Physics teachers on teaching the law of radioactive decay

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Topic flag

- The law of radioactive decay is well known both ways:

Using the number of radioactive nuclei (N), and also using the concept of radioactive activity (A)

$$N(t)= N(0)\cdot 2^{-t/T} \qquad A(t)=A(0)\cdot 2^{-t/T}$$

In both formulae the concept of half life (T) is essential.

- Teaching the law of radioactive decay is one of the most problematic issues in physics didactics.
- In Hungary the law we mentioned is in the secondary school syllabus for grade 11 (, which means students aged 17-18).
- In a survey I asked a number of physics teachers to report on how they can cope with teaching this law in their everyday practice.

Collecting the data

- The annual meeting of physics teachers:

  Hévíz, 27-30. March 2015.

  About 160 attendance, the estimated number of practicing high school physics teachers present is 65-70. (2500+)

- PROBLEM!!!
- We laid the sheets of survey at the registration desk. Only 5 colleagues took one with them to support our work.
- I personally asked if they could fill in the survey for my research, 47 colleagues accepted the sheet, and 35 returned it.

The sample of colleagues

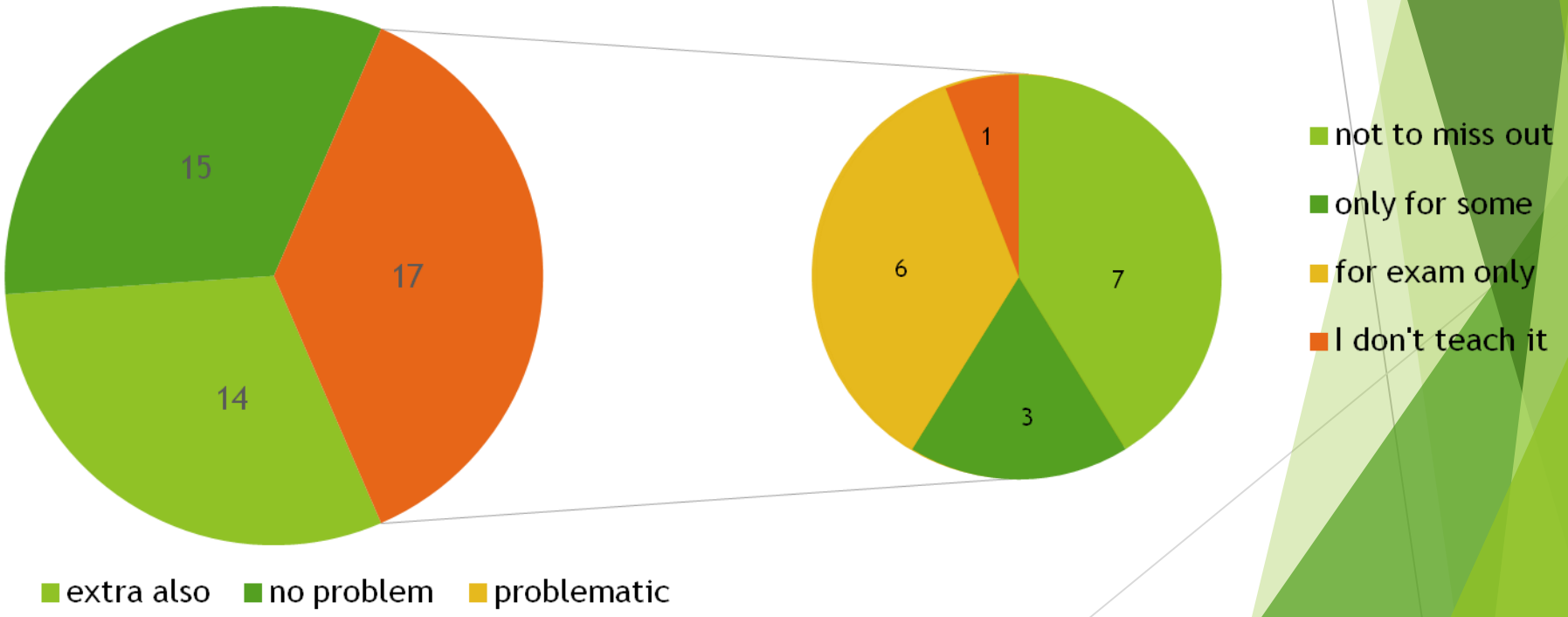
- First I wanted to see clearly who I can work with.
- The first task was to circle the type of high school the colleague has practice in.

