Inclusione e personalizzazione nell’insegnamento delle STEAM

Lezione 1: Definizioni della didattica
Parte III: Didattica per XXI secolo

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Twenty First Century Science: Insights from the Design and Implementation of a Scientific Literacy Approach in School Science

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XXI Century Science

Table 4. Science explanations

SE1	Chemicals (the idea of a "substance")
SE2	Chemical change (the atomic/molecular model)
SE3	Materials and their properties (linking structure and function)
SE4	The interdependence of living things
SE5	The chemical cycles of life
SE6	Cells as the basic units of living things
SE7	Maintenance of life
SE8	The gene theory of inheritance
SE9	The theory of evolution by natural selection
SE10	The germ theory of disease
SE11	Energy sources and use
SE12	The idea of radiation
SE13	Radioactivity
SE14	The structure and evolution of the Earth
SE15	The structure of the Solar System
SE16	The structure and evolution of the Universe

Rob Tiplis (2015): Learning to Teach Science

that the physics of familiar topics (forces and movement, for example) contains the ideas above.

Although physics has some common themes across its whole run, it is worth breaking them down into smaller subsets or topics. These groupings are my own and are used for convenience and relevance to schools. Physics, if nothing else, is a triumph of reductionism and many of the above topics could be grouped together into even fewer categories. However, I have made an attempt to do so below, by stating the kinds of questions that can be addressed by each topic.

Forces and fields

How do objects interact with each other? What effects do these forces have on each other? How can we characterise the effect mass and charge have on space? What is the relationship between work, energy and force?

The nature of matter

What is matter made of? How are the building blocks organised and catalogued? What interactions take place between them? How do the building blocks behave both individually and collectively? How is the microscopic world linked to the world we see around us?

Materials

What are the bulk properties of matter? How can we explain ideas about a material's physical properties in terms of its atomic structure and arrangement?

Electricity and magnetism

What happens when materials have charges? How do charges affect each other when they are stationary? What happens when they start moving? What happens when charges are moved? How can we get magnetic effects in materials and from moving charges? What happens when we interact a current with a magnetic field? What happens when we drive charges around wire loops? How can electricity shift energy from one place to another?

Electromagnetic radiation

How can a combination of electric and magnetic fields produce waves that transfer energy? How are the properties of these waves related to the size, frequency and energy of the waves? What do we use these waves for in everyday life, medicine and other areas of science?

Radioactivity

Why do some atoms break down by emitting particles or electromagnetic radiation? Why is it only certain particles are emitted? Why do large nuclei emit helium nuclei (alpha particles) and smaller ones high-speed electrons? Why do very large nuclei sometimes split in two and give out energy? Why can small nuclei sometimes combine to form larger atoms and also give out energy?

Energy transfer

What is energy? Where can it be stored? How can it be shifted from one place to another by particles, radiation, electric or mechanical work? Why is it that when we try and work out how much energy is in a system we always get the same number? How efficient are our energy transfers? How does heat transfer from a hot object to a cold? Why does heat go from hot to cold but not the other way around?

The Earth in space

How do everyday ideas like day, month, year or seasons relate to astronomical phenomena? What evidence is there that we live in a heliocentric solar system? What observations can we make in the classroom?

The universe

What are stars? How do they form? How do they die? What is their life cycle? What happens when you have groups of stars? How did the universe form? What evidence do we have for that? What tools do we have for observing the universe? Is there life elsewhere in the universe?

EXPLANATIONS AND MISCONCEPTIONS

As a teacher of physics, you will have to think not only about the correct science but about how to explain it to young people. This pedagogical content knowledge is crucial. Which explanations are helpful? What misconceptions do young people have about particular parts of physics? Which teaching approaches help deal with these misconceptions? What simplifications are used? Which models help link the unseen world to the world of observables? Some of the references at the end of the chapter help with this and work done by the Institute of Physics is available at www.talkphysics.org.

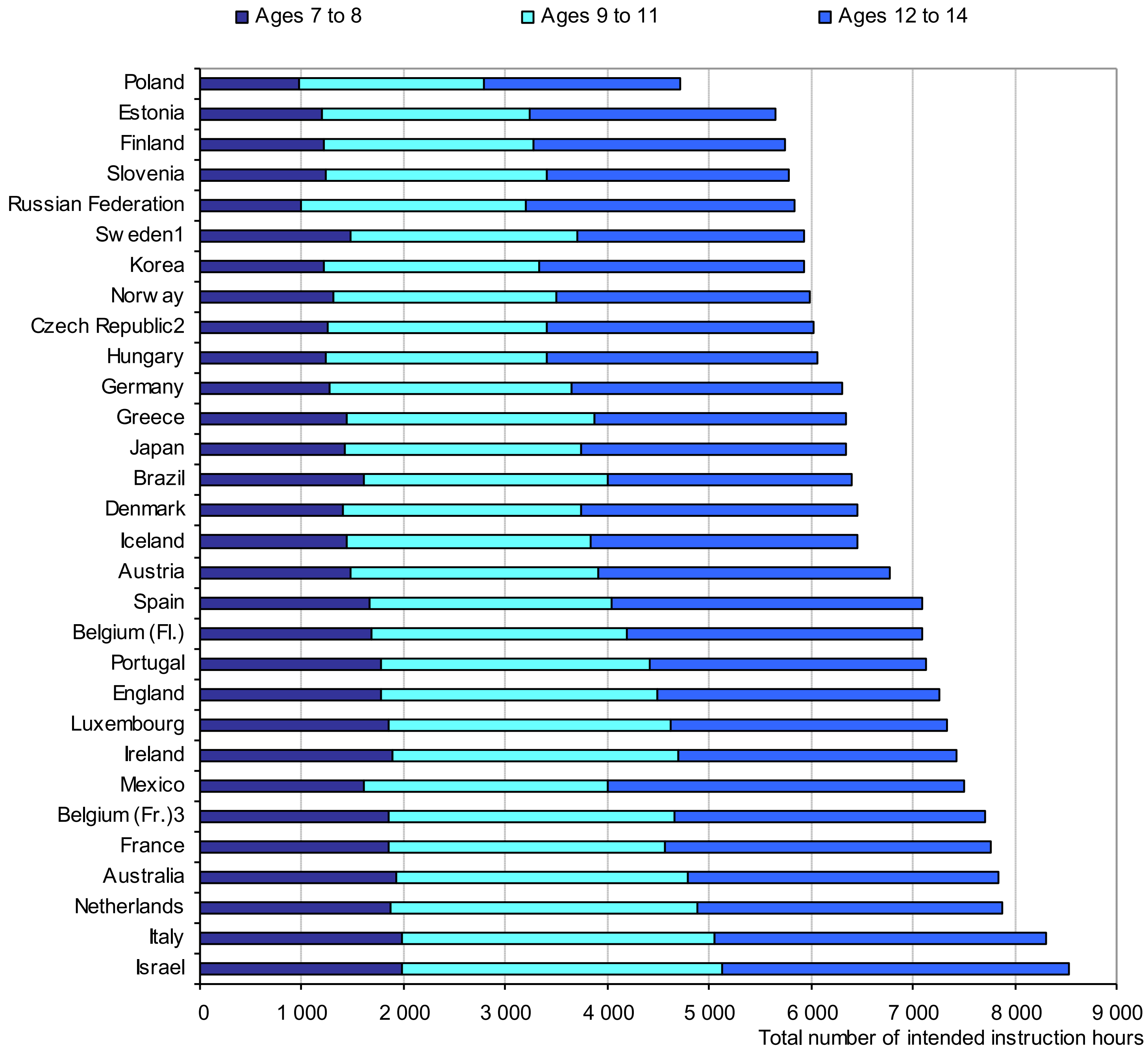
MODELLING

There are a number of models that help us begin to understand physics and it is sometimes helpful to think about how we use these to help us. Two important images in physics to help us imagine what the world is 'really' like and help us understand a range of phenomena are:

- *particles* (dust, molecules, atoms, electrons, protons, neutrons, quarks, photons . . .);
- *waves* (water, sound, earthquakes, radio, microwaves, infrared, light, ultraviolet, X-rays, γ-rays).

We can also use predictions with pencil and paper; for example $E=mc^2$ or Maxwell's equations.

In electricity, we need models to help us understand what is going on inside the wire and to make predictions about what circuits might do. While these may be useful, it is important to realise that these models have limitations and thinking about where they break down is as important to learning as when they are useful.



Orari cumulativi della scuola nell'età 7-14 anni

Education at a Glance 2010: OECD Indicators http://www.oecd.org/document/52/0,3746,en_2649_39263238_45897844_1_1_1_1,00.html#d
Indicator D1: How much time do students spend in the classroom? http://dx.doi.org/10.1787/888932310472

OU Milton Keynes

Facts and figures

The Open University in facts and figures

The OU is the largest academic institution in the UK, in terms of student numbers. It has:

- more than 240,000 students
- close to 7,000 tutors
- more than 1,100 full-time academic staff
- more than 3,500 support staff

Since the OU's launch in 1969 almost 1.8 million people worldwide have achieved their learning goals by studying with us.

