Innovative methods of didactics

Lecture 5
Principles of hyper-constructivism

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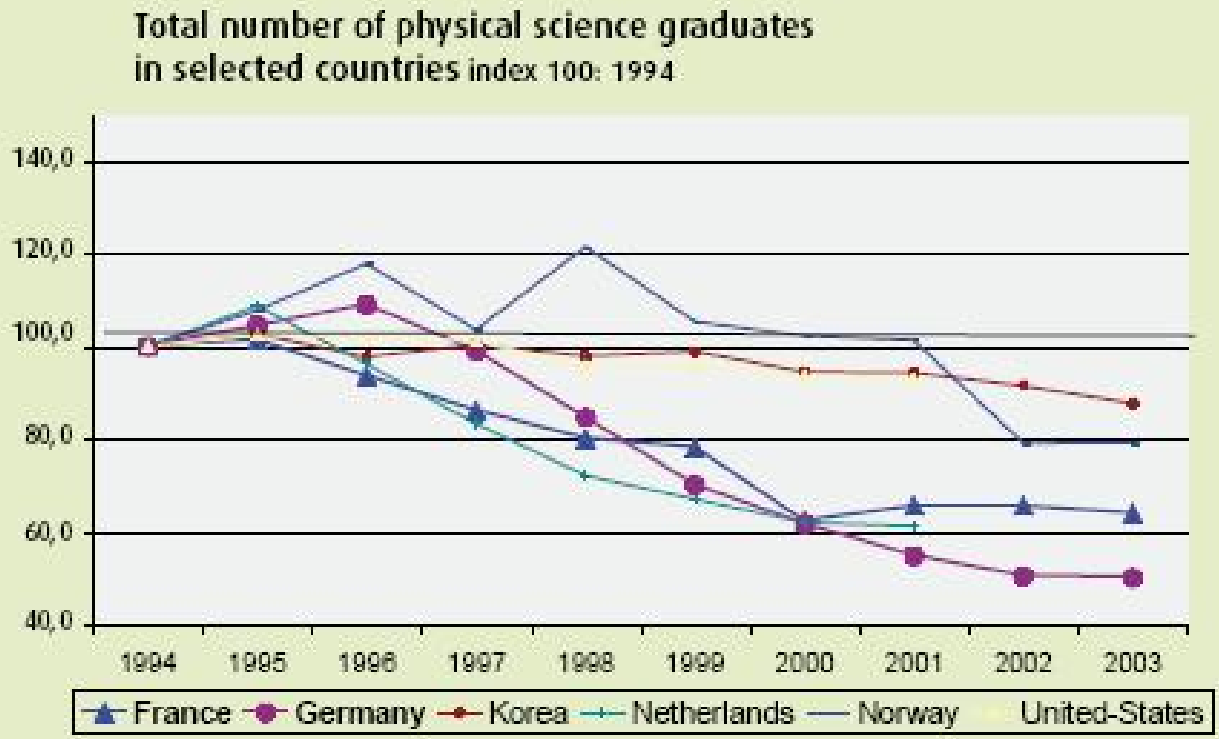
a/a 2020/2021

New Didactics: Outline

1. Motivation: need for new didactics
2. Constructivism: Kuhn & Berger
3. Cognitivistic didactics: features
4. PCK: Shulman & Crispiani
5. Physics: desparate need for ND
6. Virtual „reality: need for realism
7. Hyper-contructivism & neo-realism
8. Pedagogical „by-products” (Poland)
9. Ways of implementation…

1. EU (2007) „Rocards' Report"



ISBN – 978-92-79-05659-8
ISSN 1018-5593

Printed in Belgium

UE (2007): Rocard's Report

New pedagogy (!)

1. EU Treaty (2010)

[4] "DRAWING INSPIRATION from the cultural, religious and humanist inheritance of Europe, from which have developed the universal values of the inviolable and inalienable rights of the human person, freedom, democracy, equality and the rule of law,

RECALLING the historic importance of the ending of the division of the European continent and the need to create firm bases for the construction of the future Europe,

CONFIRMING their attachment to the principles of liberty, democracy and respect for human rights and fundamental freedoms and of the rule of law".

Wersja skonsolidowana Traktatu Unii Europejskiej, DzU UE C83 Vol. 53 (30.03.2010), s. 21.

1. USA: no student left behind

S. Goldman (1999): teaching that includes active involvement of pupils, previously reserved only for selected schools, become available to all.

1. Democracy acts via…

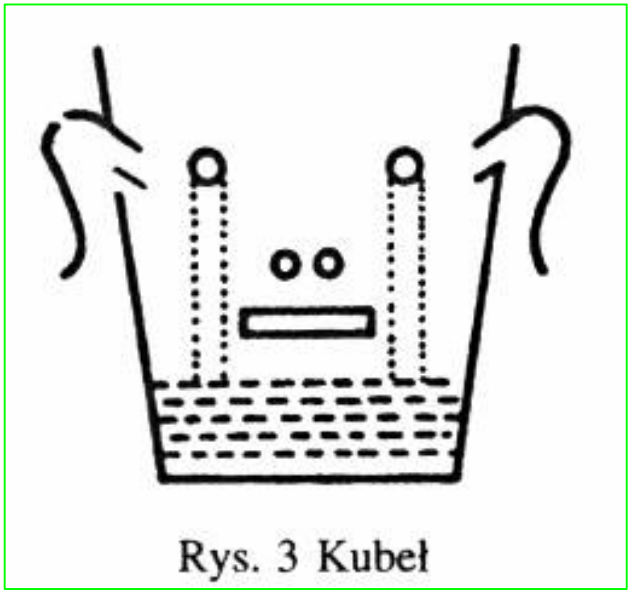
Democracy functions by majority decisions on major issues which, because of their complexity, require an increasing amount of background knowledge. For example, environment and ethical issues cannot be subject of informed debate unless young people posses certain scientific awareness. At the moment, decisions in this area are all too often based on subjective and emotional criteria, the majority lacking the general knowledge to make an informed choice. Clearly this does not mean turning everyone in a scientific expert, but enabling them to fulfill an enlightened role in making choices which affect their environment and to understand in broad terms the social implications of debates between experts.

EU White Book in Education and Training, European Commission, 1995
citato da P. Black (King's College, London),
Assessment and Pedagogy in Science Education, in: Physics Teaching and Learning, GIREP Book of Selected Papers, ed. M. Michelinie e S. Pugliese Jona

All, and thinking

2. K. Popper: „Dust-bin" theory of mind

Our senses are input ways to our mind. I called it „dust-bin" theory of mind. The best illustration for this is the picture below,.



Rys. 3 Kubeł

Karl Popper, *Objective Knowledge. Evolutionaly epistemological theory,* 1974

P. L. Berger & T. Luckman: Social Constructions of Reality

- „The phenomenological analysis of everyday life, or rather of the subjective experience of everyday life, refrains from any causal or genetic hypotheses, as well as from assertions about the ontological status of the phenomena analyzed. It is important to remember this. Commonsense contains innumerable pre- and quasi-scientific interpretations about everyday reality, which it takes for granted. If we are to describe the reality of commonsense we must refer to these interpretations, just as we must take account of its taken-for-granted character – but we do so within phenomenological brackets."
- In other words: reality has sociological not philosophical (ontic) status (!) → epistemic relativism

T. Kuhn:
Structure of Scientific Revolutions

- Copernican revolution ← social need
- → R. Bacon (XIIIth century): calendar needs urgently a reform, otherwise…
- → Greek texts available in Padova
- → Gutenberg's revolution
- Some 30-40 yrs of night observations
- Clear critical thinking
- Help of Retyk (mathematician)
- Bi-valent historical moment (*1517)
- So, the need for the scientific revolution, is the *need for knowledge*, to which we attribute the feature of **truth** (willingly - an objective truth).