Type of High School	Top third	Medium third	Bottom third	Number of colleagues
Secondary Grammar	6.5	9.5	3.5	19.5
	7	10	4	**21**
Secondary Technical	4.5	6.5	2.5	13.5
	5	7	3	**15**
Vocational	2			2
	3			**3**

- 35 colleagues participated in the research.

Monitoring reality

- Anonymous since it is in the syllabus, so it is a compulsory task.
- Many notes „depending on the class” → each X is a different answer (46)



A survey of the most outstanding problems in teaching the law

- **10 questions:**

A1-A4 bad attitude

M1-M3 poor skills in mathematics

S1-S3 scientific issues

- **The scale:1-5**

matches the Hungarian evaluation system

where 1 means that it is considered not an important issue or not even true

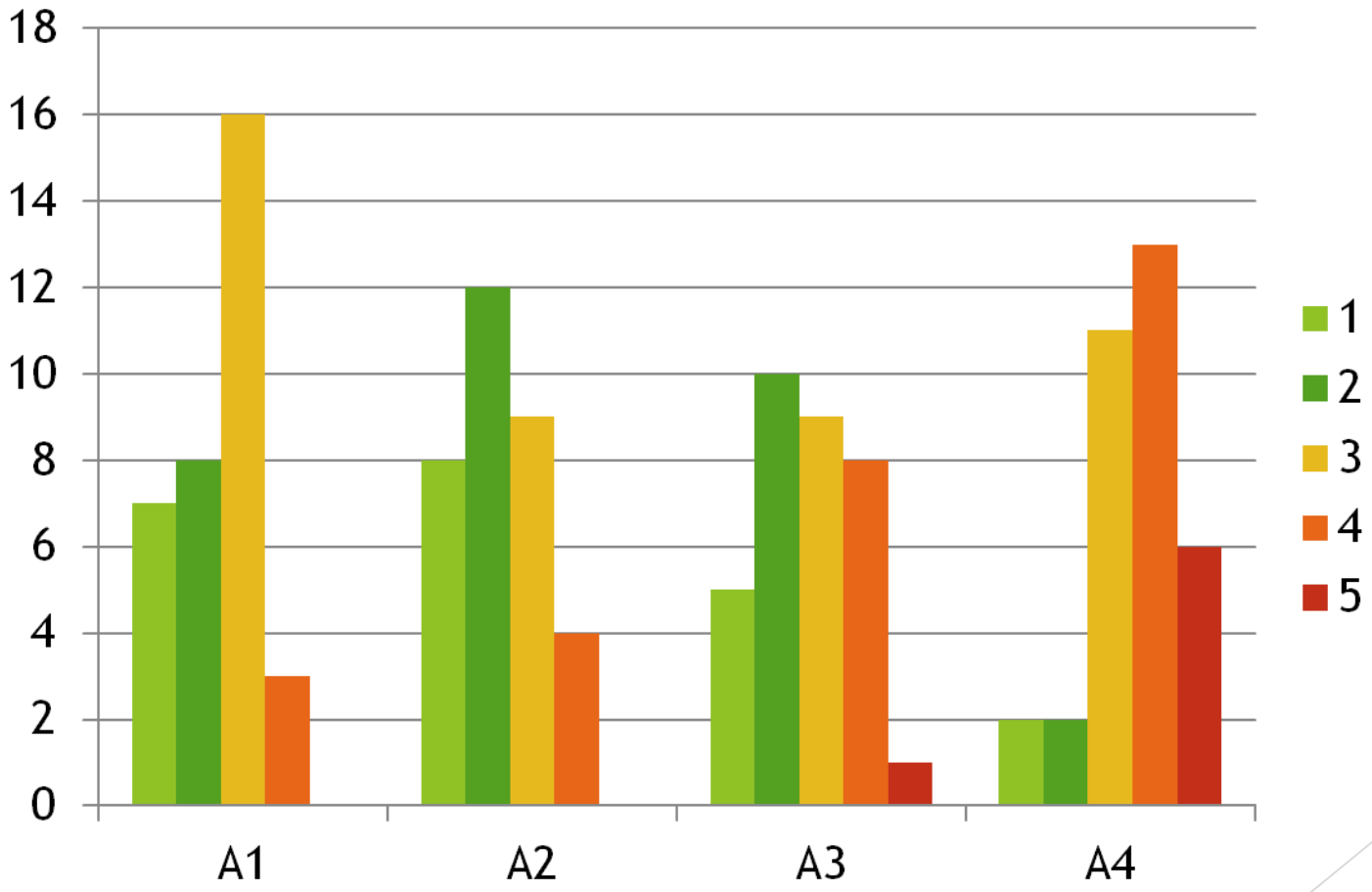
and 5 means that the teacher considers it one of the most important factors

A survey of the attitude

- I mentioned 4 aspects in this set.