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- The Open University has 15 curriculum partnerships established in 23 countries

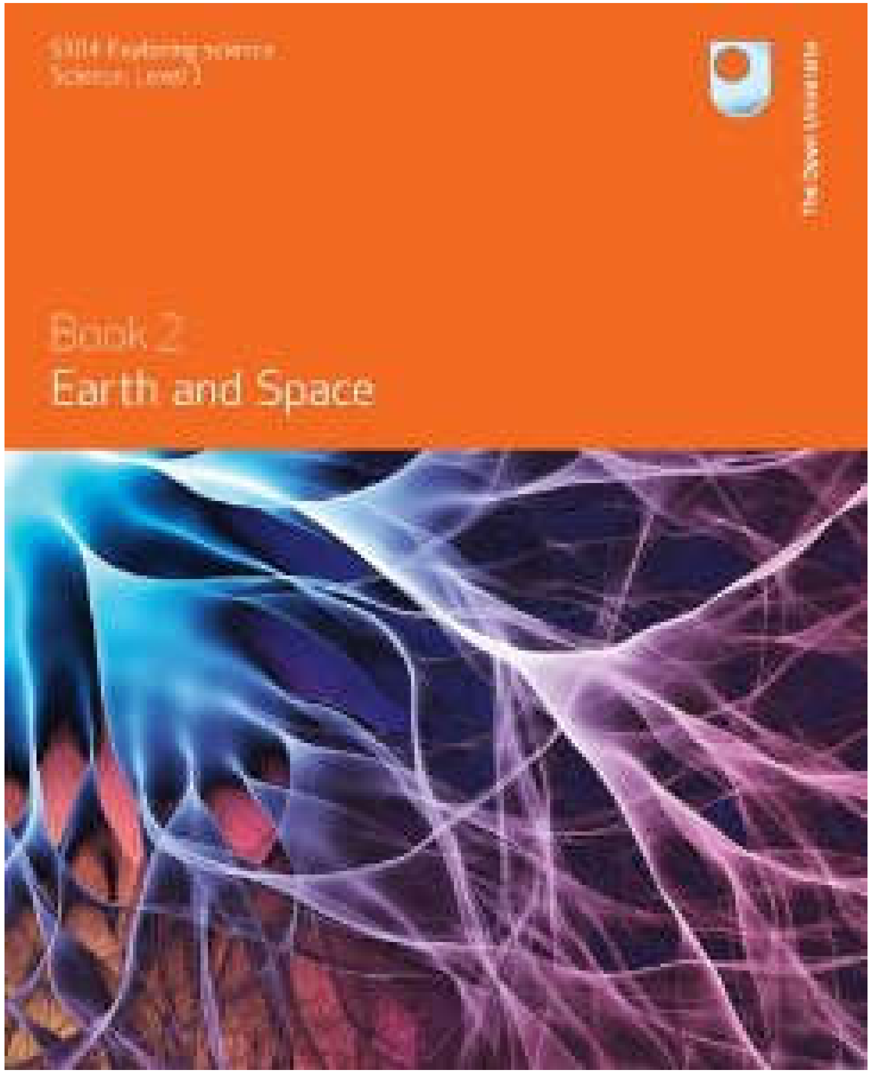
The OU's mission
Teaching and learning
Facts and figures
History of the OU
Partnerships

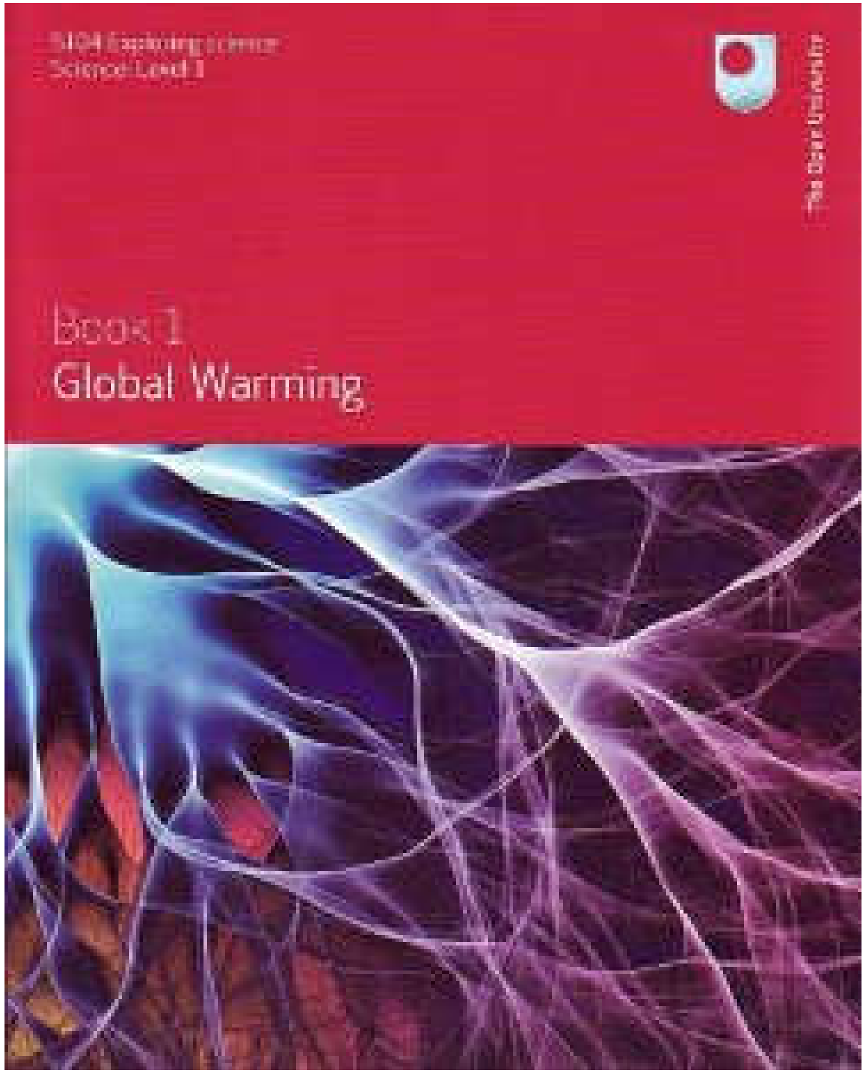
Open Research Online

Since its launch in 2006, the University's publicly-available research repository - Open Research Online - has recorded more than 2.2 million visitors. The repository makes

2 mln absolwentów od 1969 roku

„Exploring science” S104
Insegnamento trans-disciplinare





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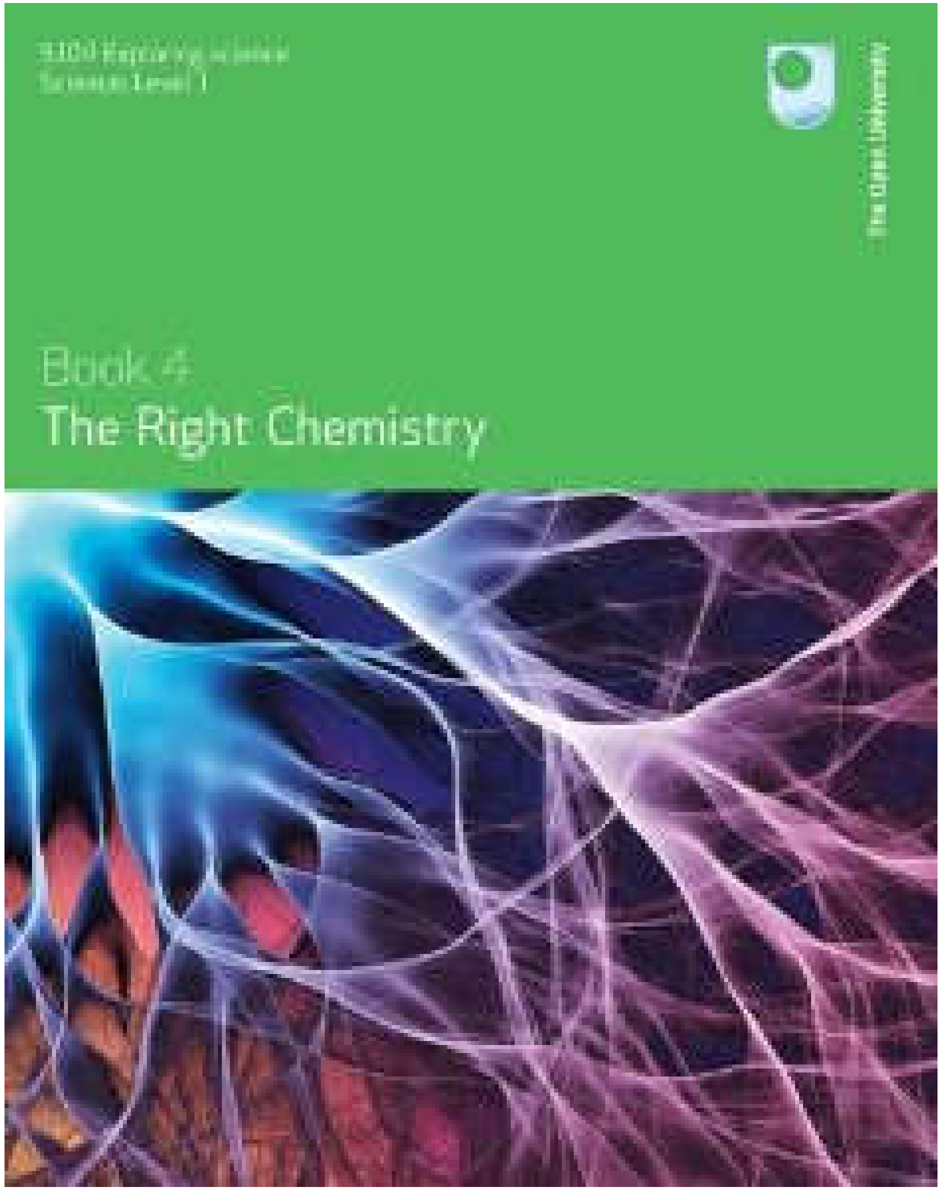

