INSTITUT FIZIK MALAYSIA
MALAYSIAN INSTITUTE OF PHYSICS

Physics Olympiads and Its Value to Physics Education in Malaysia

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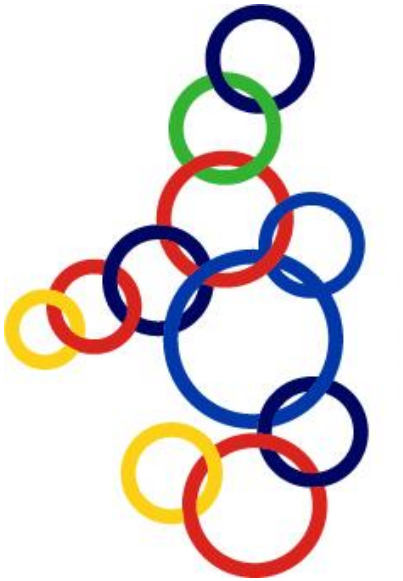
Universiti Kebangsaan Malaysia
The National University of Malaysia

NARATIF BAHARU UKM
UNIVERSITI WATAN KITA

Introduction



Introduction

Logos of various **sports** competitions: SEA Games, Summer Olympics, World Cup.

Logos of various **academic** competitions: Physics Olympiads.

Question 1. What does excellence in competitions signify about the country's talent development system?

Question 2. Why should a country devote resources – or invest – in competitions?

Outline

Who are its various stakeholders?

What can be used as its indicators?

Our involvement

Our achivements

Framework for talent development

Common myths

The way forward

Physics education ecosystem

Formal and informal

Physics learned in schools (topic, subject), colleges (subject), universities (program).

Physics learned through broadcast media, print media, Internet media and social interactions **OR** through visits to STI-related places.

Stakeholders

Seen. Policy makers, administrators, teachers and technicians, students, parents.

Unseen. Textbook authors, equipment suppliers, private tutors, academic societies.

Career pathways

Graduate study (physics, engineering, **others**), employment in public or private sectors (STEM or **non-STEM fields**).

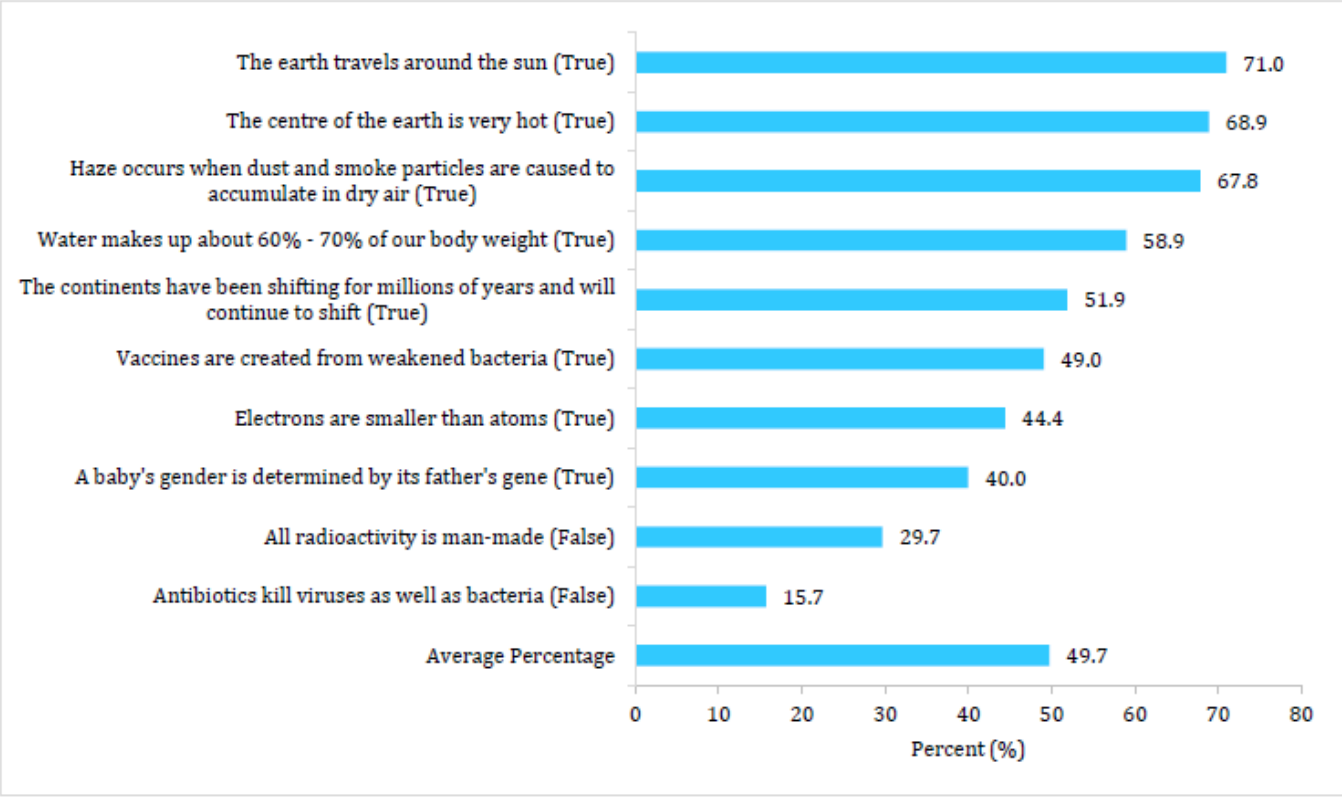
Formal channels

PRIMARY EDUCATION A subtopic	LOWER SECONDARY A subtopic	UPPER SECONDARY Own subject	PRE-UNIVERSITY Own subject
Physical science Magnets Light and dark Electricity Measurements Density Properties of light Sounds Energy Electricity Heat Force Speed **Earth and space** Earth Solar System Lunar phases and constellations Eclipses	**Energy and sustainable living** Light and optics Electricity and magnetism Force and motion Heat Sound waves Electrical power and generation Energy and power Radioactivity **Exploration of Earth and space** Earth structure and processes Stars and galaxies Solar System Meteoroid, asteroid and comets	Measurements Force and motion I Gravitation Heat Waves Light and optics Force and motion II Pressure Electricity Electromagnetism Electronics Nuclear physics Quantum physics	Mechanics and thermodynamics Electricity and magnetism Oscillations and waves, optics and modern physics

*Reference: Dokumen Standard Kurikulum dan Pentaksiran, Ministry of Education Malaysia.

Informal channels

Figure 4.1: Correct Answers to Questions on STI Concepts and Ideas



*Reference: Public Awareness of Science, Technology and Innovation Report 2019, MOSTI.

Figure 7.7: Top 5 Most Trusted Sources of STI Information among Malaysians

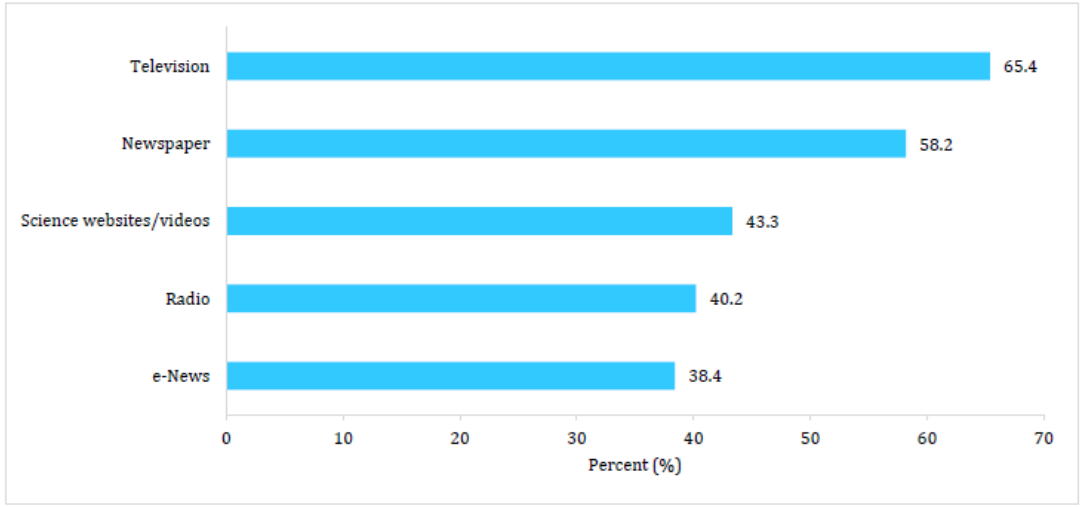
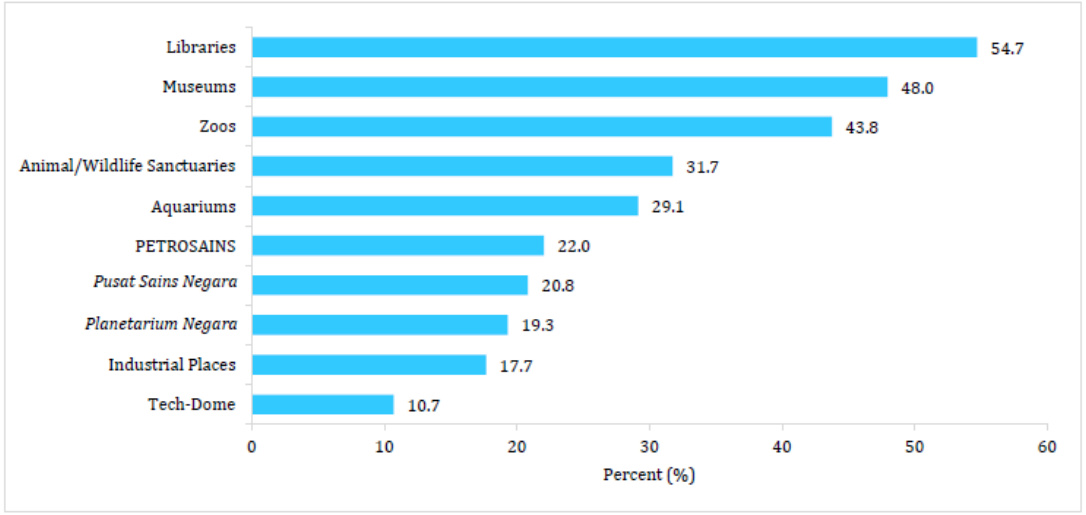
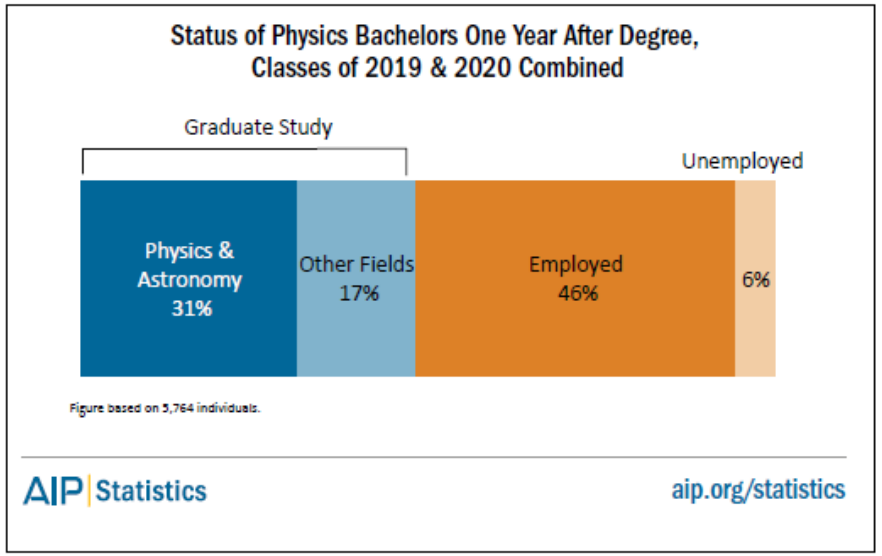
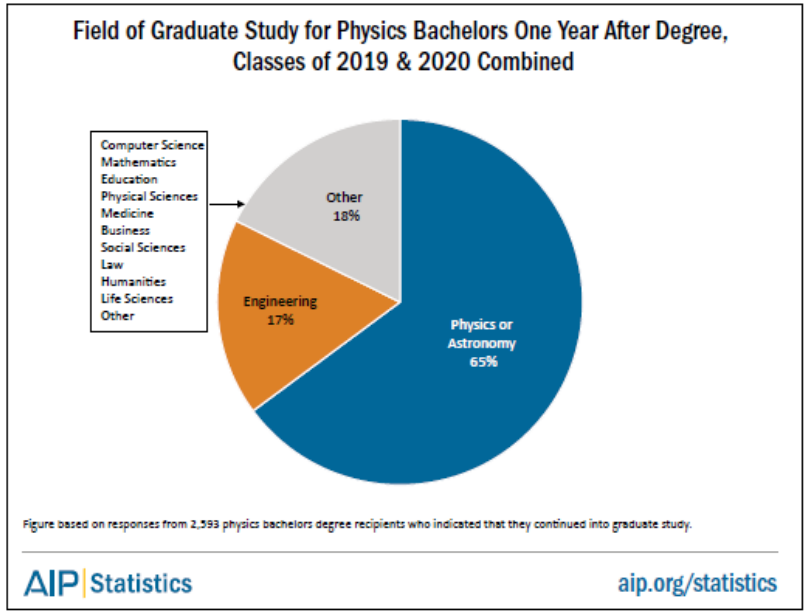
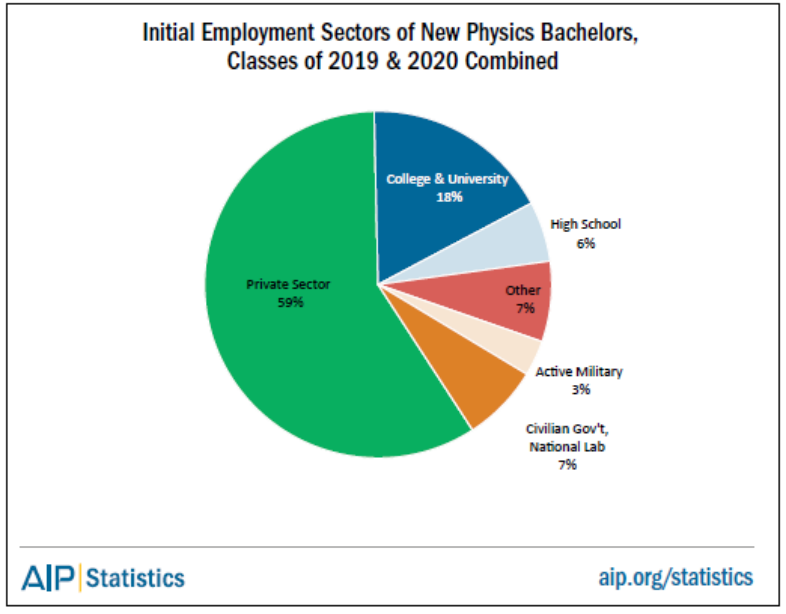


