

ASSESSMENT OF SCIENTIFIC LITERACY ON BASIC CONCEPTS IN MECHANICS

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1 INTRODUCTION

The discussion among students and teachers on the Department of physics, Faculty of Arts and Sciences, on objectives of teaching and learning physics, as well as on the amount and level of physics knowledge of average citizen, resulted in an idea to carry out the survey on general scientific literacy in adult population.

The main objective of this survey was to show the discrepancy between the wanted and achieved teaching and learning objectives during the primary and secondary education, by examining the actual and applicable knowledge of adults whose profession is not connected to physics.

2 METHODS

The survey has been done as an anonymous query through which 167 adult people aged 20 to 75 years were examined. The examinees were selected randomly in the population of the city of Rijeka and its surroundings, but with the exclusion of people that have any kind of professional connection to science and technology. In order to reach younger educated population, the questionnaire was also offered to students of Faculty of Arts and Sciences. In this way, the sample consisted of 90 randomly selected students oriented to social sciences and humanities and 77 randomly selected examinees (of all ages) from the local population. Age, education and gender distribution of examinees are given on Figs. 1, 2, 3.

The survey questions were of two types; the first part consisted of 26 questions with single-choice five offered answers, while the second consisted of ten conceptual questions to be answered by examinee. All the questions were selected as ones that could be easily answered after having elementary school physics curriculum. In this work we present only the results obtained on the questions related to mechanics, which appeared in 8 single-choice and 4 conceptual questions.

Single choice questions on mechanics were:

1. Buoyancy is:

- a) a pressure exerted by atmosphere on body
- b) a force exerted by fluid on the body immersed
- c) a pressure in the liquid which spreads equally
- d) a force that body exerts on the support
- e) I don't know

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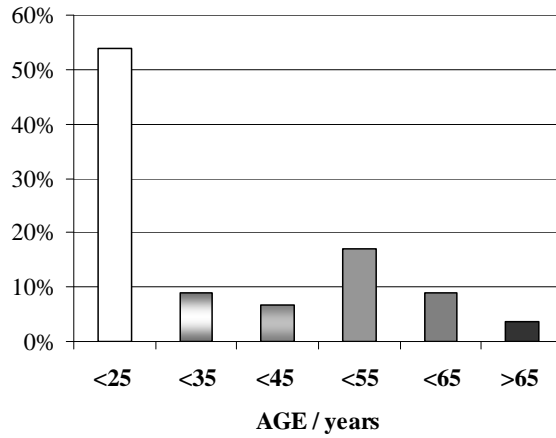


Figure 1 Age distribution of the sample.

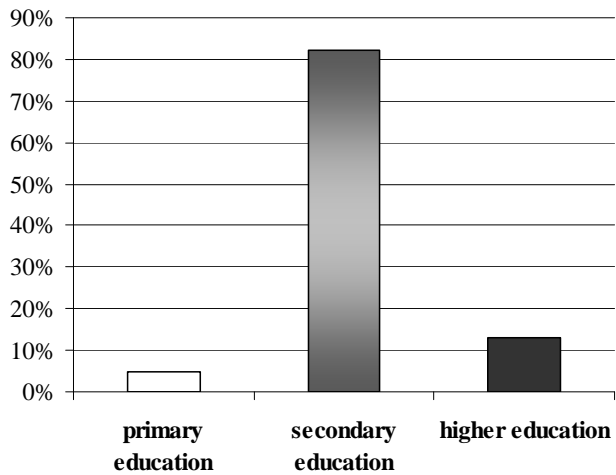


Figure 2 Education distribution of the sample.

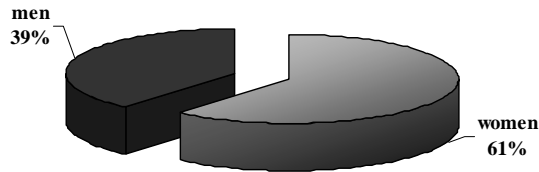


Figure 3 Gender distribution of the sample.