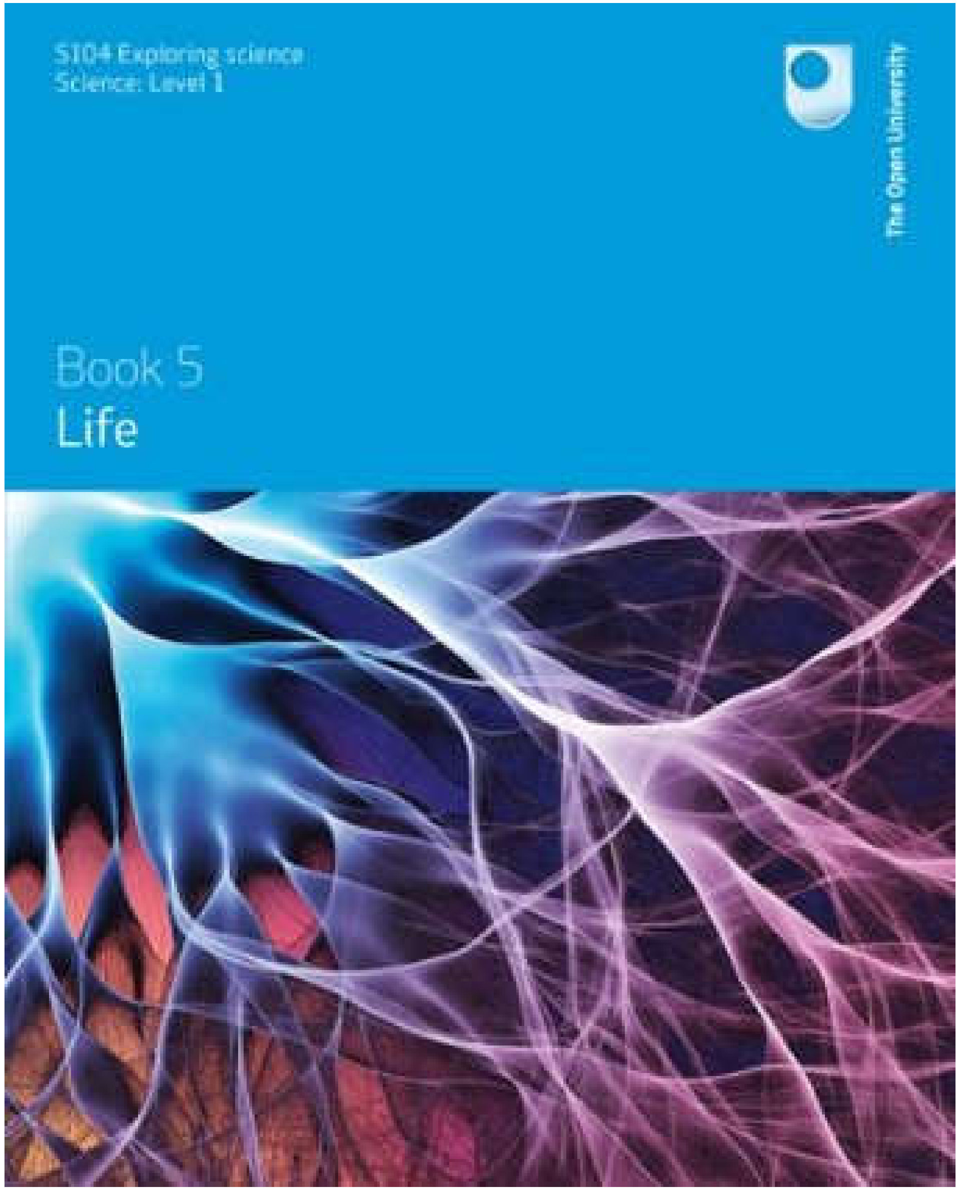

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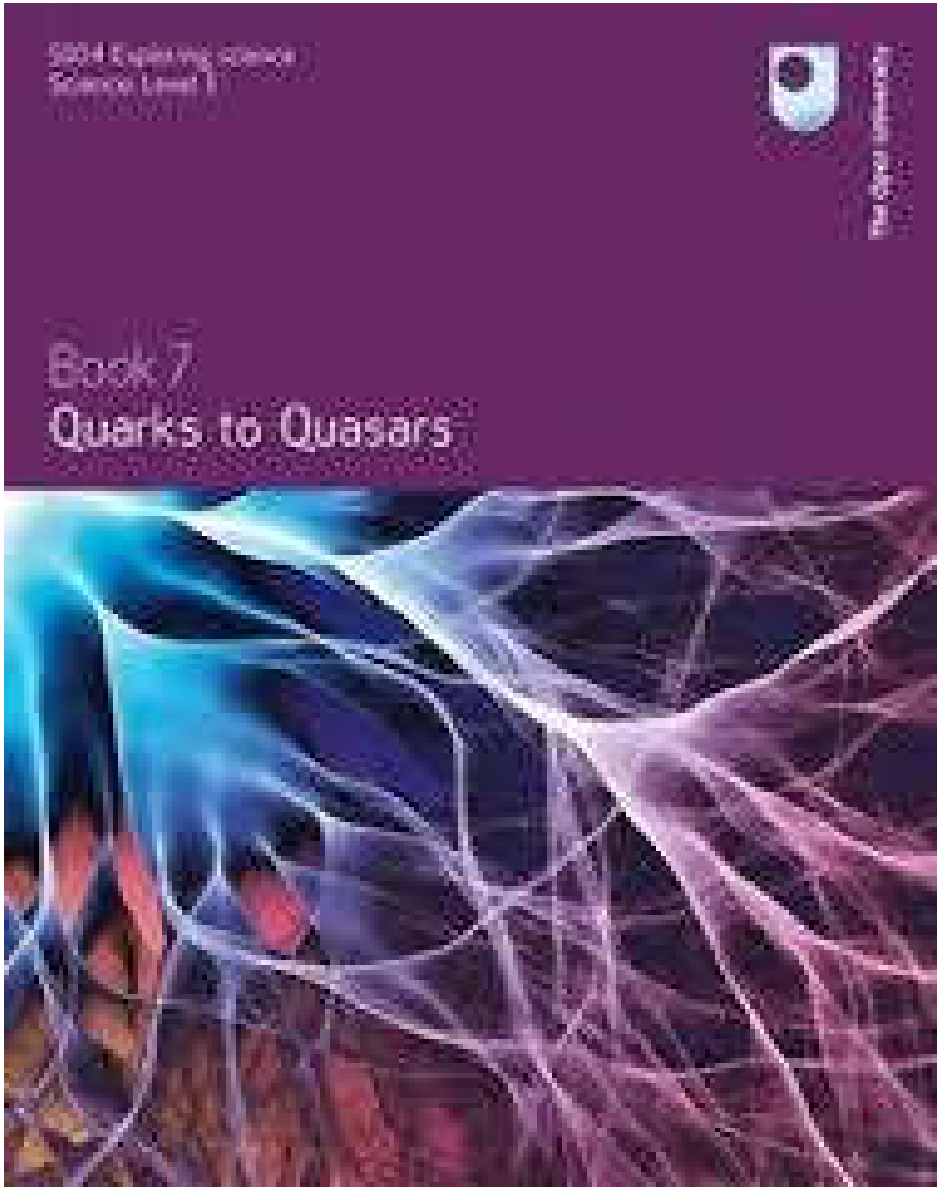
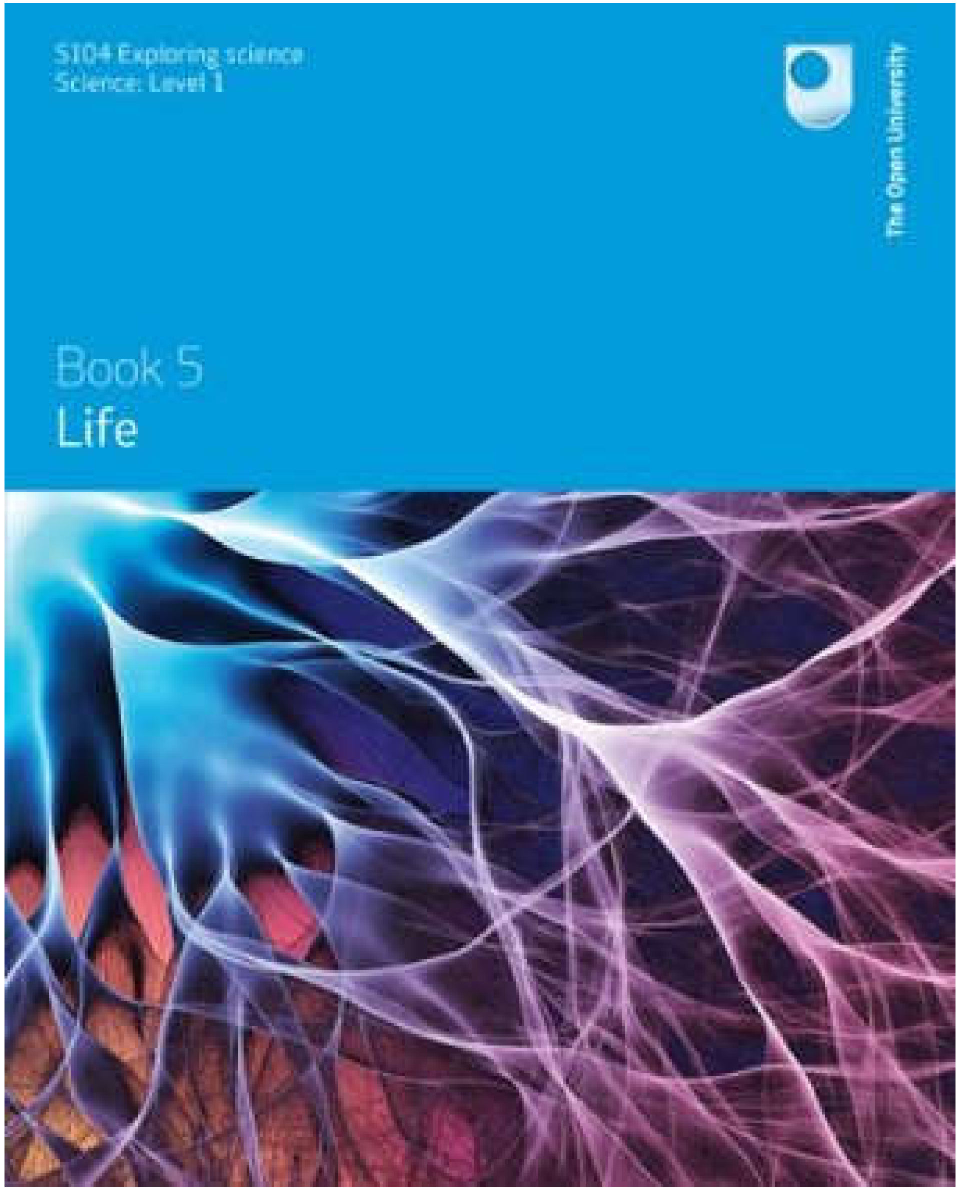