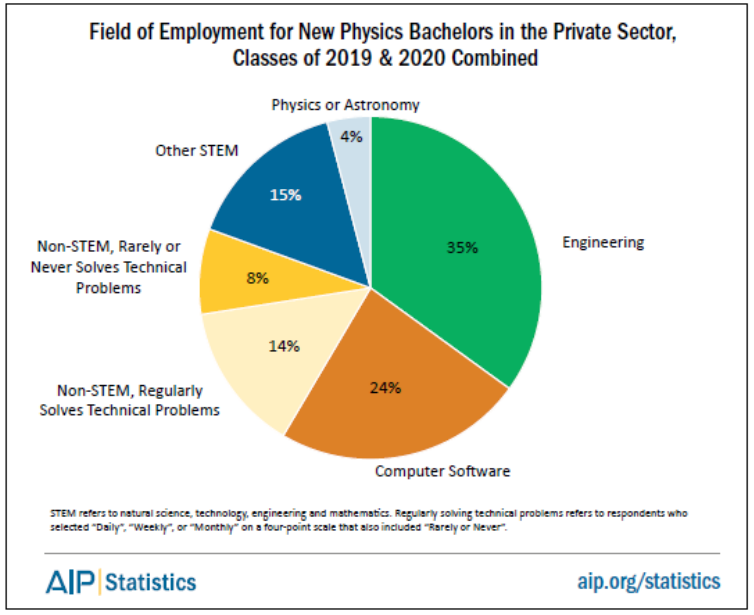
Figure 7.13: STI Places Visited by Malaysians in the Last 12 Months











*Reference: American Institute of Physics Statistical Research Center.

Physics education indicators

Data from surveys by local and international agencies.

- Public Awareness of Science, Technology & Innovation Malaysia (2019)
- Public Views about Science (2020)
- Program for International Student Assessment (2018)

Data from public examinations.

- SPM
- STPM

Data from course enrollments.

- University physics programs

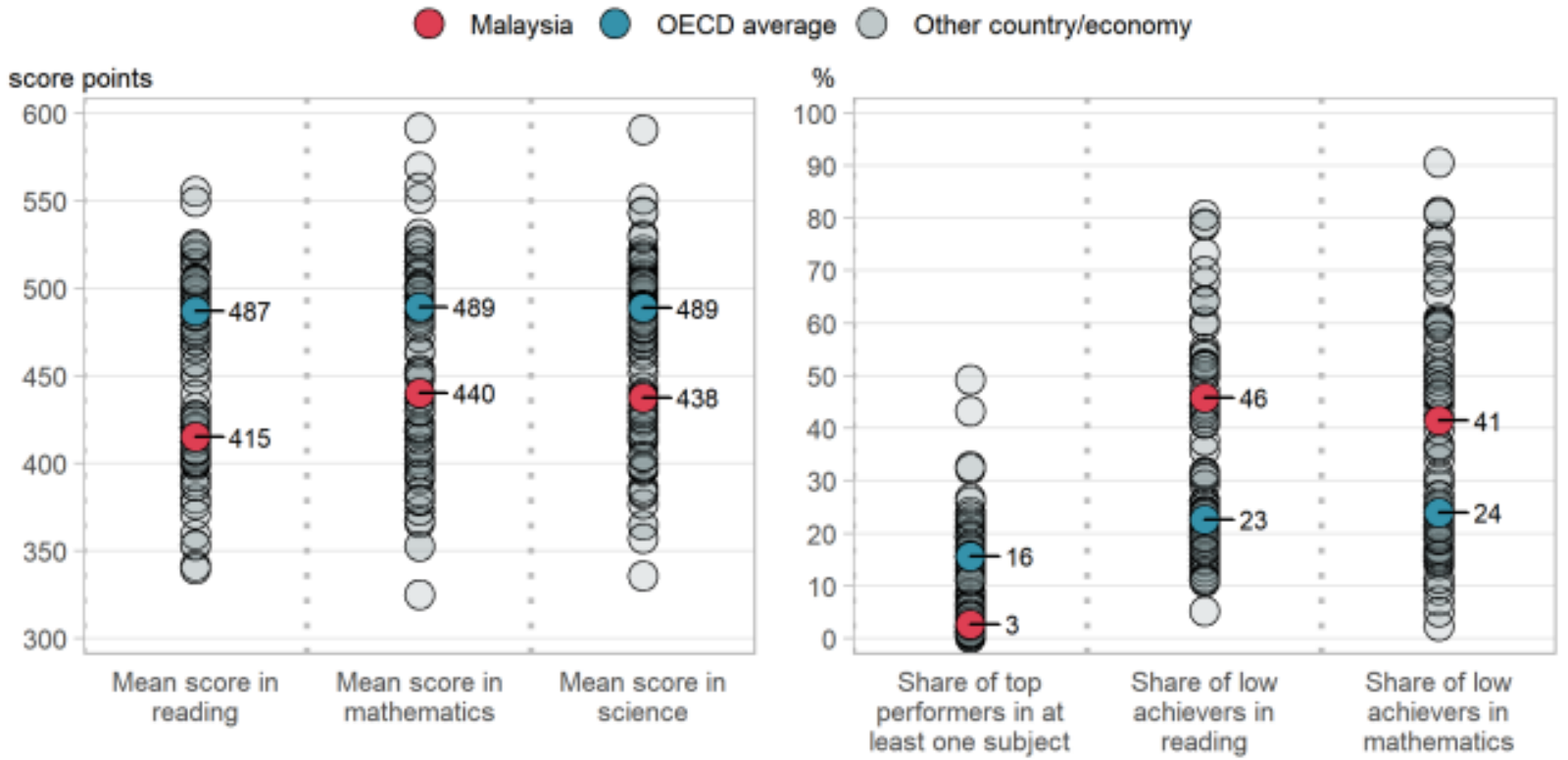
Data from media visibility.

- Popular issues
- Pseudoscience

Surveys

What 15-year-old students in Malaysia know and can do

Figure 1. Snapshot of performance in reading, mathematics and science



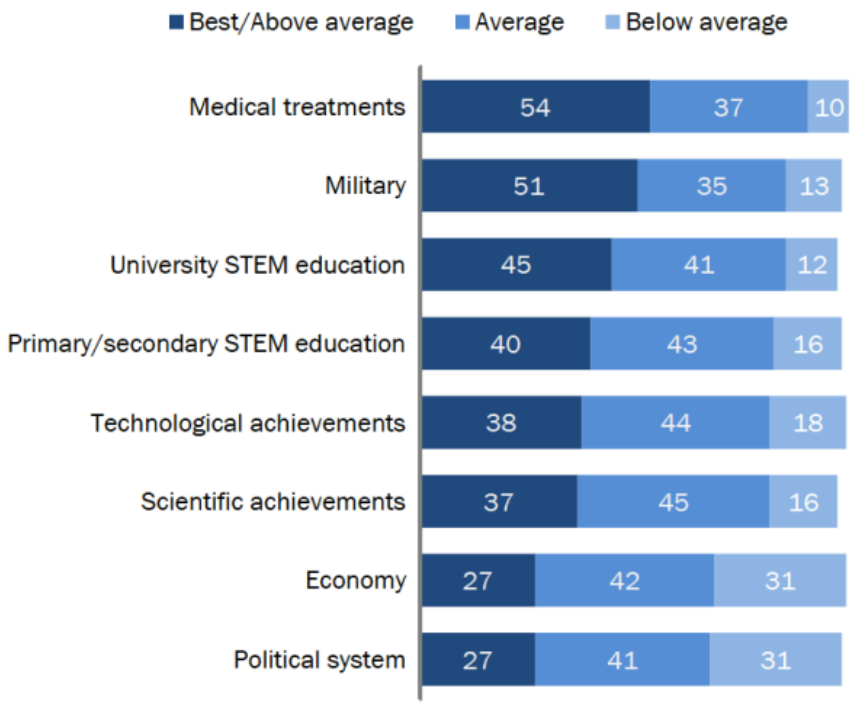
Note: Only countries and economies with available data are shown.
Source: OECD, PISA 2018 Database, Tables I.1 and I.10.1.

*Reference: Results from PISA 2018 Country Note – Malaysia, Organisation for Economic Co-operation and Development.

Surveys

Views on how Malaysia compares on medical treatments, scientific achievements and more

% of Malaysian adults who say Malaysia is __ in the following areas

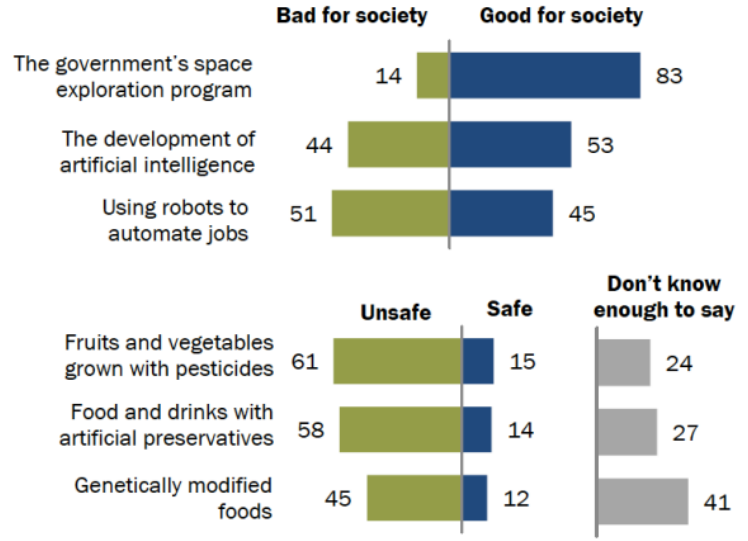


Note: Respondents who did not give an answer are not shown.
Source: International Science Survey 2019-2020. Q4a-h.
"Science and Scientists Held in High Esteem Across Global Publics"

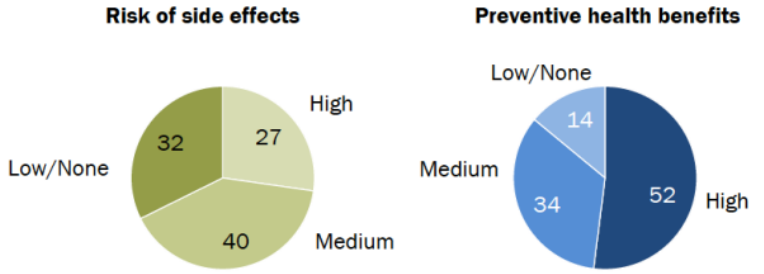
PEW RESEARCH CENTER

Opinions on science-related issues, from AI to food to childhood vaccines

% of adults in Malaysia who say the following



Rating childhood vaccines for diseases such as measles, mumps and rubella



Note: Respondents who gave other responses or did not give an answer are not shown.
Source: International Science Survey 2019-2020. Q11a-c, Q16a-b, Q18, Q19, Q20.
"Science and Scientists Held in High Esteem Across Global Publics"

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Examinations

Kod	Mata Pelajaran	Tahun	Peratusan Calon					Bil. Duduki	GPMP
			Cemerlang A+, A, A-	Kepujian B+, B, C+, C	Lulus DE	A+→E	Gagal G		
4531	Fizik	2021	23.6	53.9	21.7	**99.2**	**0.8**	90,583	4.40
4531	Physics	2020	23.6	56.9	18.7	**99.2**	**0.8**	93,728	4.27
		2019	23.4	58.5	17.3	**99.2**	**0.8**	97,759	4.25
		Beza	**0.2**	**-1.6**	**1.4**	**0.0**	**0.0**	**-4,031**	**0.02**

*Reference: Laporan Analisis Keputusan Sijil Pelajaran Malaysia 2020 dan 2021, Lembaga Peperiksaan Malaysia.