Immanuel Kant:
Do we study transcendental reality?

- Old question of Plato ↔ Aristotle:
- Do we study *reality* or only *projections of reality* (like in cinema)?
- As experimental physicist, I answer: reality (electrons, quarks, waves) exist and we can manipulate them
- But do we study them, or our *ideas* on them?
- Scientists asks the Nature, but not as a child, but like a judge: „Is that truth that on 1st May in Sopot you have stabbed John?
- Scientist verifies **concepts**
- → First: concepts, then: → experiments to verify them, →detailed experimental procedures, →arrival (Si/No)

3. ? „Cognitivism”

- „The cognitive revolution as originally conceived virtually requires that psychology join force with anthropology and linguistics, philosophy and history, even with the discipline of law.” (p.3)
- „Very early on, for example, emphasis began shifting from „meaning” to „information”, from the *construction* of meaning to the *processing* of information. […] Information processing inscribe messages at or fetches them from an address in memory on instructions from a central unit, or it holds them temporarily in a buffer store, and then and manipulates them in prescribed ways: it lists, orders, combines, compares precoded information.” (p.4)
- We take from J. Bruner, the concept of „information” as pre-existing: teaching is manipulating the information in a prescibed way.

J. Bruner, *Act of Meaning*, Harvard University Press, 1990

What is cognitivistics?

- Generally, it is the science on the human mind, and it is more than:
- Psychology, that studies, among others, behaviours
- Pedagogy, which has as subject the education
- Neuro- physiology, which studies electric currents in the mind
- Linguistics, which studies language as the mirror of the mind

Human mind is much more complicated than its external appearances/ extenuations/ signs.

Umysł człowieka jest dużo bardziej skomplikowany, niż jego zewnętrzne przejawy.

3. „Cognitive didactics”

[…] that cognitive didactics in not a single method, is not based on one procedure or protocol, but accumulates a series of statements and doubts on the [didactical] observations themselves, and appeals to the previous knowledge – from neuro-psychology to pedagogy, ethology, sociology etc. - to the most reliable aspects of the reasoning, i.e. the human mind” (p.8)

Piero Crispiani, *Didattica cognitivista*, Roma, Armando Editore, 2006.
Bronisław Siemieniecki, *Pedagogika kognitywistyczna. Studium teoretyczne*, Impuls, Kraków, 2013
Grzegorz Karwasz, Jolanta Kruk, *Idee i realizacje dydaktyki interaktywnej. Wystawy, muzea i centra nauki*, Wyd. Nauk. UMK, Toruń, 2012.

How cognitivism changes didactics?

- Teaching ceases to be a *transmissional* passing of knowledge from one generation to another (like it was in times of Homer)
- While teaching, we observe thoroughly what happens in the mind of the student (otherwise it is, according to Polish philosopher, K. Ajdukiewicz, speaking of a guy to a portrait, „mówienie dziada do obrazu")
- Teaching becomes, to a great extent, an individual *constructing* of knowledge, practical skills and life competences in the mind of a young person.
- Learning becomes a discovery adventure of a young man/ woman
- Teacher performs a role of *„pedagog"*, i.e. that who walks with/ along the student.

How does it change the role of teacher?

- Teacher must know not only his subject contents knowledge (know Newton's laws), but also a methodological know-how (know why Newton's laws are formulated in this and not different way) and also the knowledge on various ways of *constructing* in pupil's mind a give term/ law/ explanation.
- Lee Shulman in 1987 r. called it „Pedagogical knowledge contents"
- We call it the principle „9:1" – teacher must know about his subject 9 times more that he/ she is to transmit to the pupil. .
- The teacher must know not only the correct answer but also must understand why the pupil gives this particular wrong answer.
- In a sense of cognitive didactics no pupil's answer is wrong/ useless.

4. L. Shulman: Pedagogical Knowledge Contents

- „The advocates of professional reform base their arguments on the belief that there exists a „knowledge base for teaching" – a codified or codifiable aggregation of knowledge, skill, and technology, of ethics and dispositions, of collective responsibility – as well as a means for representing and communicating it."
- „[…] we learned how particular kinds of knowledge and pedagogical strategies necessarily interacted in the minds of teachers." (p. 5)
- […] Among these categories, pedagogical knowledge is of special interest because it identifies the distinctive bodies of knowledge for teaching. It represents the blending content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction. (p.8)

L. Shulman *Knowledge and Teaching. Foundations of New Reform*, Harvard Educational Review, 1987

4. P. Crispiani: „Stili ad arte”

- „Apart from didactics programmed and modelled, there exist, and luckily from always, the maestry of teaching, that analyses itself everyday, which knows walking sometimes random, navigation „by eye”, tortous and crossing routes, recognized immediate professional solutions, correct choices, unexpected actions. It acts on the basis of resources of constant reflection, of own action and experience, and the comparison with theoretical formalisms, i.e. with the knowledge filtered by time, free from instantaneous and rewarding suggestions. […]
- It belongs do the didactical actions also the style of teaching, as the method of acting plastical and adapted, well-thought and lived, scientifically oriented but also with a great own contribution.

P. Crispiani, *Didattica cognitiva*, p. 4

5. Physics: desperate need for ND

A typical, classical exercise of physics teaching in secondary schools is the following:

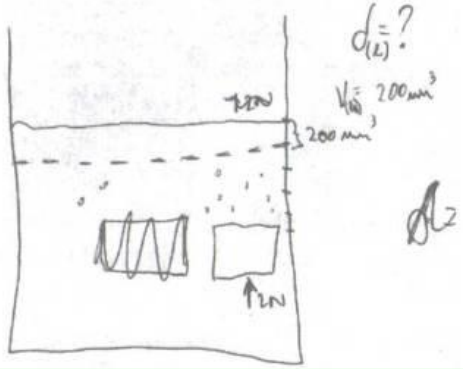
Determine the density of a liquid if the buoyant force on a body is 2 N and the volume of the displaced liquid is 200 mm³.

For almost 70% of the students this problem is:

- difficult
- not attractive
- insignificant
- they have no idea how to solve it.

One example of a "solution" is shown in Fig. 1.