Riferimento alla sensibilità sociale

Figure 2.1 Cuttings from newspaper stories focusing on some of the more extreme consequenc
warming.

Figure 2.2 Photograph showing considerable damage to houses caused by a tornado in an area of the UK's second largest city, Birmingham, in July 2005.

Figure 2.3 If you wait long enough, you too could roll five sixes (although, admittedly it may take a while – on average you will get five sixes every 8000 or so rolls). So, the unlikely event does occasionally happen.

Competenze trasversali

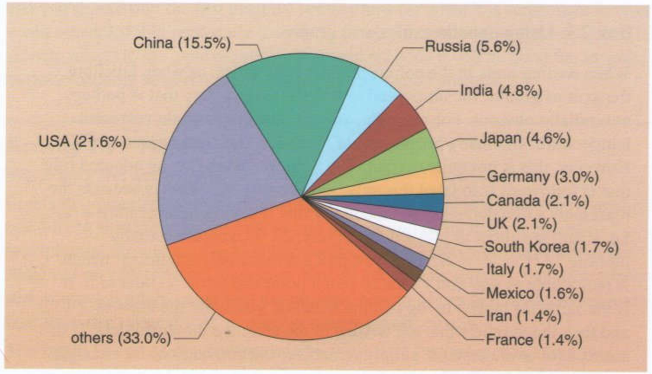
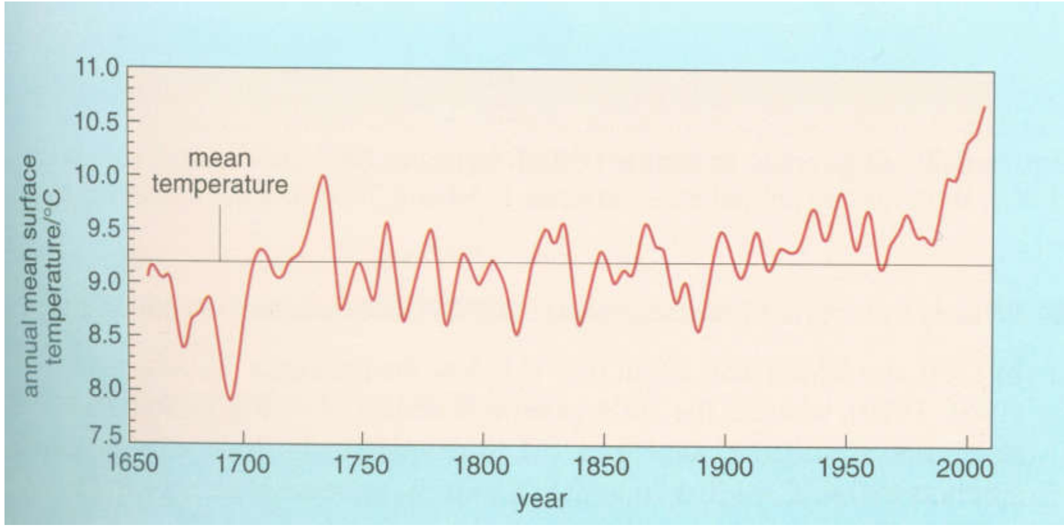
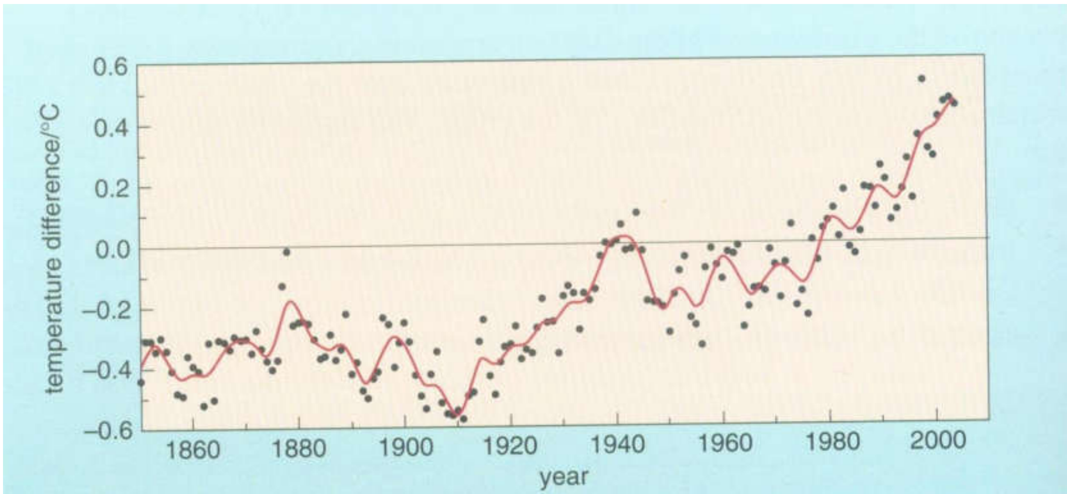


Figure 2.8 Pie chart showing the proportion of carbon emitted globally into the atmosphere in 2004. The pie chart has 14 slices, with 13 slices representing the 13 countries that emitted more than 100 million tonnes of carbon each, and the remaining slice representing the contributions from all other countries combined. The 13 specified countries account for 67.0% of the world's total carbon emission.

Table 2.1 Anthropogenic emissions of carbon dioxide into the atmosphere in 2004, expressed in terms of the mass of carbon in millions of tonnes, and their proportions of the total world emissions. Countries that emitted over 100 million tonnes of carbon are listed individually. (You may have noted that the percentage values actually add up to 100.1%. This is because the individual values are only quoted to the nearest 0.1%, and this leads to what is known as a rounding error.)

