EXERCISE AND SPORTS SCIENCE

Upper Secondary

G3

Implementation starting with
2024 Secondary Three Cohort

Ministry of Education
SINGAPORE

CONTENTS

1. INTRODUCTION

Curriculum Concept

Through the study of Exercise and Sports Science (ESS), students are grounded in the sub-disciplines of sports science with an understanding of sociology in relation to sports. They develop **disciplinary thinking and practices** of the subject and **interdisciplinary understanding**[1] to problem-solve and evaluate performance for improvement in different practical settings. They also adopt a balanced view in examining issues influencing sports and participation in physical exercise.

In ESS, movement is the focal point for performance, analysis and critique. Students understand the relationships amongst the sub-disciplines of sports science and how systems within these sub-disciplines interact to influence how the human body moves in relation to each other and in different contexts. Movement contexts exist in specific exercises and sports, which in turn, manifest themselves in why and how people exercise and participate in sports in society, as influenced by socio-cultural factors such as ethics, equity and commercialisation.

> **Movement.** The sub-disciplines of sports science are inter-related, and they influence how the human body moves in different contexts. A multi-faceted perspective is needed to analyse performance holistically and modify movement for improvement. Socio-cultural factors have an influence on people moving, exercising and staying active, thus shaping the movement culture of a society.
>
> **Systems and interactions.** The human body is a complex system of many interacting parts and the various systems in the human body interact with each other to create movement. It is of essence to be cognisant of the role of each sub-discipline of sports science and how they interact with one another within a system to influence movement. A society is a system of inter-related parts and is greatly shaped by the interaction of the socio-cultural factors of ethics, equity and commercialisation. It is the interaction of these factors that will continue to shape how people move, exercise and participate in sports.

As students make sense of their acquired knowledge in the areas of study (i.e., Exercise Physiology, Motor Learning and Development, Biomechanics, Sports Psychology, and Sports Sociology), they apply their learning in the performance of physical activities, analysis of performance, and critique of issues in exercise and sports from socio-cultural and global perspectives. These reinforce students' learning and thus deepen their understanding of the acquired knowledge and skills in the respective areas of study.

The curriculum concept for ESS is diagrammatically illustrated in Figure 1.

[1] Interdisciplinary understanding is the capacity to integrate knowledge and modes of thinking drawn from two or more disciplines to produce a cognitive advancement, for example, explaining a phenomenon, solving a problem, creating a product, or raising a new question in ways that would have been unlikely through single disciplinary means (Mansilla, 2005).

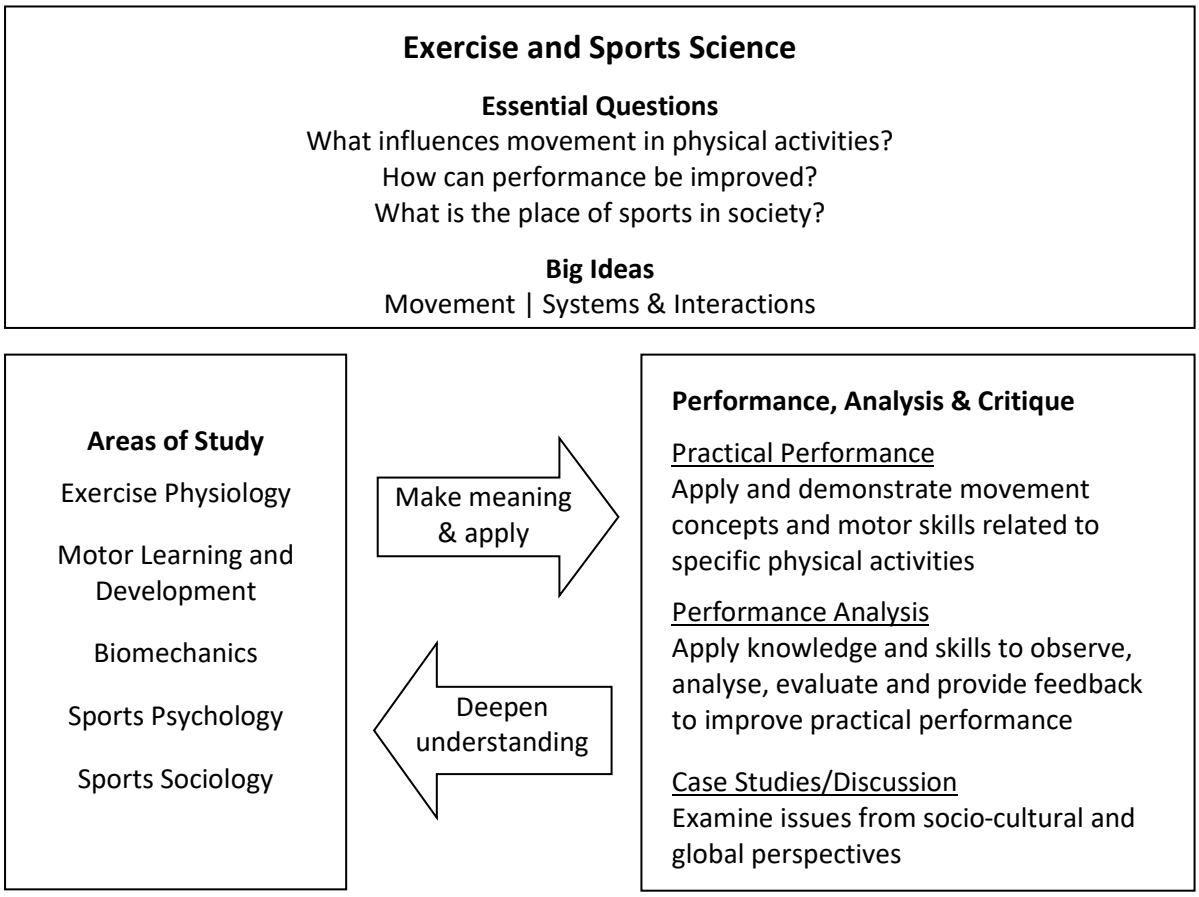

Figure 1. O-Level Exercise and Sports Science Curriculum Framework

SYLLABUS AIMS

The aims of the syllabus are for students to:

a. apply the knowledge and skills in exercise physiology, biomechanics, and sports psychology to observe, analyse, evaluate and improve practical performances in exercise and sports;
b. develop the movement concepts and motor skills to be proficient in the performance of an individual/dual[2] sport and team sport;
c. understand the benefits and risks associated with exercise and sports to manage personal participation in them; and
d. examine issues related to sports and participation in physical activity from socio-cultural and global perspectives.

Key Understandings

The syllabus intends for students to understand that:

a. the sub-disciplines of sports science are inter-related and will influence how the human body moves in different contexts;
b. a multi-faceted perspective is needed to analyse performance holistically for improvement; and

[2] Dual sports activities refer to sports that one can do with a partner such as badminton, tennis and fencing.

c. socio-cultural factors have an influence on people moving, exercising and participating in physical activities.

Knowledge

The syllabus intends for students to know:

a. the various systems such as musculoskeletal system and cardiorespiratory system, and the short-term effects and long-term adaptions of training;
b. the factors influencing motor learning and development, the information processing model, and movement concepts;
c. how natural laws and forces affect the body and objects in sports movement and performance;
d. the concepts of motivation, arousal, anxiety and goal setting, and their impact on performance; and
e. the issues pertaining to ethics, equity and commercialisation.

Skills

The syllabus intends for students to:

a. apply the performance analysis process to improve performance in exercise and sports;
b. apply sports science concepts and principles to create a training programme;
c. apply risk assessment to manage personal participation in exercise and sports;
d. apply movement concepts and motor skills in exercise and sports;
e. examine critically issues related to sports and participation in physical activity from socio-cultural and global perspectives;
f. communicate ideas and beliefs while discussing issues regarding ethics, equity and commercialisation in sports; and
g. analyse and interpret data on issues related to sports and participation in physical activity to make valid inferences.