Physics as a mental, compulsory exercise

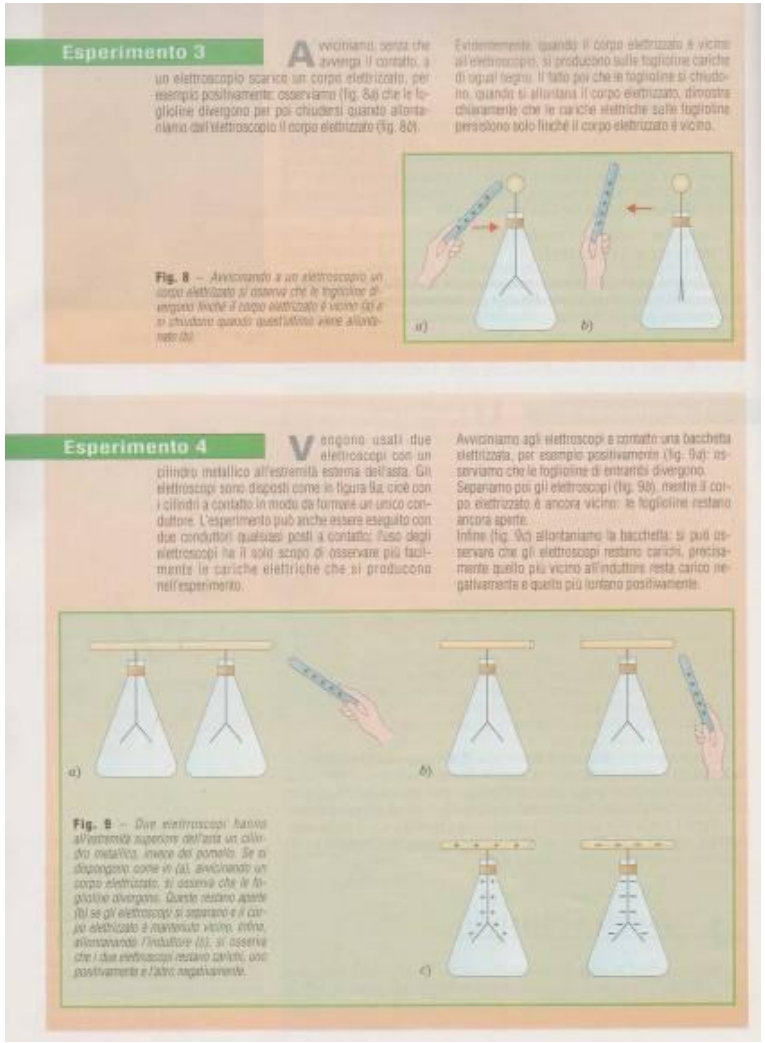


By sure, a task of this kind excludes motivation for physics. Formal teaching, and the problem is a typical example of it, has only success:

- If students have already a spectrum of everyday experiences which permit them to elaborate and to construct abstract concepts.
- If students have already developed a good level of logical-abstract thinking.

Loredana Sabaz, *Ginnasio Gian Rinaldi Carli, Koper-Capodistria*, GIREP 2005, p. 135

Electrostatics



Esperimento 3

Avviciniamo, senza che avvenga il contatto, a un elettroscopio scarico un corpo elettrizzato, per esempio positivamente: osserviamo (fig. 8a) che le foglioline divergono per poi chiudersi quando allontaniamo dall'elettroscopio il corpo elettrizzato (fig. 8b).

Evidentemente, quando il corpo elettrizzato è vicino all'elettroscopio, si producono sulle foglioline cariche di uguale segno. Il fatto poi che le foglioline si chiudono, quando si allontana il corpo elettrizzato, dimostra chiaramente che le cariche elettriche sulle foglioline persistono solo finché il corpo elettrizzato è vicino.

Fig. 8 – *Avvicinando a un elettroscopio un corpo elettrizzato si osserva che le foglioline divergono finché il corpo elettrizzato è vicino (a) e si chiudono quando quest'ultimo viene allontanato (b).*

Esperimento 4

Vengono usati due elettroscopi con un cilindro metallico all'estremità esterna dell'asta. Gli elettroscopi sono disposti come in figura 9a, cioè con i cilindri a contatto in modo da formare un unico conduttore. L'esperimento può anche essere eseguito con due conduttori qualsiasi posti a contatto: l'uso degli elettroscopi ha il solo scopo di osservare più facilmente le cariche elettriche che si producono nell'esperimento.

Avviciniamo agli elettroscopi a contatto una bacchetta elettrizzata, per esempio positivamente (fig. 9a): osserviamo che le foglioline di entrambi divergono.
Separiamo poi gli elettroscopi (fig. 9b), mentre il corpo elettrizzato è ancora vicino: le foglioline restano ancora aperte.
Infine (fig. 9c) allontaniamo la bacchetta: si può osservare che gli elettroscopi restano carichi, precisamente quello più vicino all'induttore resta carico negativamente e quello più lontano positivamente.

Fig. 9 – *Due elettroscopi fissati all'estremità superiore dell'asta un cilindro metallico, invece del pomello. Se si dispongono come in (a), avvicinando un corpo elettrizzato, si osserva che le foglioline divergono. Queste restano aperte (b) se gli elettroscopi si separano e il corpo elettrizzato è mantenuto vicino; infine, allontanando l'induttore (c), si osserva che i due elettroscopi restano carichi, uno positivamente e l'altro negativamente.*

(Troppe) dettagliato percorso sperimentale (anzi, storico) senza deduzione

„Troppa esemplificazione porta a infantilismo”

Too much showing is infantile

Nadmiar poglądowości prowadzi do infantylności
(K. Sośnicki)

INT. J. SCI. EDUC., 2003, VOL. 25, NO. 9, 1049–1079

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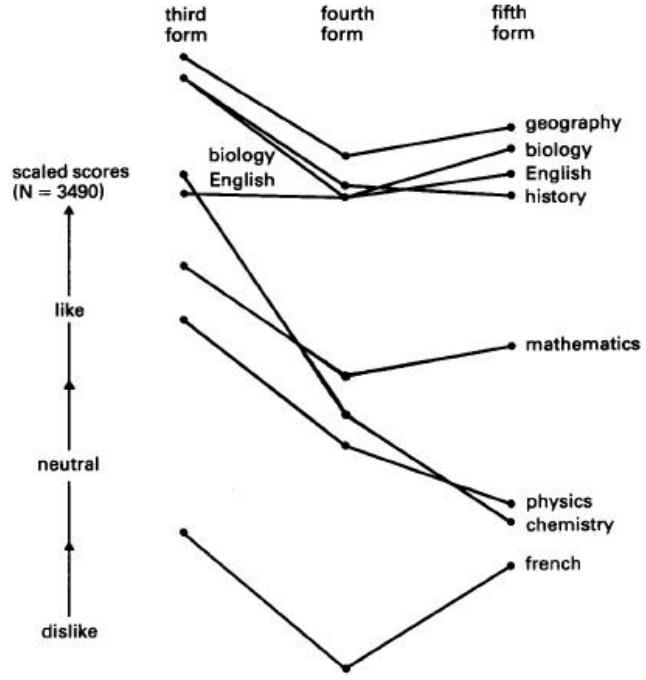
SPECIAL ISSUE: AFFECT

Attitudes towards science: a review of the literature and its implications

Jonathan Osborne, King's College London, UK; e-mail: jonathan.osborne@kcl.ac.uk; Shirley Simon and Sue Collins, Institute of Education, University of London, UK

Table 3. Number of engineers and scientists per million of the population

Country/region	*Number of engineers and scientists per million of the population (1993)*
Japan	3548
The US	2685
Europe	1632
Latin America	209
Asia	99
Africa	53



Attitudes toward secondary school subjects (Whitfield 1979).