Country	Mass of carbon/million tonnes	Proportion of total world emissions/%
USA	1580	21.6
China	1130	15.5
Russia	407	5.6
India	347	4.8
Japan	336	4.6
Germany	220	3.0
Canada	154	2.1
UK	152	2.1
South Korea	124	1.7
Italy	122	1.7
Mexico	114	1.6
Iran	104	1.4
France	104	1.4
All other countries	2410	33.0





Richiedere solo questo che abbiamo insegnato

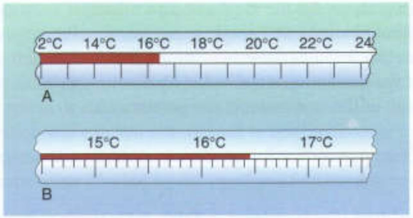
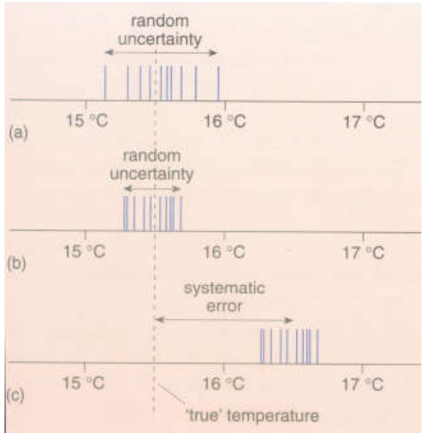
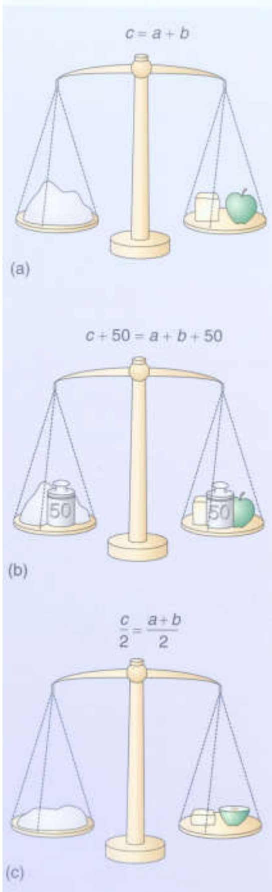


Figure 3.2 Two thermometers, A and B, measuring the air temperature in the same place. Thermometer A has scale divisions of 1 °C whereas thermometer B ha scale divisions of 0.1 °C.





■ To how many significant figures are each of the following measurements given: (a) 6.4×10^2 m; (b) 5.405×10^2 m; (c) $5.405\ 00 \times 10^2$ m?

□ (a) Two significant figures; (b) four significant figures; (c) six significant figures.

Box 3.2 Scientific notation and its use with a calculator

Scientific notation is a useful way of writing numbers, particularly very large or very small numbers. Scientific notation relies on the fact that *any* value can be rewritten as a number that is *equal to or greater than 1 but less than 10*, multiplied by a simple power of ten. Take, for example, a number such as 123. In scientific notation this becomes 1.23×10^2. Similarly, 12 345 in scientific notation becomes 1.2345×10^4. In these two examples, the powers of ten are 10^2 (i.e. 100) and 10^4 (i.e. 10 000). When converting values that are less than one into scientific notation, the power of ten becomes negative. For example, 0.000 123 45 is 1.2345×10^{-4} in scientific notation. This is because 0.000 123 45 is equal to 1.2345×0.0001 and

$$0.0001 = \frac{1}{10\,000} = \frac{1}{10^4} = 10^{-4}$$

Note that 1 and 10 can also be written as powers of ten. You know that 100 is 10^2 and 0.1 is 10^{-1}; perhaps you can see that the 'in between' powers of ten are thus: $10 = 10^1$ and $1 = 10^0$. So, in scientific notation, 12.3 is 1.23×10^1 and 1.23 is 1.23×10^0. Note that any number written using a power of ten could be referred to as being in 'powers of ten' notation. Hence, 23.4×10^4 is in powers of ten notation; however, it is only when written as 2.34×10^5 that it would be in proper scientific notation.

You should ensure that you can type numbers in scientific notation into your calculator correctly. For example, you should know the difference in entering, say, -6.78×10^6 as opposed to 6.78×10^{-6} (or indeed, -6.78×10^{-6}). Also, do not fall into the trap of entering a simple power of ten, such as 10^4, as 10×10^4 (which is actually 10^5). This is avoided if you remember that 10^4 is actually 1×10^4 in scientific notation. Finally, take care not to enter (or write), say, 3.46×10^4 as 3.46^4.

Ensure you are comfortable with entering scientific notation and powers of ten into your calculator by checking you get the following answers to these multiplications and divisions.

$2.45 \times 10^5 \times 3.2 \times 10^7 = 7.84 \times 10^{12}$

$3 \times 10^8 \times 6.6 \times 10^{-34} = 1.98 \times 10^{-25}$

$6.666 \times 10^{-34} \div 2.222 \times 10^0 = 3 \times 10^{-34}$

$-2.1 \times 10^4 \times 2.1 \times 10^{-4} = -4.41$ (i.e. -4.41×10^0)

$10^6 \times 10^6 = 10^{12}$ (i.e. 1×10^{12})

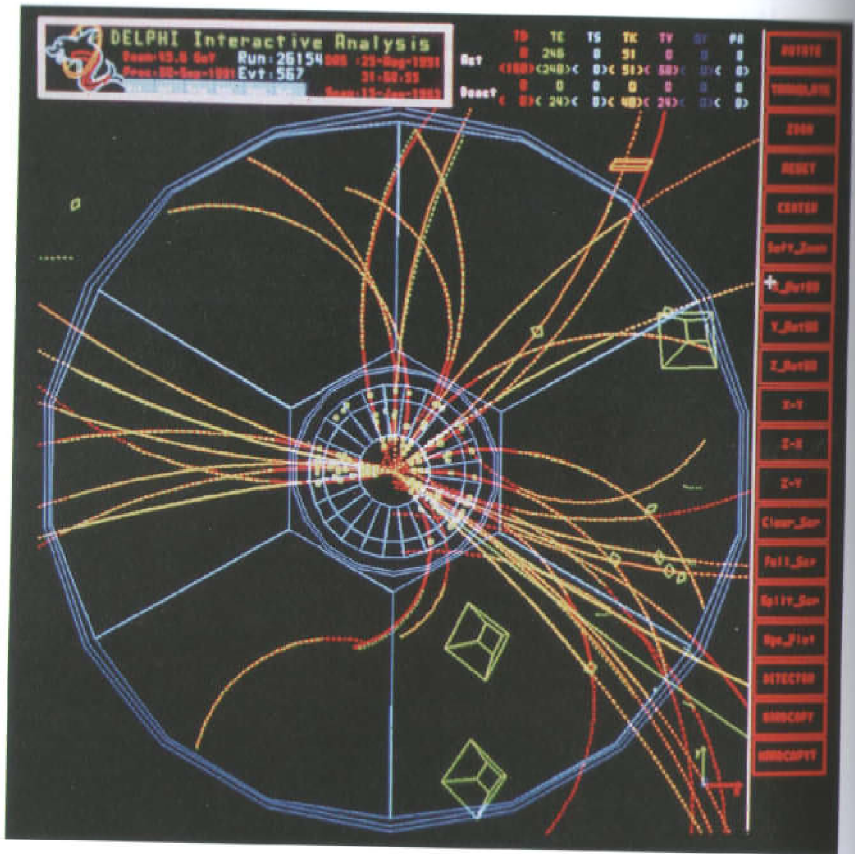
$10^8 \div 10^{-34} = 10^{42}$ (i.e. 1×10^{42})

$10^4 \times 3.14 = 31\ 400$ or 3.14×10^4

I quark (oggetti più piccoli)

Consider, for example, an experiment conducted at the Large Electron–Positron (LEP) collider at the European Organization for Nuclear Research (CERN), near Geneva, where positrons of kinetic energy 50 GeV collide with electrons with the same kinetic energy travelling in the opposite direction (Figure 11.2). In this case, an electron and a positron may annihilate each other, producing a quark–antiquark pair, with total energy 100 GeV or 10^{11} eV. These energies are certainly impressive; 10^{11} times greater than the few eV that is typical for the energy levels of the hydrogen atom and even 10^5 times greater than the combined mass-energy of the electron and positron (i.e. 1 MeV). But what can such high energies achieve, against the strong force? In fact, 100 GeV of energy can separate a quark–antiquark pair by only about 100 times the size of a proton.

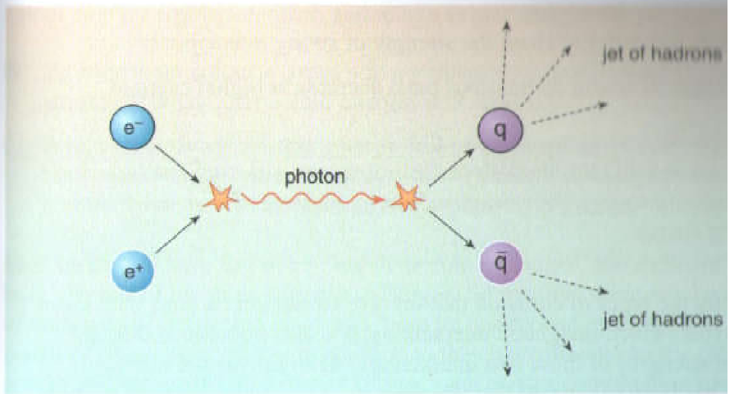
Schematic
article tracks
a collision in the
–Positron (LEP)
RN.