Desired Student Outcomes

The ESS students:

a. are knowledgeable in the sub-disciplines of sports science. They are able to adopt an interdisciplinary approach to problem-solve practical situations related to exercise and sports. Through the study of the subject, they develop the analytical skills to observe, analyse and evaluate practical performance for improvement.
b. adopt a critical perspective when looking at issues related to sports in Singapore and the world. Through the study, they deepen their understanding of the factors influencing exercise and sports; and develop greater sensitivity and critical thinking when examining issues.
c. are competent and confident to participate in at least an individual/dual sport and a team sport safely. Through the study, they develop the knowledge and skills in these sports and participate in them for recreation, health, and personal challenge and achievement.

They will have a strong foundation to continue in areas of studies directly related to exercise, sports, health and wellness at post-secondary education institutes. Through the course of study, they will also develop the relevant 21st Century Competencies, allowing them to be well-prepared to pursue other fields beyond exercise and sports science at the post-secondary level.

21ST CENTURY COMPETENCIES

The Framework for 21st Century Competencies and Student Outcomes ("21CC Framework") shows how Core Values, Social-Emotional Competencies and Emerging 21st Century Competencies support the realisation of MOE's Desired Outcomes of Education. Refer to Figure 2.

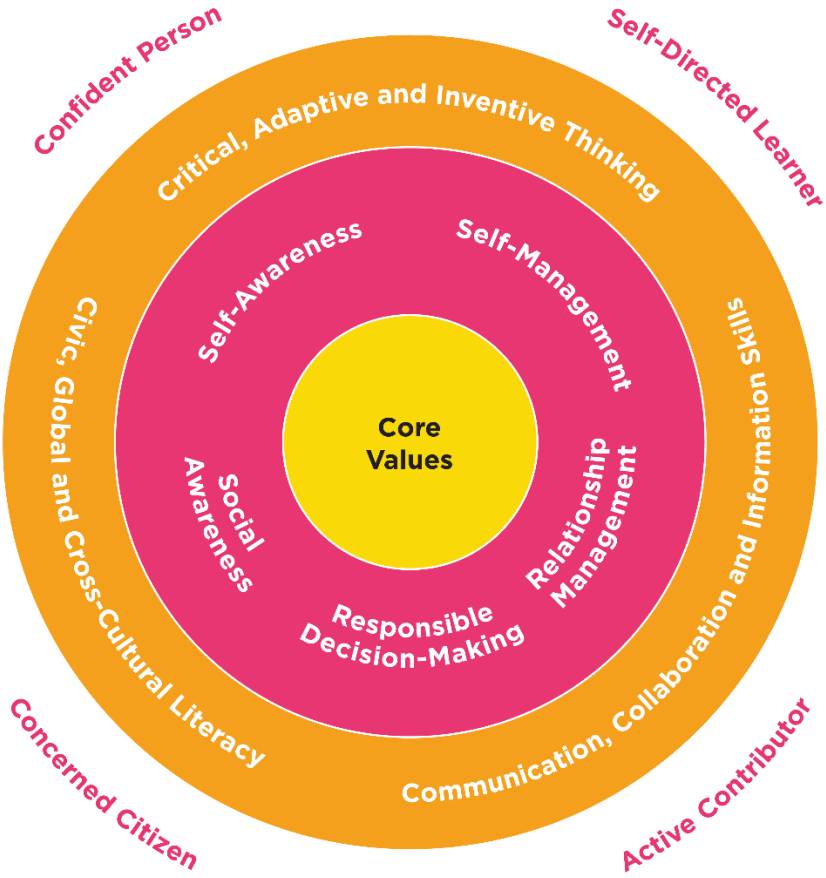

Figure 2. Framework for 21st Century Competencies and Student Outcomes

As values form the core of one's character, they are positioned at the centre of the framework. Social-Emotional Competencies, shown as an inner ring around the Core Values, are necessary for students to enact their values purposefully and demonstrate good character in all contexts of life. Building on a sound character foundation, the outer ring of Emerging 21CC enables students to thrive in and beyond school while living, learning and working in rapidly changing, highly digitalised and interconnected environments.

The development of Core Values, Social-Emotional Competencies and Emerging 21CC are complementary and mutually reinforce one another. Therefore, the holistic development of 21CC involves intentional teaching and reinforcing of knowledge, skills, dispositions and values from the core and both rings collectively. They should be developed through the total curriculum, which includes all student learning experiences delivered within and outside the structured timetable. These values and competencies will help our students live out the Desired Outcomes of Education.

As part of the total curriculum, ESS provides a platform for students to develop or reinforce these competencies, with a particular focus on Critical, Adaptive and Inventive Thinking (CAIT), as well as Communication, Collaboration and Information Skills (CCI). The learning experiences that facilitate the development of these competencies, aligned with the ESS learning outcomes has to be intentionally and meaningfully designed and enacted. Table 1 below illustrates how the ESS skills outcomes are aligned with the Learning Goals and Developmental Milestones for Emerging 21CC.

<table>
<tr><th>O-Level ESS Skills Outcomes</th><th>Emerging 21CC:
Learning Goals & Developmental Milestones</th></tr>
<tr><td>

- Examine critically issues related to sports and participation in physical activity from socio-cultural and global perspectives

</td><td>

Critical Thinking

CAIT 1: Exercises sound reasoning and decision-making

<table>
<tr><th>Lower Sec</th><th>Upper Sec to Pre-University</th></tr>
<tr><td>1.3 The student can use evidence and adopt different viewpoints to explain their reasoning and decisions.</td><td>1.4 The student can use evidence and adopt different viewpoints to explain their reasoning and decisions, having considered the implications of the relationship among different viewpoints.</td></tr>
</table>

</td></tr>
<tr><td>

- Apply the performance analysis process to improve performance in exercise and sports
- Apply sports science concepts and principles to create a training programme
- Apply risk assessment to manage personal participation in exercise and sports
- Analyse and interpret data on issues related to sports and participation in physical activity to make valid inferences

</td><td>

Adaptive & Inventive Thinking

CIAT 3: Assesses different contexts and situations in order to make connections and draw new insights

<table>
<tr><th>Lower Sec</th><th>Upper Sec to Pre-University</th></tr>
<tr><td>3.3 The student can understand the similarities and differences between different contexts or situations and how this might affect their perspective or approach.</td><td>3.4 The student can draw on the similarities and differences between different contexts or situations to extract new insights to inform their perspective or approach.</td></tr>
</table>

CAIT 5: Explores possibilities and generates novel and useful ideas

<table>
<tr><th>Lower Sec</th><th>Upper Sec to Pre-University</th></tr>
<tr><td>5.3 The student can generate ideas that may involve modifying existing ones and explore different pathways that are appropriate to respond to an issue or challenge.</td><td>5.4 The student can generate ideas that are unique or modified substantially from existing ones and explore different pathways that lead to solutions.</td></tr>
</table>

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<table>
<tr><th>O-Level ESS Skills Outcomes</th><th>Emerging 21CC:
Learning Goals & Developmental Milestones</th></tr>
<tr><td></td><td>CAIT 6: Evaluates and refines ideas to formulate novel and useful solutions<table><tr><th>Lower Sec</th><th>Upper Sec to Pre-University</th></tr><tr><td>6.3 The student can evaluate and refine their ideas using relevant strategies and based on a set of criteria that is appropriate for the task or context.</td><td>6.4 The student can evaluate and refine their ideas iteratively, using relevant strategies and based on a set of criteria that is appropriate for the task or context.</td></tr></table></td></tr>
<tr><td>• Communicate ideas and beliefs while discussing issues regarding ethics, equity and commercialisation in sports</td><td>Communication

CCI 2: Engages empathetically with diverse perspectives<table><tr><th>Lower Sec</th><th>Upper Sec to Pre-University</th></tr><tr><td>2.3 The student can respond with respect and empathy. The student is sensitive to the diverse backgrounds that influence different perspectives while interacting with others.</td><td>2.4 The student can respond with respect and empathy. The student is sensitive to the diverse backgrounds that influence the context of communication with others.</td></tr></table></td></tr>
<tr><td>• Apply movement concepts and skills in exercise and sports (in team practical activity)</td><td>Collaboration

CCI 4: Collectively defines and negotiates the roles and tasks determined by the group to achieve its goals<table><tr><th>Lower Sec</th><th>Upper Sec to Pre-University</th></tr><tr><td>4.3 The student can determine and effectively assume the role they will play by considering the dynamics of the group.</td><td>4.4 The student can reflect on their working relationships with the group and adapt to contribute to the shared goals, as determined collectively by its members.</td></tr></table></td></tr>
</table>

Table 1. Alignment with Learning Goals for Emerging 21CC

With reference to Table 1, teachers can design ESS learning experiences accordingly, selecting appropriate content, pedagogy and assessment practices to attain the ESS learning outcomes, as well as reinforce or grow students' competency over time.

