PISA 2015 教師專業發展活動：科學科教師講座

促進教師的評核素養：從PISA的研究到科學科課堂實踐

Enhancement of Teachers' Assessment Literacy: From the PISA Study to Science Classroom Practice

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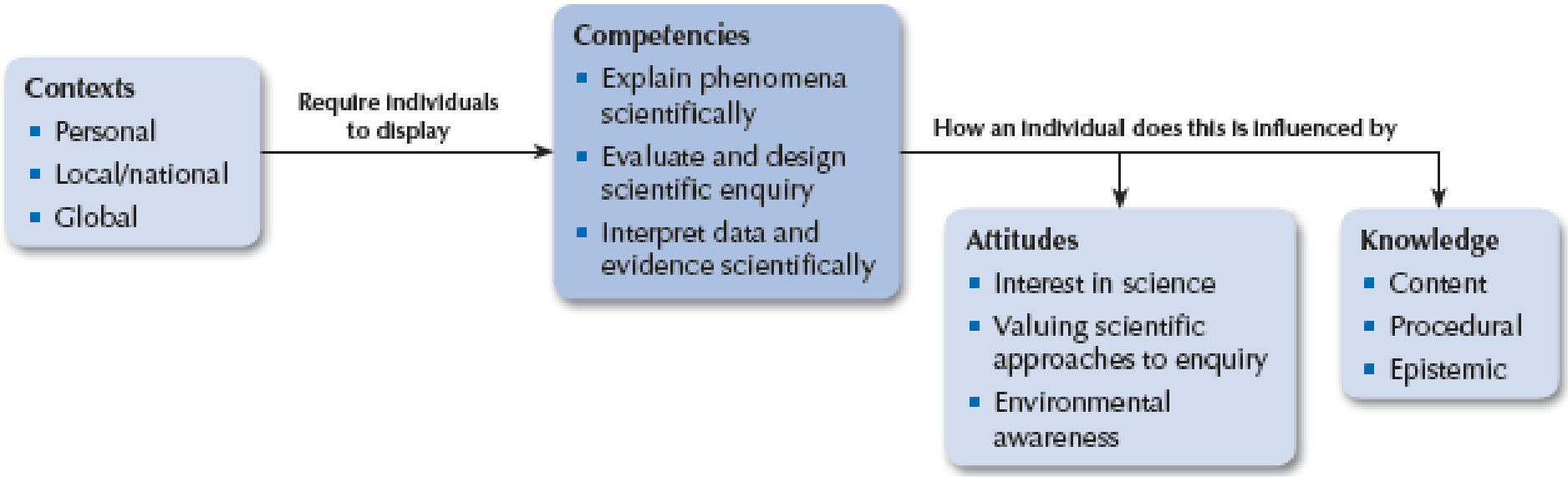
In PISA 2015, scientific literacy is defined as:

"Scientific Literacy (科學素養) is the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen."

Framework of Scientific Literacy in PISA 2015



Source: Adapted from *PISA 2015 Draft Science framework* (OECD, 2013, p.12), Figure 1

Scientific Competencies Assessed in PISA 2015

Explaining Phenomena Scientifically

Offer explanations for a range of natural and technological phenomena

Evaluate and design scientific enquiry

Describe and appraise scientific enquiries and propose ways of addressing questions scientifically

Interpret data and evidence scientifically

Analyse and evaluate scientific information, claims and arguments in a variety of representations and draw appropriate conclusions

Knowledge Assessed in PISA 2015

Content knowledge

major **explanatory ideas and theories** from the fields of physics, chemistry, biology, earth and space sciences, and how they **apply in contexts** where the elements of knowledge are interdependent or interdisciplinary

Knowledge Assessed in PISA 2015

Procedural knowledge

knowledge about the **concepts and procedures that are essential for scientific enquiry,** and that underpin the collection, analysis and interpretation of scientific data.

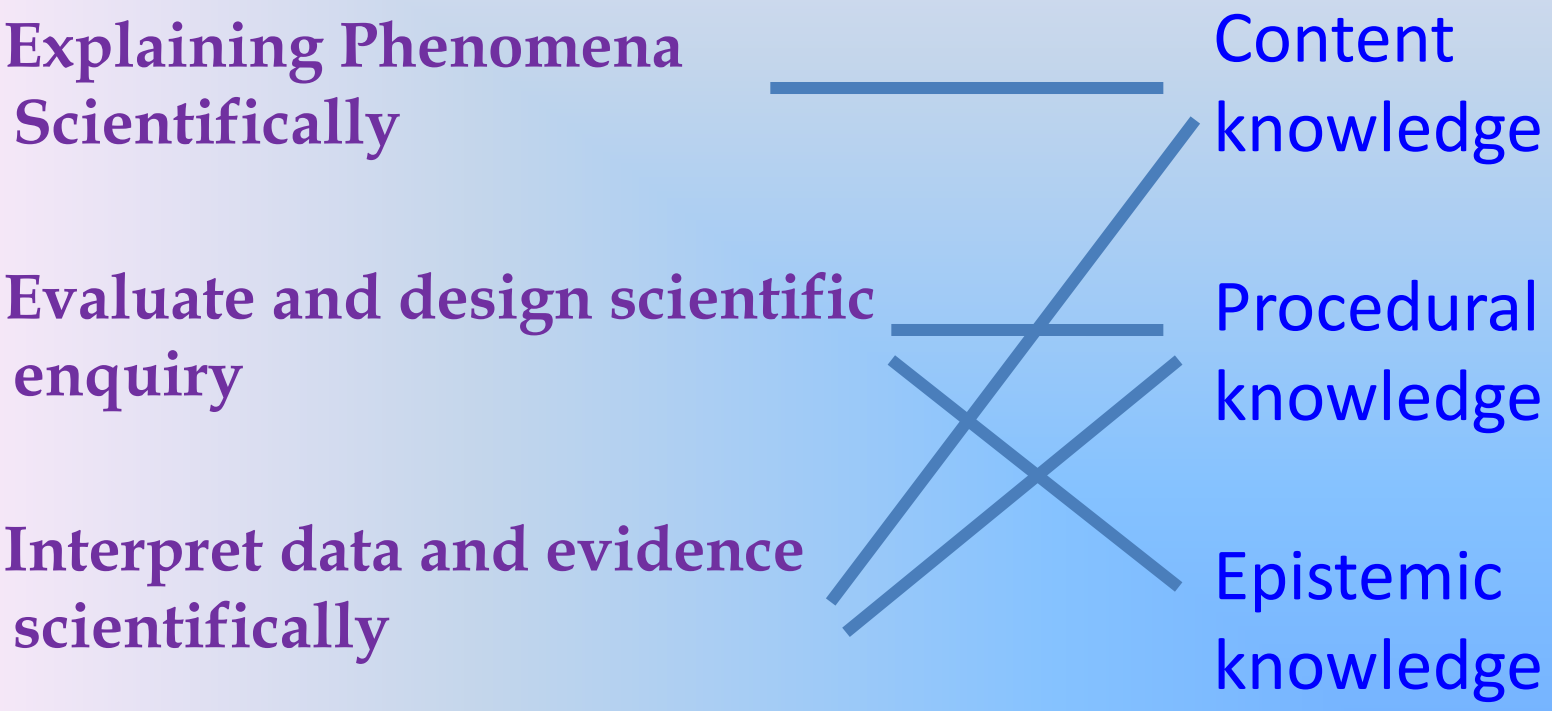
Knowledge Assessed in PISA 2015

Epistemic knowledge (~ Nature of science)

an understanding of the **nature and origin of knowledge in science**

understand the distinction between **observations, facts, hypotheses, models and theories**, but also to understand **why certain procedures**, such as experiments, are central to establishing knowledge in science

Competency related to knowledge



CONTEXTS

	Personal	local/national	Global
Health	Maintenance of health, accidents, nutrition	Control of disease, social transmission, food choices, community health	Epidemics, spread of infectious diseases
Natural resources	Personal consumption of materials and energy	Maintenance of human populations, quality of life, security, production and distribution of food, energy supply	Renewable and non-renewable, natural systems, population growth, sustainable use of species
Environment	Environmentally friendly actions, use and disposal of materials and devices	Population distribution, disposal of waste, environmental impact	Biodiversity, ecological sustainability, control of pollution, production and loss of soil/biomass
Hazard	Risk assessments of lifestyle choices	Rapid changes (e.g. earthquakes, severe weather), slow and progressive changes (e.g. coastal erosion, sedimentation), risk assessment	Climate change, impact of modern communication
Frontiers of science and technology	Scientific aspects of hobbies, personal technology, music and sporting activities	New materials, devices and processes, genetic modification, health technology, transport	Extinction of species, exploration of space, origin and structure of the Universe