- A1 *Physics among our students is not popular: they don't like, understand, or study this subject.*
- A2 *The attitude of our students is negative to nuclear physics.*
- A3 *They already have fact-fragments in this topic from the media.*
- A4 *This topic is in the last year of the secondary physics course, and is not a compulsory subject to the High School Leaving Exam.*

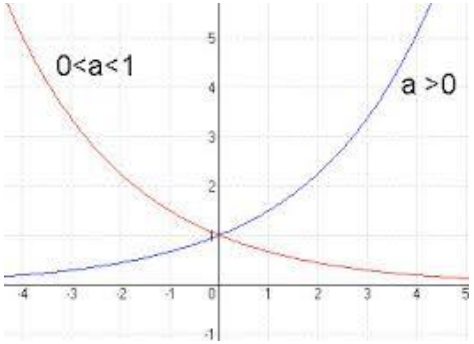
The rates for the A questions



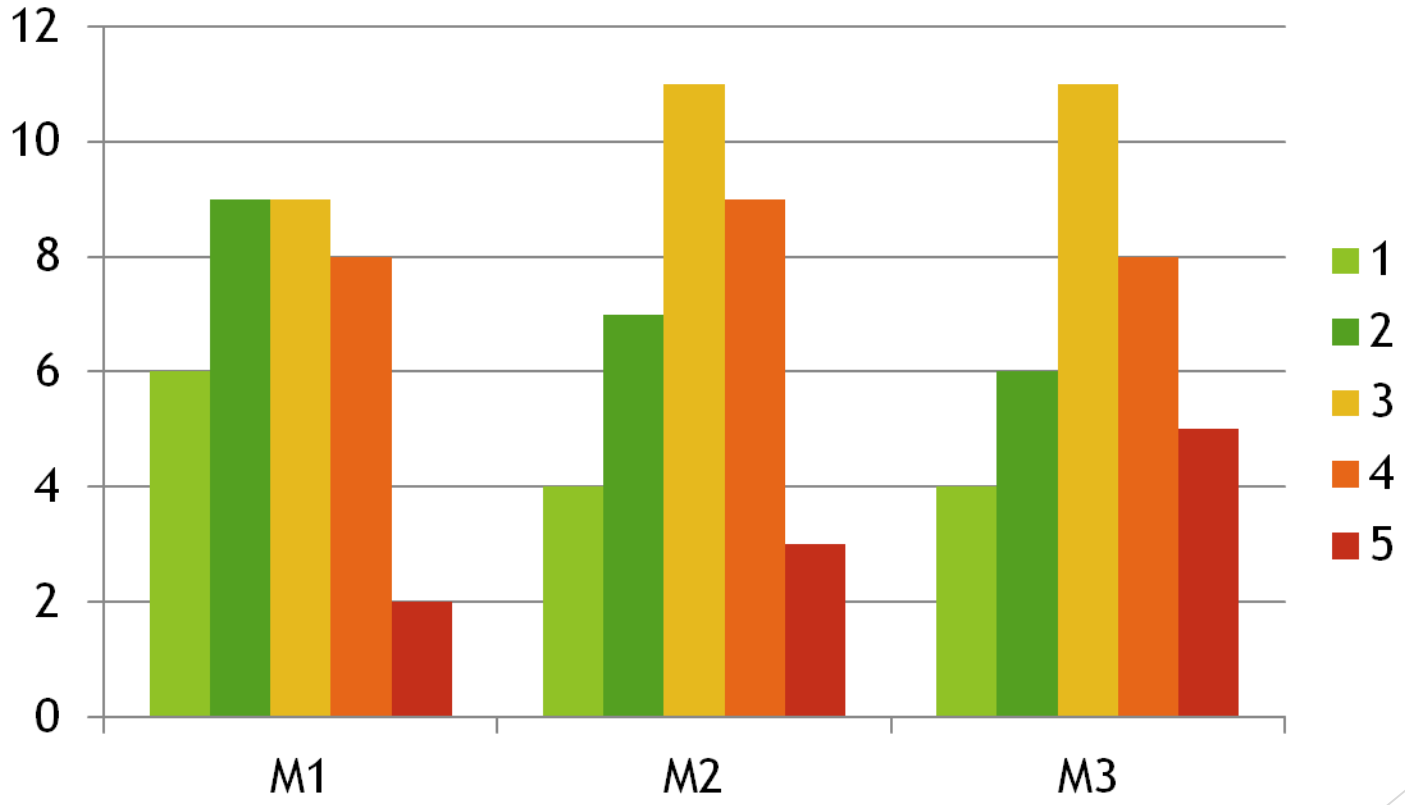
Poor mathematical skills

- I mentioned 3 aspects of mathematical skills.