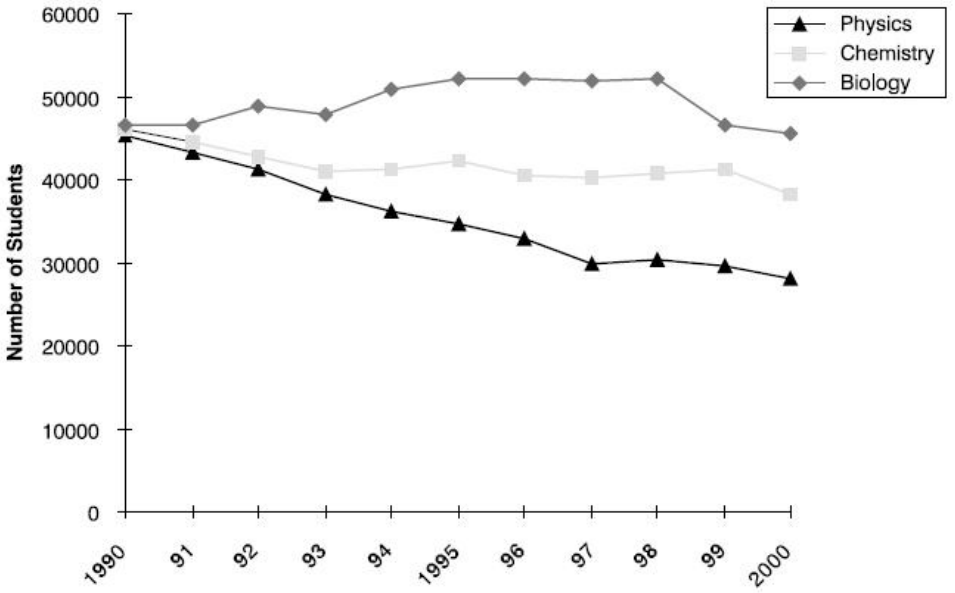


Figure 1. Data for numbers of students examined in physics, chemistry and biology from 1990 to 2000 in England and Wales at A-level. (Data provided by UK Examination Boards and HMSO.)

5. Physics & Pedagogy: wishful thinking

Pupils shall be able to:

Argue how a theory is relate to evidence

1. Explore actively possible uses of phenomena
2. Explore actively technological implications of a new discovery
3. Describe how scientists gain and interpret data
4. Describe how science and technology uses new ideas
5. Communicate scientific ideas to different audiences
6. Ask questions to themselves about physics and how it is related to everybody life
7. List some connections between different field of physics.

Comment: Achieving of overall aims and learning objectives are realistic only for the most advanced pupils.

E. Mechlova, L. Konicek, *Evaluation of Superconductivity Program,* in:
Informal Learning and Public Understadning of Physics, 3rd Int. GIREP Seminar, Udine, 2005, Contributions, p. 412

5. „Inquiry-Based Teaching"

For many elementary teachers, teaching science primarily involves worksheets and definitions.

As stated in the literature, science education reform emphasizes the need for science instruction to foster students' abilities to think and behave like scientists. To

Do we need all these „scientists"?
The „scientific" way of thinking is not everything

B. R. Brand, S. J. Moore, *Enhancing Teachers Application of Inquiry-Base Strategies Using a Contructivist Sociocultural Professional Development Model,* Int. J. Science Education, 33 (2011) 889

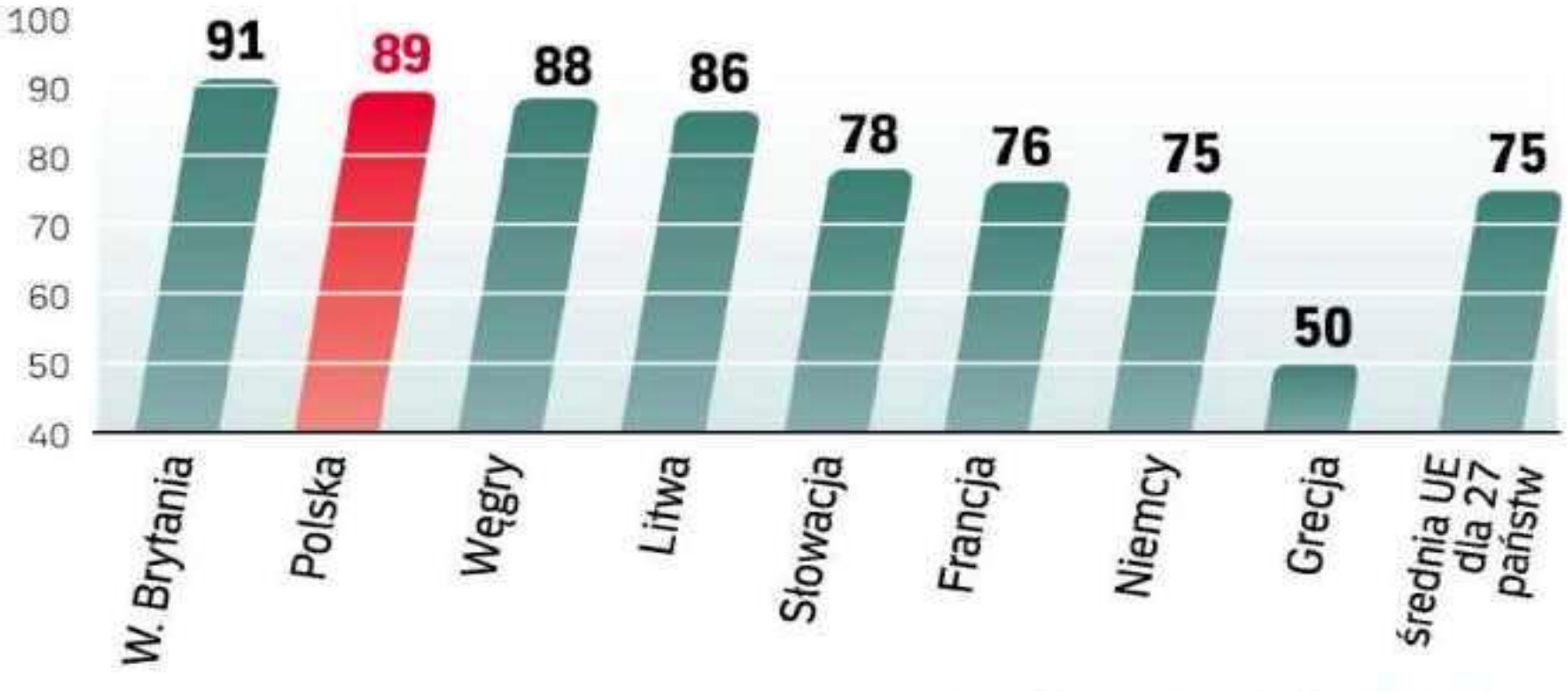
5. „The present system does not meet the needs of any...”

The present system does not meet the needs of any but a small minority of the students I teach. It is base on a specification of content in the National Curriculum that requires students to memorize and repeat facts about scientific knowledge that are of little interest or relevance to them. It does not prepare them to understand the scientific issues that will meet in everyday life.

Harrison et al. 2004, citato da P. Black (King’s College, London),
Assessment and Pedagogy in Science Education, in: Physics Teaching and Learning,
GIREP Book of Selected Papers, ed. M. Michelinie e S. Pugliese Jona

Pochi, ma buoni? / Few but good?

6. Children in age 6-17 using internet (2009)



A. Niewińska: *Polska sieć groźna dla dzieci*. „Rzeczpospolita" 8.02.2010

6. Hyper-inflation of information

$$\vec{F} = 0$$

to całkowity pęd ciała (układu ciał) nie zmienia się:

$$\Delta\vec{p} = 0$$
$$\vec{p} = \text{const}$$

Powyższe zdanie stanowi treść zasady zachowania pędu. Zasada zachowania pędu jest konsekwencją symetrii translacji w przestrzeni (twierdzenie Noether)

$$\vec{x} \to \vec{x}' = \vec{x} + \vec{a}.$$

Jeżeli energia potencjalna jest niezmier

$$U(\vec{x}) = U(\vec{x}') = U($$

$$\mathbf{p = mv}$$

Ma on taki sam kierunek i zwrot, co wektor prędkości danego ciała, ale jego wartość obliczamy mnożąc wartość prędkości przez liczbę – wartość masy danego ciała.