2. LEARNING CONTENT

Overview

Areas of Study

The Physical Education curriculum lays a strong foundation for the study of Exercise and Sports Science (ESS). By highlighting the significance of movement and an individual's interaction with the environment, Physical Education aims to develop the whole child to bring about a nation of physically competent and confident individuals who enjoy a lifetime of active and healthy living safely and responsibly. ESS builds upon the knowledge, understanding, skills, practices and values acquired from Physical Education to provide breadth and depth to the study of exercise and sports through the areas of exercise physiology, biomechanics, motor learning and development, sports psychology, and sports sociology.

To facilitate the teaching and learning of each area of study, Key Understandings (KUs) are articulated to highlight key concepts and connections among them. Essential Questions, distilled from the KUs, serve as triggers to facilitate the process of teaching and learning in the respective areas of study.

Exercise Physiology is a study of how the human body works to produce movement. Students will learn about the musculoskeletal and cardiorespiratory systems, and the effects of exercise on the structure and functions of the human body. They will apply training principles through manipulating the variables of training methods to allow their body to train, perform and recover better.

Motor Learning and Development is a study of how motor skills are acquired and refined through practice and feedback. Students will understand the individual and environmental factors affecting performance in exercise and sports. They will apply their understanding to refine their movement concepts and motor skills.

Biomechanics is a study of how natural laws and forces affect the body and objects in sports movement and performance. Students will understand the mechanical cause-effect relationships that determine human movement and apply biomechanical principles such as stability, summation of force and projectile motion in physical activities to improve movement.

Sports Psychology is a study of how psychological factors of motivation, arousal and anxiety affect performance. Students will understand how mental preparation for performance can be just as critical as physical preparation and learn how to apply the goal-setting principles and coping strategies in moderating these factors for optimal performance.

Sports Sociology is a study of how socio-cultural issues influence why and how people exercise and participate in sports. Students will critically examine sports participation

from both global and local perspectives, particularly in relation to issues such as ethics, equity and commercialisation.

To enable students to construct meaning (i.e., to come to an understanding) of important ideas and processes, they will need to first acquire factual information and basic skills as outlined in the knowledge and skills segments for each area of study. The learning outcomes specify minimally what ESS students should know and be able to do for each area of study. They serve to guide the development of unit and lesson planning, and the conduct of the lessons.

Application in Authentic Context

The five areas of study in ESS are inter-related and influence how the human body moves in different contexts. While each area of study affords opportunities for students to acquire the knowledge, understanding and skills within the specific sub-disciplines in exercise and sports sciences, applying them holistically in practice to understand, analyse and appreciate human movement is essential. By engaging in physical activities and performance analysis, students can draw upon the knowledge, understanding and skills learnt across the different areas of study and apply them to improve performance. This integrated approach enables students to develop a holistic understanding of human movement and its underlying concepts.

Physical Activities. Students are guided to develop the activity-specific movement concepts and motor skills to be competent in the performance of an individual/dual physical activity and a team physical activity. They will perform these skills with precision, control and fluency. They will apply these skills and movement concepts in authentic performance situations safely. In developing their competency to perform the physical activities, students will also apply the sports science concepts learnt to improve their performance.

Performance Analysis. Guided by the performance analysis process (refer to Figure 3), students will observe, analyse and evaluate their individual performance and develop an action plan to improve the quality and effectiveness of their performance in areas such as physical fitness, tactical awareness and decision-making, and technical skills. Through authentic application of the learning content, students will critically analyse movement (e.g., by applying knowledge of biomechanical principles) and improve their own performance by manipulating inter-related variables (e.g., training principles) that influence movement.

The process provides the affordance for students to reinforce their data management skills such as collecting, analysing, interpreting and presenting data. Technology (e.g., apps and video editing software) can be leveraged to support the performance analysis. Hence, students will be able to strengthen their digital competency such as keeping up to date with technological development, using digital resources and managing data in meaningful ways.