Examinations

For Semester 1, 1 795 candidates sat for the examination of this subject and 62.00% of them obtained a full pass.

The achievement of the candidates for this subject according to grades is as follows:

Grade	A	A–	B+	B	B–	C+	C	C	D+	D	F
Percentage	10.03	5.35	9.30	9.30	8.86	8.30	10.86	3.40	10.19	3.68	20.72

For Semester 2, 1 782 candidates sat for the examination of this subject and 60.38% of them obtained a full pass.

The achievement of the candidates for this subject according to grades is as follows:

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	10.61	4.26	5.11	4.94	10.66	13.02	11.78	6.85	5.72	3.14	23.91

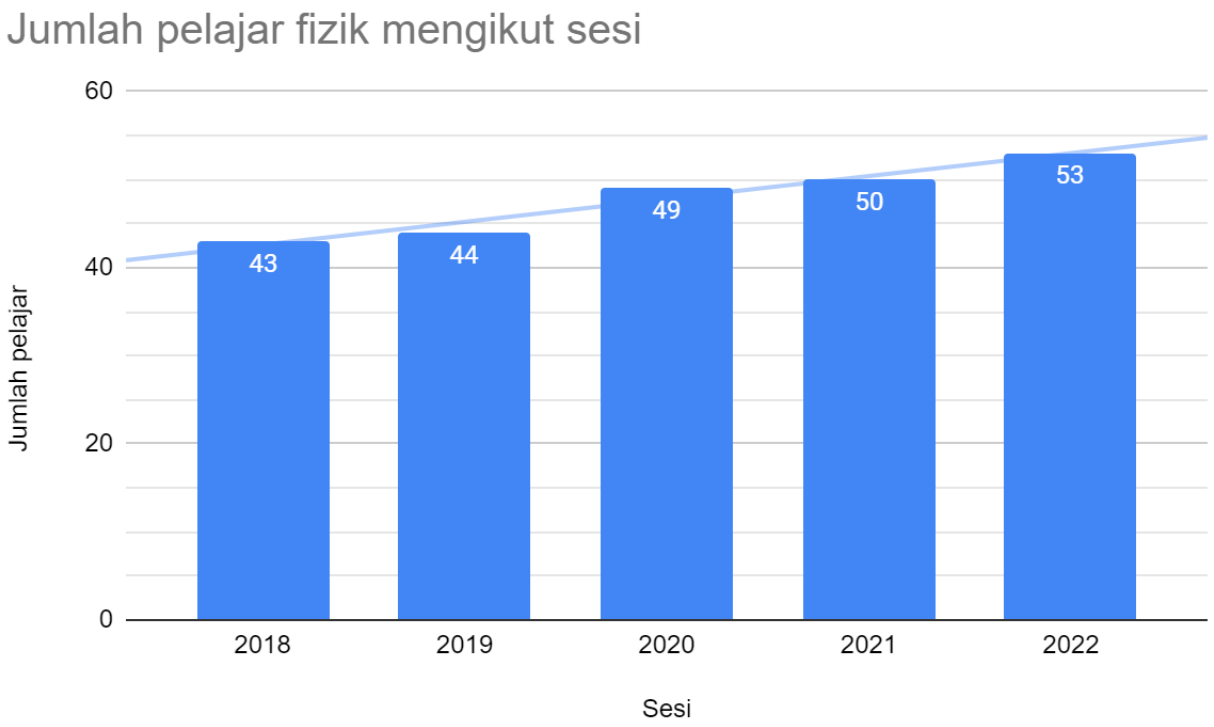
For Semester 3, 1 783 candidates sat for the examination of this subject and 55.18% of them obtained a full pass.

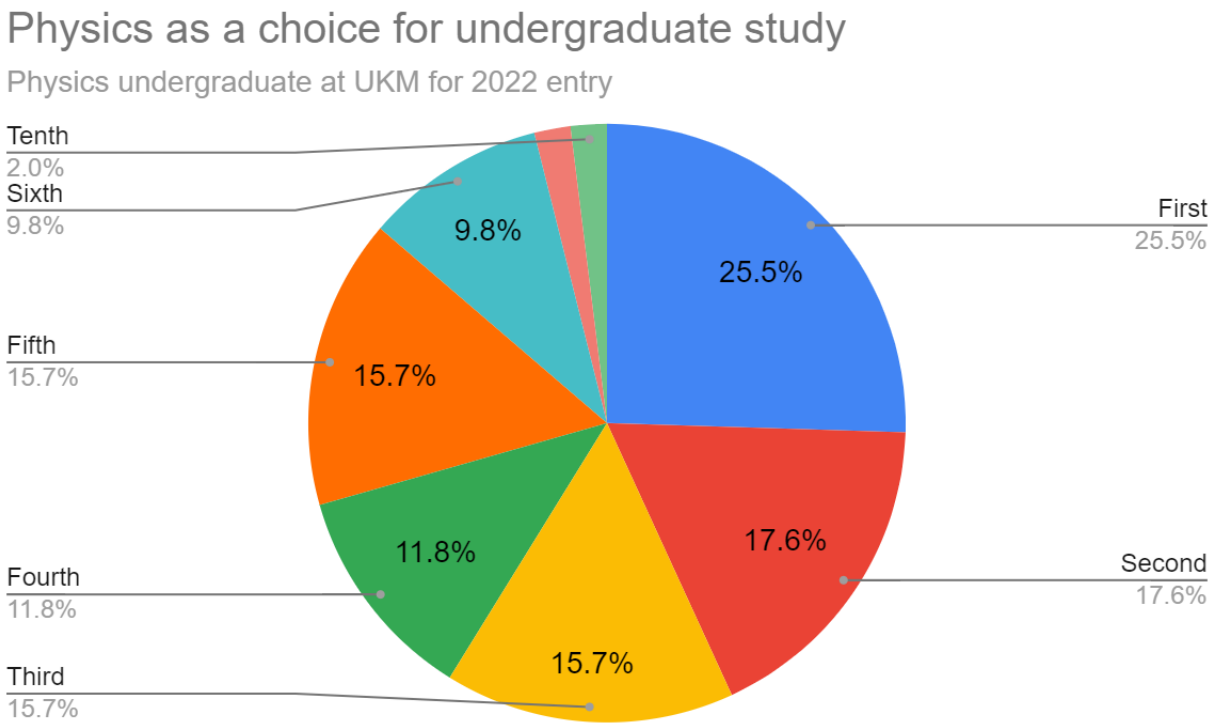
The achievement of the candidates for this subject according to grades is as follows:

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	9.20	5.27	6.79	6.39	9.14	7.85	10.54	5.55	5.66	5.95	27.65

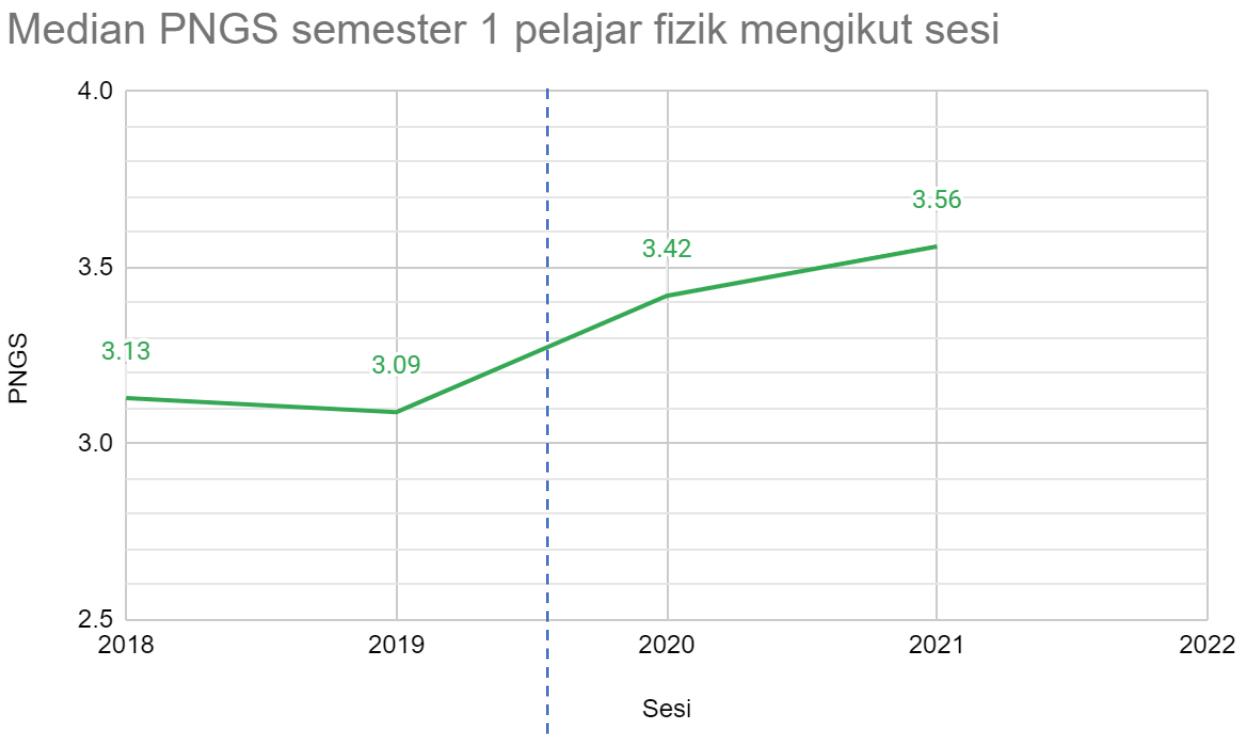
*Reference: Laporan Peperiksaan STPM 2020, Majlis Peperiksaan Malaysia.

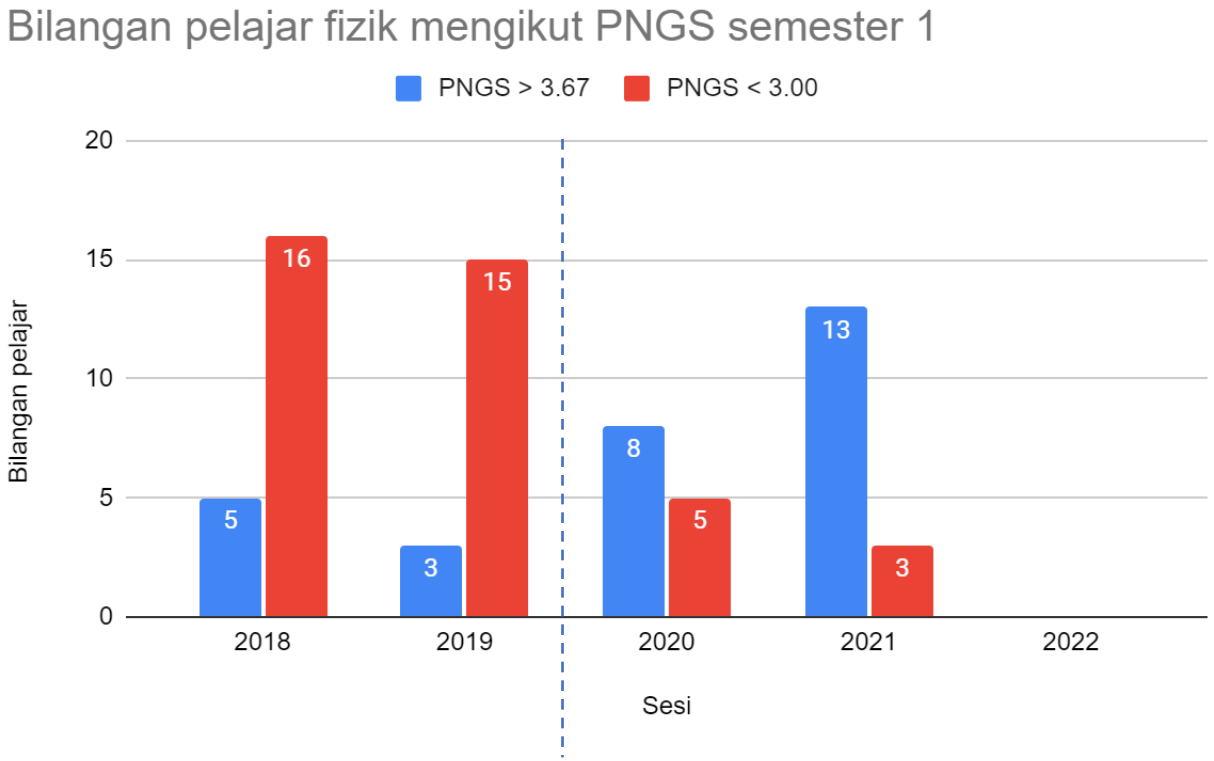
Enrollment


Jumlah pelajar fizik mengikut sesi
60
40
20
0
Jumlah pelajar
43
44
49
50
53
2018
2019
2020
2021
2022
Sesi