Mean performance in scientific literacy in PISA 2015

Country/Region	Mean	S.E.	Significance
Singapore	556	(1.2)	▲
Japan	538	(3.0)	▲
Estonia	534	(2.1)	▲
Chinese Taipei	532	(2.7)	▲
Finland	531	(2.4)	▲
Macao-China	529	(1.1)	O
Canada	528	(2.1)	O
Viet Nam	525	(3.9)	O
Hong Kong-China	523	(2.5)	--
China	518	(4.6)	O
Korea	516	(3.1)	O
New Zealand	513	(2.4)	▼
Slovenia	513	(1.3)	▼
Australia	510	(1.5)	▼
United Kingdom	509	(2.6)	▼

Science Performance in different areas of competency

	Overall science scale	Mean performance on each science competency subscale		
		Explain phenomena scientifically	Evaluate and design scientific enquiry	Interpret data and evidence scientifically
Singapore	556	553	**560**	556
Japan	538	539	536	541
Estonia	534	533	535	537
Chinese Taipei	532	536	**525**	533
Finland	531	534	529	529
Macao	529	528	525	**532**
Canada	528	530	530	525
Hong Kong	523	524	524	521
China	518	520	517	516
Korea	516	510	515	**523**

* Blue is significantly higher than red

	Mean performance in science (overall science scale)	Mean performance in each science knowledge subscale	
		Content knowledge	Procedural and epistemic knowledge
Singapore	556	553	558
Japan	538	539	538
Estonia	534	534	535
Chinese Taipei	532	538	528
Finland	531	534	528
Macao	529	527	531
Canada	528	528	528
Hong Kong	523	526	521
China	518	520	516
Korea	516	513	519

* Blue is significantly higher than red

Using PISA framework to improve our own assessment

Using PISA framework to improve our own assessment

- Understand and review critically the subject you are teaching from an international perspective
- You can use the classification table to classify and analyse the test items beyond the PISA items
- Assessment: not only on content knowledge but also on process skills
- Understand student ability
- Understand item difficulty
- Assessment of, for, as Learning

Classification of item

Question type	☐ True & False ☐ Multiple Choice ☐ Closed Constructed Response (i.e. short answer) ■ Open Response (i.e. give explanation on something)
Competencies	☐ Explain phenomena scientifically ☐ Evaluate and design scientific enquiry ■ Interpret data and evidence scientifically
Domain of knowledge	***Content Knowledge:*** ☐ Physical systems ☐ Earth and space systems ☐ Living systems ***Procedural and Epistemic Knowledge:*** ■ Procedural Knowledge ☐ Epistemic Knowledge
Application area	☐ Health ☐ Natural Resources ☐ Hazards ■ Environment ☐ Frontiers
Item Focus	■ Global ☐ local/national ☐ Personal
Cognitive demand	☐ High ■ Medium ☐ Low
Item difficulty level	☐Level 6 ■ Level 5 ☐ Level 4 ☐ Level 3 ☐ Level 2 ☐ Level 1
Comment/Reference	

	Hong Kong	International average (53 countries)
% correct	20.8 %	29.8 %

周鴻騰(台灣PISA 種子教師):

其實我不斷回到 PISA 的理論基礎及素養架構說明、PISA 評分規準、分類方式及材料選取的技巧、以及不斷觀摩之前的試題。也不斷在實作過程中，將問題提出進行小組討論與決策。透過本次研習出題經驗，也讓自己發揮創意、活用教材、了解 PISA 測驗的出題技巧，是一個很不賴的學習。

(取自“**PISA** 科學素養評量手冊”)

http://pisa.nutn.edu.tw/sample_tw.htm

Computer-based Items

- **Interactive items**

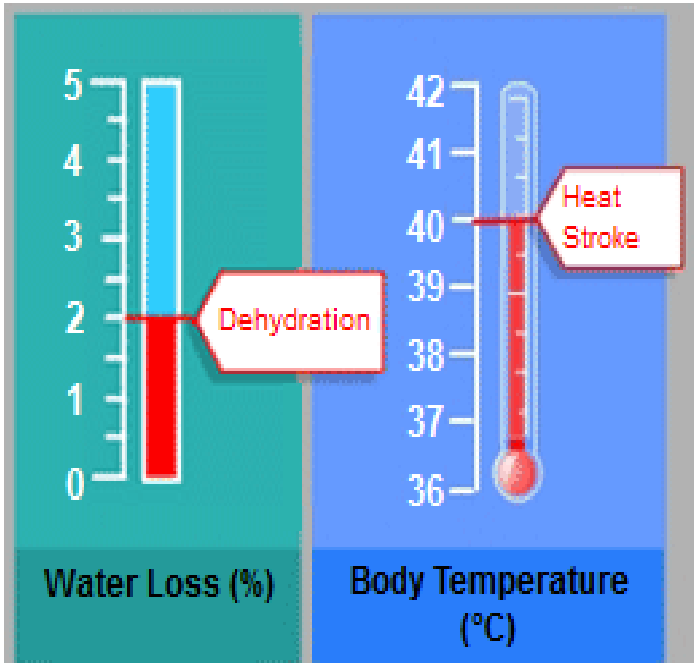
Example: RUNNING IN HOT WEATHER

RUNNING IN HOT WEATHER

During long-distance running, body temperature rises and sweating occurs.

If runners do not drink enough to replace the water they lose through sweating, they can experience dehydration. Water loss of 2% of body mass and above is considered to be a state of dehydration. This percentage is labeled on the water loss meter shown below.

If the body temperature rises to 40°C and above, runners can experience a life-threatening condition called heat stroke. This temperature is labeled on the body temperature thermometer shown below.



Running in Hot Weather

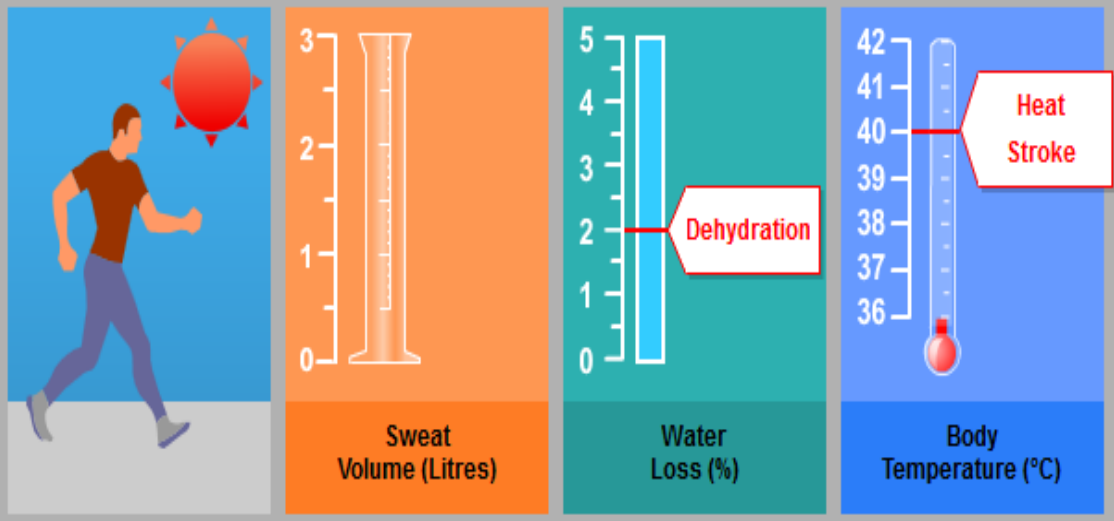
Introduction

This simulation is based on a model that calculates the volume of sweat, water loss, and body temperature of a runner after a one-hour run.

To see how all the controls in this simulation work, follow these steps:

1. Move the slider for **Air Temperature.**
2. Move the slider for **Air Humidity.**
3. Click on either "Yes" or "No" for **Drinking Water.**
4. Click on the "Run" button to see the results. Notice that a water loss of 2% and above causes dehydration, and that a body temperature of 40°C and above causes heat stroke. The results will also display in the table.