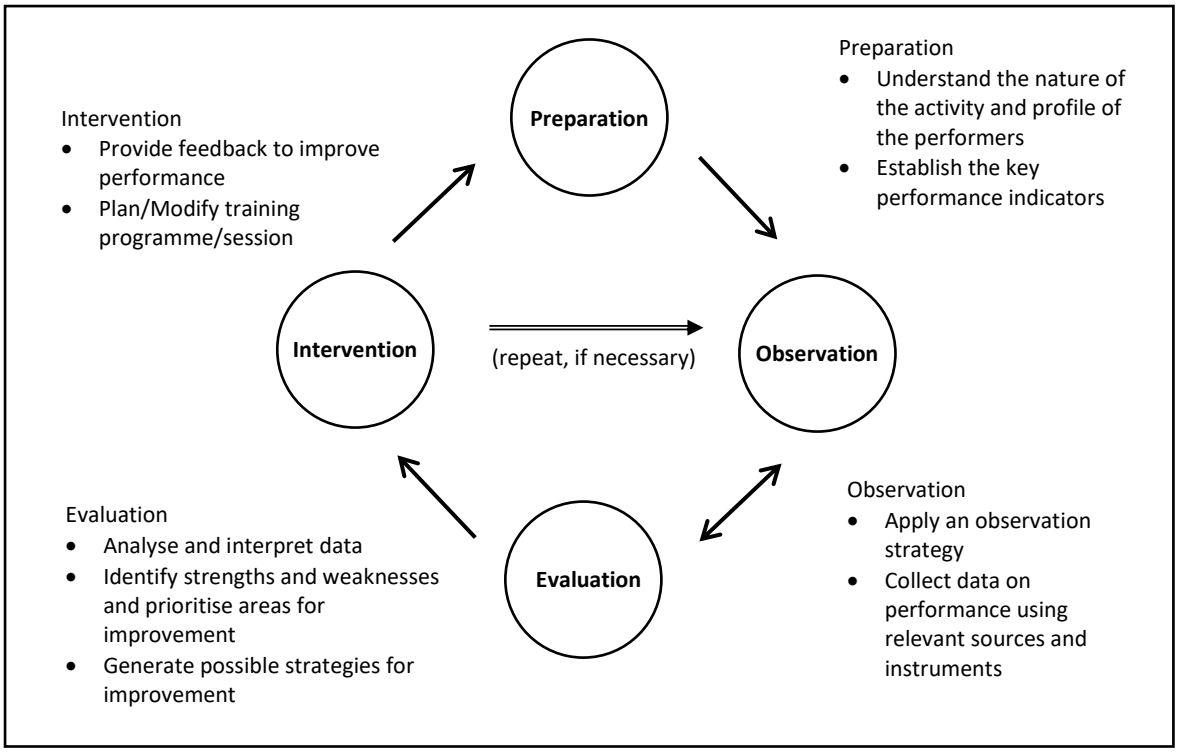

Figure 3. Performance Analysis Process

EXERCISE PHYSIOLOGY

<table>
<tr><th colspan="2">Overview</th></tr>
<tr><td colspan="2">Exercise Physiology is a study of how the human body works to produce movement. Students will learn about the musculoskeletal and cardiorespiratory systems, and the effects of exercise on the structure and functions of the human body. They will apply training principles through manipulating the variables of training methods to allow their body to train, perform and recover better.</td></tr>
<tr><th>Key Understandings</th><th>Essential Questions</th></tr>
<tr><td>Students will understand that:
the musculoskeletal and cardiorespiratory systems interact to influence movement, and are affected when exposed to short and long-term bouts of physical activity; and
application of training principles through manipulating variables of training methods can lead to improved performance.</td><td>How does the human body move?
What are the effects of physical activity on the human body?
How can the human body's systems become more efficient?</td></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Students will know:
the major bones and joints in the body and their functions;
the type and characteristics of muscles and how muscles work with the skeletal system to enable movement;
the components and functions of the circulatory and respiratory systems and how they work together to influence movement;
the different energy systems in the human body and their functions;
the short-term effects and long-term adaptations of physical activity on the human body;
the different types of sports injuries; and
the training principles and methods to design an effective training programme.</td><td>Students will be able to:
explain how the human body systems interact to influence movement;
evaluate the energy systems needed for different physical activities;
design a training programme to improve performance through the application of training principles and methods;
identify hazards, assess risks and adopt control measures to manage personal participation in exercise and sports; and
analyse and interpret data in relation to exercise and training.</td></tr>
</table>

Topic	Learning Outcomes Students will be able to:

Skeletal System	• Describe the functions of the skeletal system
	  ○ shape and support
	  ○ protection
	  ○ muscle attachment for movement
	  ○ blood cell production
	
	• Describe the types of bones and their functions
	  ○ long
	  ○ short
	  ○ flat
	  ○ irregular
	
	• Identify the major bones and classify them into the different types of bones
	  ○ cranium
	  ○ clavicle
	  ○ scapula
	  ○ sternum
	  ○ humerus
	  ○ radius
	  ○ ulna
	  ○ carpals
	  ○ metacarpals
	  ○ phalanges
	  ○ ribs
	  ○ vertebrae
	  ○ pelvis
	  ○ femur
	  ○ patella
	  ○ tibia
	  ○ fibula
	  ○ tarsals
	  ○ metatarsals
	
	• Describe the types of joints
	  ○ immovable joints
	  ○ slightly movable joints
	  ○ freely movable joints
	
	• Describe components of a freely movable joint
	  ○ joint capsule
	  ○ synovial membrane
	  ○ synovial fluid
	  ○ cartilage
	  ○ ligaments

Topic	Learning Outcomes Students will be able to:

	• Describe the types of freely moveable joint and their types of movement
	  ○ ball and socket
	  ○ hinge
	  ○ pivot
	  ○ gliding
	
	• Describe how the following types of movement are linked to the appropriate joint type
	  ○ flexion/extension
	  ○ abduction/adduction
	  ○ rotation
	  ○ circumduction
	
	• Identify the planes and axes of the human body in relation to the types of movement

Muscular System	• Describe the characteristics of the types of muscles
	  ○ visceral muscles (also known as smooth muscles)
	  ○ cardiac muscles
	  ○ skeletal muscles
	
	• Describe the functions of the major muscle groups
	  ○ trapezius
	  ○ latissimus dorsi
	  ○ pectoralis major
	  ○ deltoid
	  ○ biceps brachii
	  ○ triceps brachii
	  ○ abdominals
	  ○ obliques
	  ○ gluteus maximus
	  ○ quadriceps
	  ○ hamstrings
	  ○ gastrocnemius
	
	• Explain how muscles work together
	  ○ action of agonists (prime movers) and antagonists
	  ○ isotonic (concentric/eccentric) and isometric contractions
	
	• Explain how the skeletal and muscular systems (i.e., musculoskeletal system) work together to enable movement during exercise and sports

Topic	Learning Outcomes Students will be able to:

Circulatory System	• Describe the components and functions of the circulatory system
	  ○ blood vessels
	  ○ heart
	  ○ blood
	
	• Describe the pathway of blood through the heart and the rest of the body
	  ○ atria
	  ○ ventricles
	  ○ valves
	  ○ major blood vessels
	  - aorta
	  - pulmonary artery
	  - vena cava
	  - pulmonary vein
	
	• Explain the relationship between cardiac output, heart rate and stroke volume at rest and during exercise
	  ○ including interpreting graphical representations of the relationship

Respiratory System	• Describe the components and functions of the respiratory system
	
	• Describe the pathway of air through the respiratory system
	  ○ mouth/nose
	  ○ trachea
	  ○ bronchi
	  ○ bronchioles
	  ○ lungs
	  ○ alveoli
	
	• Describe the process of inhaling (at rest) and exhaling (at rest) with reference to the roles of the following
	  ○ intercostals muscles
	  ○ rib cage
	  ○ diaphragm
	
	• Explain the lung volume and capacity
	  ○ tidal volume
	  ○ respiratory rate
	  ○ minute ventilation
	  ○ vital capacity
	  ○ total lung capacity

Topic	Learning Outcomes Students will be able to:
	• Explain how the circulatory and respiratory systems (i.e., cardiorespiratory system) work together to influence movement during exercise and sports

Energy Systems	• Explain how energy can be released for muscle contraction
	  ○ aerobic respiratory
	  - glucose + oxygen → energy + carbon dioxide + water
	  ○ anaerobic respiratory
	  - glucose → energy + lactic acid
	
	• Explain the role of macronutrients as energy sources for aerobic and anaerobic exercises
	  ○ carbohydrates
	  ○ fats
	  ○ protein
	
	• Evaluate the relative contributions of the energy systems during aerobic and anaerobic exercise, including interpreting graphical representation of the relative contributions of the energy system
	  ○ aerobic energy system
	  ○ anaerobic energy system
	  - lactic acid system
	  - creatine phosphate system
	
	• Apply the understanding of training zones to improve the energy systems for performance in exercise and sports
	  ○ including interpreting graphical representations of training zones

Training Principles and Methods	• Define the components of fitness
	  ○ health-related fitness
	  - body composition
	  - cardiorespiratory endurance
	  - flexibility
	  - muscular endurance
	  - muscular strength
	  ○ skill-related fitness
	  - agility
	  - balance
	  - coordination
	  - power
	  - reaction time
	  - speed

Topic	Learning Outcomes Students will be able to:

	• Explain the importance of each component of fitness for different exercises and sports
	
	• Apply the principles of training to manipulate the training variables in developing a training programme
	  ○ principles of training (SPORI)
	  - specificity
	  - progressive
	  - overload
	  - reversibility
	  - individuality
	  ○ training variables (FITT)
	  - frequency
	  - intensity
	  - time
	  - type
	
	• Apply the methods of training to improve the components of fitness and the energy systems involved in exercise and sports
	  ○ circuit training
	  ○ continuous training
	  ○ cross training
	  ○ fartlek training
	  ○ interval training
	  ○ plyometric training
	  ○ resistance training

Fitness Testing	• Explain the rationale and limitations of fitness testing • Identify tests to measure each component of fitness with justification • Analyse, using fitness tests, an individual's physical performance in exercise and sports ○ including interpreting test results against normative data

Effects of Exercise on the Body	• Explain the short-term effects of exercise on the musculoskeletal and cardiorespiratory systems
	  ○ heart rate, stroke volume and cardiac output
	  ○ tidal volume, respiratory rate and minute ventilation
	  ○ Delayed Onset Muscle Soreness (DOMS)
	
	• Explain the long-term adaptations of the musculoskeletal and cardiorespiratory systems to aerobic and anaerobic exercises
	  ○ size and strength of heart

Topic	Learning Outcomes Students will be able to:
	- resting heart rate and stroke volume o capillarisation of lungs and muscles o strength of the respiratory muscles (intercostals and diaphragm) - vital capacity o muscles, tendons and ligaments o bone density
Injury and Prevention	• Describe the common injuries sustained at joints and muscles and their associated causes o dislocation o sprain o torn cartilage o strain • Apply risk assessment and management in exercise and sports o hazard identification o risk evaluation o risk control • State the importance of warm-up and cool-down activities in exercise and sports • Describe the importance of hydration before, during and after exercise and sports

MOTOR LEARNING AND DEVELOPMENT

Overview	
Motor learning and development is a study of how motor skills are acquired and refined through practice and feedback. Students will understand the individual and environmental factors affecting performance in exercise and sports. They will apply their understanding to refine their movement concepts and motor skills.	
Key Understandings	**Essential Questions**
Students will understand that: • motor learning and development are influenced by various factors which would impact the performance of motor skills.	• How does an individual develop a motor skill in sports?
Knowledge	**Skills**
Students will know: • the different classifications of skills; • factors affecting motor learning and development; and • the movement concepts and motor skills.	Students will be able to: • apply the games-related concepts in sports; and • analyse and interpret data of tactical performance in sports.