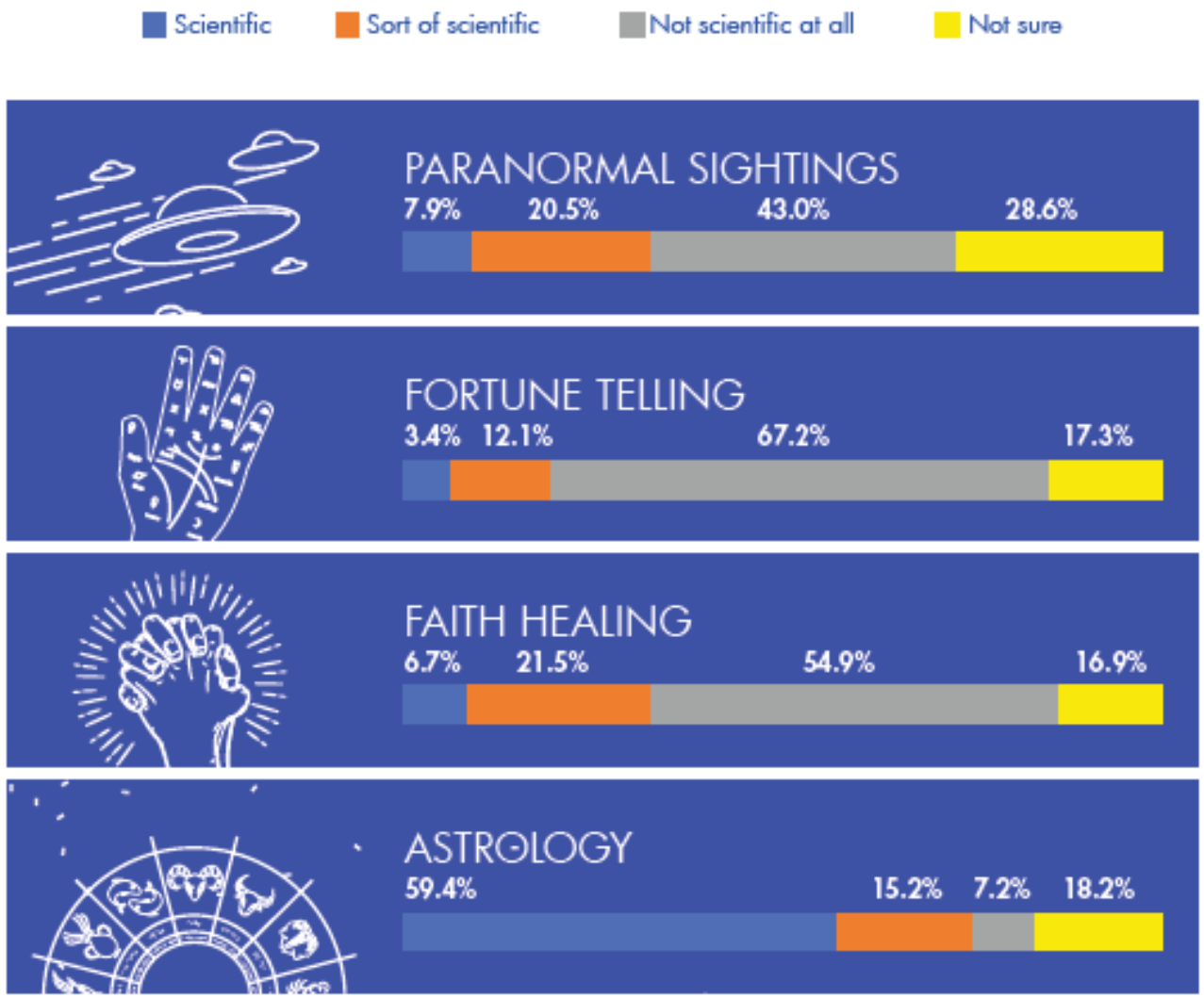

Physics as a choice for undergraduate study
Physics undergraduate at UKM for 2022 entry
Tenth
2.0%
Sixth
9.8%
Fifth
15.7%
Fourth
11.8%
Third
15.7%
First
25.5%
Second
17.6%
25.5%
17.6%
15.7%
11.8%
15.7%
9.8%

Enrollment


Median PNGS semester 1 pelajar fizik mengikut sesi
PNGS
4.0
3.5
3.0
2.5
3.13
3.09
3.42
3.56
2018
2019
2020
2021
2022
Sesi


Bilangan pelajar fizik mengikut PNGS semester 1
PNGS > 3.67
PNGS < 3.00
Bilangan pelajar
20
15
10
5
0
16
15
5
3
8
5
13
3
2018
2019
2020
2021
2022
Sesi

Media visibility



*Reference: Public Awareness of Science, Technology and Innovation Report 2019, MOSTI.

Main issues in physics education

Students – quantity, **quality**, career feasibility

Educators – quantity, **intellectual preparedness**, renumeration

Public – perception, understanding

How has the pandemic influenced the quality of physics education?

Conclusion. Physics in Malaysia has an **identity/image** problem – What is it for? How does it serve the needs of the nation?

Background

"In recognition of the growing significance of physics in all fields of science and technology, and in the general education of young people, and with the aim of enhancing the development of international contacts in the field of school education in physics, an annual physics competition has been organized for secondary school students. The competition is called the International Physics Olympiad and is a competition between individuals."

The International Physics Olympiad (IPhO) is the highest physics competition for high school students.

Background

It is one of the international science Olympiads.

The first competition was held in 1967 in Poland.

Each country may send one national team.

One national team consists of five students and two team leaders.

The students must be under the age of 20 by 30th June in the year of the competition to compete (upper age limit).

Is there a lower age limit?

The team leaders must have a background in university physics.

What does a team leader do?

Background

Background

Physics have both theoretical and practical aspects.

Students are expected to apply what they know to new situations, critically and creatively.

- Theoretical examination (solve 3 structured problems in 5 hours)
- Experimental examination (perform 2 experiments in 5 hours)

What is the expected level of IPhO problems?

- IPhO syllabus ≈ first year undergraduate physics.
- Pre-university: STPM, IB, A-levels, Asasi Pintar UKM, UEC.
- Mathematical background: calculus.
- Experimental skills: measurement, data analysis, error analysis.
- Time management.

Background

Timetable of competition:

1. Programme of IPhO 2015

Day and Date	For Contestants	For Leaders
Saturday, July 4	Arrival (Check-in after 14:00 hrs) and Registration	
Sunday, July 5	Registration (08:00 hrs) and Opening Ceremony (16:00 - 19:00 hrs)	
Monday, July 6	Excursion	Experiment Discussion
Tuesday, July 7	Experiment Examination	Excursion
Wednesday, July 8	Excursion	Theory Discussion
Thursday, July 9	Theory Examination	Excursion
Friday, July 10	Excursion	Excursion
Saturday, July 11	Excursion	Moderation and IB meeting
Sunday, July 12	Closing Ceremony (10:00 - 13:00 hrs) and Departure	
Monday, July 13	Departure (Check-out before 12:00 hrs)	

Background

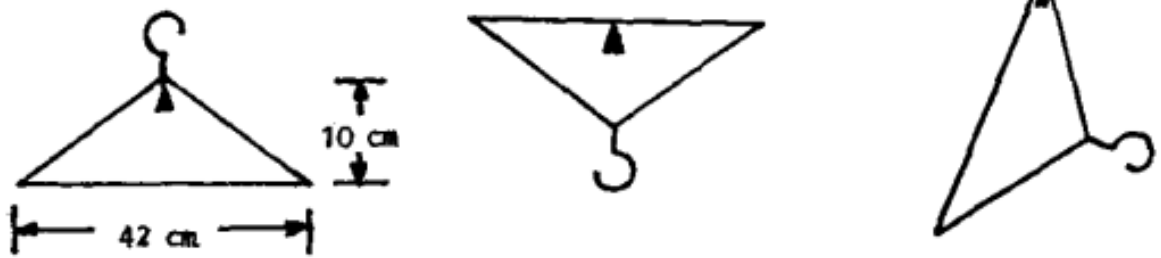
Sample theoretical problem:

Problem 2: Oscillating coat hanger

A (suitably made) wire coat hanger can perform small amplitude oscillations in the plane of the figure around the equilibrium positions shown. In positions a) and b) the long side is horizontal. The other two sides have equal length. The period of oscillation is the same in all cases.

What is the location of the center of mass, and how long is the period?

a) b) c)



Background

Sample theoretical problem:

2 Motion of a charged ball

A solid, homogeneous spherical ball of mass m and radius R is made of insulating material and has charge Q distributed uniformly throughout its volume. The ball is placed on a large horizontal surface, and set in rolling motion without slipping in such a way that its center starts to move with initial horizontal velocity v_0. There is a uniform magnetic field (flux density) of magnitude B perpendicular to the surface. The coefficient of static friction is large enough to prevent the ball from slipping on the surface. The moment of inertia of the ball about an axis through its center is $2mR^2/5$.

Describe the motion of the center of the ball and the shape of its trajectory.

Hint: Depending on your approach you may use the following identity:

$$\vec{a} \times (\vec{b} \times \vec{c}) = \vec{b}\,(\vec{a} \cdot \vec{c}) - \vec{c}\,(\vec{a} \cdot \vec{b})$$

valid for any three vectors $\vec{a}$, $\vec{b}$ and $\vec{c}$.

Background

Sample experimental problem:

Theory

A laser beam of wavelength λ, falling normally on a cylindrical wire of diameter a, is diffracted in the direction perpendicular to the wire. The resulting intensity pattern as observed on a screen is shown in Fig. 7.

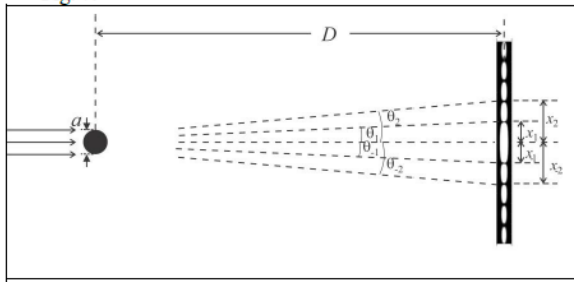


Figure 7: Schematic of the diffraction pattern due to single cylindrical wire of diameter a.

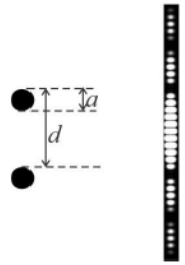


Figure 8: Schematic of diffraction pattern due to two cylindrical wires

The intensity distribution as a function of angle θ with the incident direction is given by

$$I(\theta) = I(0)\left[\frac{\sin\beta}{\beta}\right]^2 \quad \text{where } \beta = \frac{\pi a \sin\theta}{\lambda}$$

The central spot is bright and for other angles, when $\sin\beta$ ($\beta \neq 0$) is zero, the intensity vanishes. Thus the intensity distribution has n^{th}minimum at the angle θ_n, given by

$$\sin\theta_n = \pm n\frac{\lambda}{a} \qquad n = 1, 2, 3, 4, 5 \ldots.$$

Here $\pm$ refers to both sides of the central spot ($\theta = 0$).

The diffraction pattern due to two parallel identical wires kept at a distance d from each other (Fig. 8) is a combination of two patterns (diffraction due to a single wire and interference due to two wires). The resultant intensity distribution is given by,

$$I(\theta) = I(0)\cos^2\delta\left[\frac{\sin\beta}{\beta}\right]^2$$

where $\delta = \frac{\pi d \sin\theta}{\lambda}$ and $\beta = \frac{\pi a \sin\theta}{\lambda}$

Diffraction due to Helical Structure[1]

(Total marks: 10)

Introduction

The X-ray diffraction image of DNA (Fig. 1) taken in Rosalind Franklin's laboratory, famously known as "Photo 51", became the basis of the discovery of the double helical structure of DNA by Watson and Crick in 1952. This experiment will help you understand diffraction patterns due to helical structures using visible light.

