Communicational Strategies and Physics Education

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Introduction

The recent research of subject-pedagogy (national and international) reflects the changed social demand expected from science education. The necessary knowledge for all of the pupils to give orientations to this modern world (curriculum), the unfavourable pupils' opinion on science subjects (attitude), the changed learning milieu, the radical change of teacher's role (reforming teachers' and pupils' strategies) stand in focus of researches.

1. Results of recent studies

The results of the international research TIMSS 2003 are not well-known in Hungary. The study presents useful data on the level of knowledge and attitudes of students, on the structure and different organizing methods of science lessons (Fig. , Fig. 2, Fig.3) [1]. The organizer of this research was the IEA. In our study the answers of the 2nd population are analysed (8th grade, 3306 Hungarian students).

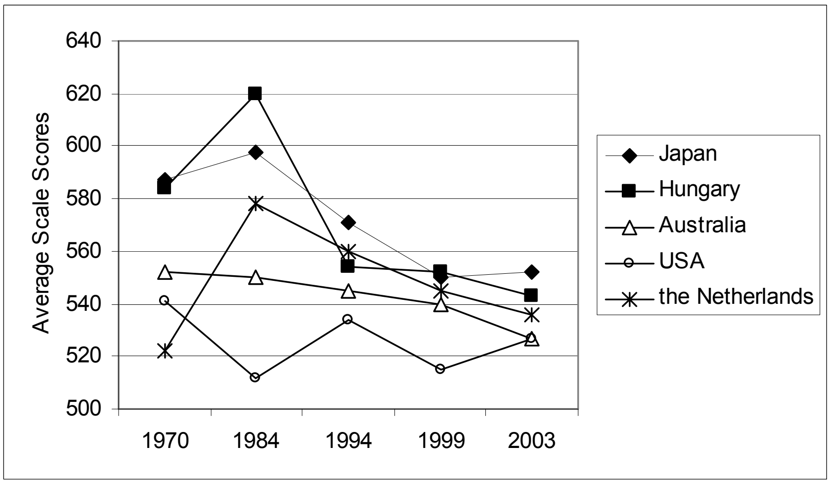


Fig. 1. The changes of level of scientific knowledge

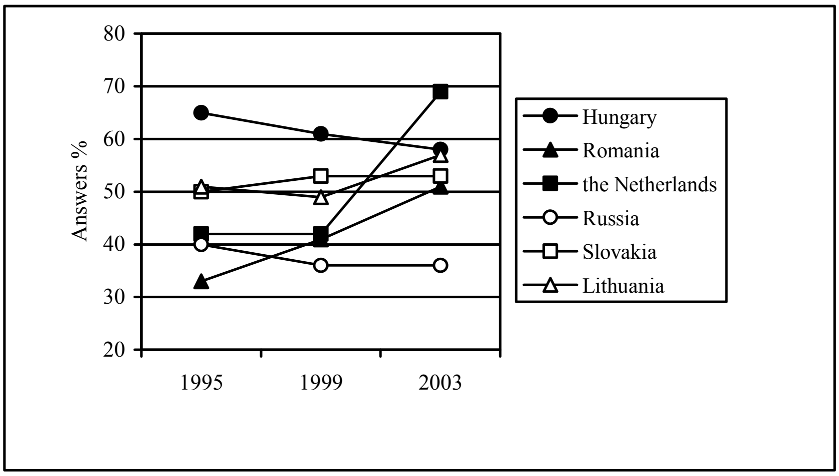


Fig. 2. The change in rejection of physics

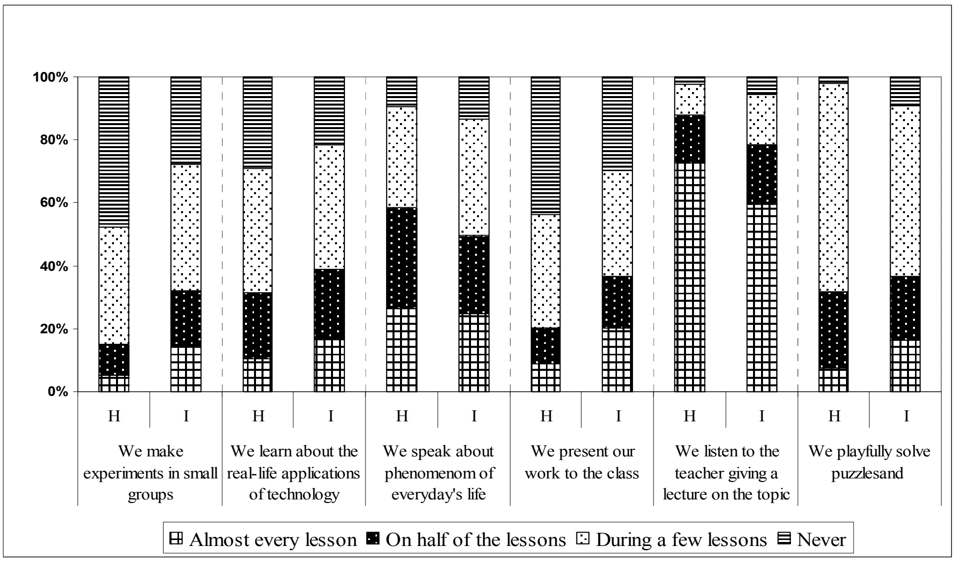


Fig.3 The structure of lessons

The results of these studies suggest that radical change is needed in science education.