Topic	Learning Outcomes *Students will be able to:*
Classification of Skills	• Classify the skills in sports with justification o basic and complex o fine and gross o open and closed
Factors affecting Motor Learning and Development	• Explain the factors affecting motor learning and development in relation to the o individual o task o environment
Information Processing Model	• Describe how an individual processes information in exercise and sports o input stage o decision-making stage o output stage o feedback stage • Compare the differences between the performance of a novice and an expert, in relation to the stages of the Information Processing Model
Feedback	• Explain the types of feedback and their application in motor learning o intrinsic feedback o extrinsic feedback - knowledge of performance - knowledge of results
Movement Concepts and Motor Skills Framework	• Apply the movement concepts and motor skills, using the Movement Concepts and Motor Skills Framework, in physical activities
Game-related Concepts	• Apply the game-related concepts[3] in sports o territorial-invasion games o net-barrier games o striking-fielding games
Tactical Analysis	• Analyse, using notational analysis, an individual and team's tactical performance in sports

[3] Reference 2024 Physical Education Teaching and Learning Syllabus, Ministry of Education, Singapore.

BIOMECHANICS

Overview	
Biomechanics is a study of how natural laws and forces affect the body and objects in sports movement and performance. Students will understand the mechanical cause-effect relationships that determine human movement and apply biomechanical principles such as stability, summation of force and projectile motion in physical activities to improve movement.	
Key Understandings	**Essential Questions**
Students will understand that: • force, motion and stability affect movement and performance in exercise and sports; and • proper application of biomechanical principles will lead to improved and refined human movement.	• How can efficient movement be achieved?
Knowledge	**Skills**
Students will know: • the effect of the natural laws and forces on the human body in movement and performance; • the biomechanical principles such as stability, summation of forces and projectile motion; and • the movement phases of skill performances for analysis.	Students will be able to: • apply biomechanical principles such as force, stability, summation of forces and projectile motion to analyse movement for refinement and improvement; and • observe, analyse and evaluate efficiency of movement.

Topic	Learning Outcomes Students will be able to:
Newton's Laws of Motion	• Define the term force • Explain, using Newton's laws of motion, the effects of forces on movement in exercise and sports
Factors affecting Stability	• Define the term centre of mass • Explain how the factors of stability can affect movement in exercise and sports o mass o centre of mass o base of support o line of gravity
Summation of Forces	• Explain how summation of forces can be applied to performances in exercise and sports o sequentially o simultaneously
Projectile Motion	• Explain how the factors of projectile motion can influence performance, including the human body as a projectile o height of release, angle of release, velocity of release • Explain how Magnus effect influences projectile motion o back spin, top spin, side spin
Movement Phases	• Describe the movement phases of skill performances in exercise and sports o preparation o execution o follow through
Technical Analysis	• Analyse, using the phase analysis model, an individual's technical performance in exercise and sports • Analyse an individual's technical performance with the aid of a performance analysis application

SPORTS PSYCHOLOGY

Overview	
Sports Psychology is a study of how psychological factors of motivation, arousal and anxiety affect performance. Students will understand how mental preparation for performance can be just as critical as physical preparation and learn how to apply the goal-setting principles and coping strategies in moderating these factors for optimal performance.	
Key Understandings	**Essential Questions**
Students will understand that: • psychological factors (e.g., motivation and arousal), along with other factors (e.g., physiological and skill level) can affect participation and performance in physical activities.	• How can psychology influence participation and performance in physical activities?
Knowledge	**Skills**
Students will know: • the relationship between arousal and performance; • the factors affecting anxiety and coping strategies; and • the factors affecting motivation.	Students will be able to: • apply the principles of goal setting to improve performance in physical activities; and • use coping strategies in managing anxiety to improve performance in physical activities.

Topic	Learning Outcomes *Students will be able to:*

Motivation	• Explain the factors affecting the types of motivation and how motivation influences performance
	  ○ intrinsic
	  ○ extrinsic

Arousal and performance	• Describe the physiological responses of the body to arousal • Explain, using Inverted U Theory (Yerkes-Dodson Theory), the relationship between arousal and performance

Anxiety	• Explain state and trait anxiety and their effects on performance
	
	• Apply coping strategies in managing anxiety
	  ○ relaxation techniques
	  ○ mental rehearsal
	  ○ positive self-talk
	  ○ selective attention
	
	• Explain how cognitive appraisal affects performance

Goal Setting	• Apply SMART principle in setting and reviewing goals to optimise performance
	  ○ specific, measurable, achievable, realistic, time
	
	• Evaluate the types of goals
	  ○ performance
	  ○ process
	  ○ outcome

SPORTS SOCIOLOGY

<table>
<tr><th colspan="2">Overview</th></tr>
<tr><td colspan="2">Sports Sociology is a study of how socio-cultural issues influence why and how people exercise and participate in sports. Students will critically examine sports participation from both global and local perspectives, particularly in relation to issues such as ethics, equity and commercialisation.</td></tr>
<tr><th>Key Understandings</th><th>Essential Questions</th></tr>
<tr><td>Students will understand that:
socio-cultural factors affect behaviours and participation in exercise and sports; and
recognising that individuals and groups (in terms of race, gender, disability and socio-economic status) have different starting bases and resourcing them according to their needs will increase inclusivity and participation in exercise and sports.</td><td>How do social and cultural values influence behaviours in exercise and sports?
What are the facilitators and barriers to participation in exercise and sports?
What is the impact of commercialisation on exercise and sports?</td></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Students will know:
how socio-cultural factors influence behaviours and participation in exercise and sports;
how equity can affect participation in exercise and sports; and
the impact of commercialisation on participation in exercise and sports.</td><td>Students will be able to:
evaluate the impact of issues such as equity and commercialisation on the level of participation in exercise and sports; and
examine ethical issues regarding the behaviours of individuals and groups in exercise and sports.</td></tr>
</table>

Topic	Learning Outcomes *Students will be able to:*

Ethics	• Compare sportsmanship and gamesmanship in sports
	
	• Discuss the issue of performance-enhancing drugs in sport
	  ○ types of drugs and their effects
	  ○ reasons for drug taking

Equity	• Discuss the issues affecting exercise and sports participation
	  ○ race
	  ○ gender
	  ○ disability
	  ○ socio-economic status

Commercialisation	• Discuss the relationship among sport (sporting event, performer, spectator), sponsorship and the media

3. PEDAGOGY

SINGAPORE CURRICULUM PHILOSOPHY AND SINGAPORE TEACHING PRACTICES

The Singapore Curriculum Philosophy (SCP) and Singapore Teaching Practice (STP) guide the beliefs and processes of learning, teaching and assessment in Exercise and Sports Science (ESS). Placing students' interest and needs at heart, the SCP leads ESS teachers to think about the teaching and learning of the curriculum. Taking reference from SCP, ESS teachers:

a. believe in holistic education
b. believe that every child wants to learn and can learn
c. focus on students' learning needs when designing learning experiences
d. believe that learning flourishes:

    - in caring and safe environments
    - when students construct knowledge actively
    - through the development of thinking skills and dispositions
    - when assessment is used to address students' learning gaps

The STP then draws on these beliefs about how students learn and teachers teach. It articulates the importance of understanding the subject's knowledge bases deeply and the pedagogical practices that lead to engaged learning. ESS teachers should use these beliefs, the knowledge bases (e.g., ESS Teaching and Learning Syllabus) and pedagogical practices when planning and enacting lesson ideas to enhance the learning experiences of students, by helping them find more meaning and make connections in the knowledge, understanding and skills gained through the curriculum.