Objective

To determine geometrical parameters of helical structures using diffraction.

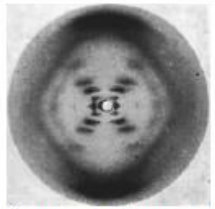


Figure 1: Photo 51

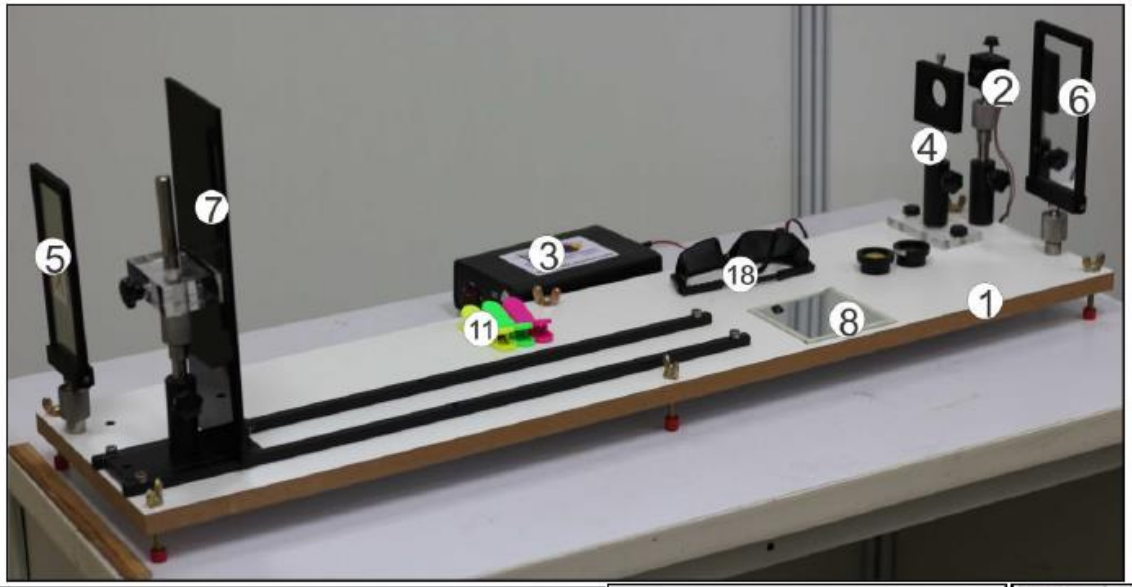


Figure 2: Apparatus for E-I

Background

Sample experimental problem:

1 Hidden Charge

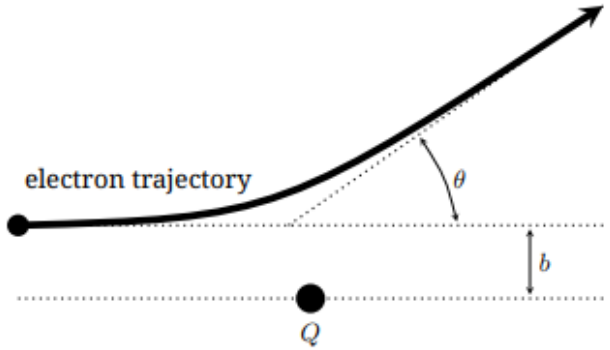
1.1 Introduction

An unknown point charge Q is fixed in a region of space. Electrons launched parallel to the z axis far from the charge will scatter electrostatically off of the fixed charge and strike a detecting screen. It is possible learn about the details of the hidden charge by varying the initial kinetic energy as well as the initial x_i and y_i coordinates of the electron beam and measuring the final coordinates x_f and y_f of where an electron strikes a finite flat screen perpendicular to the z axis and located at $z = 0$.

It is useful to know the Rutherford scattering formula,

$$b = \frac{kqQ}{2E}\frac{1}{\tan(\theta/2)}$$

where b is the impact parameter, E is the energy of the electron, $q = -1.602 \times 10^{-19}\mathrm{C}$ is the charge of the electron, $k = 8.99 \times 10^{9}\ \mathrm{Nm^2/C^2}$, and θ is the scattering angle. The impact parameter is defined as the closest approach of the electron to the target, assuming that the electron were unaffected by the target and hence would move in a straight line; the scattering angle is angle between the original velocity vector of the electron far from the target and the final velocity vector of the electron far from the target after scattering.



1.2 Task

The task is to determine the position (x_Q, y_Q, z_Q) and also the magnitude and sign of the fixed charge Q, as precisely as possible. You should provide rough, order of magnitude error estimates on these results. There is Gaussian error associated with initial beam location that is on the order of 0.5 mm.

As with all experiments, you must provide clearly labelled tables of data, clearly labelled graphs, and sufficient formulae derivations to make it clear what you have measured, and how you are deriving your results.

Background

Comparison between STPM questions and IPhO problems.

STPM problems	IPhO problems
Smaller scope of topics: • No rotation in mechanics. • No special relativity in modern physics.	Broader scope of topics: • Rotation of rigid bodies included. • Special relativity in modern physics.
One problem focused on a single topic.	One problem involving many topics. • Radiation and particles from the Sun. • Large Hadron Collider.
Algebra is the default, minimal calculus.	Calculus is the default.
Practicals are guided, not timed and in groups/pairs.	Practicals are open-ended, timed and individual.
Using known formulas to solve old problems.	Using known concepts to solve new problems.

Malaysia's participation

Since 2001, the Physics Education Subgroup, Institut Fizik Malaysia was responsible for the selection, training and competing stages, especially under the leaderships of Mr. Chia Song Choy and Prof. Lim Swee Cheng.

Until 2010, Kuiz Fizik Kebangsaan represented the first selection stage.

Malaysia's participation

Now, the Malaysia Physics Olympiad Committee is based in the Department of Applied Physics, Faculty of Science and Technology, Universiti Kebangsaan Malaysia.

The committee includes representatives from KPM, MARA, USIM, UM, and private schools.

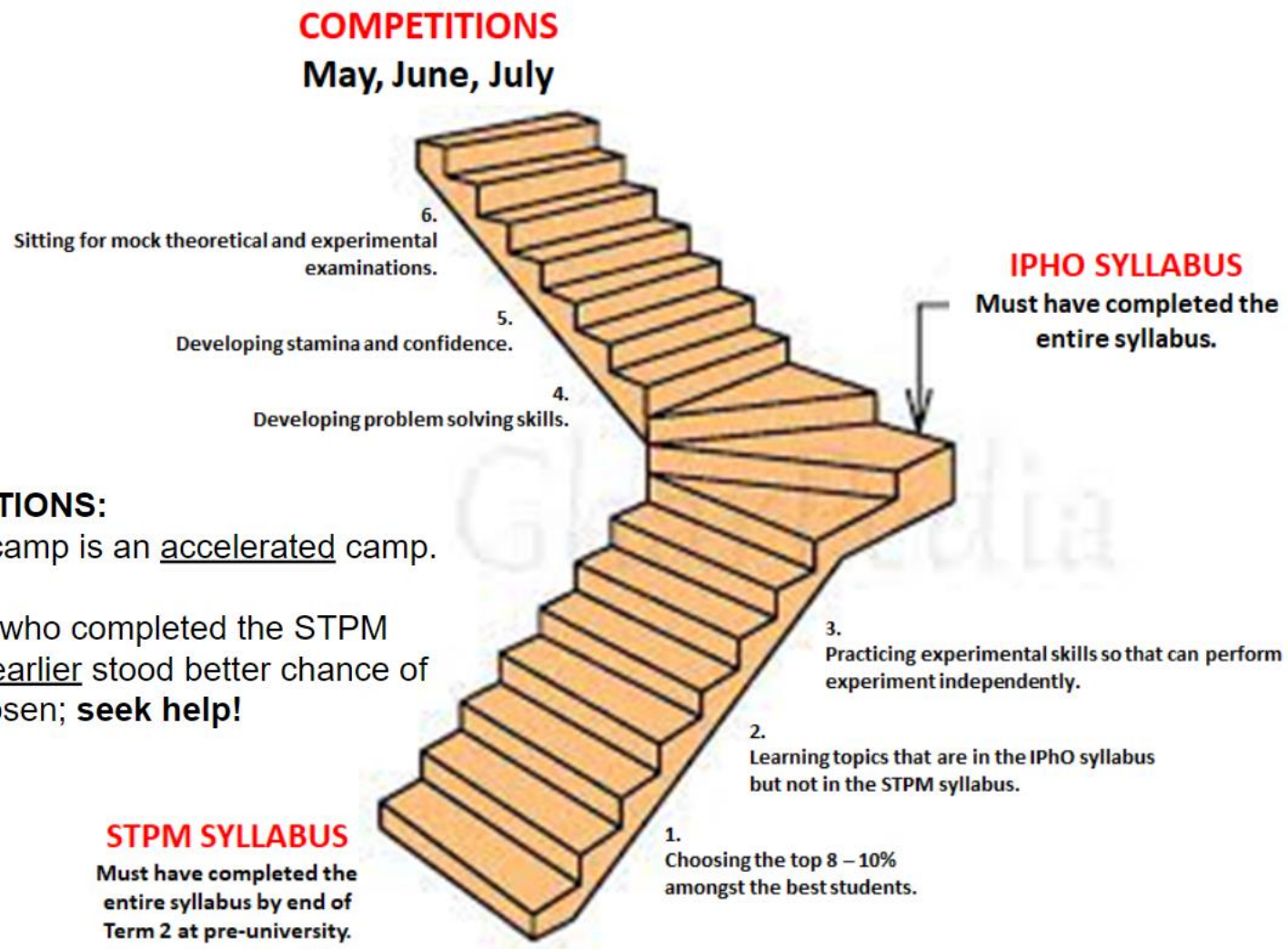
Malaysia's participation

Where students come from?		STPM, Matrikulasi, SPM			MARA, Asasi Pintar UKM, Asasi Sains UM			UEC, A-levels	
Stages	What is it?	Category A			Category B			Category C	What do you get?
0	Announcement by the committee.	Students nominated by teachers.			Students nominated by lecturers.			Students register with the committee.	
1	First selection test	300 students			-			-	National-level KPM certificate for scores > 50%
2	Second selection test	30-40 students			10-20 students			10-20 students	Gold, silver, bronze, HM ranking/KPM certificate
3	Online training camp	10 students			5 students			5 students	
EuPhO		**S1**	**S2**		**S3**	**S4**	**S5**	APhO	International-level KPM certificate
4	Physical training camp	3 students			1 student			1 student	
IPhO		**S1**	**S2**	**S3**	**S4**			**S5**	International-level KPM certificate