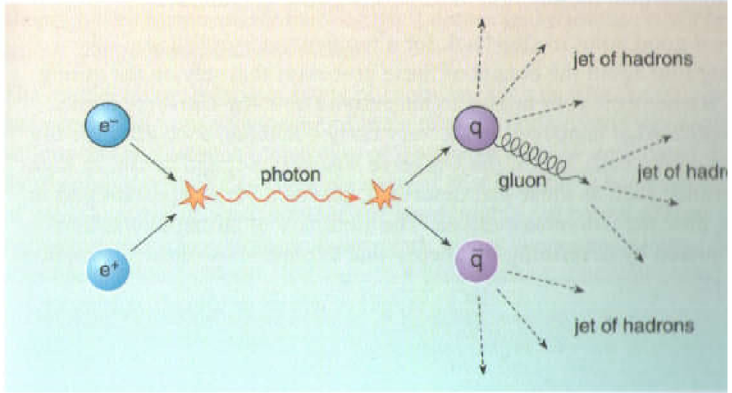


But if quarks do not emerge from these collisions, what happens to the 100 GeV that is put into the collision? Energy cannot be destroyed, but can only be transformed from one kind to another (Book 3, Chapter 2). In the mess of debris that results from high-energy collisions between electrons and positrons, there is a tell-tale clue as to the original interaction that occurred at very short distances:

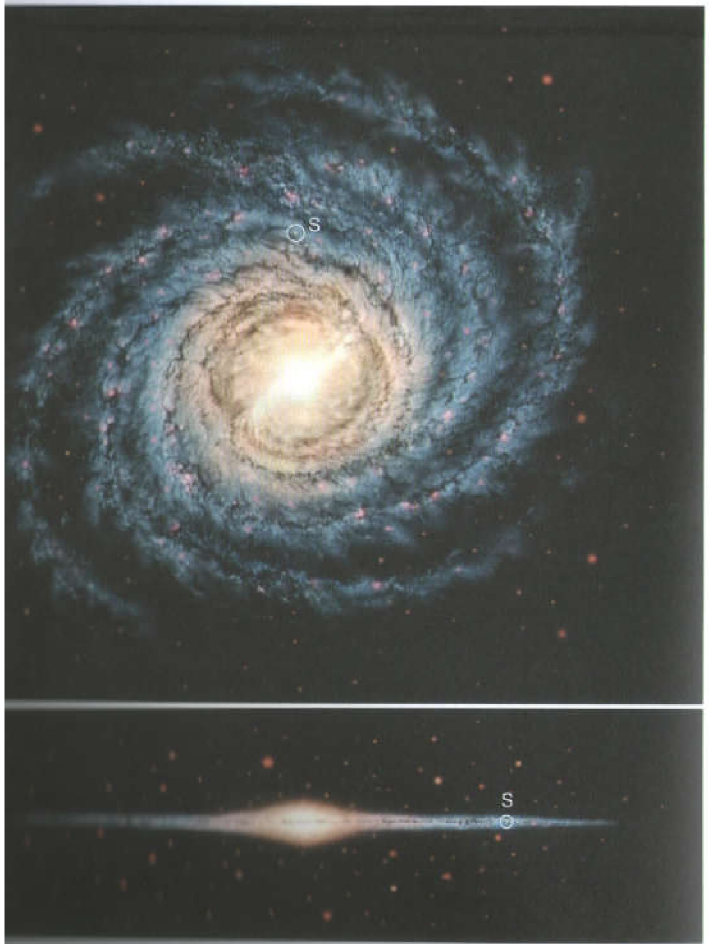
can be thought of as producing what is known as a virtual photon. Th
for this name is that the virtual photon only has a temporary existence
immediately undergoes a pair creation event, giving rise to a quark an
pair. Both the matter–antimatter annihilation event and the pair creatio
electromagnetic interactions. The virtual photon is understood merely
carrying the electromagnetic force from the annihilation event to the pa
event; it does not escape from the process and is never detectable. Simi
the quarks and antiquarks created from the virtual photon cannot separ
indefinitely. Instead, their kinetic energy and mass energy are converte
kinetic energy and mass energy of many more matter and antimatter pa
including lots more quarks and antiquarks. Remember, as long as energ
conserved, any energy transformations are possible. The many quarks
antiquarks then combine to form a variety of hadrons, and it is only th
that then emerge from the collision as a pair of jets.

It so happens that Figure 11.3 is not the whole story of what may occu
electron–positron collision producing hadron jets; sometimes *three* jet
produced. A schematic illustration of this situation is shown in Figure





Le galassie (oggetti più grandi)



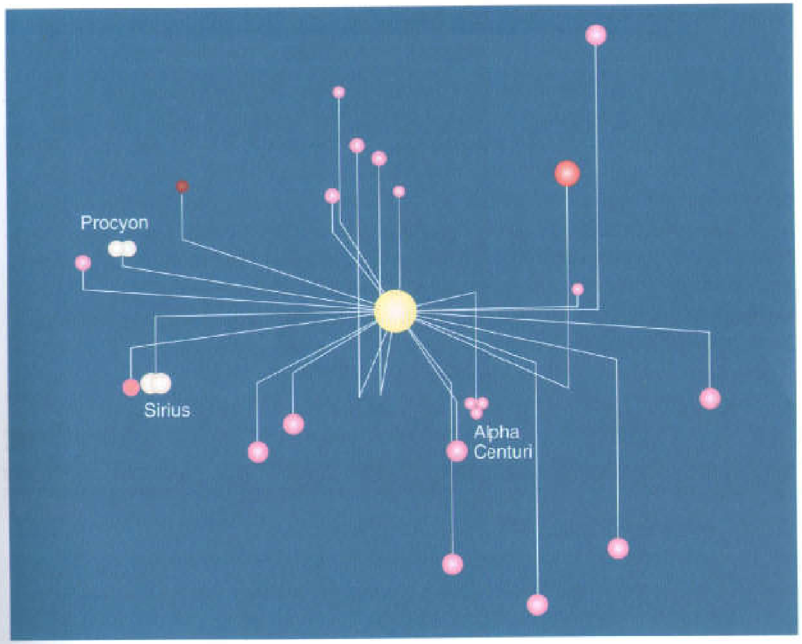


Figure 4.2 neighbourhoo showing the 2 Note, in this c 'star' includes three stars in o other. The size representing th as the luminos

...e star GQ Lupi (about 450 light-years, or 135 pc, from the Sun), ...t yet certain if the object is indeed a planet or merely a very small ...n star in a binary (two-star) system.

...s 4.1.2 to 4.1.5, you will consider four different techniques for ...xtrasolar planets by indirect methods. Before doing so, however, in ...ppreciate these different methods, you will revisit some principles of ...d motion from Book 2 Chapter 14.

...e effect of a planet on stellar motion

gravitational force that the Sun exerts on Jupiter has a magnitude F_J, then the magnitude of the gravitational force that Jupiter exerts on the Sun is also F_J. Thus the Sun must be accelerated by Jupiter. The outcome is that as Jupiter orbits the Sun, the Sun goes around an orbit of its own. However, the acceleration of the Sun is small.

From Newton's second law of motion (Book 2 Section 14.2), an expression for the magnitude of the acceleration a_S of the Sun can be obtained in terms of Jupiter's mass, m_J, and the Sun's mass, m_S. Newton's second law of motion states that, for any mass m:

$$F = ma \tag{4.1}$$

Applying this to the case in hand:

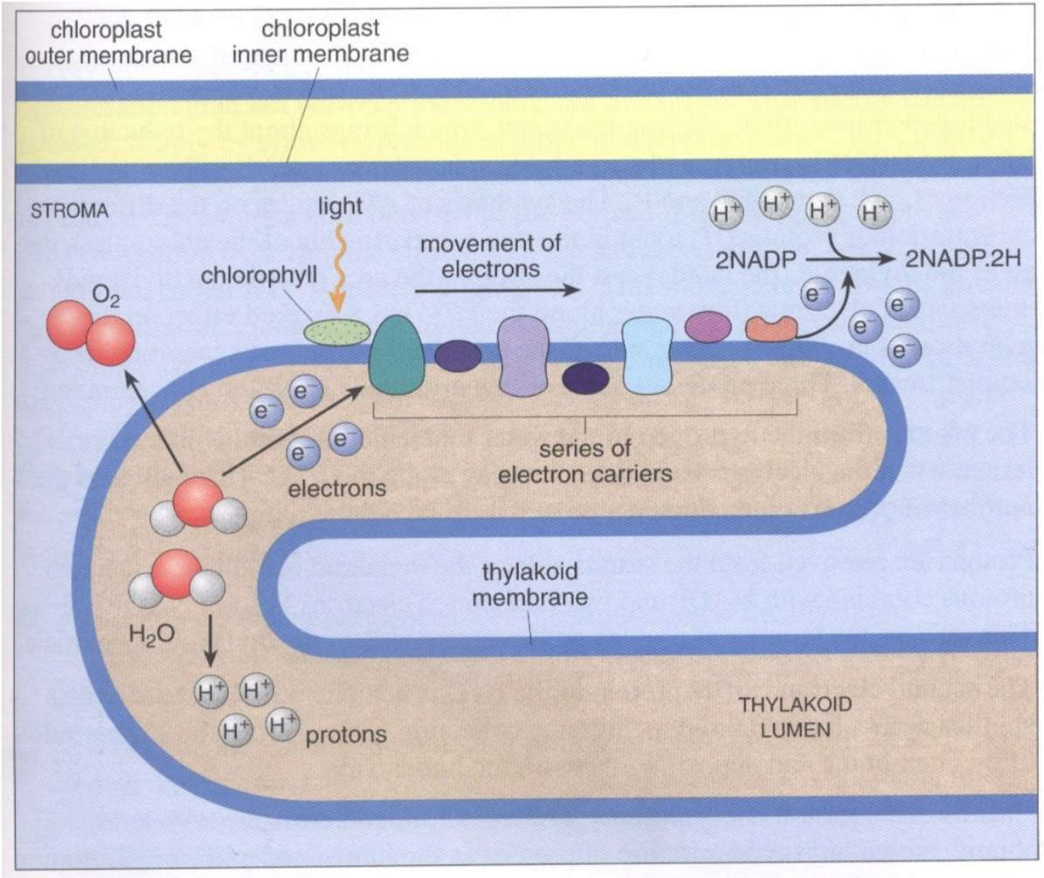
$$F_J = m_J a_J \quad \text{and also} \quad F_J = m_S a_S$$