The Pedagogical Practices of STP outlines four fundamental Teaching Processes that make explicit what teachers reflect on and put into practice before, during and after their interaction with students in all learning contexts. The Teaching Processes are as follows:

- Positive Classroom Culture
- Lesson Preparation
- Lesson Enactment
- Assessment and Feedback

The teachers play a pivotal role in shaping the way students learn the subject. Instructional decisions taken by the teachers and the kind of environments they create greatly influence how and what students learn in ESS.

Understanding Students

In planning an effective lesson for students, teachers need to make crucial considerations around content, pedagogy and assessment (refer to the Teaching Process of Lesson Preparation in STP for elaboration). One of its Teaching Areas, *Considering Learners' Profiles,*

emphasises the importance of making lesson design decisions based on the information teachers have about their students.

Teachers must consider their students' profile in the five dimensions (socio-cultural background, learning preferences, biological traits, emotional state and academic strengths). Qualitative and quantitative information about the students in the five dimensions are gathered over time from formal and informal sources, such as diagnostic, formative and summative assessments; students' reflections; and observations within and outside the classroom. Informed by the knowledge of the learners' profiles, teachers can identify appropriate teaching aids and learning resources such as articles, rich media objects, interactive content and online materials to help students better understand key concepts in sports science.

By assessing students' prior knowledge and readiness in the content, teachers will be able to gauge their students' developmental capacity and plan appropriate teaching actions that will meet their needs. An understanding of their students' academic strengths will also guide teachers to select and sequence the content to be taught. Content should also be designed and presented in contexts that are familiar and of interest to the students. Students associate better with content that they have prior knowledge of, is of relevance to them or which matches their interests.

Knowing the profiles and prior knowledge of students will enable teachers to determine if the differentiation of content, process, product, or environment is necessary and the extent of differentiation required. Differentiated Instruction is a teacher's planned and adaptive response to meet the diverse learning needs of all students to maximise their progress in learning.

PEDAGOGICAL APPROACHES AND STRATEGIES

Learn by Doing

For an applied subject, ESS teachers should create learning experiences and provide opportunities for students to be actively involved in using or even testing theories in authentic situations. Students should be involved in hands-on practical activities and experiments that enable them to gain first-hand experience, and more importantly, to reflect on what they have applied and learnt. In this way, not only would students learn effectively, it would also lead to heightened interest and inspire self-confidence. Through such efforts, values, social-emotional competencies and emerging 21CC are also intentionally developed.

> **Practical Activities.** Through practical activities, the nexus between the theoretical and the practical is strengthened, as students are exposed to multiple experiences and behaviours through different spaces and environments while applying their knowledge to improve performance. ESS students will develop the critical eye to analyse biomechanical movement, understand the inter-relatedness of the different variables influencing the movement of an individual in different environments; and appreciate the performance of an athlete, while applying the knowledge, skills and competencies to improve their own physical performance and lifestyle.

Case studies. Using authentic case studies, ESS students will acquire a global and critical perspective as they examine social and cultural issues related to sport and society. Through the discussion, students will learn to analyse issues from multiple perspectives, present and justify their own stance while appreciating differing views. Students thus will acquire a more balanced and holistic views of the issues examined, and make 'individual sense' of their learning as they work with others and deepen their understanding of the place of sport in today's society.

The Learn by Doing approach affords authentic and practice-oriented learning experiences, which can be enacted using various teaching strategies. The use of a repertoire of teaching strategies engages students because each lesson is different, and students will have the opportunity to learn differently. In tandem with this, different learning goals will require different teaching roles (with their associated teaching strategies) to work together in the pursuit of identified learning results, as shown in Table 2. ESS teachers should be cognisant that these strategies and approaches are hardly mutually exclusive but can supplement each other to enhance student learning and maximise teaching effectiveness. They can leverage the strategies, or a combination of the strategies, listed to facilitate the learning process.

Acquire	**Make Meaning**	**Transfer**
This goal seeks to help learners acquire factual information and basic skills.	This goal seeks to help learners *construct meaning (i.e. come to an understanding)* of important ideas and processes.	This goal seeks to support the learners' ability to *transfer* their learning autonomously and effectively in new situations.
Direct Instruction In this role, the teacher's primary role is to *inform* the learners through explicit instruction in targeted knowledge and skills; differentiating as needed. *Strategies include:* • Lecture • Graphic organisers • Questioning (convergent) • Demonstration/modelling • Guided practice • Feedback, corrections • Differentiation	Facilitative Teaching Teacher in this role, engage the learners in actively processing information and *guide* their inquiry into complex problems, texts, projects, cases, or simulations; differentiating as needed. *Strategies include:* • Using analogies • Graphic organisers • Questioning (divergent and probing) • Discussion • Guided practical practice • Feedback, corrections • Rethinking and reflection prompts • Differentiation	Coaching In a coaching role, teachers establish clear performance goals, supervise ongoing opportunities to perform (independent practice) in increasingly complex situations, provide models and give on-going feedback (as personalised as possible). They also provide "just-in-time teaching" (direct instruction) when needed. *Strategies include:* • Providing specific feedback in the context of authentic application • Conferencing • Prompting self-assessment and reflection

Table 2. Learning Goals and Teaching Roles (Adapted from McTighe & Wiggins, 2012)

Students learn best when their learning experiences have context and are connected to their lives and their experiences. Hence, teachers teaching ESS should plan and organise student learning experiences situated in practical and real-life situations while facilitating students' construction of knowledge in a social setting. Through such a social constructivist approach, students will take responsibility for their own learning while being engaged in authentic and meaningful learning tasks. Students will develop self-directed and regulated learning while demonstrating the transference and application of understanding across different contexts.

TECHNOLOGY-ENABLED TEACHING AND LEARNING

Integrating technology can enhance teaching and learning practices in the ESS classroom. Effective use of technology can increase knowledge of subject disciplines, improve student attitudes towards learning and better facilitate the acquisition of new skills.

E-Pedagogy

The **MOE e-Pedagogy Framework**, as shown in Figure 4, centres around the development of students into future-ready learners. The future-ready learner leverages technology individually or collaboratively to achieve learning outcomes of ESS, process skills, 21CC and learning dispositions. The framework provides a holistic perspective of the various aspects involved in using technology for teaching and learning.

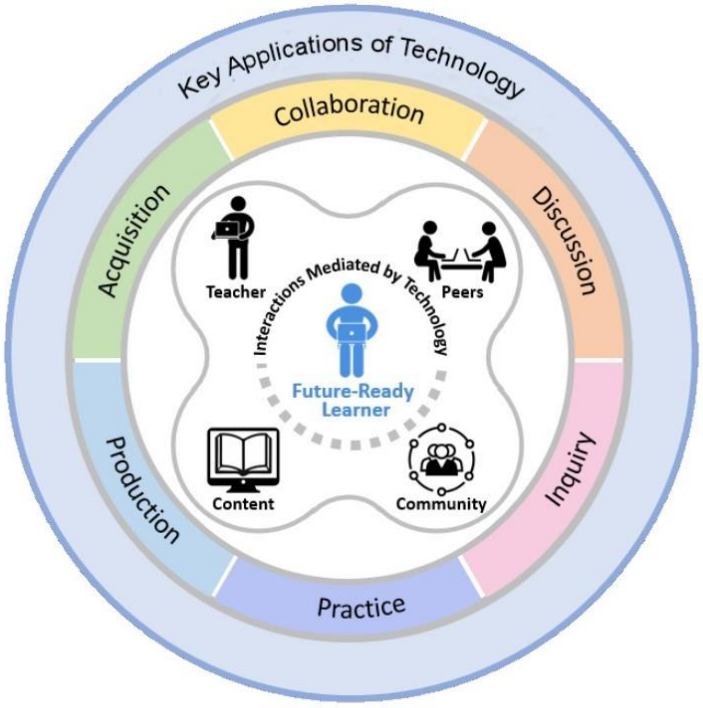

Figure 4. MOE e-Pedagogy Framework

The framework sets out six types of learning experiences: acquisition, collaboration, discussion, inquiry, practice, and production (refer to Table 3). Teachers can design the six learning experiences (LE) using the Active Learning with Technology frame that pulls together the learning activities and tasks that harness technology to meet intended learning objectives.