Note: The results shown in the simulation are based on a simplified mathematical model of how the body functions for a particular individual after running for one hour in different conditions.



Air Temperature (°C) 20 25 30 35 40

Air Humidity (%) 20 40 60

Drinking Water ◉ Yes ○ No

Run

Air Temperature (°C)	Air Humidity (%)	Drinking Water	Sweat Volume (Litres)	Water Loss (%)	Body Temperature (°C)

PISA 2015

Running in Hot Weather
Question 3 / 6

▸ **How to Run the Simulation**

Run the simulation to collect data based on the information below. Click on a choice, select data in the table, and then type an explanation to answer the question.

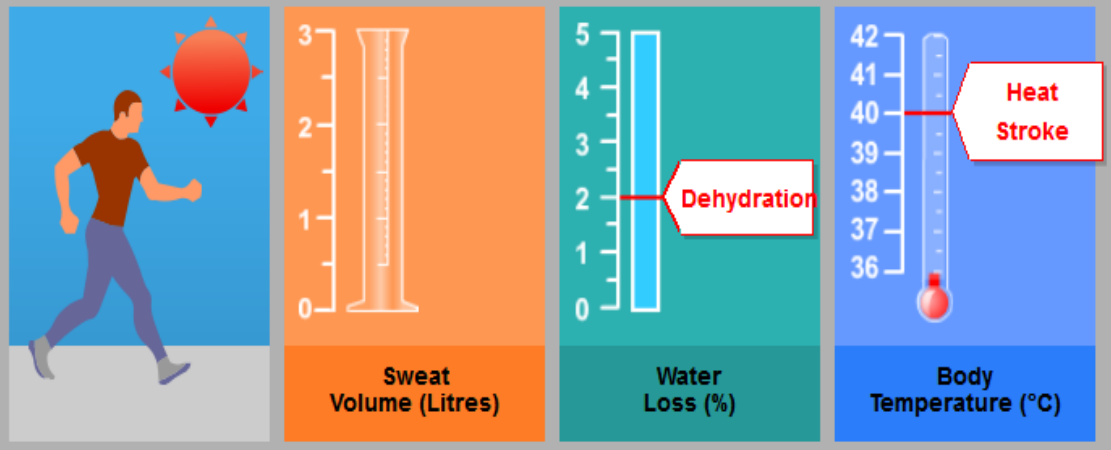
When the air humidity is 60%, what is the effect of an increase in air temperature on sweat volume after a one-hour run?

- Sweat volume increases
- Sweat volume decreases

Q03

Select two rows of data in the table to support your answer.

What is the biological reason for this effect? Q04



Air Temperature (°C) 20 25 30 35 40

Air Humidity (%) 20 40 60

Drinking Water ◉ Yes ○ No

Run

Air Temperature (°C)	Air Humidity (%)	Drinking Water	Sweat Volume (Litres)	Water Loss (%)	Body Temperature (°C)

Item Number:	*S623Q03 and S623Q04*
Question type:	*Q03: Simple Multiple Choice and Open Response* *Q04: Open Response*
Competency:	*Q03: Evaluate and Design Scientific Enquiry* *Q04: Explain Phenomena Scientifically*
Knowledge category:	*Q03: Procedural knowledge* *Q04: Content knowledge*

Items : **S623Q03 & S623Q04**

- Go to OECD website to do the simulation

http://www.oecd.org/pisa/test/

S623Q03

Full Credit

The student selects: **Sweat volume increases**

AND

The two selected rows must have air humidity of 60% and two different air temperatures selected (one lower and one higher). In addition, drinking water must have the same setting (either “Yes” or “No”) in both of the selected rows.

S623Q04

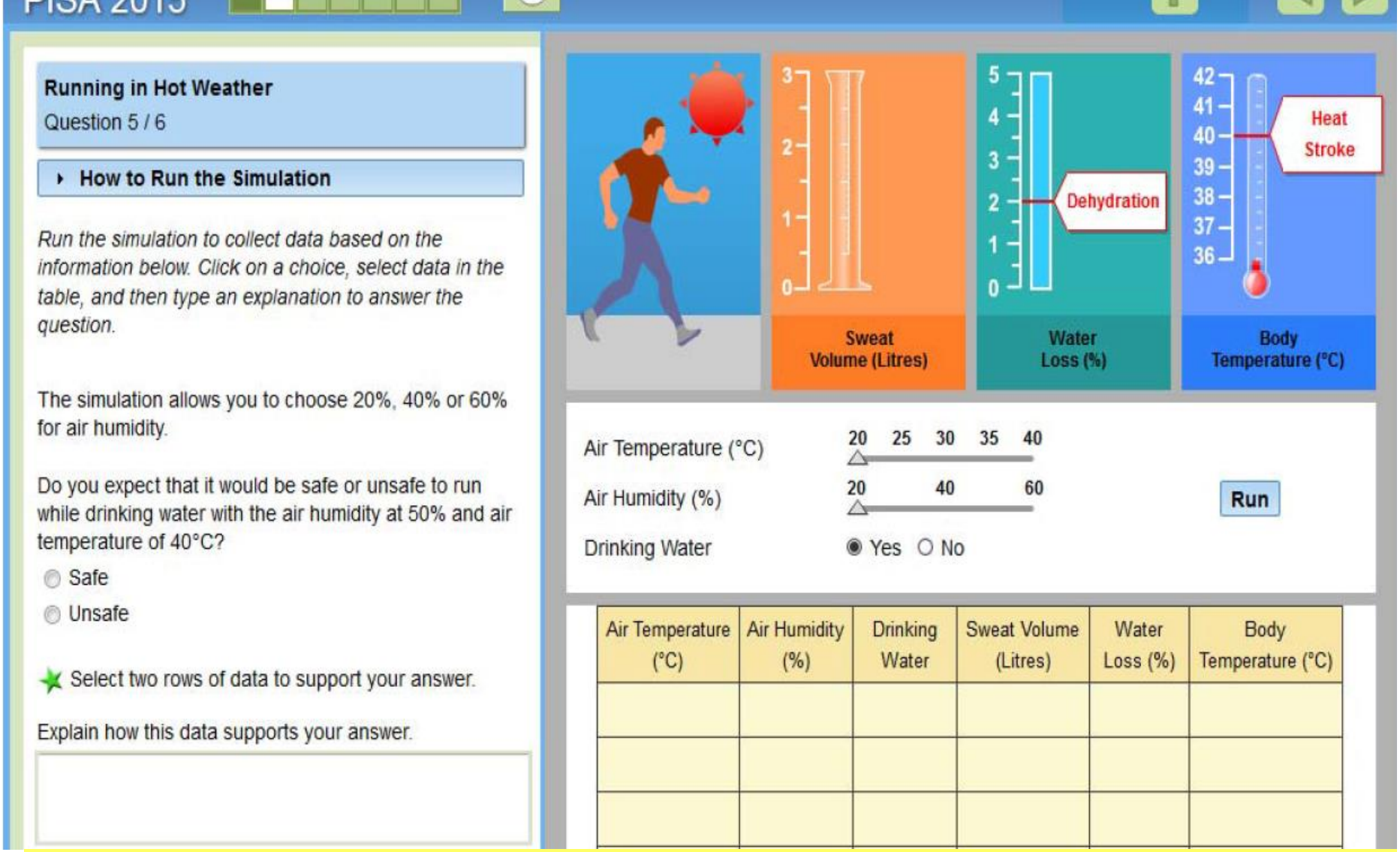
Full Credit

The student’s response indicates or implies the function of sweat in cooling the body and/or regulating body temperature.

- Sweat evaporates to cool the body when temperatures are high.

	% correct (in PISA 2015 FT)	
	Hong Kong	International (53 countries)
S623Q03	47.1%	44.4%
S623Q04	12.2%	17.7%

- For S623Q03, HK students, on average, outperformed international students from 53 countries
- For S623Q04, it requires students to draw on their knowledge of biology (content knowledge) to explain that sweating cools the body at higher temperatures
- The cognitive demand: medium, but the mean score of 53 countries is only 18%.
- The performance of Hong Kong students : very poor (% correct: 12 %). 15-year-old HK students did not learn this topic in school.