Widać, że wzór na energię kinetyczną możemy też przedstawić w postaci:

$$\mathbf{E_k = p^2/2m \ (= ½ \ m^2 \ v^2 \ /m)}$$

W mechanice kwantowej nierelatywistyczna (poruszająca się z małą prędkością w porównaniu z c) cząstka swobodna o określonym pędzie p = ħk i określonej energii E =E_k= ħω, opisywana jest funkcją falową: exp i(kx-ωt), spełniającą równanie Schrödingera zależne od czasu (dla uproszczenia w jednym wymiarze):

$$\mathbf{- \hbar^2/2m \ (\partial^2\Psi/ \partial x^2) = i \hbar \ \partial\Psi/ \partial t}$$

6. From a real experiment to its mathematical abstraction

VIII LO Toruń, fot. J. Kosicki

6. From a real experiment to its mathematical abstraction

VIII LO Toruń, fot. J. Kosicki

6. From a real experiment to its mathematical abstraction

GK, UniUdine, photo M. Karwasz

6. Virtual worlds ↔ real worlds

(Rosmini Liceum from Trento in Toruń)

6. Virtual worlds ↔ real worlds

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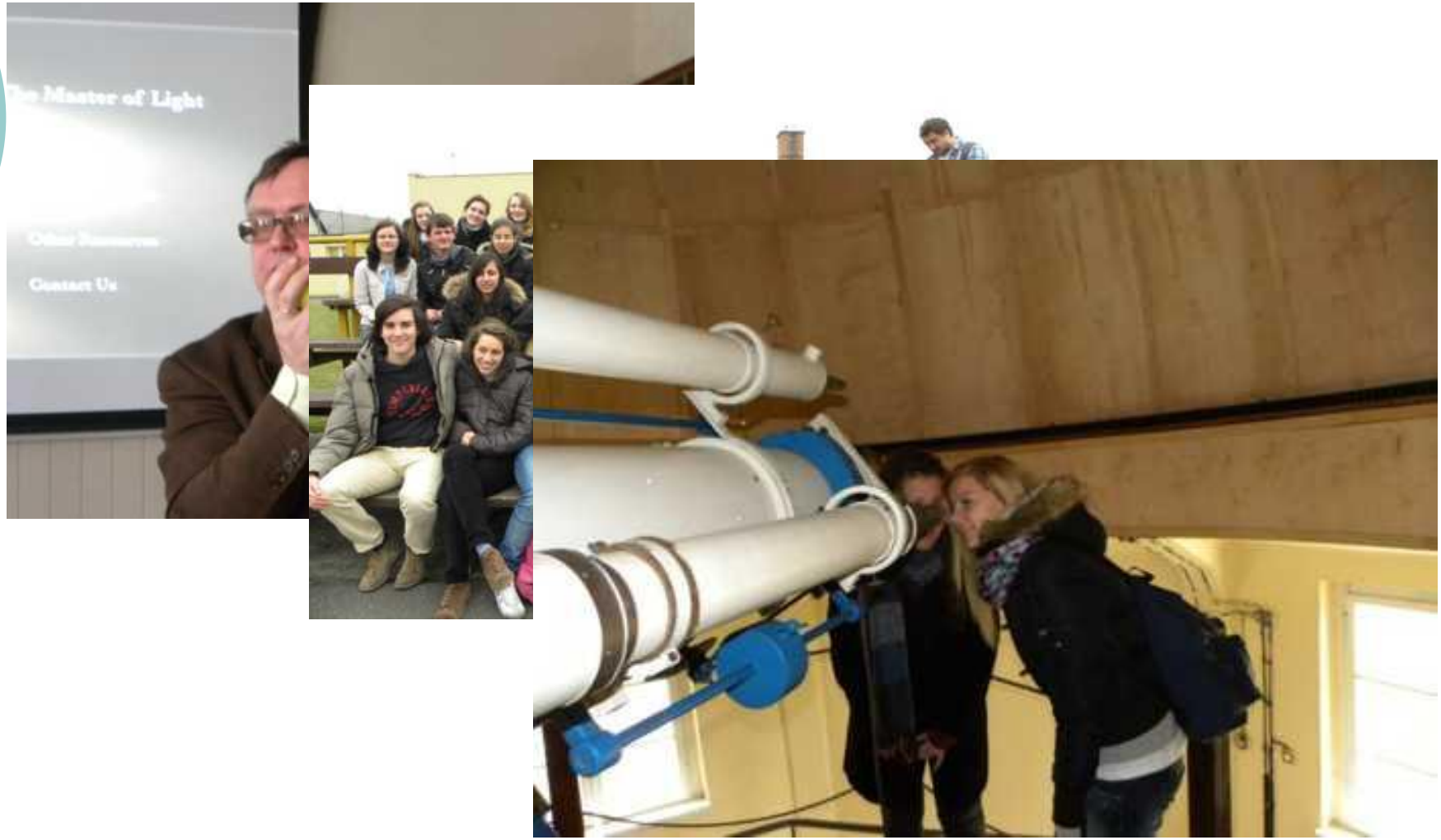
6. Virtual worlds ↔ real worlds

(Rosmini Liceum from Trento in Toruń)



7. New didactics: „principles”

- Similar to the traditional didactics, but completely different:
- Frequently postulated activity of students we substitute by an *autonomous* [~Berger & Luckmann] constructing, in a shool/ extra-school group, of a fragment of knowledges that was planned by the teacher
- Students/ pupils construct this knowledge themselves, based on posessed resources (own information, experiments, internet).
- The teacher solely streams their group thinking in the planned direction
- In case of difficulties the teacher does not say: „Wrong! Insufficient! Sit down!” but streams questions in such a way that the student and/or his/her colleagues find the error themselves.
- Obviously, it requires a huge resources of knowledge and experience by the teacher. In physics, additionally – experiments at hand.

7.Hyper-constructivism & Neo-realism

- These two main strategies:

1) constructing the knowledge by pupils, but under a strict and wise control of the

2) using all available (i.e. really existing) resources – objects, experiments, books, internet

we define as:

- **hyper-constructivism** (i.e. going beyond the social constructivism, in which the knowledge is merely discussed and socially accepted)
- **neo-realism** – all that what can be shown should be shown (illustrated, tought), must be shown, and even more (GK↔A. Einstein)

7. Hyper-constructivism: principles

- Information is pan-available
- Teaching is *interactive*
- Sum of individual knowledges is the starting *resource*
- First, that is teacher who defines *implicitly* the arrival goal (i.e. a law, a principle, a phenomenon).
- The heurestic goal corresponds to *ontological category* (Kant)
- Teacher has to *induce* this category in the mind of student
- The arrival path is defined (case-by-case) *acccording* to the knowledge of audience
- In constructing the arrival path the teacher uses the knowledge available in the target group and (physics) on *ad-hoc* experiments (or texts, in languages)
- **Learning becomes an active (and involving) discovery**

7. Hyper-constructivism

(a) Hyper-constructivism resembles walking on the lake, knowing that under its surface there are closely (at a step distance) planted trunks

(b) In neolithic times such closely spaced trunks served to assure security for settlers (Lago di Ledro, Trentino, foto MK).

Strategies for Cognitive Didactics
Neo-realism

GK ↔ Einstein:
Everything that can be shown should be shown,
and even more.