Types of LE	Learning Disposition / Process Skills	Learner Actions
Acquisition 	Understand critical features and structure of a concept by studying information	Students learn new knowledge through studying, analysing, comparing, organising curated information to identify structures and patterns to deepen understanding of concepts.
Collaboration 	Group knowledge construction of a shared output (construct idea, challenge, modify, defend or redevelop)	Students plan and establish group goals and processes. They collectively ideate, discuss, negotiate diverse ideas and co-construct meaning that contributes towards production of a shared output.
Discussion 	Relate and communicate with others to see different perspectives and refine own understanding	Students generate and exchange ideas and perspectives, supported by evidence and explanations. They engage in peer critique to refine understanding of their ideas.
Inquiry 	Fosters fundamental skills of developing own knowledge (continually adapted and refined)	Students form an informed prediction to an inquiry task. They investigate by exploring, clarifying and analysing information sources and data. They formulate an explanation based on evidence and evaluate and reflect on their findings and new learning.
Practice 	Develops the practice and mastery of the subject's ways of thinking and doing	Students are involved in tasks to develop the practice of subject discipline in an immersive environment. Through feedback gathered, they can improve their subsequent actions in an iterative manner and acquire a better grasp of relevant knowledge and skills in any subject.
Production 	Motivates students to propose solutions to a real-world problem and generate a consolidated expression of knowledge via a tangible artefact	Students explore a real-world problem and produce tangible artefacts (video, built structure etc) iteratively to solve them. Their thought processes and decision points are captured online, allowing the teacher to track student growth and provide timely feedback.

Table 3. Six Types of Learning Experiences

For example, the inquiry-based learning approach lends itself well to enable students to develop interdisciplinary learning within the sub-disciplines of sports science. This approach allows students to apply both inductive and deductive reasoning in a real-life situation. Authentic resources, such as videos of actual sports and games, can provide real-life contexts and data for inquiry-based learning. Figure 5 shows the frame for an inquiry-based learning experience.

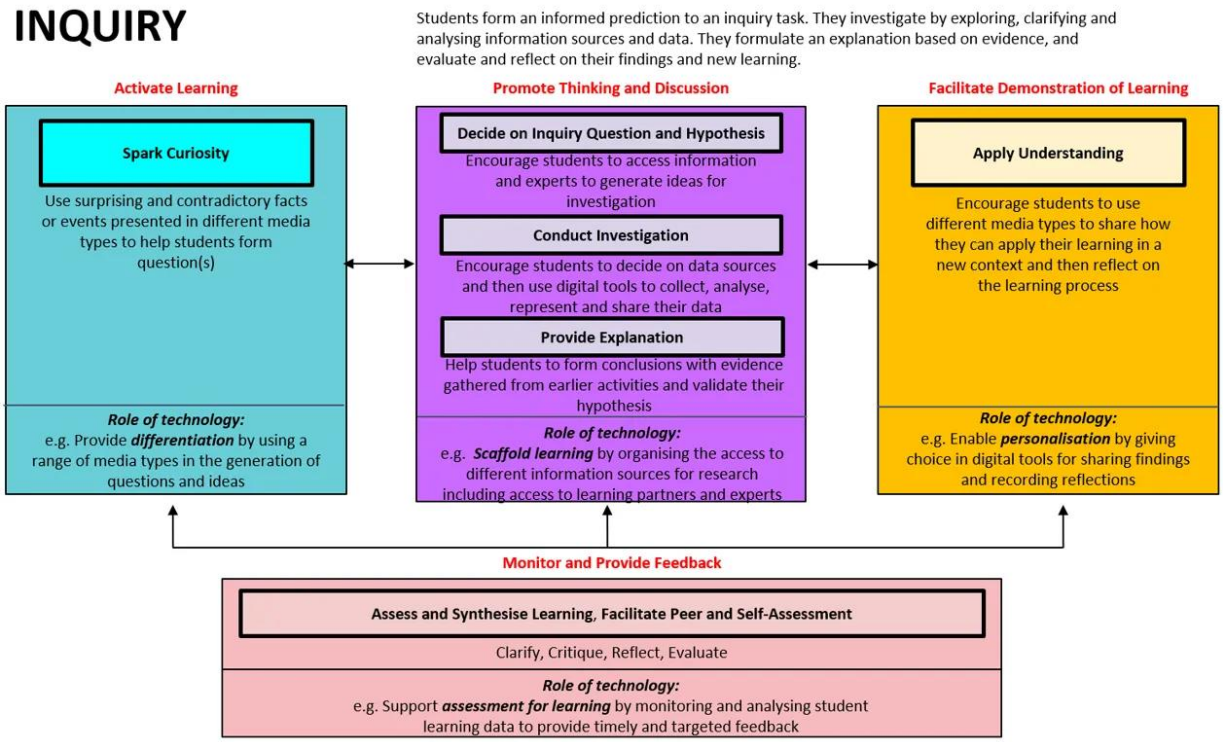

Figure 5. Inquiry Learning Experience

Students will be more engaged as technology enables them to access information in different ways while constructing new knowledge. For instance, ESS students can learn to sharpen their movement observation skills by recognising the different phases of a movement through video analysis while applying biomechanical principles to modify movement for improvement; and understanding how the circulatory system works in the human body through graphics and other visual stimuli.

Blended Learning

Blended Learning in MOE's context refers to the re-imagination of students' educational experience by providing them with a more seamless blending of different modes of learning. It allows teachers to re-think curriculum and assessment design, and innovate pedagogies to enable students to benefit from a wider spectrum of learning experiences.

Through a combination of live online lessons and online/offline learning where students learn remotely and at their own pace, ESS teachers can provide opportunities for students to learn during face-to-face lessons with peers and themselves in school, complemented by out-of-school learning activities without the physical presence of their peers and themselves. Students will be afforded opportunities to learn through a combination of ICT-mediated and non-ICT-mediated learning experiences.

Teachers should consider the following when designing learning experiences for home-based learning:

a. Content, concept and/or skill acquisition

- Select content, concepts and/or skills that students are able to acquire in a self-directed way.
- Provide opportunities for students to assess their own understanding, e.g., quizzes with automated marking and feedback on the Singapore Student Learning Space (SLS).

b. Consolidation of learning

- Provide opportunities for students to consolidate their learning through practice and/or self-assessment, e.g., assignments and review activities.

c. Applied learning

- Create lessons that help students draw connections between classroom learning and real-life contexts and applications. Learning contexts for curriculum coverage via home-based learning can be the home environment or virtual learning experiences.
- Provide opportunities for students to demonstrate learning in novel ways and, in the process, develop inventive thinking and produce creative products.

Well-selected technological tools and digital learning materials can extend the ESS teacher's capacity to instruct and enhance students' capacity to engage in construction and co-construction of meaning through active learning. Technological tools and digital learning materials that teachers thoughtfully chose and skilfully used in the design of learning experiences can help to spark students' curiosity in the phenomenon and issue being studied, scaffold their thinking and sense-making, encourage collaborative learning, as well as reflection on learning.