- Students need to **use the simulation to develop a hypothesis about the safety of running** at 40°C at 50% humidity (a humidity value that cannot be set on the slider)

Item Number	S623Q06
Competency	Evaluate and Design Scientific Enquiry
Knowledge	Procedural
Cognitive Demand	High

Item : **S623Q06**

- Go to OECD website to do the simulation

http://www.oecd.org/pisa/test/

Full Credit

The student selects **Unsafe**

AND

The two rows selected have 40% humidity at 40°C with Drinking Water=Yes and 60% humidity at 40°C with Drinking Water=Yes

AND

The student gives an explanation that indicates that with the runner suffering from heat stroke at both 40% and 60% humidity, there is a risk of heat stroke at 50% humidity in the same conditions.

Partial Credit

The student selects **Unsafe** AND Correct rows are selected AND The student's explanation is missing, unclear or incorrect.

OR

The student selects **Unsafe** AND Correct rows are **not** selected AND The student gives a correct explanation referring to results from the simulation.

	% correct (in PISA 2015 FT)	
	Hong Kong	International (53 countries)
S623Q06	57.3%	37.6%

- This item uses a simulation to assess scientific enquiry processes not assessed in the paper-based booklets.
- % correct: the mean score of 53 countries (38%) vs Hong Kong (57%).
- Reasons for Hong Kong's good performance ?

HKCISA Newsletter

使用電腦模擬來進行科學探究

PISA 2015科學科的電腦化評估題目初探

初中的科學探究

在 2002 年，香港課程發展議會重新

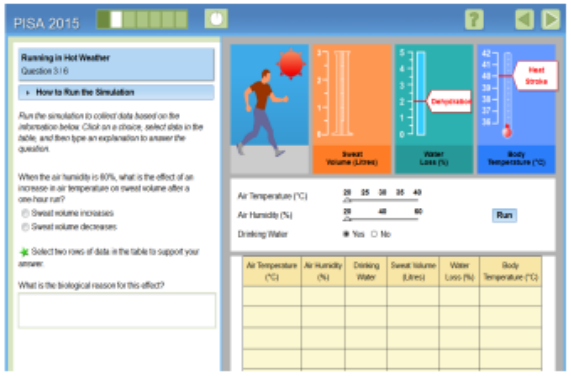
中三的科學教育學習領域課程，訂立了

樣本題目一：在熱天跑步(Running in Hot Weather)

題目背景資料簡介：
在熱天跑步，體溫上升並會出汗。如果跑手因流汗流失的水分等於或大於體重的 2%時，就被認為處於脫水狀態。如果體溫上升到 40°C 或以上，跑手將會中暑。
學生可操控「氣溫」、「空氣濕度」、「喝水」這三個變項來進行模擬，以得知跑手在某特定條件下會否脫水及中暑。模擬結果[註1]（如水分流失量及體溫等）會分別顯示在水分流失計及體溫計中，結果數據亦會記錄在表格內。

以下問題(見圖一)為「當空氣濕度為 60% 時，氣溫上升對跑步一小時後的排汗量有甚麼影響？」

圖一：



(資料來源: 取自 OECD (2015) "PISA 2015 Released Field Trial Cognitive Items")

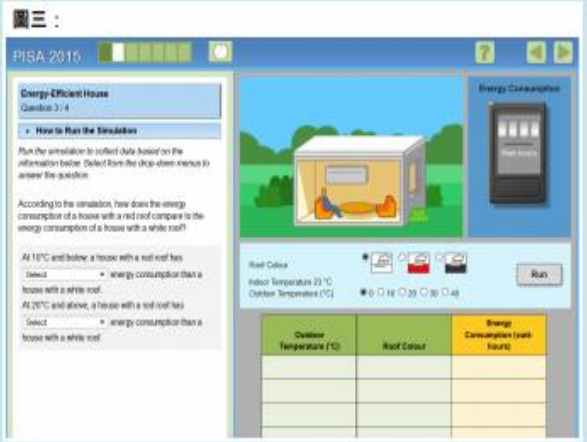
樣本題目二：節能房屋 (Energy-Efficient House)

以下是有關節能房屋的問題(見圖三)，學生需利用模擬探究在不同室外溫度下，不同的屋頂顏色如何影響能源消耗。

評估的科學能力：「科學地分析數據及證據 (Interpret Data and Evidence Scientifically)」的能力。

如何尋找答案？初時學生會以為紅色比起白色吸收較多熱能，因而認為紅色屋頂房屋在 20°C 有較低能源消耗。學生進行模擬，以比較白色屋頂房屋及紅色屋頂房屋分別在 10°C 和 20°C 時的能源消耗量。

圖三：



(資料來源: 取自 OECD (2015) "PISA 2015 Released Field Trial Cognitive Items")

	體溫 (°C)
	38.9
	39.1

It can be downloaded from the HKCISA website:
http://www.fed.cuhk.edu.hk/~hkcisa/nl/newsletter_vol25.pdf

Coding (Marking) Student Answers

Item Labels and Coding (Marking)

- Items that have to be coded by coders:

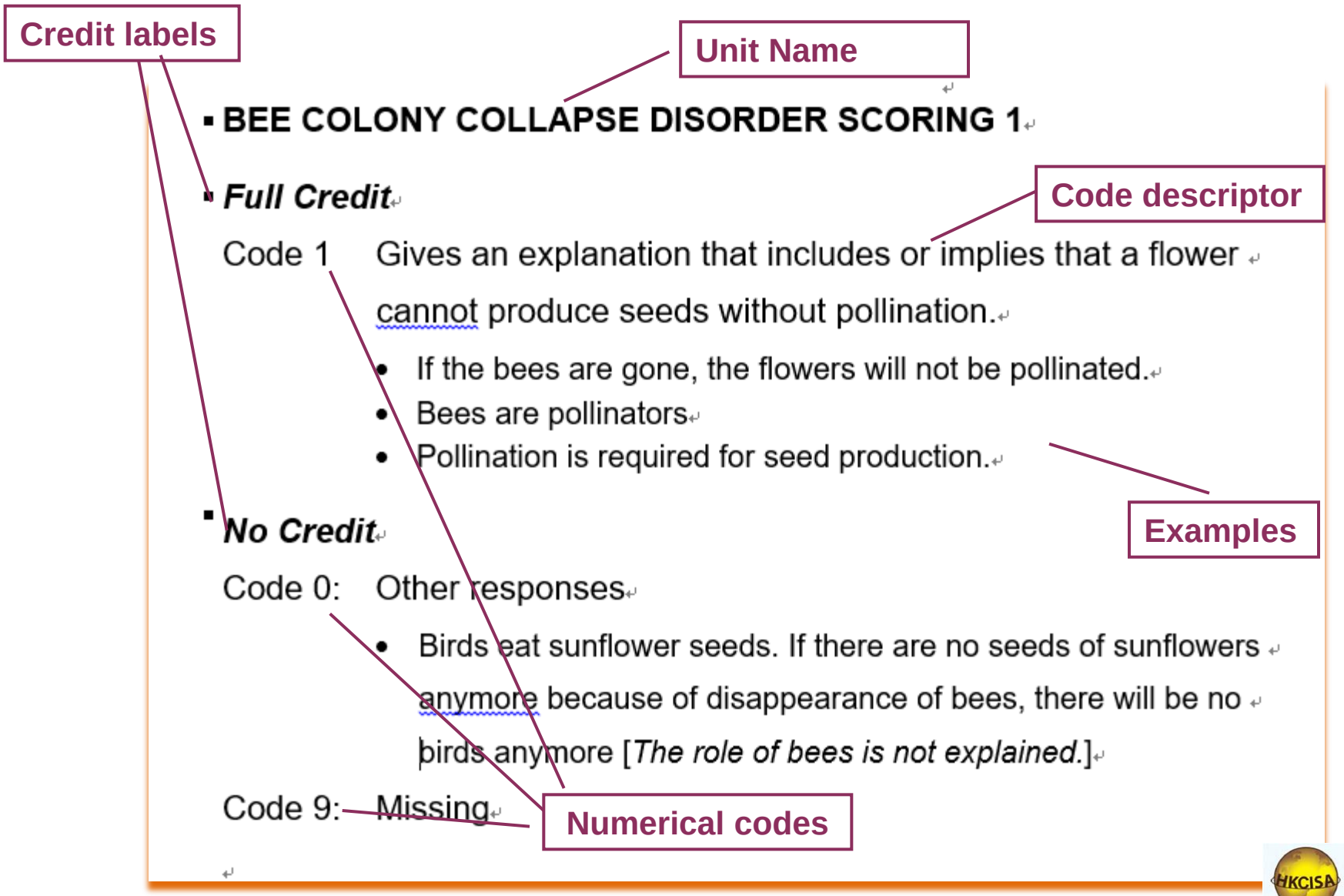
  FOSSIL FUELS *S613Q02 – 01 11 12 21 99*

  BEE COLONY COLLAPSE *S600Q04 – 0 1 9*

- Items that are scored automatically by computer (multiple-choice and complex multiple-choice items):

  VOLCANIC ERUPTIONS *S644Q01*

Layout of the Coding Guide



Coding (Marking)

- General principles for coding
  - Spelling and grammar
  - Exercising judgement
  - Common problems

Spelling and Grammar

- The PISA science assessment is *not* a test of written expression
- *Every effort* should be made to understand what the student means
- *Spelling and gramma* mistakes should be ignored unless they make it impossible to determine what the student means (key words?)