7. Recalling long-term goals

- And this should lead to such a formation of adult persons that their civilisation success is assured, where by „civilisation success" we intend both economic and cultural ones.
- How it was written by one of most prominent humanists of XXth Century and, E. Morin (1999), the aim is not only to change the system of education but the system of thinking.
- The goal is not the „head well filled-up" like in the dust-bin joke theory of mind by K. Popper, but „tête bien faite" – mind well prepared.
- And all of this is to respect a clear axiology: cultural, religious and humanistic inheritance of Europe (UE Treaty, 2010)

More at: **http://dydaktyka.fizyka.umk.pl/Cogito**

7. Long-term goals: OECD „AHELO"

Methods

The test will look at:

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

Analytical reasoning

Problem-solving

Written communication

Discipline-specific skills (in economics and engineering for the feasibility study)

Contextual information to link the data to student backgrounds and learning environments.

Find out more on the the assessment and the instruments here

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

8. Pedagogical „by-products”

Individual decision - making
Individual responsability
Individual visibility
In-dividual personality

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8. Social „by-products”

Individual roles
Self-division of tasks
Group collaboration
Solidarity of the class

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Learning is joyful (emotional)

„Everything plays”, Lublin, 2010

Learning is joyful (emotional)

„Why do objects fall?” Głogów 2011

Learning is joyful (emotional)

„Jumping from cosmos” Poznań, 2012

Free inquiring, autonomous answering

„Going downhill” Gorzów, 2009

Free inquiring, autonomous answering

„Going downhill” Gorzów, 2009

9. Implementations: Why do objects fall?

1) becasue they are attracted by gravity [80% at age 11-12]

1a) *What gravity is?*

1b) It is attracting of objects by Earth.

1c) *Why does Earth attract objects?*

1d) Because the gravity acts → go to 1a

Mathematics/ Logics: „only tautologies are for sure true”
Experimental Physics: „but they bring **little new** knowledge” !

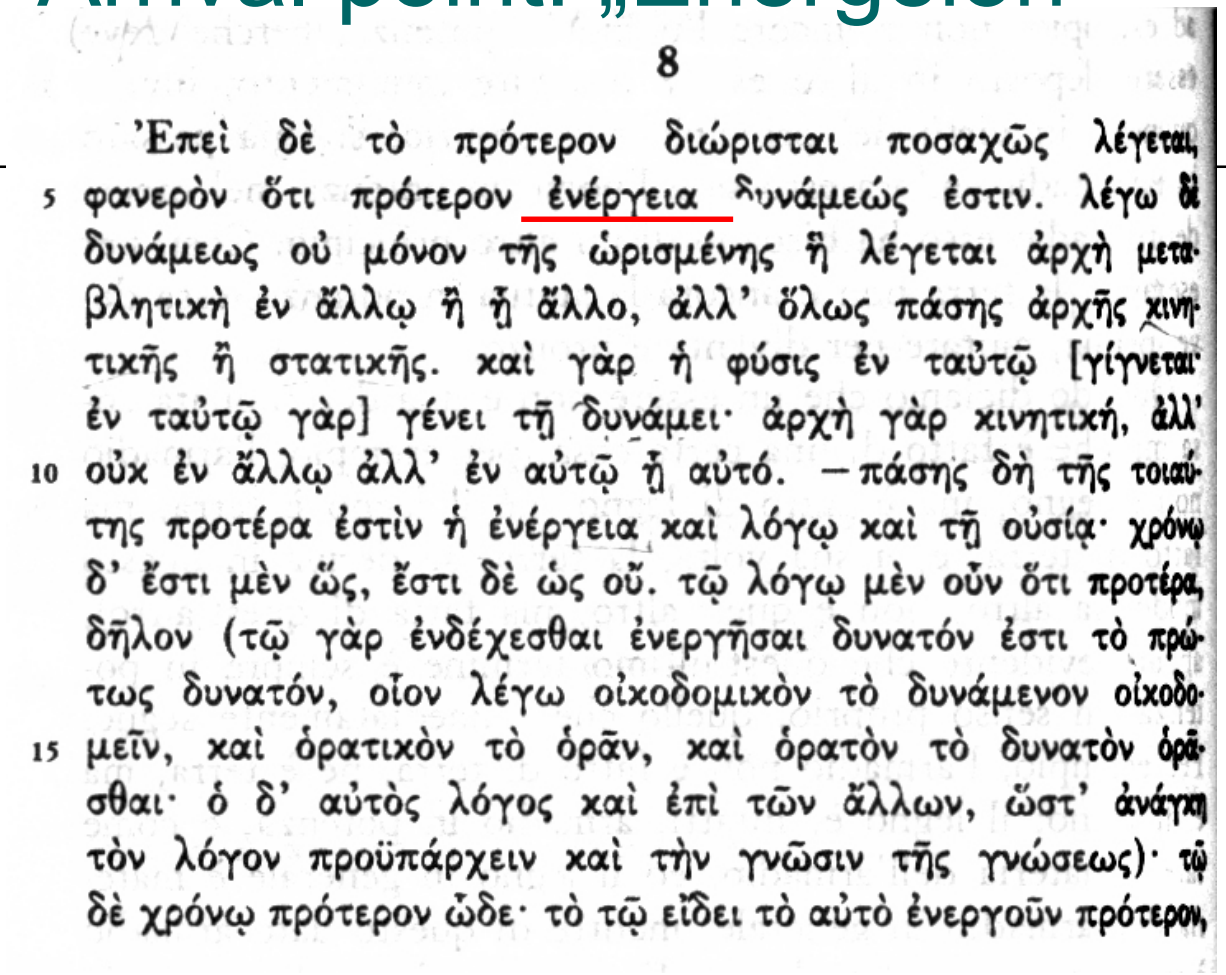
Interactive lesson scenario:

1. Why do objects fall?
2. Can they rise by themselves?
3. What should we do to make them rise?
4. Is there any other way?
5. How can we call this property?
6. Check your breakfast

Didactical tunnel: Going donwhill

- **Dlaczego ciała spadają**? Bo działa na nie grawitacja?
- A dlaczego podskakują, zsuwają się, staczają?
- Też grawitacja? To chyba jest nieco bardziej skomplikowane.
- Jak odróżnić ruch jednostajny od przyspieszonego?
- A jak ciała przyspieszają? A kiedy jest tarcie to też przyspieszają?
- Na te wszystkie pytania – szkolne i domowe – odpowiada wystawa **„Z górki na pazurki”**

Arrival point: „Energeion”



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Ἐπεὶ δὲ τὸ πρότερον διώρισται ποσαχῶς λέγεται, φανερὸν ὅτι πρότερον ἐνέργεια δυνάμεώς ἐστιν. λέγω δὲ δυνάμεως οὐ μόνον τῆς ὡρισμένης ἣ λέγεται ἀρχὴ μεταβλητικὴ ἐν ἄλλῳ ἢ ᾗ ἄλλο, ἀλλ' ὅλως πάσης ἀρχῆς κινητικῆς ἢ στατικῆς. καὶ γὰρ ἡ φύσις ἐν ταὐτῷ [γίγνεται· ἐν ταὐτῷ γὰρ] γένει τῇ δυνάμει· ἀρχὴ γὰρ κινητική, ἀλλ' οὐκ ἐν ἄλλῳ ἀλλ' ἐν αὐτῷ ᾗ αὐτό. —πάσης δὴ τῆς τοιαύτης προτέρα ἐστὶν ἡ ἐνέργεια καὶ λόγῳ καὶ τῇ οὐσίᾳ· χρόνῳ δ' ἔστι μὲν ὡς, ἔστι δὲ ὡς οὔ. τῷ λόγῳ μὲν οὖν ὅτι προτέρα, δῆλον (τῷ γὰρ ἐνδέχεσθαι ἐνεργῆσαι δυνατόν ἐστι τὸ πρώτως δυνατόν, οἷον λέγω οἰκοδομικὸν τὸ δυνάμενον οἰκοδομεῖν, καὶ ὁρατικὸν τὸ ὁρᾶν, καὶ ὁρατὸν τὸ δυνατὸν ὁρᾶσθαι· ὁ δ' αὐτὸς λόγος καὶ ἐπὶ τῶν ἄλλων, ὥστ' ἀνάγκη τὸν λόγον προϋπάρχειν καὶ τὴν γνῶσιν τῆς γνώσεως)· τῷ δὲ χρόνῳ πρότερον ὧδε· τὸ τῷ εἴδει τὸ αὐτὸ ἐνεργοῦν πρότερον,