- M1 *The law is one of the exponential formulae. The students don't know the exponential functions properly.*
- M2 *The low mathematical competence of the students effect that they are not able to apply their knowledge.*
- M3 *In mathematics classes there are not enough exercises for using mathematics in real problems and applications.*

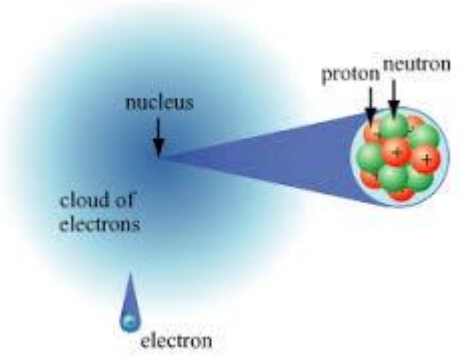


The rates for the M questions

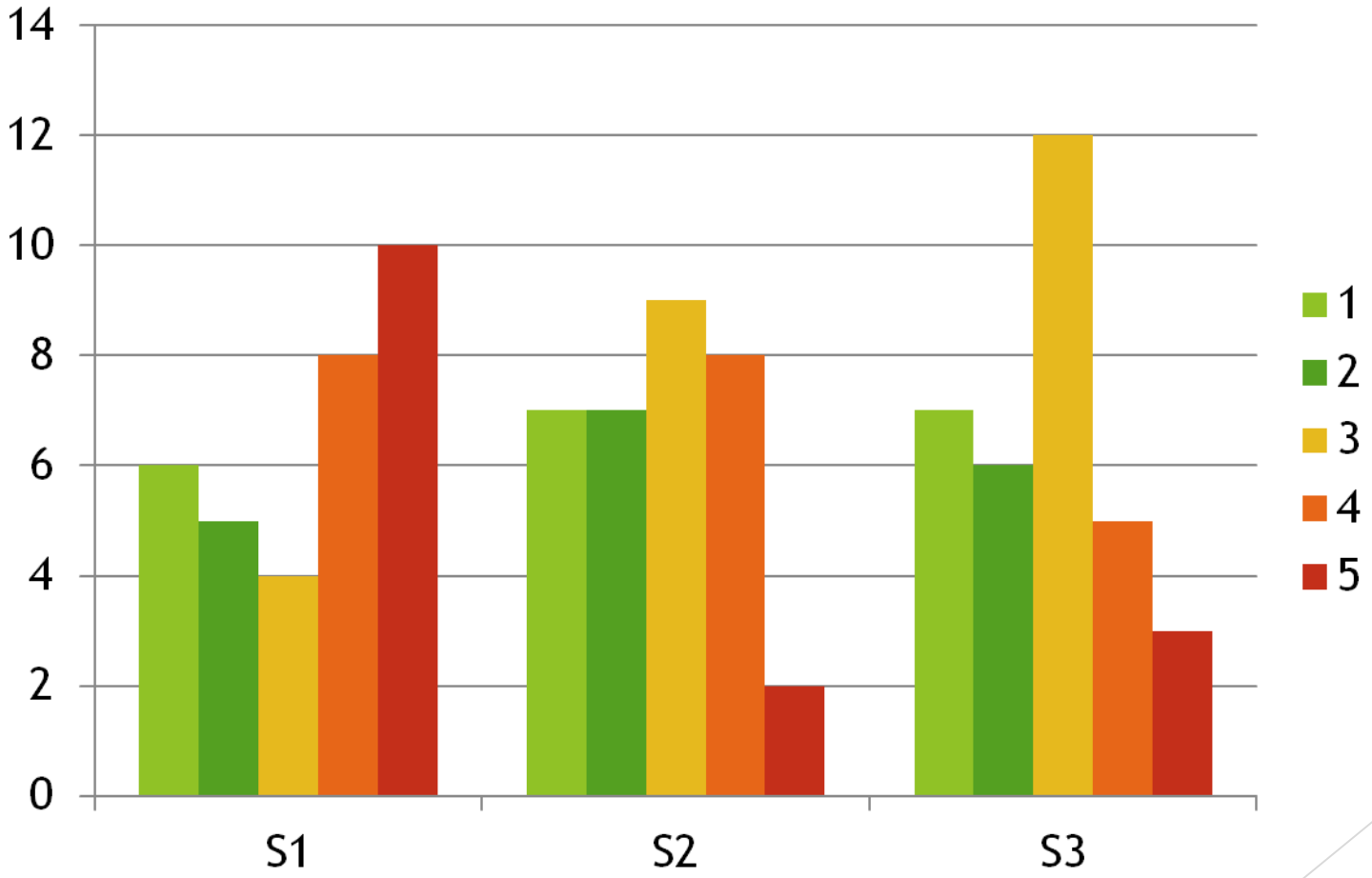


Scientific issues

- On the sheets the respondents found 3 statements. They had to rate them just as the previous ones.
- S1 *There is no possibility to carry out experiments.*
- S2 *The model students should use is far too abstract.*
- S3 *There is a lack of knowledge in the model they should study also in chemistry.*



The rates for the S questions



Analysing the data

- The mean values

Qs	Attitude				Mathematics			Scientific issues		
Means (/q)	2.44	2.27	2.70	3.56	2.74	3.00	3.12	3.33	2.73	2.73
Means (topic)	2.75				2.95			2.93		

- So the main problems are …
  - 3.56 (A4) not a compulsory subject for HSLE (érettségi)
  - 3.33 (S1) no possibility for experiments
  - 3.12 (M3) not enough exercises of applications in math classes
- Two remarks:
  - Some are enviable: they rate each but one (2 for S1) problem to 1
  - International surveys show bad attitude. We don't experience it, take it as a result rather than as a cause OR just don't rate it high.

Further causes mentioned by the respondents

- „Many have misconceptions, they can't differ from the distorted esoteric knowledge."
- „Hungarian physicists' activity in the last century." (????)
- „They study no other exponential law, they have nothing to bind it to."
- „In mathematics the statistical nature of the phenomenon, the incidental events are difficult to comprehend. But some students can get fired up just because of this."
- „I didn't rate anything to 5, because my highest mark goes to *Severe Literacy Problems*."

Monitoring didactical solutions, methods

- I studied what solutions are **liked, known and in use** in the teaching practice among our colleagues
- In a list of didactical solutions they had to rate

in column 1
- A - know and like the mentioned method
- B – familiar with the method
- C – don't know that method

in column 2
- A – mostly this is used in class
- B – has experience with the method
- C – has no experience with the method

