

## PHYSICS MISCONCEPTIONS IN SEVENTH GRADE

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**Abstract.** The goal of this research is to examine the understanding of basic physics concepts in Physics among 7<sup>th</sup> grade students in primary education. The results of the research reveal an interesting and bit surprising situation. Some common misconceptions occur, such as the one related to the concepts of mass and weight. Also, some new unexpected situations are discovered. A general conclusion is that students encounter difficulties in explaining these concepts. Students learn the concepts superficially and they do not understand them. The research also reveals a problem with the Macedonian vocabulary.

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### 1. INTRODUCTION

In science, words have to be accurate, clear and correct. Many times a lot of international concepts are being used, which sometimes, because of their inadequacy and limit in translation, may cause problems in the scientific communication. A lot of scientists and teachers try to introduce the science to the younger generations through determining the scientific concepts, by choosing the descriptive way, trying to express them in Macedonian words.

We know that the studying, or the process of acquiring knowledge, is one of the ways of the cognition of the external world. In the knowledge, a lot of phenomena and objects from the everyday life, their properties, relations and laws that they are submitting to, are being expressed. As its results, the students are form perceptions, concepts, judge and make logical conclusions.

The main goal of some teachers is fulfilling obligations towards curriculum, i.e. running with the students through as more concepts and contents as possible, without considering the way these processes are being done and the depth of the acquired knowledge.

One of the main goals in the teaching Physics is correct and proper way of understanding the physical concepts ( the first and the second level according to Bloom), their application (the third level according to Bloom) and their proper use in new and unknown situations ( higher levels according to Bloom) [2].

However, what does *the concept* mean? *The concept* is defined as “a thought or an intention; something that we realize; something that’s made up in the head; an abstract idea that’s being generalized with specific events” (Webster's Dictionary) [3].

Researches through the history have shown that no matter what is the achievement, in physics it is not only about working on learning the teaching material and success in solving specific problems, but in most cases it depends on the students abilities to make statements and to use their ideas in a clear and accurate way.

To understand the essence of a subject, proper understanding of the basic concepts, which form the foundations of that subject, is of crucial importance. This research is trying to find out the level of the students abilities to form an image about the concepts, to explain their views, thoughts, interests and understanding of some physics concepts.

## 2. THE RESEARCH

**The main goal of this research is to examine:**

1. How and how much seventh grade students understand physics concepts.
2. What are the most common misconceptions for certain concepts that students have?

The research includes 35 concepts. Some of them like trajectory, atom, joule, inertia, weight and others are studied for the first time in seventh grade, while others like mass, volume, meter, state of aggregation and others are previously known. All of them are provided in the seventh grade curriculum, in the following topics:

1. Bodies, substances, physical quantities and measurement of physical quantities
2. Motion and forces
3. Energy

In order to achieve the goals of this research, a questioner was given to the students, where the students had to choose their level of knowledge of a certain concept. An example of a concept and the levels of knowledge are given in Table 1. Students could choose two options for each concept between “I can’t explain” and “I’m explaining it like this...” In the last column, the students had the chance to explain the concept. They could use small drawing, chart, formula, synonymous or something else.

The examination is conducted during a physics class with duration of 30 minutes.

**Table 1** An example of a question in the questioner

A given concept	It is the first time I am hearing of this concept	I have heard of this concept before	I cannot explain this	I am explaining it like this ...
Mass	✓		✓	

58 students with various abilities are included in this examination. 17 students are from urban environment and 10 of them are excellent students. 41 students are from rural environment and 12 of them are excellent students. That means that about 38% of the students that were included in this research are excellent students.

Very simple explanations of the concepts were considered correct. For example:

1. Mass- quantity that is measured in kilograms” or “quantity which can be measured with scales,
2. Aggregate state - can be liquid, solid or gaseous...

### 3.RESULTS

1. Over 95% of the students have heard about the concept of *mass*, but only 13,8% of them can explain it. That means, although this concept is clear to them, it cannot be explained even by the excellent students. Although they knew that it is something related with physics, this concept, for a less than 1% of the students, is an association for *a dining table!!!* (there is one word in Macedonian for mass and for dining table).

2. 32,8% of the students explained the concept of **aggregate state** and that’s one of the concepts that students understand more;

3. The concept of *inertia* is explained by 31% of the students. But, the definition they gave was like “reciting” the definition from the textbook, so there is an impression that they did not understand this concept.

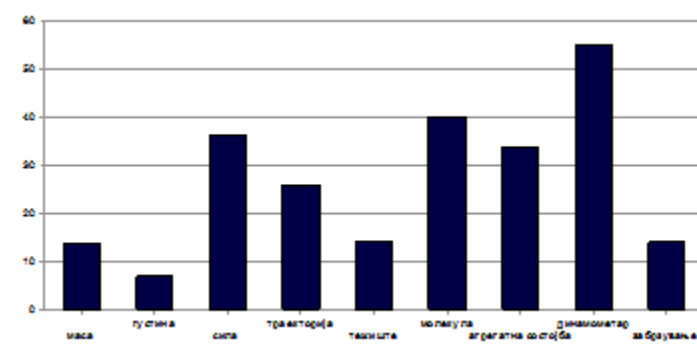


Fig. 1 Distribution of the correct answers and explanations

4. The concepts of *elapsed time* and *physical quantity* are being explained only by 0.5% of the students...

5. The concepts of *meter, joule, Pascal and other units* are defined as *units of length, mechanical work, pressure, etc.*, respectively and these answers are accepted as correct. Only two of the students, for the concept of *meter* gave the answer “*basic unit of length*”, and two of them for the concept of *joule* wrote  $1J=1N*1m$

6. The concept of *plasma* (the fourth state of aggregation) is not being studied in seventh grade. This concept was mentioned only in the additional instructions and that’s why it wasn’t expected for the students to recognize it.