Principles for Exercising Judgement

- The labels "Full Credit", "Partial Credit" and "No Credit" divide responses into three groups according to the degree to which the responses answer the question.
  - They indicate the *level of response expected of a 15-year-old*
- "Full Credit" responses may *not* necessarily be fully correct or perfect responses.
  - Don't apply a "deficit model" (deduct if fall short of a perfect answer)
- Benefit of the doubt (to the student)
  - Should not assume students do not know

Common Problems in Coding

- Answers comprises a correct/partly correct part (A) and yet another part (B)
  - If B contradicts A: no credit
  - If B is irrelevant to the Q – count A only

- Wrong Response Formats
  - Examples: Instead of checking "Yes" or "No", the student writes "Yes" or "No"
  - Forget the format

MC - Bird Migration

Item context

Bird migration is a seasonal large-scale movement of birds to and from their breeding grounds. Every year volunteers count migrating birds at specific locations. Scientists capture some of the birds and tag their legs with a combination of coloured rings and flags. The scientists use sightings of tagged birds together with volunteers' counts to determine the migratory routes of birds.

Q1 大部分候鳥先在一個地區聚集，然後大群地遷徙，而不是個別地遷徙。這種行為是進化的結果。下列哪一項是對大多數候鳥進化出這種行為的最佳的科學解釋？

A. 個別或小群地遷徙的鳥類，較不可能生存和繁衍。
B. 個別或小群地遷徙的鳥類，較有可能找到充足食物
C. 大群地飛行可容許其他種類的鳥兒加入遷徙行列。
D. 大群地飛行可以讓每一隻鳥更有機會找到築巢地方

Think about the answer and do the Kahoot test 1

Competency	Explain Phenomena Scientifically
Knowledge System	**Content** - Living
Context	Global - Environmental Quality
Difficulty	501 - Level 3

	A	***B***	***C***	***D***
% of HK	52	15	16	17

	Hong Kong	Macao	B-S-J-G (China)	Taipei	Singapore	Japan	Korea	Canada	Estonia	Finland	OECD average
% correct	52.09	56.81	62.66	52.14	68.97	67.03	59.49	60.96	74.24	63.24	57.84

Any explanations on HK students' performance on that item?

- learning about bird migration and tagging
- Leaning about evolution – survival of fitness

Q2

指出一個可能造成義工們點算候鳥的數目不準確的因素，並解釋這因素是如何影響義工點算的結果。

1. Write your answer in the worksheet.
2. Mark the students' answers in the worksheet (0/1).
3. Do Kahoot test 2.

	因為單靠肉眼是很難準確觀察. 結果會與實際情況有差異	
	數量太多，一大群的鳥類很難有一個確實的數據很有可能會點多或點少。	
	彩色環和彩旗可能會掉落,使結果並不準確	
	鳥類遷徙途中因意外死亡 義工的結算數目減少	
	天氣因素，下雨會造成能見度下降，可能造成義工們點算候鳥的數目不準確。	
	鳥的特徵大同小異,可能重復點算候鳥	
	候鸟的繁殖，当他们繁殖时，由于不知道繁殖明确数字，因此数目就不知道增加了多少，从而影响了点算的结果	
	它們的腿的標記可能鬆脱，候鳥飞行位置可能有变。 標記鬆脱令義工們无法點算候鳥的數目，候鳥飞行位置有变令義工們无法點算候鳥的數目	0

Coding guide

Full Credit

The student identifies at least one specific factor that can affect the accuracy of counts by observers.

- The observers may miss counting some birds because they fly high.
- If the same birds are counted more than once, that can make the numbers too high.
- For birds in a large group, volunteers can only estimate how many birds there are.
- The observers might be wrong about what kind of bird they are, so the numbers of that kind of bird will be wrong.
- The birds migrate at night. (marginal?)
- Volunteers will not be everywhere the birds migrate. (marginal?)
- The observers can make a mistake in counting. (marginal?)
- Clouds or rain hide some of the birds.

No Credit: Other responses, including those that confuse the roles of the scientists and the volunteers.

- Volunteers make errors [Too general]
- Volunteers are not as accurate as scientists [Too general]
- Because they capture some of the birds, not all.

Competency	Evaluate and design scientific enquiry
Knowledge System	**Procedural** - Living
Context	Global - Environmental Quality
Difficulty	630 - Level 4

	Hong Kong	Macao	B-S-J-G (China)	Chinese Taipei	Singapore	Japan	Korea	Canada	Estonia	Finland	OECD average
% correct	34.98	27.98	30.40	**19.21**	48.58	41.78	28.97	45.57	29.81	42.19	33.08

Any explanations on HK students' performance on that item?

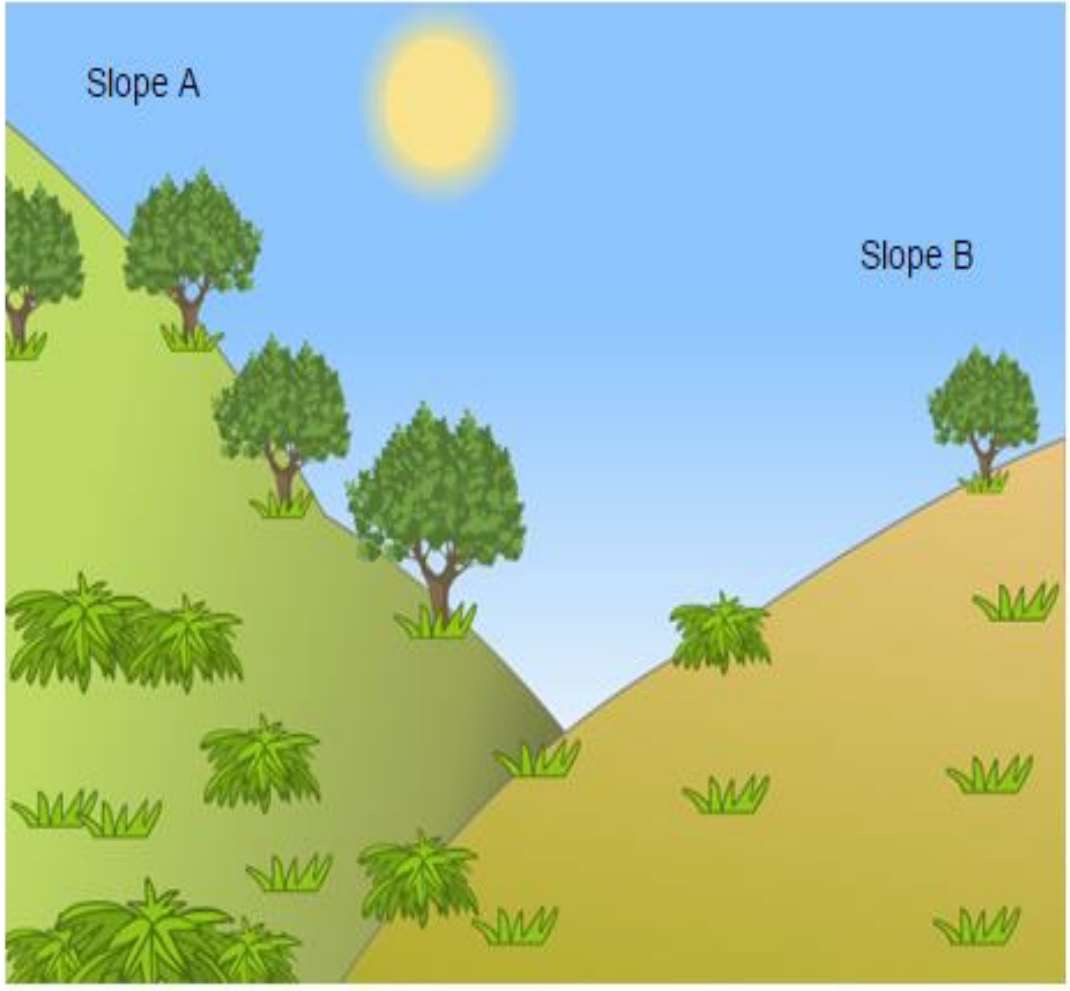
- Accuracy (errors) of measurement
- one's counting of birds at specific time and point → number of birds flying across a place (generalization)
- Counting of many organisms in the wild

SLOPE-FACE INVESTIGATION

A group of students notices a dramatic difference in the vegetation on the two slopes of a valley: the vegetation is much greener and more abundant on slope A than on slope B. This difference is shown in the illustration on the right.