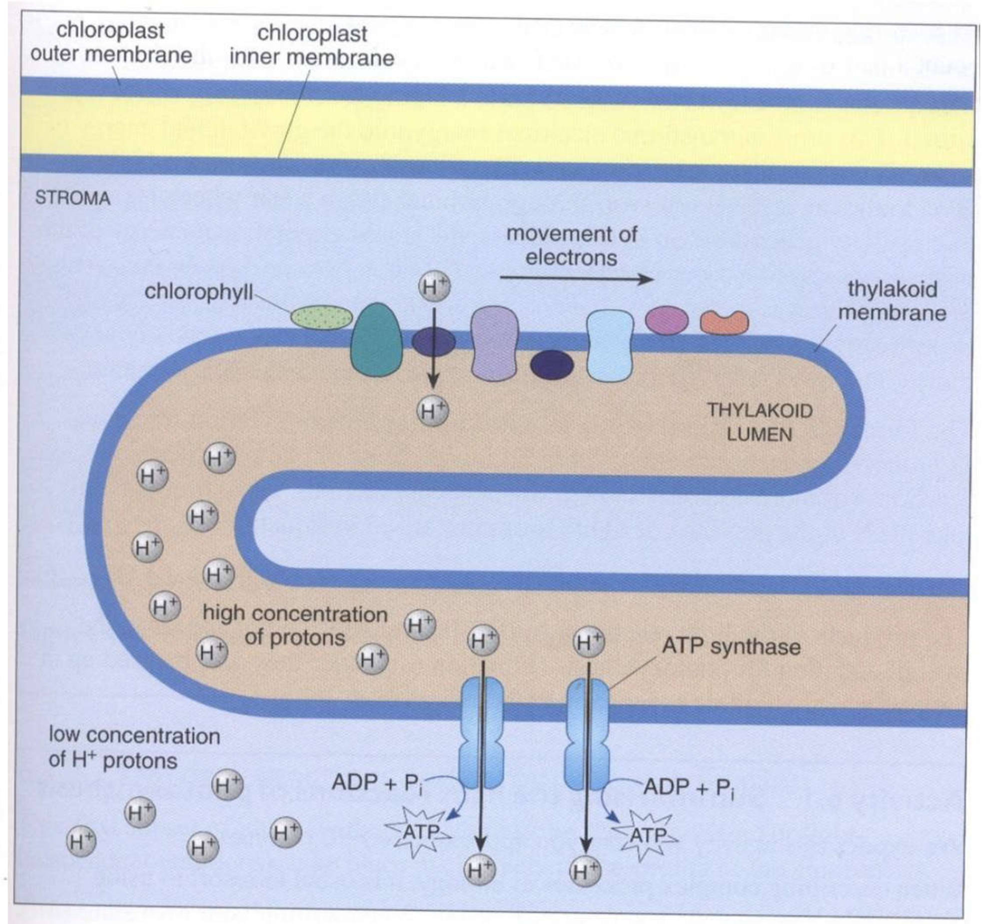
Thus $m_S a_S = m_J a_J$ and so, dividing both sides by m_S:

$$a_S = \frac{m_J a_J}{m_S} \tag{4.2}$$

The mass of the Sun is about 1000 times greater than the mass of Jupiter, and this fact can be used, in combination with the above equations, to determine the

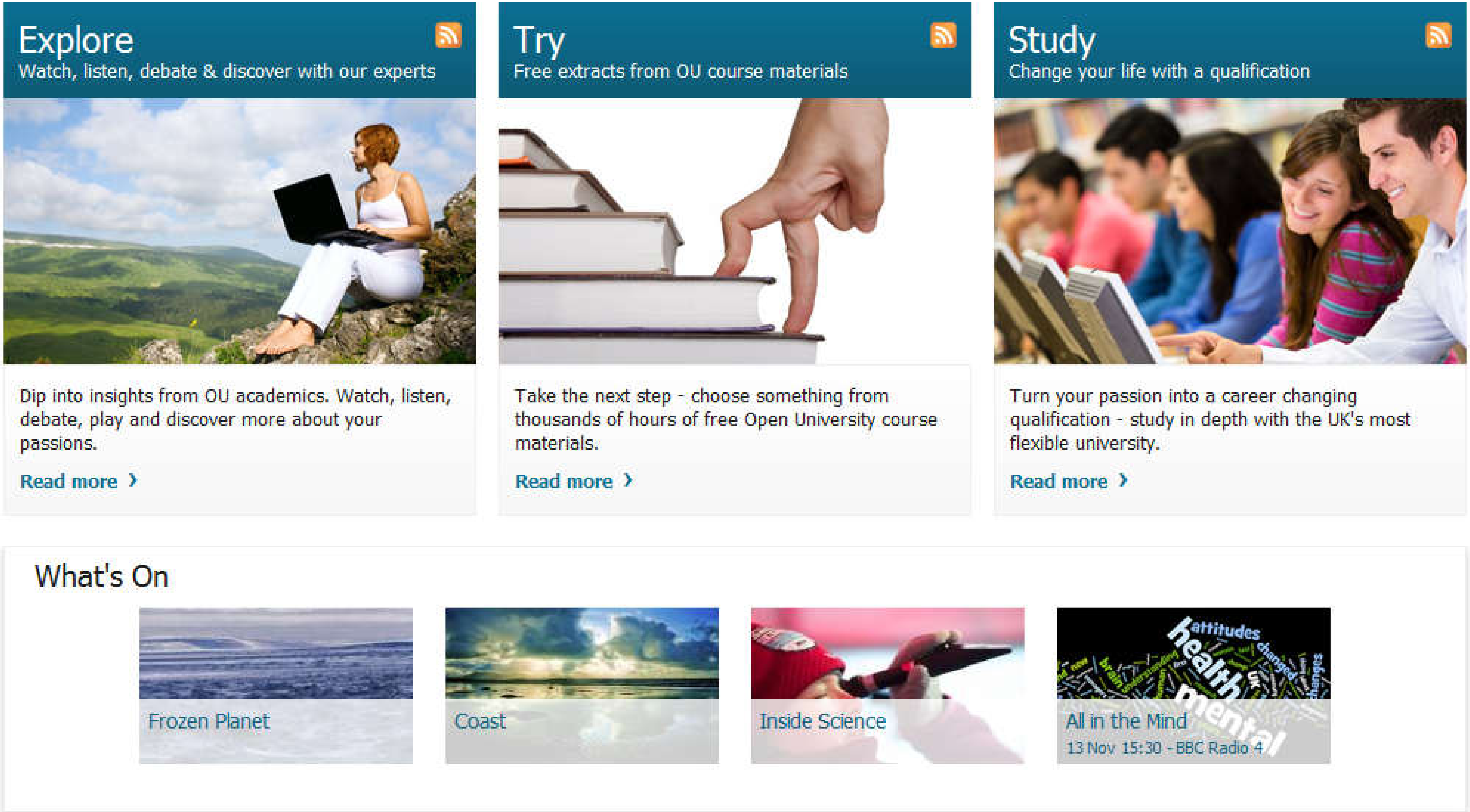
Dettagli interdisciplinari (a scopo illustrativo)





Clorofilla, cloroplasti, elettroni, protoni, ATP etc.

Open learning resources



http://www.open.edu/openlearn/history-the-arts/history/classical-studies/continuing-classical-latin/content-section-1.1

Imparare stupisce

Imparare sorprende

Imparare porta gioia

Pedagogical Contents Knowledge
Lee Shulman (1987)

ike?[4] At minimum, they would include:

- content knowledge;
- general pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organization that appear to transcend subject matter;
- curriculum knowledge, with particular grasp of the materials and programs that serve as "tools of the trade" for teachers;
- pedagogical content knowledge, that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding;
- knowledge of learners and their characteristics;
- knowledge of educational contexts, ranging from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures; and
- knowledge of educational ends, purposes, and values, and their philosophical and historical grounds.

Pedagogical Contents Knowledge

- conoscenza della materia
- conoscenza del programma (cv)
- conoscenze delle materie affini
- competenze pedagogiche, anche oltre la materia propria
- competenze amministrative
- capacità di individuare le competenze fondamentali
- contatto diretto con gli alunni
- conoscenza di fini, scopi, valori e di loro base filosofica e storica

- STEAM: un continuo aggiornarsi nella materia insegnata

Sviluppare competenze pedagogiche

Comincia a raccogliere (collezionare) le idee (e gli oggetti) per rinforzare il tuo insegnamento nel tema corrente.