2. Which is denser – water or oil?

- a) equally dense
- b) water
- c) oil
- d) depends on temperature
- e) I don't know

3. From the same height, a cotton ball and a hammer are free falling. Which would hit the ground first?

- a) a hammer
- b) a cotton ball
- c) simultaneously
- d) they will not fall, but levitate
- e) I don't know

4. Ten tons is

- a) a weight of 10 thousands kg
- b) a weight of 10 hundreds kg
- c) a mass of 10 hundreds kg
- d) a mass of 10 thousands kg
- e) I don't know

5. According to the Newton's second law of motion,

- a) a body mass depends on acceleration
- b) acceleration depends on the body mass and the force acting on body
- c) acceleration does not depend on the body mass
- d) a body is in motion as long as the force is acting
- e) I don't know

6. Body mass is

- a) larger on the Earth than on the Moon
- b) larger on the Moon than on the Earth
- c) equal on both, the Earth and the Moon
- d) dependent on the Moon phases
- e) I don't know

7. Vacuum is

- a) the area of low pressure
- b) weightless state
- c) empty space
- d) a kind of gas
- e) I don't know

8. If the body is in a weightless state,

- a) its mass equals zero
- b) its weight equals zero
- c) body is in vacuum
- d) there's no atmospheric pressure on the body
- e) I don't know

Conceptual questions on mechanical problems to be explained were:

1. Why the parachutist and the rain drops fall with the constant speed and not with acceleration?
2. Where is the air pressure higher – on the sea level or on the mountain top?
3. Why the oil floats on the water?
4. Why the ship floats, while the axe sinks, although both made of iron?

3 RESULTS AND CONCLUSIONS

Percentages of answers on single-choice questions and conceptual questions are presented in Table 1 and Table 2 respectively.

Table 1 Answers on single choice questions.

Question number	Correct	"I don't know"	Wrong
1. Buoyancy is...	55,1	25,7	19,2
2. Which is denser...	40,1	3,0	56,9
3. Free falling cotton ball and hammer...	33,5	9,6	56,9
4. Ten tons is...	32,9	3,6	63,5
5. Newton's second law...	68,9	14,9	16,2
6. Body mass is...	29,3	6,6	64,1
7. Vacuum is...	77,2	2,4	20,4
8. Body in a weightless state...	40,7	14,4	44,9

Table 2 Answers on conceptual questions.

Question number	Correct	"I don't know"	Wrong	Tray
1. Falling with the constant speed....	19,2	43,7	29,3	7,8
2. Where is the air pressure higher	47,3	16,2	36,5	0
3. Why the oil floats on the water	50,8	14,4	28,8	6,0
4. Why the ship floats	16,2	34,1	20,4	29,3

A first group of questions with single-choice answers revealed the lowest level of knowledge – recognition. It is interesting that 60% of examinees doesn't know that the water is denser than oil, 67% doesn't recognize the meaning of measure of 10 tons, and 71% doesn't know the difference between the mass and weight.

Conceptual questions, however, demanded a higher level of knowledge, procedural knowledge and explanation. Although in the first group of questions 40% knows that water is denser than oil, now 49% doesn't know why the oil floats on the water. It is especially worrying that more than 50% has no correct answer on the question whether atmospheric pressure is higher on the sea level or on the mountain, as well as to the question of why the axe sinks while the ship floats, when those questions are directly related to their experience.

The results presented are just a part of the investigations carried out in order to answer the question of sense of purpose in teaching physics, but nonetheless open numerous questions on efficacy of school system and point out to the need of detailed analysis, rethinking the objectives, setting the new criteria, but also use of other methods in teaching and learning physics.

The results presented here definitely need further and deeper research in order to obtain the results that could be more generally interpreted and upon which some suggestions for physics teaching could be reached. However, in order to enlarge the sampling of the research, the same questionnaire is planned to be distributed in few other European countries. The results obtained that way could serve for the comparisons in the wider context but also in correlation to the research of the European Union called Eurobarometers, intended to measure public opinion and knowledge on a variety of themes across its member states [1]. Scope of these investigations is to find common ground as the EU makes policies for countries with diverse cultures and to evaluate the effects of past EU programs. The results are also used to decide what sorts of projects – in education and other areas – the European Commission will support in the future.

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