Method of teaching	Known? A—B—C				Used? A—B—C		
1. Presentation and interpretation by the teacher	22	9	0		30	3	0
2. Presenting on educational film.	11	18	3		8	16	7
3. Prossesing literature (alone or in a group).	5	20	7		2	9	23
4. Project or drama pedagogy.	1	13	19		0	3	31
5. Home essay or student's presentation.	13	16	1		8	16	8
6. Computer simulation.	18	9	4		13	15	6
7. Simulation game.	7	9	15		2	7	20
8. Data-processing, simulation game, measurement the „hands-on, minds-on" way.	4	10	17		0	10	23

Some notes by the colleagues

- „I don’t know the hands-on, minds-on method, I expect I’d like it.”
- „ I organize a presentation of measurement for the entire school every year. I warmly recommend it to others!”
- „Keep in contact with companies, and visit a factory.”
- „Measuring activity with Geiger-Muller tube, the sample is prepared with vacuum-cleaner and gauze.”
- „Modelling the decay with beer-foam.”

Conclusions of the survey

- The respondents are not a representative group of active physics teachers in Hungary.
- Third of them has problems with teaching the law of radioactive decay.
- Most teachers alter the used methods to best suit the classes.
- In the colleagues opinion mathematical and scientific issues are more defining problems than the students' attitude.
- In their opinion the most outstanding problems are respectively: no need for final test, no experiments, not enough applications in math classes.
- Teachers' presentation and interpretation spiced with computer simulation are the methods in use in the classrooms.
- These colleagues know other methods as well, and might be persuaded to try them.

„Problems can't be solved by the same mind set that created them."

- **A didactical experimental research since 2011., 4+4 groups**
- **Preparation** 1.) The wonderful world of measurements

  2.) Hands-on measuring projects in classical physics

  3.) Exponential laws taught the hands-on way:

  sensing+ measurements+ data processing → Newton's law of cooling

  …….+ measurements+ data processing → Discharging a capacitor
- **Teaching** the law of radioactive decay the „hands-on, minds-on" way:
- February-April 2015.
- 1.) Investigating half-life (data processing only)

  2.) An active game with coins (60 coins → more sets), data processing

  3.) Estimating the magnitude of nuclei in a sample, „hands-on" measurement

Thank you
for your attention

Please, feel free to ask or comment.