The students investigate why the vegetation on the slopes is so different from one slope to the other. As part of this investigation, the students measure three environmental factors over a given period of time:

- **Solar radiation:** how much sunlight falls on a given location
- **Soil moisture:** how wet the soil is in a given location
- **Rainfall:** how much rain falls on a given location



SLOPE-FACE INVESTIGATION

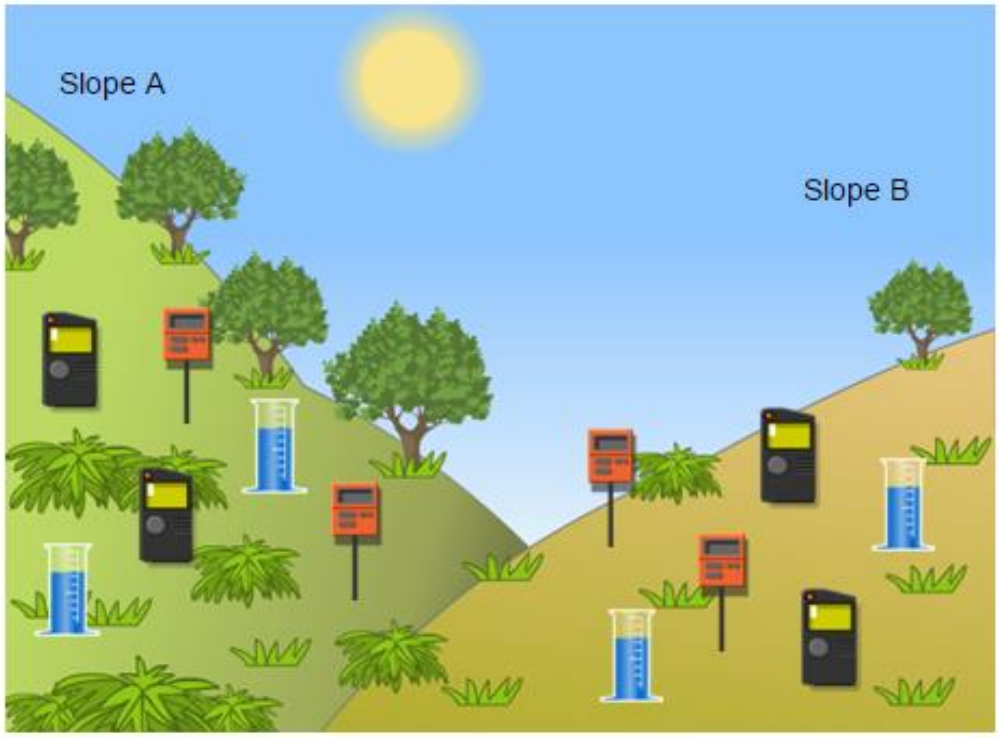
Data Collection

The students place two of each of the following three instruments on each slope, as shown below.

Solar radiation sensor: measures the amount of sunlight, in megajoules per square metre (MJ/m^2)

Soil moisture sensor: measures the amount of water as a percentage of a volume of soil

Rain gauge: measures the amount of rainfall, in millimetres (mm)



在調查兩邊斜坡植被生長情況的不同，學生為甚麼在每邊的斜坡上均放置兩套儀器？

1. Write your answer in the worksheet.
2. Mark the students' answers in the worksheet (0/1).
3. Do Kahoot test 3.

	學生答案	評分
1	減少數據出現誤差	
2	To increase the reliability of the test	
3	因為須要用兩個測試結果作比較.	
4	因為這樣可以量度兩個斜率不同的斜坡在不同高度下各項數據, 可加以比對。	
5	來集齊數據。	
6	control experiment	
7	因為要進行公平測試	
8	因為只是斜坡的其中一個部份，並不能夠完全代表整個斜坡，為了得到更確實的數據，所以需要放置兩套儀器。	
9	令結果更容觀 更準確因在同一個斜坡上的環境因素會有變化	

Coding guide

Full Credit

The student gives an explanation that identifies a scientific advantage of using more than one measurement instrument on each slope, e.g. correcting for variation of conditions within a slope, increasing the precision of measurement for each slope.

- So they could determine whether a difference between slopes is significant.
- Because there is likely to be variation within a slope.
- To increase the precision of the measurement for each slope.
- The data will be more accurate. (marginal)
- In case one of the two malfunctions
- To compare different amounts of sun on a slope [A comparison implies that there may be variation.]

No Credit : Other responses

- Two are better than one.
- The slopes might be larger.
- To check if there is a difference from one side to the other.
- The data will be more equal.
- To be sure that a fair test is carried out.

Competency	**Evaluate and Design Scientific Enquiry**
Knowledge System	**Epistemic - Earth & Space**
Context	**Local/ National - Natural Resources**
Difficulty	**517 - Level 3**

Comment

This Level 3 question allows students to demonstrate their understanding of the underlying rationale for the procedure of taking two independent measures of the phenomena being investigated. Knowledge of this rationale is the aspect of this question that assesses epistemic knowledge.

	Hong Kong	Macao	B-S-J-G (China)	Chinese Taipei	Singapore	Japan	Korea	Canada	Estonia	Finland	OECD average
% correct	**49.00**	59.01	50.52	**80.95**	76.12	53.50	62.15	64.24	70.49	52.68	52.31

Any explanations on HK students' performance on that item?

- Accuracy (errors) of measurement
- Soil moisture measured by one sensor at one point of the slope → Soil moisture of the slope (generalization)
- Replication (≠ repeated measurement) to control confounding variables between two slopes
- Two sensors to reduce measuring error
- Repeated measurement to reduce random error

Slope-Face Investigation
Question 2 / 2

Refer to "Data Analysis" on the right. Click on a choice and then type an explanation to answer the question.

Two students disagree about why there is a difference in soil moisture between the two slopes.

- Student 1 thinks that the difference in soil moisture is due to a difference in solar radiation on the two slopes.
- Student 2 thinks that the difference in soil moisture is due to a difference in rainfall on the two slopes.

According to the data, which student is correct?

- Student 1
- Student 2

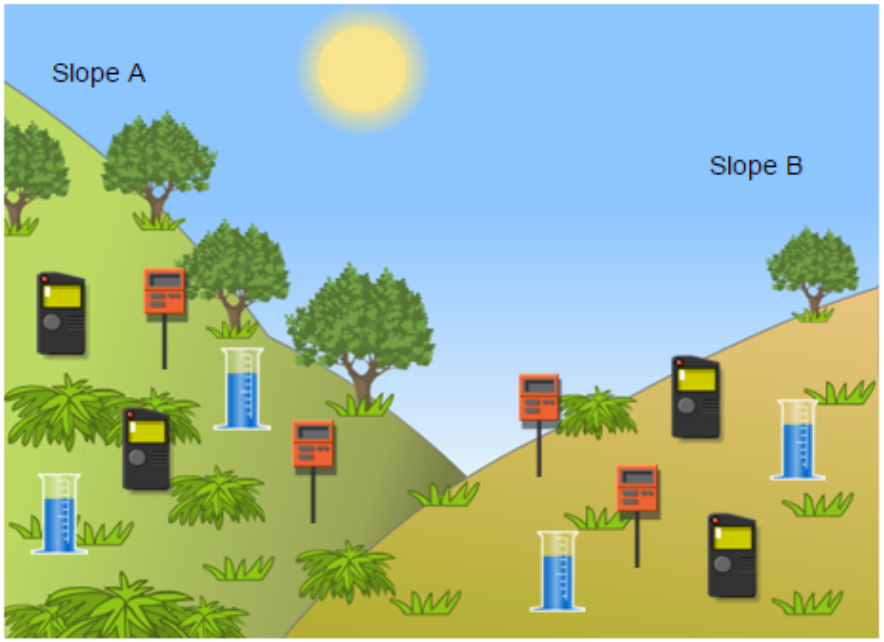
Explain your answer.