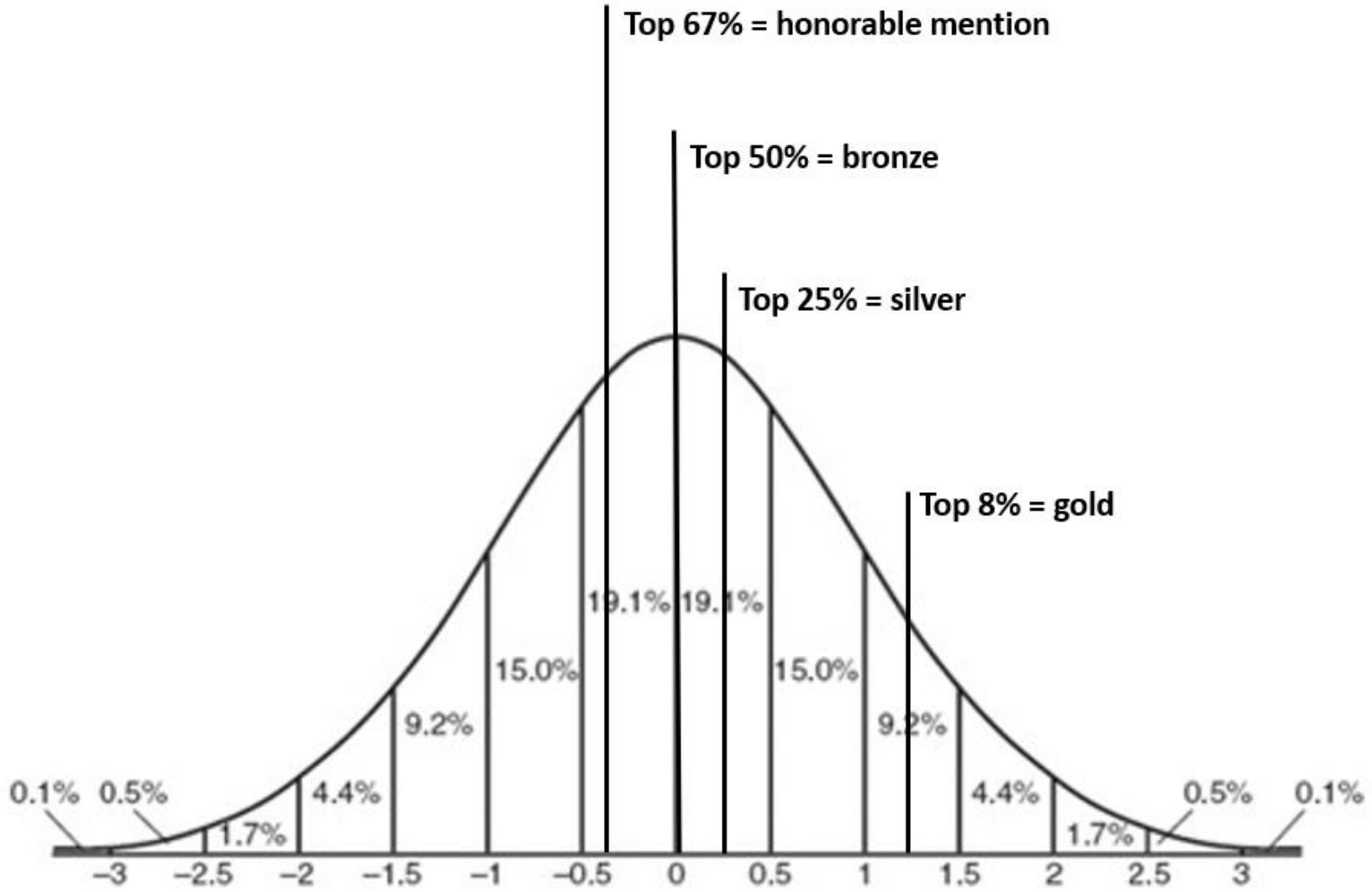
Malaysia's participation

Jan	Feb	March	April	May	June	July
STAGE 0		STAGE 1	STAGE 2	STAGE 3	STAGE 4	
Invitation from host country	Announcement					
Remote training camps	Remote training camps					
		First test Term 1 topics				
			Second test Term 2, 3 topics			
				Online training camps	Online training camps	
				EuPhO		
					Physical training camps	Physical training camps
						IPhO

Malaysia's participation



Malaysia's achievements

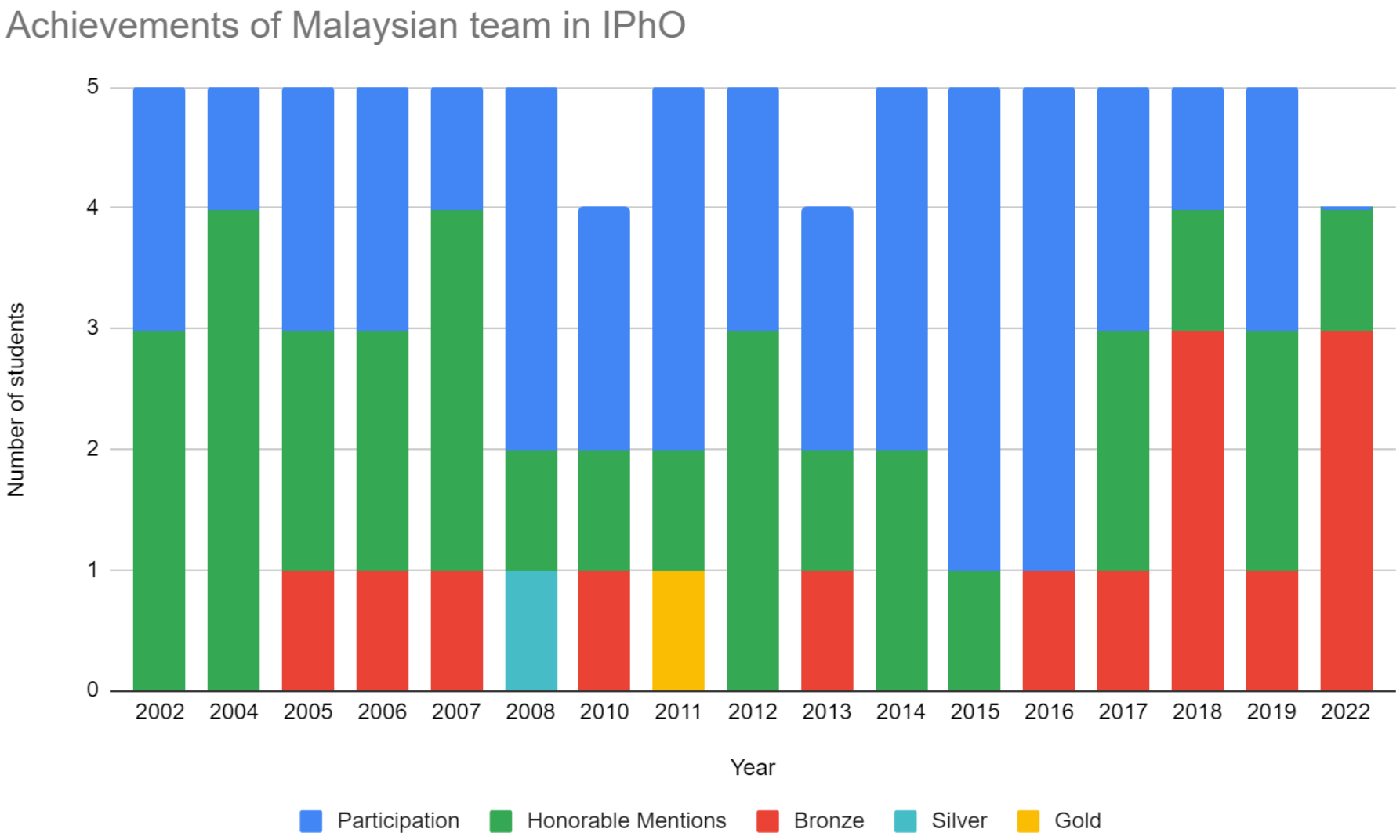


Malaysia's achievements

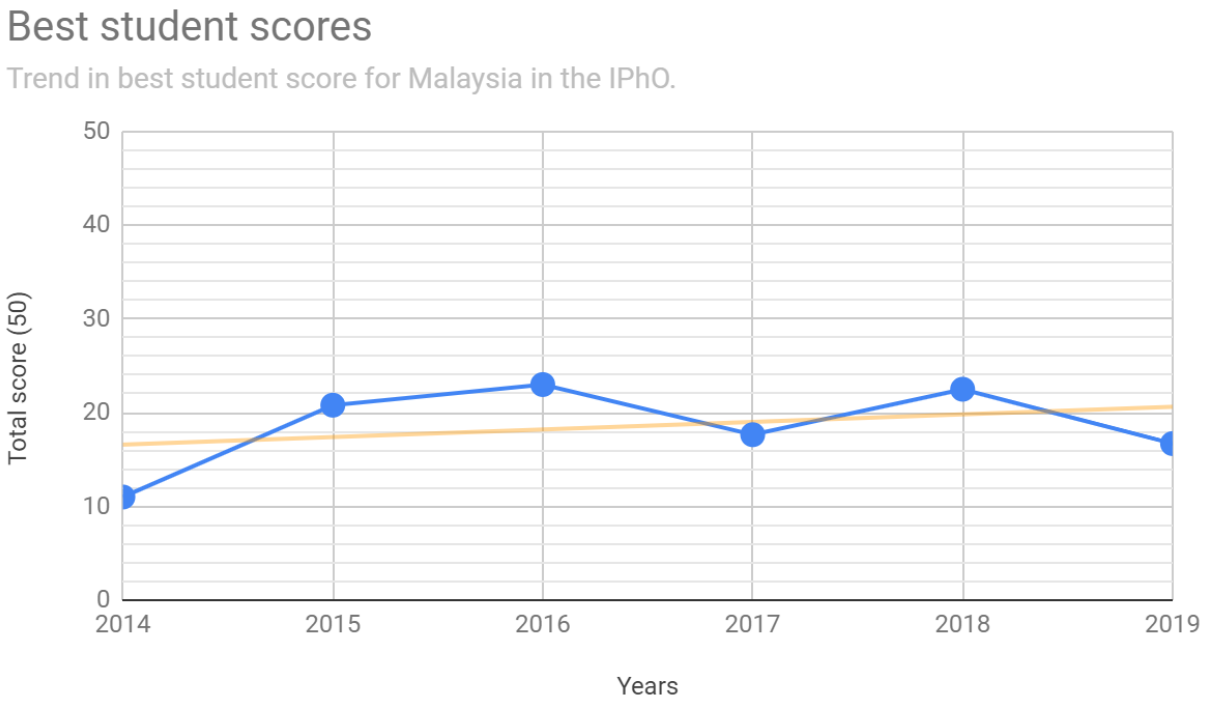
What can we be proud of?

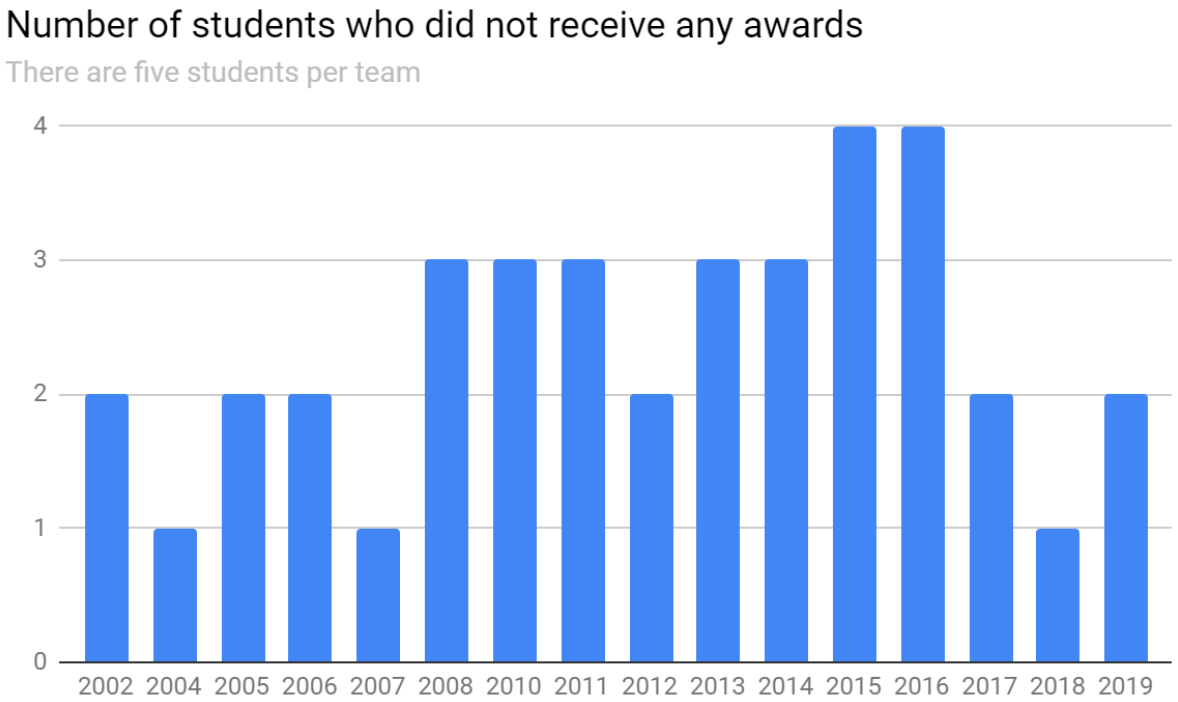
What must we improve?