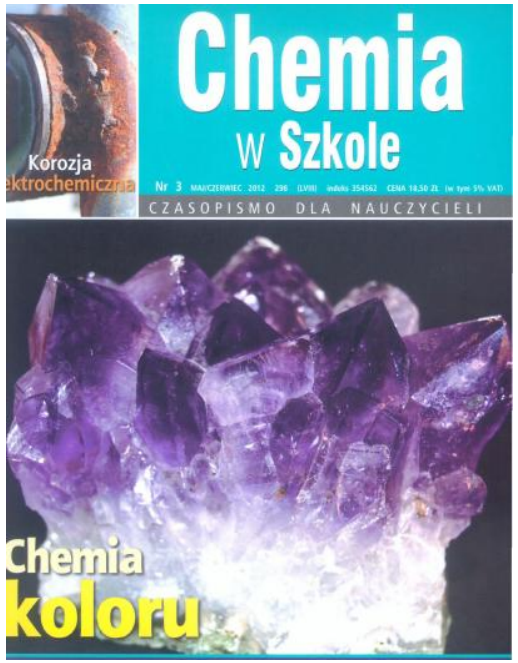
Energeion = (pre) existing, atto, action, acting
Dinamikos = potential (for changes)

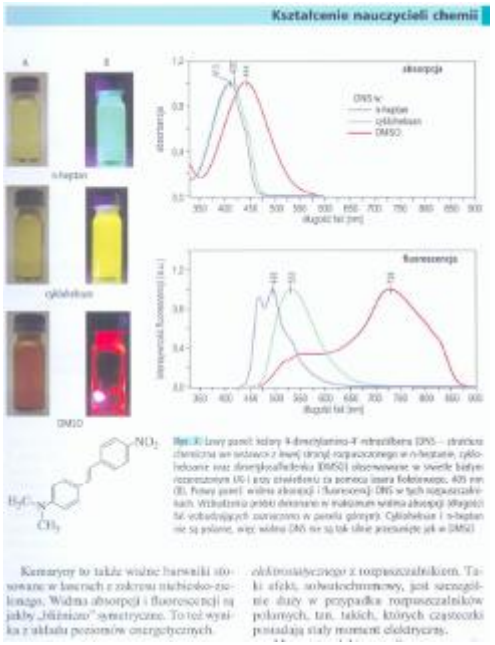
Aristotle, *Metaphysics*

Spectroscopy, or science on ghosts

- Motywacja: wykorzystujemy grę słów „spektrum = duch, zjawa”.
- W fizyce (chemii itd.) mianem widma nazywa się jakikolwiek zapis *własności* dane-go obiektu, jak np. natura białego światła ujawnia się w procesie jego rozłożenia na kolory składowe, jak ma to miejsce np. w tęczy czy na powierzchni płyty CD.
- O dziwo, słowo „spektrum” nie występuje w grece – użył go dopiero Cycero.
- Gra słów i rozszerzenie pojęć pozwala na prezentację różnych zjawisk, na pograniczu fizyki, chemii, biologii, percepcji człowieka i sztuki.
- Wykład ma charakter interaktywny, gdzie element zdziwienia jest ważnym środkiem wspomagającym przekaz dydaktyczny.
- Pedagogicznie – k ...łasnego poszukiwania
- Miał on szereg ods ...s), na festiwalach nauki, jako ogólnc ...kursu Fizyki Współczesnej

„Where do colours come from?”



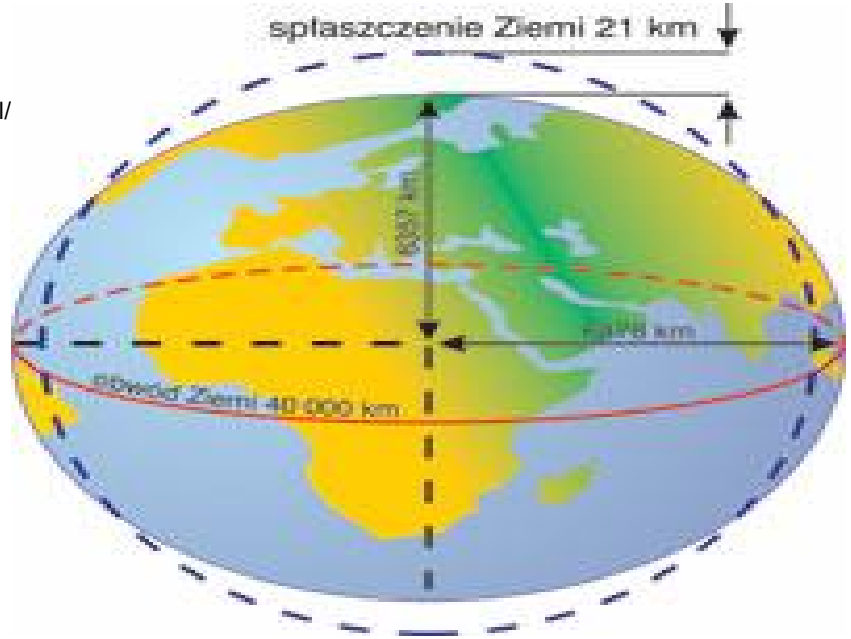


- Temat jest kontynuacją zabawy z kolorami. Pytaniem, od którego budujemy rozumowanie jest pytanie z chemii: „co to jest papierek lakmusowy?” „-Papierek, który wskazuje odczyn pH.”
- Pomijając pytanie, co to pH (→Wykład 7 „Matematyka”), odpowiedź powyższa niczego nie wyjaśnia. Jak papierek pokazuje pH? „- Przez zmianę koloru.” „A od czego ta zmiana koloru?” „- Od zmiany pH.”
- Znów tautologia, jak ta o spadaniu ciał, tylko tym razem w chemii. Musimy wyjaśnić, czym to takim specjalnym jest „lakmus” i dlaczego on (czy tylko on?) zmienia kolor po wpływem zmiany pH.
- Praca „skrystalizowała się” dzięki współpracy z prof. M. Gagosiem z UMCS

What is the shape of Earth: Geoid = Earth-like

- „kula” ziemska jest spłaszczona na biegunach: różnica promienia równikowego i biegunowego to 21 km. Powodem jest siła odśrodkowa na wirujacej Ziemi.
- W przybliżeniu więc, kształ Ziemi to elipsoida obrotowa
- Ale rzeczywisty kształt Ziemi odbiega od elipsoidy, z powodów różnicy gęstości materiału, z którego jest ona zbudowana (głównie róznic gęstości zewnętrznych warstw płaszcza i skorupy
- Róznice te wynoszą max ±100 m. Tak określona bryła – to geoida.