2. The Rocard report

„Rocard" report (2007 June) was a research of European Comission (a Hungarian member is Péter Csermely) for radical renewal of methods in science education. [2]

Some recommendations of the report:

- **improvements** in science education should be brought about through **new forms** of pedagogy,
- inquiry-based science education, raising **students' activity**, emphasize the importance of **team-work**
- **modern and cheap forms of experiments**
- **specific attention** should be given to raising the participation of **girls** in school science subjects, developing relevant methods, presentation of **role-models of successful women for girls**
- the participation of all stakeholders in science education, including experts of science education, teachers, students, **parents, scientists**, engineers and their organisations, including schools, teacher and parent organisations, universities, research institutes, **science museums, science centres**, firms and local authorities is a key factor for the success
- flexible and varied solutions to the problem of **differentiated teaching**

3. New educational strategies in schools

New educational strategies in schools are needed to raise students' interest in physics. The following experiments can give examples for applying laws of physics to real-life problems.

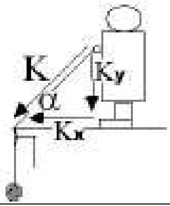
3.1. „VINGARDIUM LEVIOSA!"
How big „magic power" does a teacher have?

Fig 4 Tin can go up the slope by „itself"

Examination of combined rotational and translational motion is not an easy task for the 9th grade students. A suprising experiments (the tin can go up the slope by "itself") can make students curious (Fig 4). The phenomena and the hint for the well-known film can raise students' interest. As the material needed for the experiment is very simple, students can repeat the experiment at home.

The magnitude of the „magic force" (work-energy theorem): $F = mgh/s$. The speed of the box at the bottom of the slope after rolling back (conservation of energy): $v = \sqrt{gh}$ .The acceleration of the box (equations of dynamics): $a=g/4$. The condition of pure rolling: $\mu \geq \frac{1}{2\sqrt{3}}$.

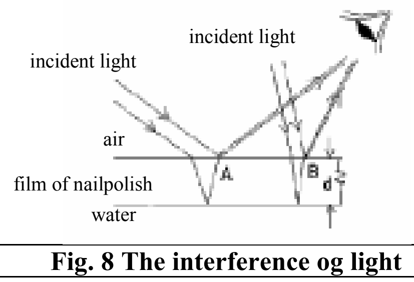
3.2. The „vague" elephant (Fig. 5)

	
Fig. 5 The vague elephant	**Fig. 6 The components of the force**

$$K=K_X+K_Y$$
$$K_X=K_2\cos\alpha$$
$$F_S=\mu N=\mu(Mg+K_Y)$$
$$K_Y=K_2\sin\alpha$$
$$Ma=K_X-\mu(K_Y+Mg)$$

Look at the angle! Task:
How big can be the counterweight? What factors does the frequency of sway depend on? Change the surface under the elephant. What do you see? Try to write down the caotic motion of the toy! [7]

3.3. „Nail-polish rainbow" (interference on a thin layer)

	
Fig. 7 The nail-polish rainbow	**Fig. 8 The interference og light**

Fill a pan with water, and place a black cardboard paper to the bottom of the pan. Drop a single drop of transparent nailpolish on the surface of the water. The nail-polish drop will quickly expand to make a circle of film on the water. Let the circle of nail-polish film dry for a few minutes. Gently lift one end of the water, making sure you catch the edge of the thin circle on the paper. Let the water drip off the paper into the pan for a little while, and then set the paper (with the circle of film clinging to the middle of it) on some newspaper to dry. After drying a beautiful and colourful (the colours of rainbow) layer can be seen (Fig. 7). The colours are due to the interference of light (Fig. 8) [3].

4. New educational strategies outside of the school

New educational strategies outside of the school e.g. experiments at home, experiments on the street and surfing on the internet can also motivate students.

4.1. Try this! The secret of nappies (Fig. 9)

Fig. 9 The polymer from nappies can absorb even 1 liter of water

Cut a baby nappy in two, put the parts to a plastic bag and shake the polymer powder out of the nappies. Take the nappies out of the bag. Put the content of the bag to a glass vet. Pour waterdrops to the vet and watch the changes. Depending on the type of the nappies the polymer can absorb even 1 liter of water while the powder becames a transparent jelly! [3]

A few examples of students' comments [4]:

"-My notes: I've got a 20 months old brother, so I met this problem every day. Before the experiment I never thought about what happened with the water inside the nappy. This task made me understand what happens so it gave me a new knowledge."