Malaysia's achievements

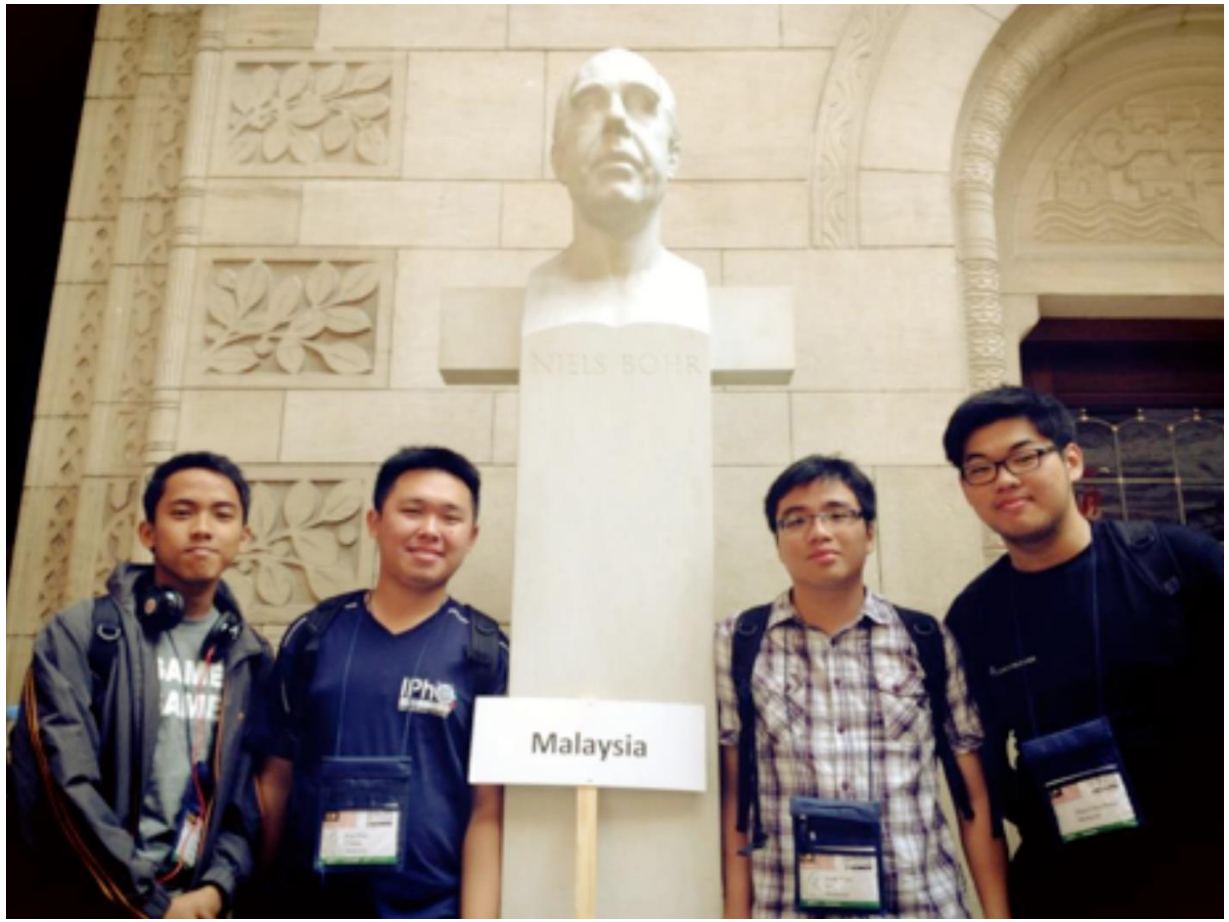


Malaysia's achievements





Malaysia's achievements



Malaysia's achievements

What can we be proud of?

- Short term versus long term
- Individual versus community

	Individual	Community
Short term	*Scholarship*	*Talents*
Long term	*Dedication*	*Talents*

What must we improve?

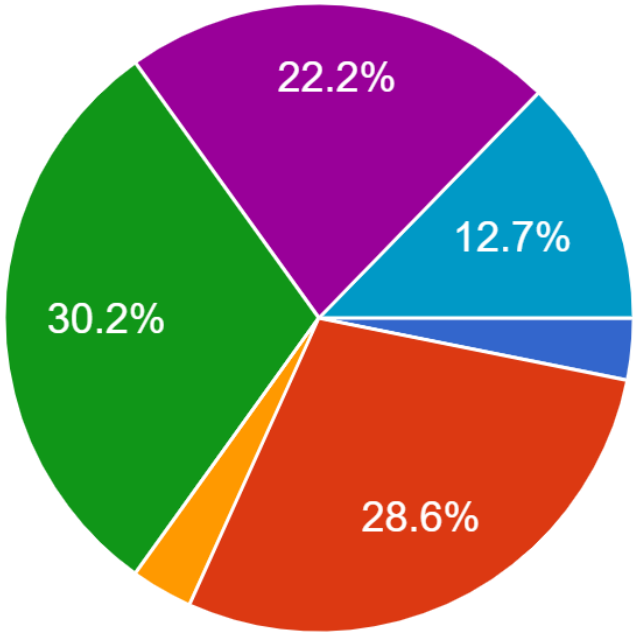
- Governance – "Twilight zone"
- Recognition – What, how and when?
- Investment – Time and energy

Conclusion. What is our end game? To participate, to win medals, to host?

Nurturing talents

Why are you interested to participate in the physics Olympiad?

63 responses



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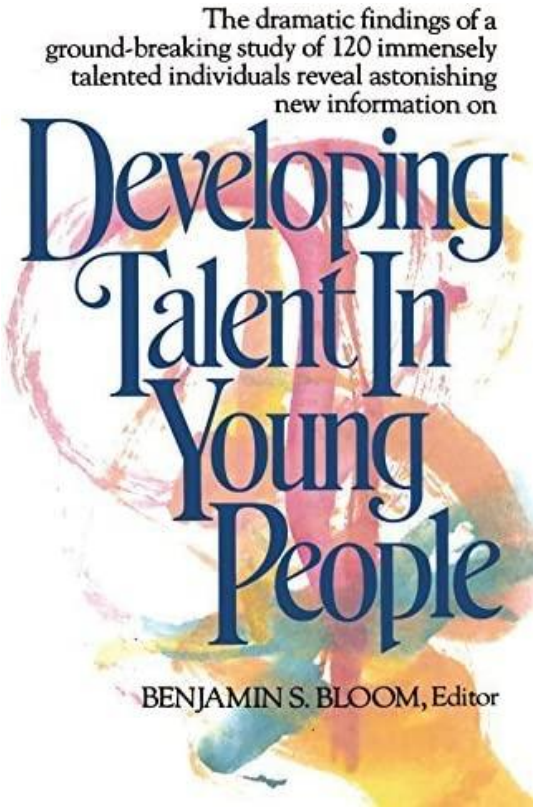
Nurturing talents

First concept. Bloom talent development framework.

Second concept. Science capital.

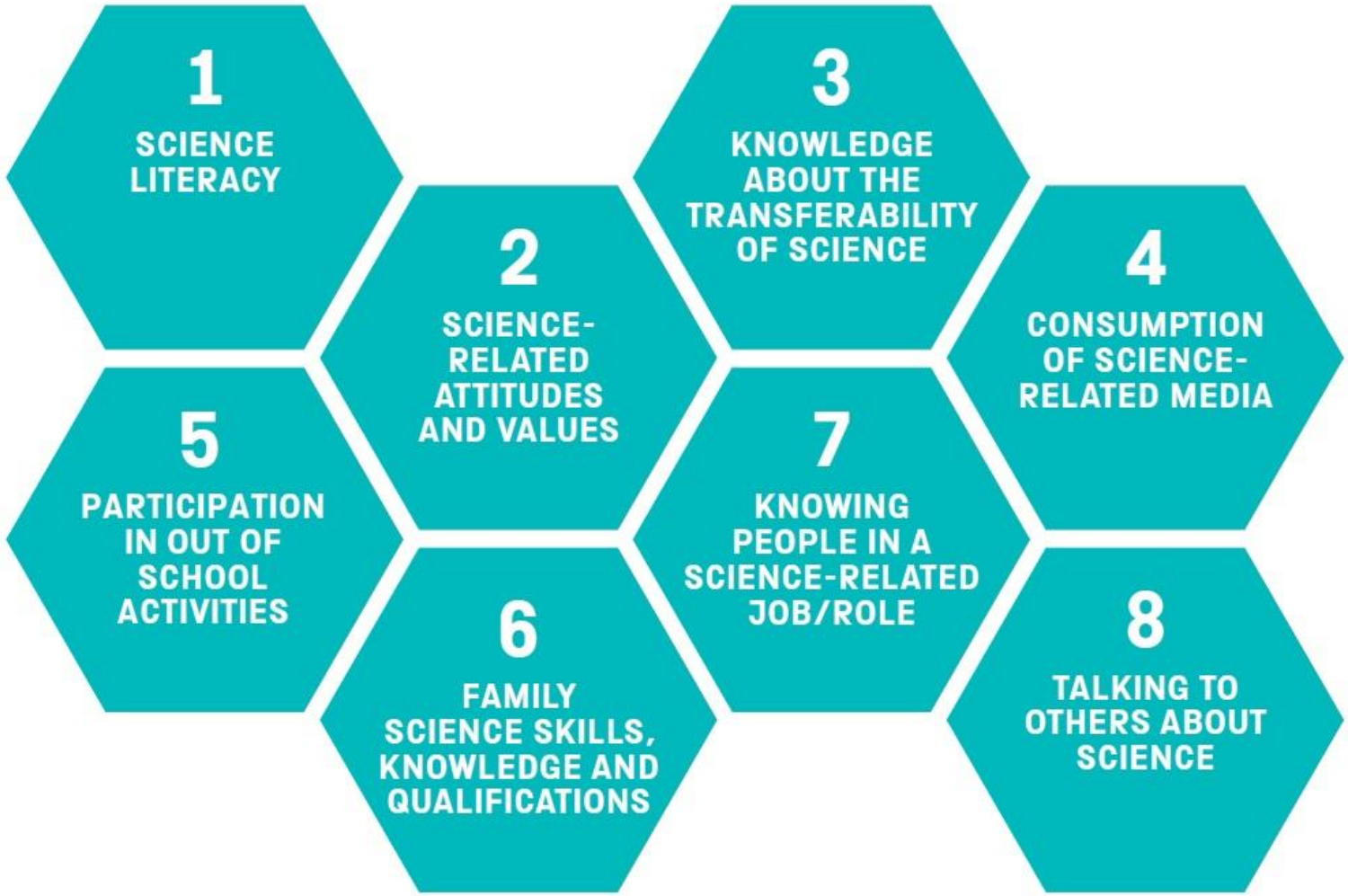
Third concept. Problem solving strategies in physics.

Bloom talent development framework

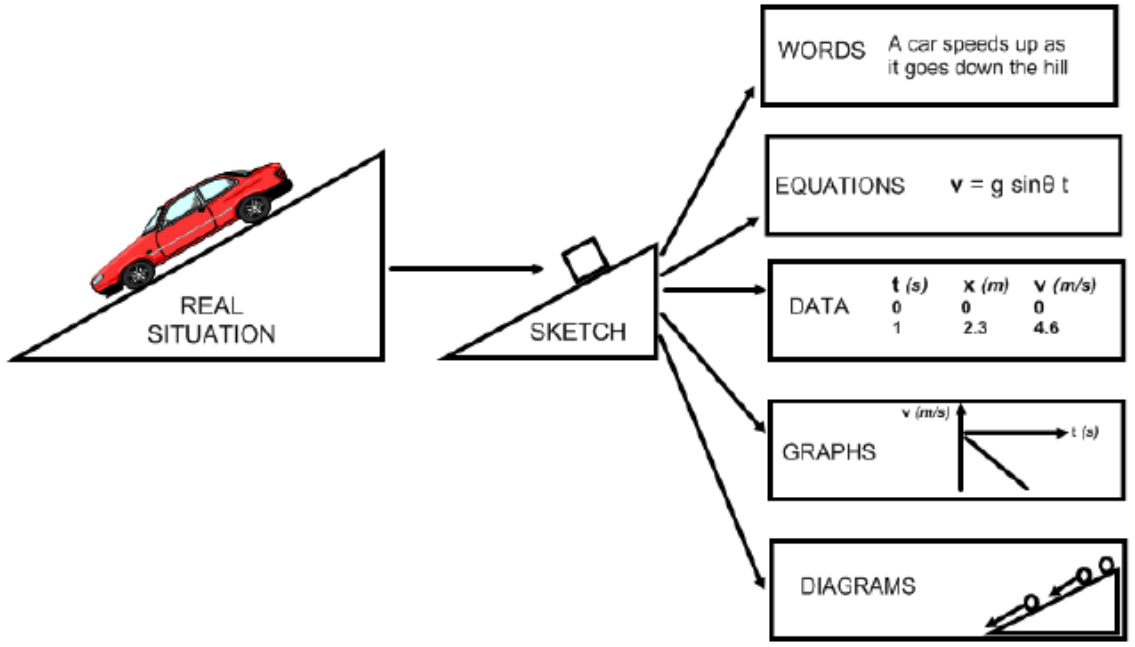


	Stage One ("Early years", Initiation)	Stage Two ("Middle years", Development)	Stage Three ("Later years", Perfection)
Talented person	Joyful, playful, excited, "special"	"Hooked", committed	Obsessed, responsible
Mentor/teacher/ coach	Kind, cheerful, caring, process-centred	Strong, respecting, skilled, demanding, emotionally bonded	Successful, respected/feared
Parents	Shared excitement, supportive, sought mentors, positive	Made sacrifices, restricted activity	

Science capital



Problem solving strategies in physics



Type	Data	Methods	Goals/outcomes
1	Given	Familiar	Given
2	Given	Unfamiliar	Given
3	Incomplete	Familiar	Given
4	Incomplete	Unfamiliar	Given
5	Given	Familiar	Open
6	Given	Unfamiliar	Open
7	Incomplete	Familiar	Open
8	Incomplete	Unfamiliar	Open

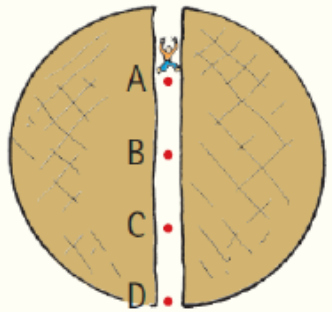
*Reference: A.H. Johnstone, 2001, *Can problem solving be taught?*

Problem solving strategies in physics

Increasing difficulty – requires scaffolding

42. Find the change in the force of gravity between two planets when the distance between them becomes 5 times smaller.
43. Many people mistakenly believe that astronauts who orbit Earth are "above gravity." Calculate g for space shuttle territory, 200 km above Earth's surface. Earth's mass is 6.0×10^{24} kg, and its radius is 6.38×10^{6} m (6380 km). Your answer is what percentage of 9.8 m/s^2?

