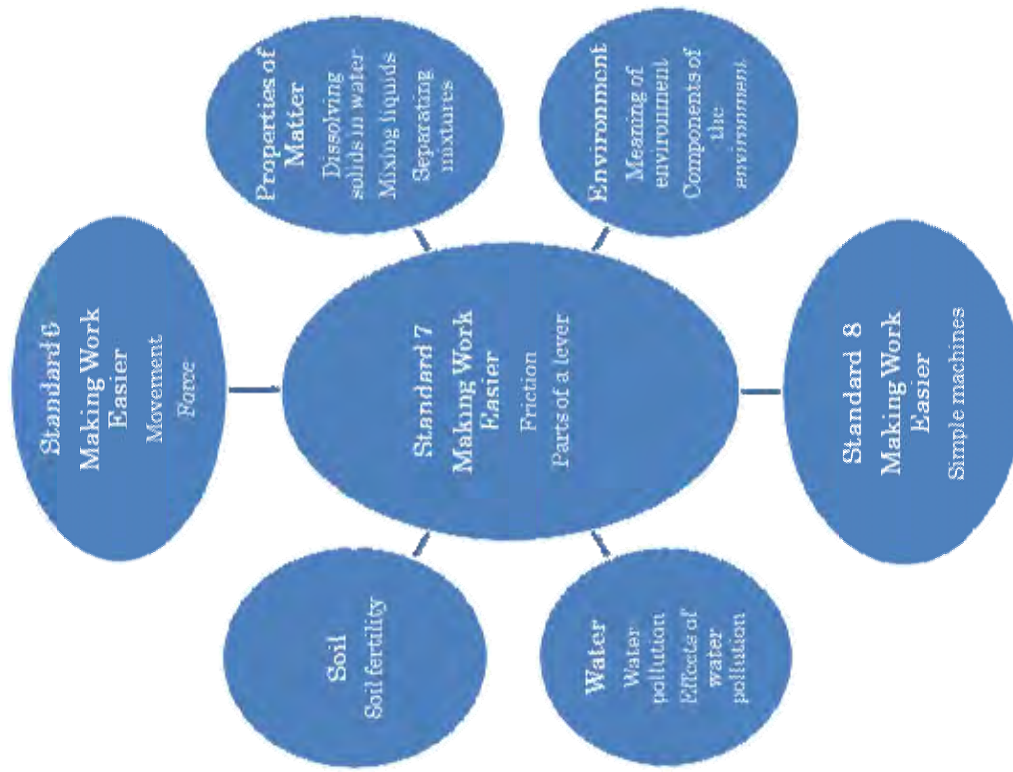
## Standard 8; Energy



## Standard 6; Making Work Easier



### Standard 7; Making Work Easier



### Standard 8; Making Work Easier