SLOPE-FACE INVESTIGATION

Data Analysis

The students take the average of the measurements collected over a given period of time from each pair of instruments on each slope and calculate the uncertainty in these averages. Their results are recorded in the following table. The uncertainty is given following the "±" sign.

	Average Solar Radiation	Average Soil Moisture	Average Rainfall
Slope A	3800 ± 300 MJ/m^2	28 ± 2%	450 ± 40 mm
Slope B	7200 ± 400 MJ/m^2	18 ± 3%	440 ± 50 mm



Scoring

Full Credit

The student selects **Student 1**

AND

Gives an explanation that indicates that there is a difference in solar radiation between the two slopes **and/or** that rainfall does not show a difference.

- Slope B gets much more solar radiation than slope A, but the same amount of rain.
- There is no difference in the amount of rainfall the two slopes get.
- There is a big difference in how much sunlight slope A gets compared to slope B.

Comment:

Students are asked to demonstrate an understanding of how measurement error affects the degree of confidence associated with specific scientific measurements, one major aspect of epistemic knowledge.

Competency	Interpret data and evidence scientifically
Knowledge System	Epistemic - Earth & Space
Context	Local/ National - Natural Resources
Difficulty	589 - Level 4

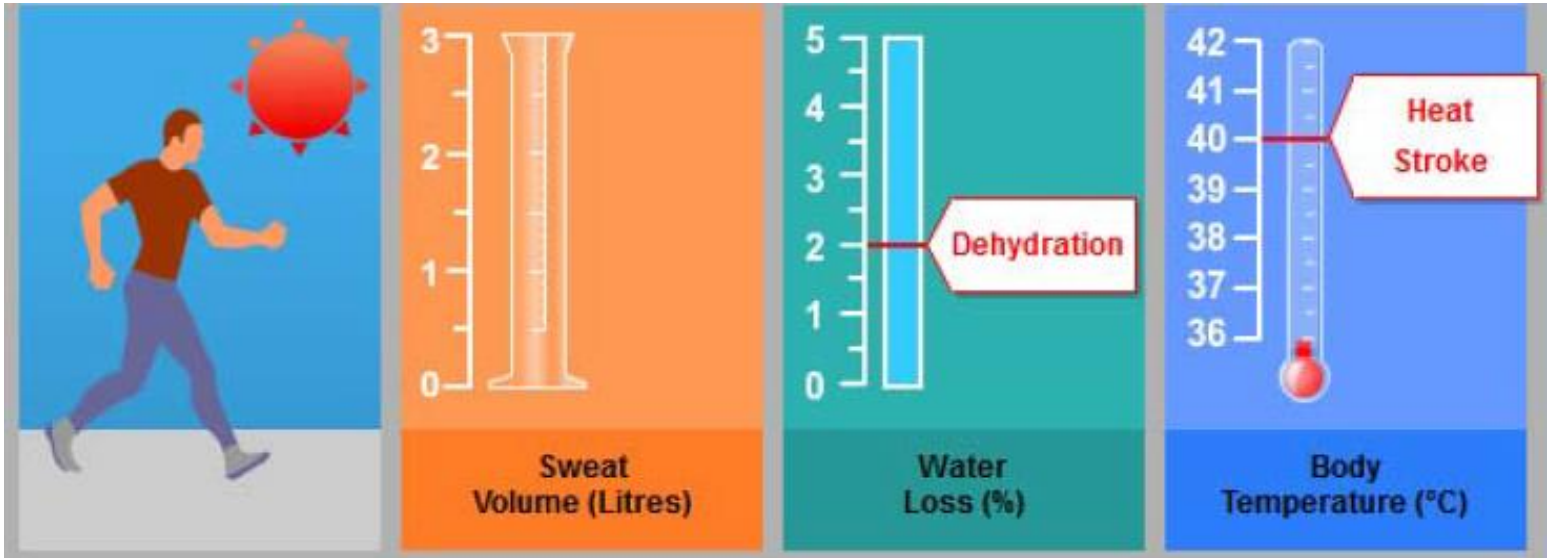
	Hong Kong	Macao	B-S-J-G (China)	Taipei	Singapore	Japan	Korea	Canada	Estonia	Finland	OECD average
% correct	36.15	37.69	39.77	43.23	47.08	49.27	40.30	43.01	49.96	44.42	34.86

Any explanations on HK students' performance on that item?

- Accuracy (errors) of measurement → uncertainty/confidence
- Covariation to support causation

  change of solar radiation → change of soil moisture

	Average Solar Radiation	Average Soil Moisture	Average Rainfall
Slope A	3800 ± 300 MJ/m^2	28 ± 2%	450 ± 40 mm
Slope B	7200 ± 400 MJ/m^2	18 ± 3%	440 ± 50 mm



Air Temperature (°C) 20 25 30 35 40

Air Humidity (%) 20 40 60

Drinking Water ◉ Yes ○ No

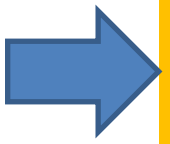
Run

Air Temperature (°C)	Air Humidity (%)	Drinking Water	Sweat Volume (Litres)	Water Loss (%)	Body Temperature (°C)