4. ASSESSMENT

ASSESSMENT IN THE SINGAPORE TEACHING PRACTICE

Assessment is the process of gathering and analysing evidence about student learning for making decision and enhancing teaching and learning. It is an integral part of the learning process and must closely align with curricular objectives, content and pedagogy. It enhances teaching and learning when assessment information is used meaningfully to guide instruction and school decision-making and provides information to students and stakeholders. The beliefs about assessment as reflected in the Singapore Curriculum Philosophy contain the core principles that define the approach to assessment.

Both school-based assessment and national examinations play important and different roles in the education system. Whether implemented as national examinations or in the classroom, assessment should lead to meaningful learning. The 'what' and 'how' of assessment should be anchored on the clarity of purpose ('why'). There should be regular gathering of quantitative and qualitative information about a student's progress and development, and such information should be used to inform learning and shape future teaching and learning practices.

The MOE Assessment Philosophy comprises the following:

a. Assessment is integral to the learning process.

Assessment is an iterative and continuous process which motivates learning and helps learners to achieve the learning outcomes. The gathering and use of assessment information must become part of the ongoing learning process. Assessment can take the form of performance tasks, classroom tests or national examinations, but the underlying goal should be to facilitate meaningful learning where the learning process is developmentally appropriate, caters to students' varied needs, and helps learners achieve the Desired Outcomes of Education.

b. Assessment begins with clarity of purpose.

Assessment should be fit for purpose and be based on sound educational principles. Decisions on 'what' to assess and 'how' to assess should be aligned with a clear purpose. A balanced assessment system consists of both assessment for learning as well as assessment of learning. This ensures that assessments are carried out during the instructional process for the purpose of improving teaching and learning, as well as provide information on students' mastery of content knowledge and skills.

c. Assessment should gather information to inform future practices.

Assessment in schools should produce both quantitative and qualitative descriptions of learner performance to provide feedback for improving future teaching, learning and performance. Assessment should also help students become self-directed

learners. There is also the need to use different modes of assessment to determine how best to support students in their progress with respect to different domains of learning.

SCHOOL-BASED ASSESSMENT

Assessment practices lie on a continuum. A balanced assessment system consists of both Assessment for Learning (AfL) and Assessment of Learning (AoL). At one end, AfL, also called formative assessment, represents the identification of learning throughout assessments. At the other end, AoL, also called summative assessment, represents the measurement of learning by using assessments. Along the continuum, more formative- or summative-oriented assessments are used to bring about a learner-centred and balanced assessment.

ESS requires authentic performance from students, which involve both cognitive and psychomotor processes. Similarly, the school-based assessment serves to provide information to take stock of students' progress and performance at the end of learning episodes. In designing formative assessment, both teachers and students understand and focus on the learning goals (which includes 21CC development), take stock of current levels of understanding in relation to the learning goals through formal or informal assessment processes, and work towards narrowing the learning gap between current understanding and the learning goals. To form an accurate picture of students' attainment, multiple evidence may be collected at appropriate junctures rather than relying on a single performance test conducted at the end of the module.

The diverse nature of content in ESS calls for a variety of appropriate assessment approaches to be used. The following are some possible sources of information to assess students' progress and performance in the various learning outcomes:

- observations of students carrying out tasks and activities, including practical performances, oral presentations and discussions
- video analysis of sports performances
- a product (e.g., training programme)
- self or peer feedback

A training programme by the students can also be used to highlight critical areas that they need to work on. Teachers can assist them by designing suitable teaching units to further enhance their development.

The design of the school-based assessment should address how the students learn best when their learning experiences have context and are connected to their lives and their experiences. Hence, the nature of ESS which requires the application of theoretical understanding through engagement and performance in physical activities, should have slightly heavier weighting on the assessment of the practical application.

THE NATIONAL EXAMINATION

At the end of the two-year course, students will sit for the O-Level Exercise and Sports Science Examination. In alignment with the purpose and aims of this syllabus, the format of the national examination comprises two compulsory components: Paper 1 (Theory, e-Examination) and Paper 2 (Coursework).

Paper 1: Theory (e-Examination)

The paper assesses students' ability to demonstrate knowledge, understanding and application of the areas of study in Exercise and Sports Science. The paper also assesses students' ability to analyse and evaluate factors that influence performance, and issues related to involvement in physical activities, and recommend improvements. Students will be required to analyse and interpret data on performance, and issues related to physical activities to make valid inferences.

The mode of the paper is a computer-based examination. The use of computer-based assessment provides more dynamic and authentic contexts compared to the pen-and-paper format. Stimuli could be presented through videos, animations, images and texts in the paper.

The question paper is divided into three sections and the duration is 2 hours. All questions in the paper are compulsory.

Section A (20 marks)
Variety of item types, e.g., Multiple-choice Questions, Matching, Drag and Drop, Checking of Boxes, Fill-in-the Blanks and Short Answer based on texts, images and short videos/animations.

Section B (40 marks)
Structured Questions based on texts, images and short videos/animations.

Section C (20 marks)
Structured Questions based on one or two videos.

Paper 2 - Coursework

The Coursework provides an opportunity for students to demonstrate their proficiency in performing practical activities. Through the Development Log, students will be able to observe, analyse, evaluate and make improvement to their physical performance by applying the sports science concepts learnt. These two components would enable students to understand the interaction of concepts and factors within sports performance, thus strengthening the nexus between the theoretical and the practical.

Performance of Practical Activities component

As part of the coursework requirement, students will choose ONE practical activity from EACH of the Individual/Dual[4] and Team categories (refer to Table 4). Students' proficiency in performing the practical activities will be assessed based on performance assessment descriptors.

Categories	Practical Activities
Individual/Dual	**Individual** • Cross-country Running • Swimming • Track and Field **Dual** • Badminton • Table Tennis • Tennis
Team	• Basketball • Floorball • Football • Hockey • Netball • Softball • Volleyball

Table 4. List of Practical Activities.

Development Log component

Students will be required to complete a Development Log, in conjunction with their two chosen practical activities. Through the Log, students will apply the process of performance analysis to improve performance in the practical activities in areas such as fitness, technical skills, and tactical awareness and decision-making. The performance analysis process comprises the four stages of observation, analysis, evaluation and feedback. The Development Log component facilitates students' interdisciplinary learning through the application of the knowledge from the areas of study to improve their performance in the practical activities. It also provides the affordance for students to develop data management skills such as collecting, presenting, analysing and evaluating data.

[4] Dual sports activities refer to sports that one can do with a partner such as badminton, tennis and fencing. (Corbin & Lindsey, 2014). For the purpose of this subject, a doubles' game in a dual sport will not be considered as a team sport.

5. GLOSSARY

This glossary serves as a guide - it is neither exhaustive nor definitive. Students should appreciate that the meaning of a term must depend in part on its context.

Term	Description of Term
analyse	Break down information into its components to examine the parts and understand how they relate to one another.
classify	Group things based on common characteristics.
comment	An open-ended instruction, inviting students to explore/infer/articulate points of interest or critical viewpoints relevant to the context of the question/topic/issue/situation/problem.
compare	Provide both similarities and differences between things or concepts.
define	State the formal meaning or the equivalent paraphrase of a term.
describe	Provide details about the main points/characteristics/observations of the topic. It is often used with reference to particular actions, phenomena, experiments, etc...
evaluate	Analyse information/data to form judgement of a subject in relation to its context based on qualities/criteria such as strengths/weaknesses and alternatives.
explain	Reasoning and/or making reference to theory in relation to the context.
identify	Select factors/characteristics in relation to context.
justify	Provide reasons to support an idea/methodology/process/response.
predict	Making a logical connection between pieces of information/data to deduce what is likely to happen.
state	Giving a concise answer which generally involves the recall of information and could be in relation to a context.
suggest	Propose possible ideas/reasons/solutions in relation to a context, which may be a 'novel' situation.

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