"Reasons for mistakes:

-I could not get all the polymer out of the nappy.

-The polymer might have absorbed more water if I poured more.

-I could not measure the volume exactly because the surface was not straight."

4.2. Measure it at home!

Measure the minimum torque needed to break a wood stick! [5]

An example from the answers: *"My grandfather helped me in making the frame as I do not know how to bend nails, and cut and make holes in the metal plate. But the plan of the frame was totally my idea!"* (Fig. 10)

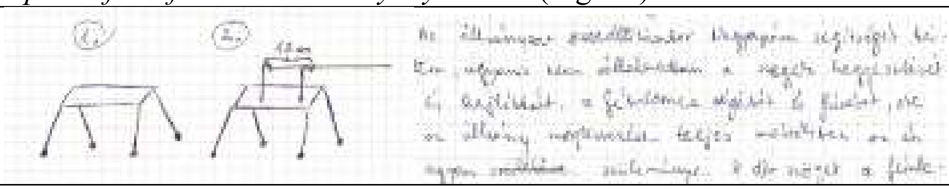


Fig. 10 Example from the answers

4.3. Measure on the street!

The measurement of velocity of cars with a digital camera [6]

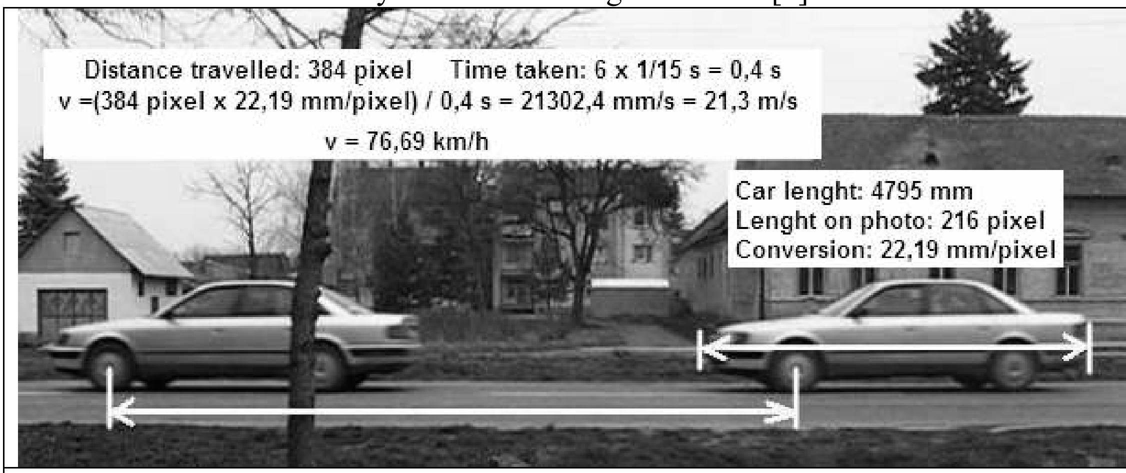


Fig. 11 The measurement of velocity of cars with a digital camera

For measuring the velocity of cars we have to make a short video on the traffic standing 10-20 m away from the road. The following two photos were taken from the video recorded on the street (Fig. 11). A pixelcoordinates should be transformed into real length. If we recognize the type of a certain car, we can check its lenght on webpages about cars. The car in the photo is an *Audi A6 Quattro*, its length is 4795 mm. The length of its image on the photo is 216 pixels, so 1 pixel is 22,19 mm. The velocity of the car can be easily counted looking at the photo. The velocity of the car is 76,69 km/h, which is much more than the speed limit on that road.

4.4. Do you know? – Surfing on Internet

E. g.Who was Maria Telkes?

Fig. 12 Maria Telkes

Known as the "Sun Queen" for her contributions to solar energy research, Hungarian-born American scientist Maria Telkes was one of the first to research practical ways for people to use solar energy (Fig. 12). She spent much of her life researching solar energy and designed many solar-powered ovens, stills, and generators. She designed the heating system in the first solar-heated home built in Dover in 1948. She invented a solar still which converted salt water to drinking water for life rafts at sea. This mobile distilling system was used for saving lives of pilots met with an accident above sea.

The heat storage equipment designed by Telkes was able to store heat energy for an extended amount of time. Telkes discovered how to store cold as well, using the principles of heat storage. Her chemical and physical inventions still have an importent role in technology nowadays. She worked for several American universities, she was retired as a professor at University of New York. She died in 1995 being forgotten by the scientific public life. [8]

Conclusion

From the many new approaches of science education we have looked presented in more detailed those procedures (based on our investigations), which give preference to pupils activity during the lessons in the classroom and outside of the school (so-called outdoors science).

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