http://www.mt.com.pl/-mapa-ziemi

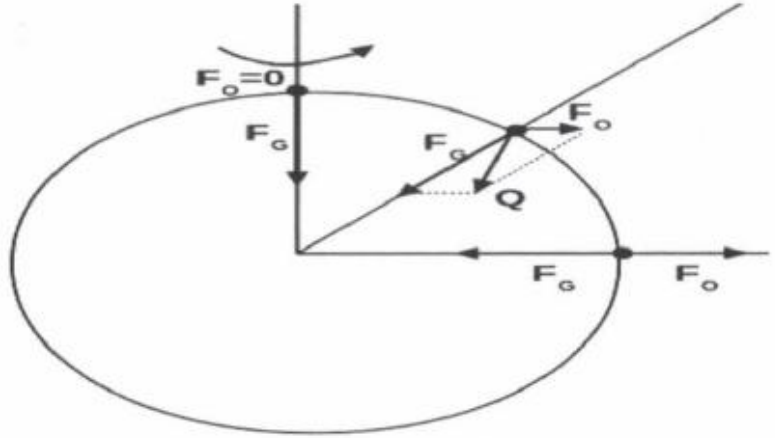


promień równikowy – 6378 km
promień biegunowy – 6356 km
spłaszczenie – 0,003

Earth's elipsoid → Earth covered by waters

- Na wirujący obiekt (Ziemię) działa siła odśrodkowa. To ona powoduje spłaszczenie Ziemi przy biegunach i jej wybrzuszenie „na równiku".
- Przyspieszenie ziemskie na równiku jest mniejsze niż na biegunie, gdyż działa dodatkowo siła odśrodkowa.

- Kształt Ziemi jest taki, że w każdym jej punkcie siła ciężkości jest prostopadła do jej powierzchni, jak to pokazuje zdjęcie na prawo



Rys. 2. Elipsoida obrotowa jest „idealną" powierzchnią Ziemi: jest to taka powierzchnia, że siła wypadkowa Q (pochodząca od siły grawitacji F_g i siły odśrodkowej bezwładności F_O) jest do niej zawsze prostopadła. Proporcje siły odśrodkowej i spłaszczenia Ziemi są na tym rysunku znacznie wyolbrzymione

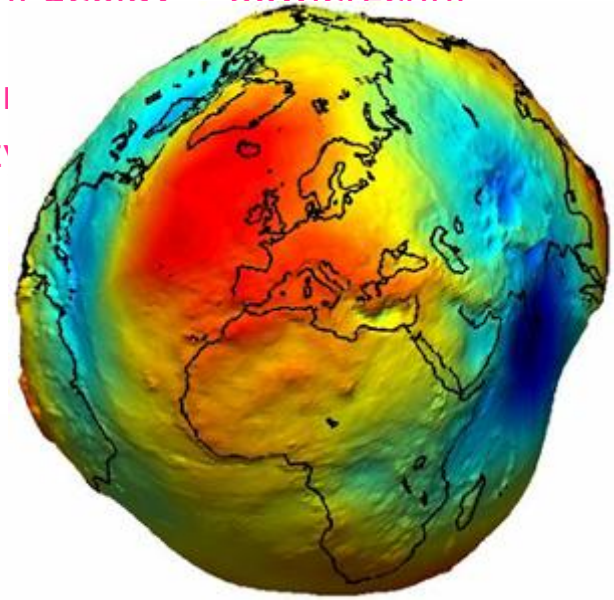
$g_{min}=9{,}78\ m/s^2$, $g_{max}=9{,}83\ m/s^2$

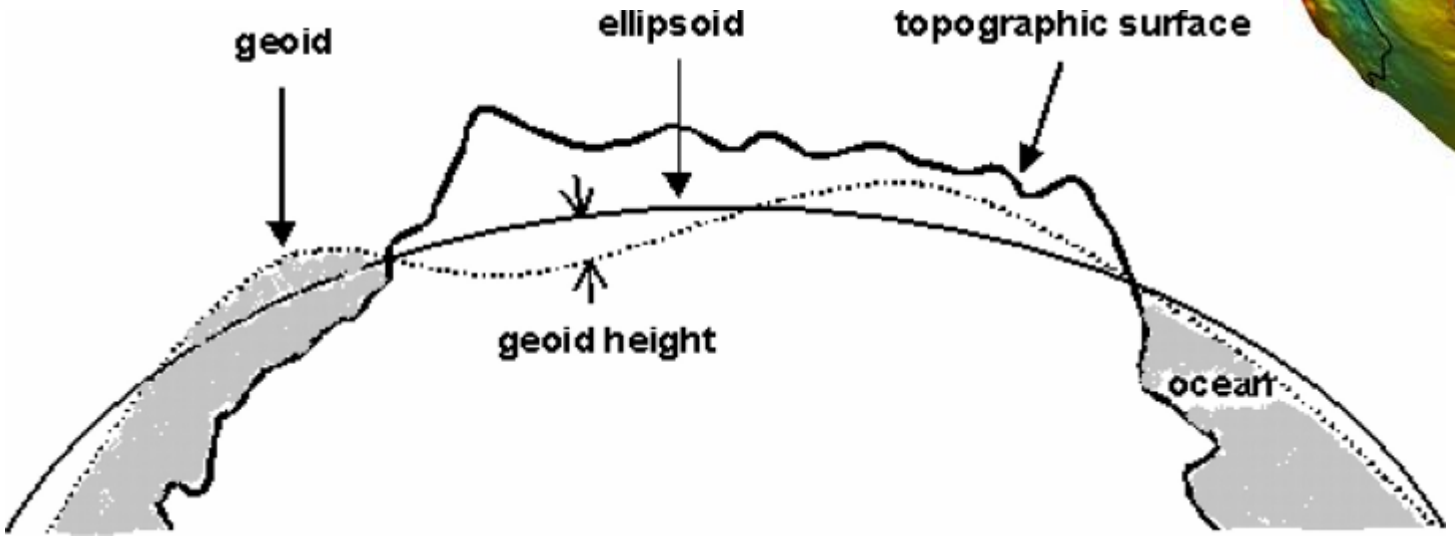
Fot. 2. Zawieszony „pion" wskazuje środek ciężkości Ziemi. Poziomica murarska wskazuje kierunek powierzchni morza, prostopadły do „pionu". Kulka położona na poziomej powierzchni nie stacza się (fot. autor)

J. Chojnacka, G. Karwasz, *Jakiego kształtu jest „kula" ziemska?,* Geografia w Szkole, 6/2011, str. 45
http://dydaktyka.fizyka.umk.pl/Wyklady_Filmy/Kula_ziemska_JCh_GK_2011.pdf

✓ Lokalne pole grawitacyjne Ziemi: geoida

- Dowolnie daleko od równika i biegunów siła ciężkości nie jest skierowana wprost „do środka” Ziemi, ale prostopadle do powierzchni geoidy – powierzchni **jednakowego potencjału sił ciężkości.**
- Odchylenia geoidy od sferoidy wynoszą mniej niż ±**100** m
- Przewyższenia geoidy nad elipsoidą odpowiadają większym gęstościom materiału we wnętrzu Ziemi, a obniżenia - obszarom o mniejszych gęstościach.





J. Chojnacka, G. Karwasz, *Elipsoida ziemska*, Foton 114 (2011)
http://dydaktyka.fizyka.umk.pl/Publikacje_2011/Elipsoida_2011.pdf

Cognitive didactics = renewed Pedagogy

Thank you for your attention!