47. Pretend you fall into a hole bored completely through the Earth. Discounting friction and rotational effects, rank from greatest to least positions A, B, C, and D for your
    a. speed.
    b. acceleration toward Earth's center.



98. Discuss and explain why this reasoning is wrong: "The Sun attracts all bodies on Earth. At midnight, when the Sun is directly below, it pulls on you in the same direction as Earth pulls on you; at noon, when the Sun is directly overhead, it pulls on you in a direction opposite to Earth's pull on you. Therefore, you should be somewhat heavier at midnight and somewhat lighter at noon."

108. If Earth were hollow but still had the same mass and radius, would your weight in your present location be greater than, less than, or the same as it is now? Discuss and explain.
109. A new discussion partner says that the International Space Station is beyond the pull of Earth's gravity, as evidenced by inhabitants in a weightless condition. Correct this misconception.

Common myths

The Physics Olympiad only benefits students.

The Physics Olympiad only benefits gifted students.

The Physics Olympiad is just like any other high school science competition.

The Physics Olympiad is beyond the reach of high school students.

Dispelling the myths

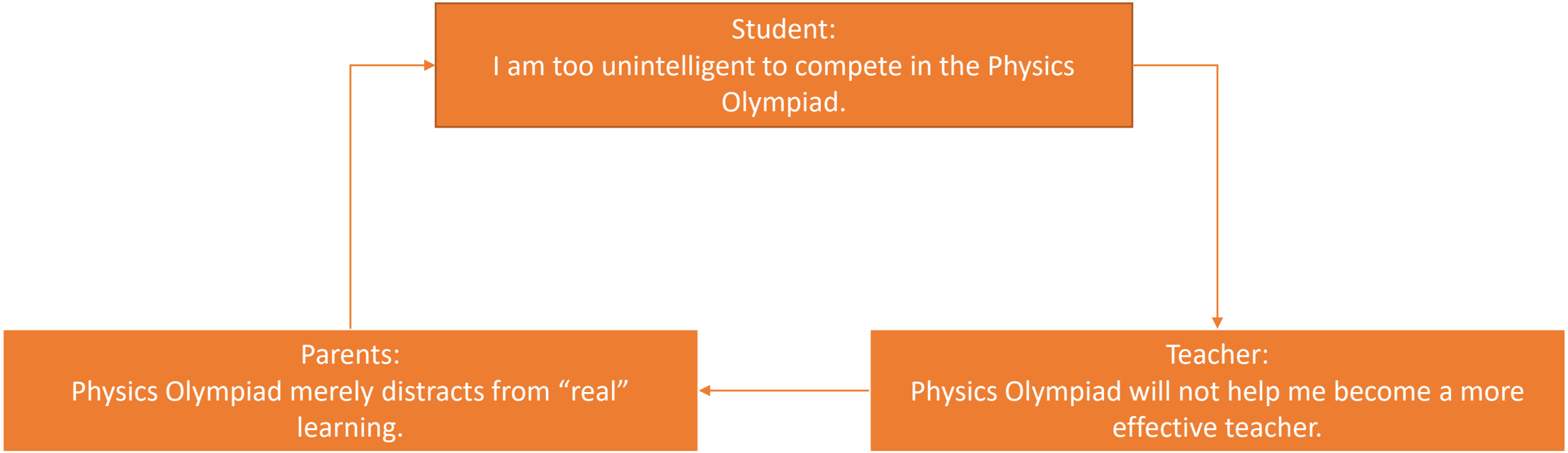
The Physics Olympiad only benefits students.
The Physics Olympiad benefits students, teachers and parents (if they want to).

The Physics Olympiad only benefits gifted students.
The Physics Olympiad attracts all types of students.

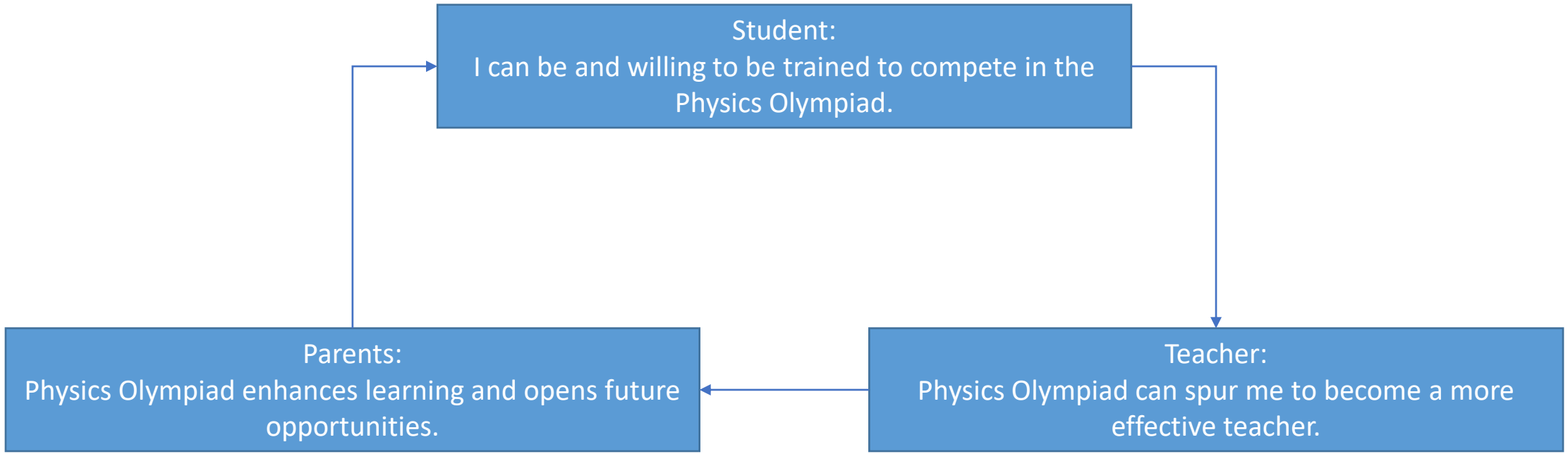
The Physics Olympiad is just like any other high school science competition.
The Physics Olympiad is the highest academic competition for physics.

The Physics Olympiad is beyond the reach of high school students.
The Physics Olympiad is well within the reach of high school students (if trained).

Vicious circle



Virtuous circle



Why are you interested to participate in the physics Olympiad?

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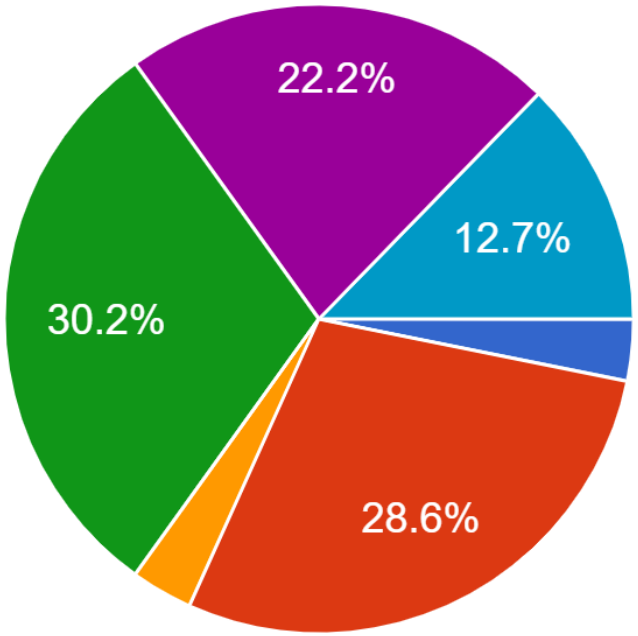

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Onwards to the future

Physics Olympiads is as much about problem solving as it is about physics.

Physics Olympiads brings people together from various sectors in the physics education community for a common cause.

Physics Olympiads contributes to the country's talent pool.

National Selection Tests

IAO - MyAO
Malaysian Astronomy Olympiad

IChO - K3M
Kuiz Kimia Kebangsaan

IEO - Kijang
Kijang Economics Competition

IESO - MyESO
Malaysian Earth Science Olympiad

IJSO - MyJSO
Kancil Science Competition

IMO - IMONST
International Mathematics Olympiad National Selection Test

IOAA - MOAA
Malaysian Olympiad in Astronomy and Astrophysics

IOI - MCC
Malaysian Computing Challenge

IOL - MyCLO
Malaysian Computational Linguistics Olympiad

IPO - PPFPM
Persatuan Pendidikan Falsafah dan Pemikiran Malaysia (PPFPM)

IPhO - OFM
Olimpiad Fizik Malaysia

Onwards to the future

I am interested. How can I participate or contribute?

It fosters a closer relationship between schools, colleges and universities.

In order to secure talents, invest in those who can nurture the talents.

Conclusion. The image problem suffered by physics can be ameliorated through the Physics Olympiad.

"Sekiranya tidak menyertai Olympiad, saya tidak terfikir akan diterima ke Harvard"

AMISO

AMISO

Malaysia in the International Science Olympiads

I HIRE PEOPLE BRIGHTER THAN ME AND THEN I GET OUT OF THEIR WAY

LEE IACOCCA


Thank you.

Extra slides

OPEN ACCESS

PAPER

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iopscience.org/ped

Teaching physics during COVID-19 pandemic: implementation and report of teaching strategies to support student learning

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Abstract

The COVID-19 pandemic presented several challenges to both teachers and students. The rapid shift to an online learning environment demanded the development of effective teaching strategies to support student learning. This work describes teaching strategies developed to teach physics during the COVID-19 period. The strategies included posting recorded lectures and live demonstrations, providing timely resources and feedback on student graded items, enhancing communication, providing additional interactive opportunities, offering extra help sessions and extra credit opportunities to students. Other factors that played a significant role for student success were faculty empathy, flexibility, and willingness to adjust teaching strategies. All students who completed the courses (without withdrawing) earned grades of C or better. Over a total of 12 physics class sections, grade distributions in Fall 2020 were better than those of Fall 2019. Only a handful of students received incomplete grades because they were directly or indirectly affected by the COVID virus. Even though student withdrawal rates were higher during the COVID pandemic, the teaching strategies adopted helped improve student grades across all sections.

Table 1. Challenges that affected student learning process during COVID-19 pandemic.

Challenge	Learning effect
Adjustment to online format	Making learning physics concepts difficult
Remote nature of instruction	No hands-on experience or immediate feedback (FO)
Human-human interaction	Students felt isolated and lost motivation to learn
Technology challenges	Sharing technology with siblings
Learning environment	Distracting family members, lack of focus or interest
Connectivity and technical difficulties	Missed classes, quizzes, added layer of learning difficulty
Lack of peer-to-peer interaction	Lack of exchange of ideas and support
Feedback from distance Student-Teacher engagement	Limited questions, expressing ideas, getting extra help, and showing worked out problem solving by hand.
LockDown Browsers for exams	Added stress, connectivity uncertainty, anxiety

Table 2. Implemented strategies that impacted their learning during COVID-19.

Instructor implemented strategies	Impact on student learning
Pre-lecture recordings	Familiarized with material before class time.
Live recorded lectures	Allowed replaying lectures at their own pace on concepts and problem solving.
Education videos/animations	Clarification of difficult concepts and an additional source of learning.
All content available on D2L	Helped to access and review material at own pace, and stay on track with assignments/due dates.
Reading quizzes	Allowed to constantly review concepts
Graded feedbacks on quizzes, classwork, labs and homework	Helped them to have a better understanding of content and be prepared for exams
Use of special Bb collaborate features (Break-Out Sessions)	Peer-to-peer interaction and exchange of ideas
Use of Bb whiteboard feature for problem solving	Enabled to follow steps used in solving problems in real time
Effective Instructor Communication	Helpful on keeping class informed on important due dates, announcements, reminders, assignment directives, etc.
Flexibility in turning in assignment	Lessened anxiety, stress level, provided support, motivated
Weekly help session	Provided a platform for extended discussion with instructor