Multiple variables

Independent variable

- Air T
- Air humidity
- Drinking water



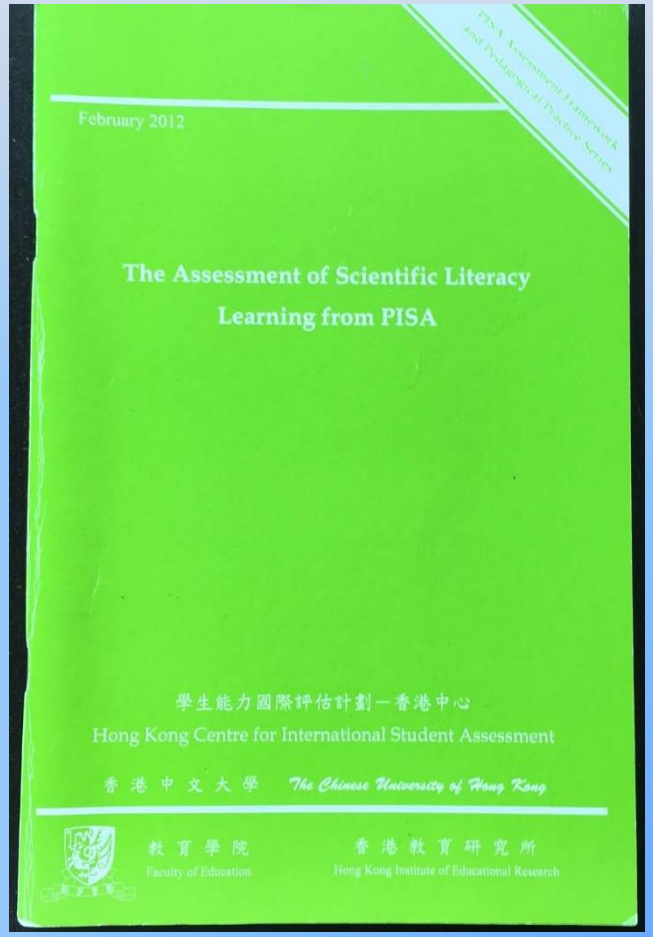
Dependent variable

- Sweat
- Body water loss
- Body T

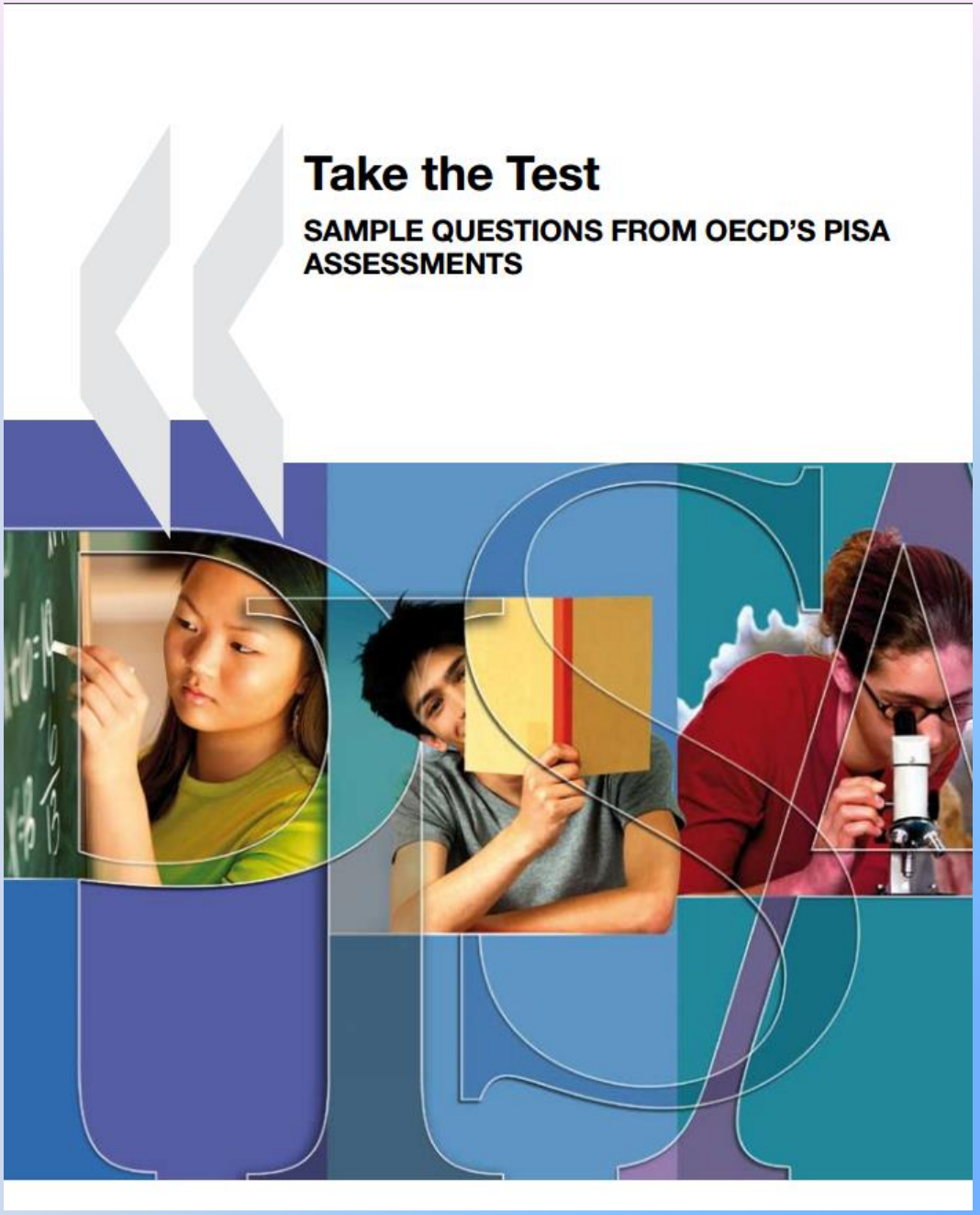
Only one IV should be changed at a time, while other IV controlled → fair test

RESOURCES

Teacher's Guides (HKCISA Centre)

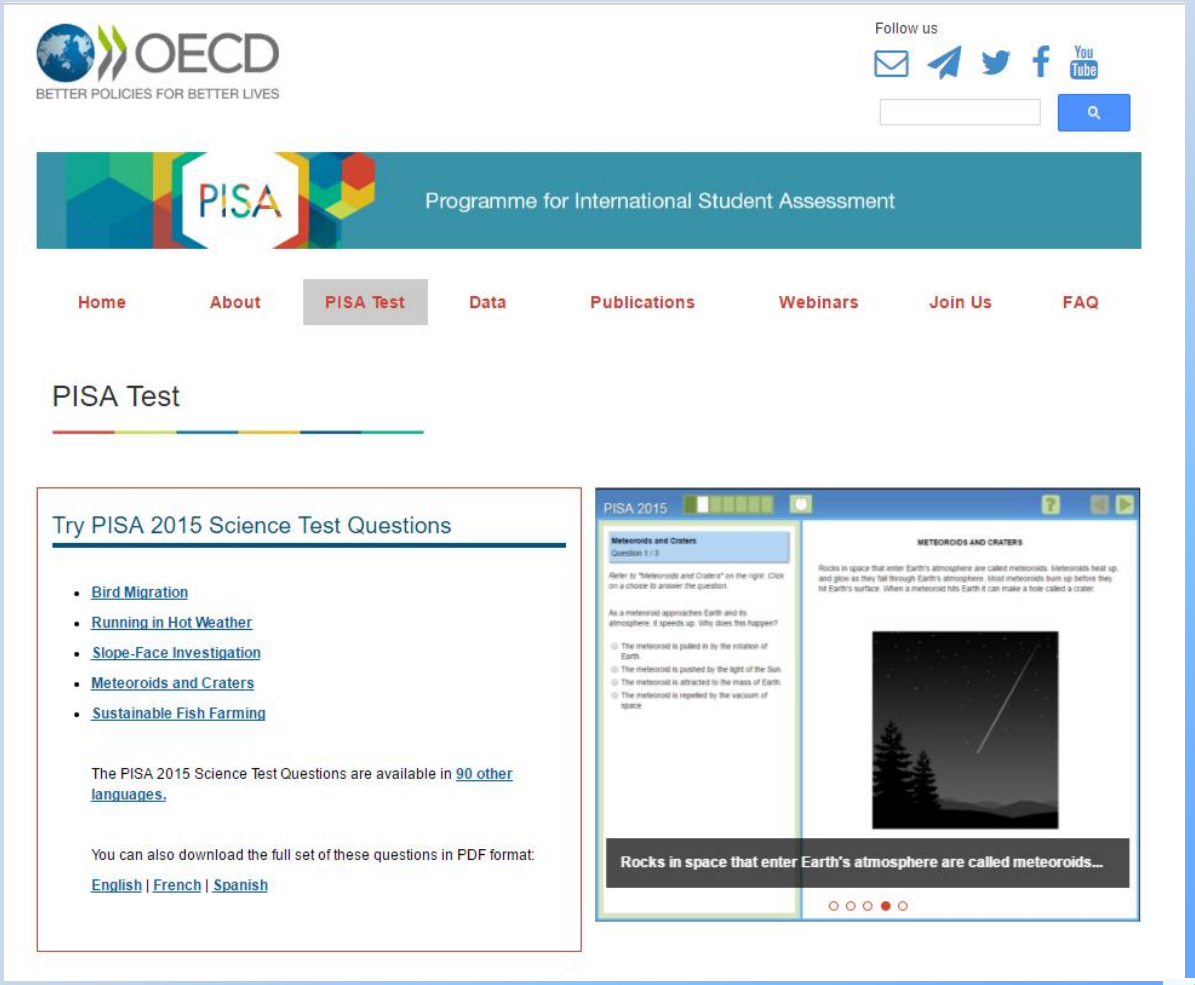


This e-book can be downloaded from OECD website



PISA released items (Online version)

- OECD website: http://www.oecd.org/pisa/test/



PISA and STEM

- STEM education: Assessment ?

  Make good use of the PISA released items

e.g 魚菜共生– “sustainable fish farming”

Concluding Remarks

- In PISA 2015, a few interactive CBA items have been designed and used to demonstrate and explore the role multivariate modelling is playing in science.
- Teachers can make good use of the released items => please refer to Teacher's Guides and the OECD website

Concluding Remarks

- Use of the PISA assessment framework - Enable teachers to classify assessment items based on several essential aspects: competency areas, knowledge type, topic and cognitive demand.
- Balanced assessments in terms of item format, competency areas and cognitive demand (i.e. cater for learners' diversity)

Concluding Remarks

- Assessment in HK is probably too strict, excluding some answers that is reasonable and showing student understandings not quite explicitly
- Reliability of assessment does not mean validity of assessment
- Strict and narrow answers expected of students do not mean high learning standards, but simply promote exam-drilling

Procedural and epistemic knowledge of science

Students should be engaged more on:

- thinking about the reasons why an experiment has to be done that way, rather than routine control of variables and repeated measures
- thinking about the various sources of errors – random, systematic, bias, sampling, uncontrolled variables…
- doing simulation experiments involving more complex variables and design

Thank you