Questa collezione può comprendere:

- esempi di applicazioni «quotidiane»
- dimostrazioni (esperimenti) utili
- modelli e analogie utili (anche digitali) per spiegare i concetti
- esempi reali dalla ricerca scientifica
- attività di connessione («ponte») tra le lezioni precedenti e prossime
- storie (e aneddoti) sulle scoperte scientifiche
- domande frequenti (e anche *misconceptions*)
- elenco di strumenti/ esperimenti utili

Kevin Smith, *Using schemes of work to support planning*, in: Learning to Teach Science in the Secondary School, ed. Rob Toplis, Routledge, London, 2016

Differenze di alunni, stile d'insegnamento, strategie di studio, sviluppo cognitivo

Quando scegli strategie d'insegnamento, è essenziale riconoscere i bisogni di studenti. I materiali di supporto per insegnanti a livello nazionale sono stati preparati nella luce della ricerca che suggerisce che gente ha una vasta gamma di preferenze con cui use propri sensi per esplorare le idee e costruire la propria visione del mondo. Gli argomenti includono lo sviluppo cognitivo, stili di studio con diverse abilità – visive, uditive, cinestetiche e le intelligenze multiple. (p. 167)

Diversi bambini non progrediscono nello stesso modo allora un insegnamento efficace deve mantenere un equilibrio tra le sfide e le risorse, fissando il lavoro al livello di aspettative adeguate, per incoraggiare la partecipazione e assicurarsi il successo. La chiave per assicurarsi il progresso è doppia: una profonda conoscenza della materia «sotto mano» e una profonda conoscenza di ragazzi nella vostra classe. Per il primo compito l'insegnante può essere preparato; la seconda si sviluppa col tempo, con crescente confidenza e fiducia tra voi e gli studenti. (p. 136)

Ralph Levinson, *Planning progression in science,* in: in: Learning to Teach Science in the Secondary School, Routledge, London, 2016, p. 136; Pete Sorensen, *Teaching strategies and organising learning*, Ibidem, p. 167

Table 4.4.2 Ways of learning: possible activities to use with pupils

1. Assessments	26. Experimenting	51. Presentations
2. Blogging	27. Fieldwork	52. Problem-solving
3. Brainstorming	28. Film	53. Projects
4. Card sorting	29. Flow diagrams	54. Quiz
5. Case studies	30. Games	55. Radio
6. Classifying	31. Group discussions	56. Reading
7. Concept cartoons	32. Inductive approaches	57. Recitation
8. Concept maps	33. Interactive whiteboard	58. Records
9. Creative writing	34. Internet searches	59. Reports
10. Critical incidents	35. Interviews	60. Role play
11. Crosswords	36. Investigations	61. Simulations
12. DARTS	37. Jig-saw activities	62. Slides
13. Data analysis	38 Lectures	63. Spider diagrams
14. Data bases	39. Mind maps	64. Spreadsheets
15. Data logging	40. Mobile learning	65. Surveys
16. Debate	41. Modelling	66. Tape work
17. Demonstrations	42. Multimedia	67. Thought experiments
18. Design tasks	43. Music	68. TV
19. Diaries	44. Mysteries	69. Video
20. Dictation	45. Note taking	70. Visitors
21. Discussion	46. Observation	71. Visits
22. Displays	47. Paired work	72. Web-page development
23. Drama	48. Photography	73. Word searches
24. Drawing	49. Posters	74. Workshops
25. Evaluation	50. Practical work	75. Writing

Toplis, op. cit. p. 167

Una sequenza di esperimenti diventa una storia narrativa

The teacher is happy that smbd undertook the pedagogical function

Hewelianum, Gdańsk, 2011, foto MK

Una sequenza di esperimenti diventa una storia narrativa

The teacher is happy
that smbd undertook
the pedagogical function

Hewelianum, Gdańsk, 2011, foto MK

Una sequenza di esperimenti diventa una storia narrativa

Hewelianum, Gdańsk, 2011, foto MK

The teacher is happy
that smbd undertook
the pedagogical function

«Didattica cognitivista»

- Didattica tradizionale = insegnare (e studiare)
- Lo scopo della didattica tradizionale: far sapere (i.e. un insieme delle informazioni, chiamato «sapienza»)
- Nel mondo odierno (AD 2022) le informazioni sono pan-disponibili, i.e. sempre, su ogni cosa ed ovunque. Non ha senso insegnare le informazioni
- Ma diventa sempre più difficile «districarsi» nella giungla delle informazioni. Così le medesima si rendono non solo *inutili* ma addirittura *disturbanti*
- Lo scopo allora non è la sapienza, ma la saggezza

OECD: „AHELO”

Methods

The test will look at:

Generic skills common to all students, such as:
Critical thinking

Analytical reasoning

Problem-solving

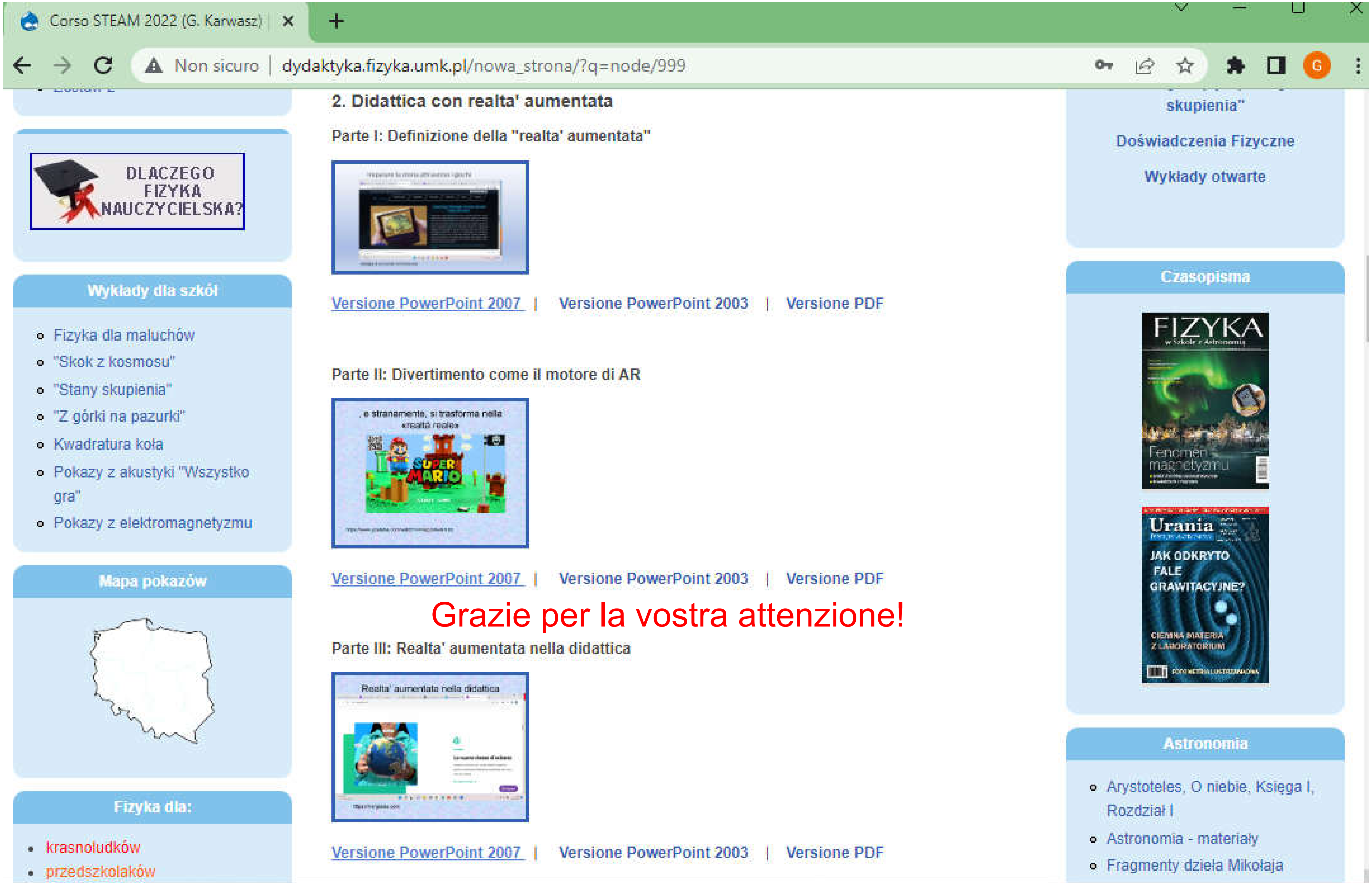
Written communication

1. Fare le domande
2. Fare le domande
3. …

→ Saper indurre l’allievo a fare domande

Testing student and university performance globally: OECD’s AHELO, OECD 2010
http://www.oecd.org/document/22/0,3746,en_2649_35961291_40624662_1_1_1_1,00.html

http://dydaktyka.fizyka.umk.pl/nowa_strona/?q=node/997



Grazie per la vostra attenzione!