7. The concept of *volume* is studied in the lower classes and mainly “it is known” to all of the students. But only one of them gave a definition like this: “*space occupied by the body*”.

8. The concept of *density* was explained by 6.9 % of the students, and most of them only wrote a formula!

9. The concept of *power* was explained by 41,2 % of the students.

10. The concept of *mechanical work* explained only 14% of the students.

11. The concept of *kinetic energy* was explained by 48,3 % of the students.

The research was done after learning of the last content of the topic about *Energy*, so that is why student remembered more the concepts related with this topic, but the level of recognition is still not satisfying.

#### 4. DISSCUSION

Besides correct answers, there are many misconceptions discovered in the incorrect answers. Some of them are standard and common, while some of them are new.

1. **Mass** - Body weight, measurement of body weight; how heavy one body is;
2. **Acceleration**- Movement with great speed; how fast we move;
3. **Volume**- Shape of a body; size of a body;
4. **Gravity**- Attraction of two bodies with huge masses; a force that the Earth is attracting bodies with;
5. **Gravity**- Exists between the bodies that fall down;
6. **Average speed**- Arithmetic mean of speeds;
7. **Trajectory**- distance travelled by the object (GAP phenomena – Graph as a picture);
8. **Fluids**- liquids;
9. **Center of gravity**- There is a wrong definition in the textbook. The students learned this definition. Teacher should point up this mistake!!!!)
10. **Speed and acceleration**- it's the same thing.

Misconceptions can originate from various sources. Beside the knowledge that's acquired in the informal education by interacting with the surrounding outside the school (family, media, street and others), the student in seventh grade comes prepared with knowledge from the previous grades, from first through sixth grade. In that process, the teacher and the textbooks can be very important factor in building misconceptions. Teacher who teach in the lower grades of elementary education (from first to fourth grade) obtain their degree at the Faculty of education or at the Faculty of Philosophy – pedagogy studies. The first ones during their studies have never attended a science subject, or they have, but only during one semester and it has limited areas (mainly in Biology). The second ones did not attend science subjects at all. That is the main reason why their understanding for the concepts from the sciences and the Physics is on a very low level. This is a very important thing to mention because in mathematics curriculum for lower grades, there is a section provided for working with data. Most of the data the teachers and students use are related to physics concepts, such as mass, length, speed, movement etc. During these lessons, insufficient knowledge and understanding of physics concepts and incompetence of the teachers is expressed the most. A proof for that is the result from this research that shows that the misconceptions are less present in some concepts that are mentioned for the first time in seventh grade, for example *instantaneous speed, kinetic energy and uniform motion*, then in concepts like *mass, volume and meter*, which are studied in the lower grades. This effect is expected to be even bigger with the introduction of the new science subjects, such as Nature, Natural Sciences and Natural Sciences and Technique in fourth, fifth

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and sixth grade, respectively, because there are not teachers who are familiar with all of the science, but only with sections of it.

Mistakes in the textbooks can generate misconceptions, as well [1]. That is the case with the definition of the center of gravity, where students answer that the center of gravity represents the “point where the vector of the weight acts”, which is wrong answer that’s given in the current Physics textbook (page 66). Of course, in this cases, the role of the teacher is very important as a last filter that has to correct all of the mistakes, illogical things and inconsistencies in the textbook, the curriculum, grading standards and all of the other acts and documents that are related to the immediate implementation of teaching.

At first sight, it sounds shocking that a very small part of the students can explain the concept of *mass*, besides the fact that they have meet that concept in the first grade, But that’s not strange at all, because it is just a standard misconception that face students from another countries, too [5,6]

The results from this research show that the students with lower GPA have misconceptions, as well as the excellent ones. Trying to change the first impression of the misconceptions, the teacher is facing this unexpected situation: “I can’t believe that this happens in my class...” (Piaget 1965), and this “cognitive conflict” occurs, between what the teacher requires from the students, and what is “the reality” in the class! [4]

Besides all of the things that were listed above as the reasons for misconceptions development, there are some others, too. Other reasons can be:

1. New concepts are studied shallow, without any deeper explanations, so they stay abstract even in the higher grades.
2. The students are not interested in studying new concepts.
3. Students have very poor scientific vocabulary, and even when they know the concept, they cannot explain it.
4. The curriculum is structured in a very crowded way, which does not allow thorough studying new concepts.

## 5.CONCLUSION

Learning new concepts is mainly based only on the first level of the Bloom’s Taxonomy – **memorizing**, and that is where it ends.

The students mentally “cannot” or they are not interested for the higher levels in the process of studying, such as understanding and applying, or even less for the examination from higher level such as analysis, synthesis, evaluation or creation. That is why more attention should be paid to the processing the new concepts, to integrating the curriculum so there will not be any obstacles during the studying, previous knowledge that students posses should not be contradictory and incomplete, and the first image that the students get for the concept to be appropriate to their intellectual ability. New methods and techniques of studying are necessary, so that the students get more involved and interested in it. Also, it seems that the teacher pays more attention and is more successful in making the choice and applying a formula, rather than making a correct image of the concept and its understanding.

We need a big, complex and long-term research, which will show the necessary concepts that students need to master at a certain age. It also has to find the connection and the compliance with the curricula of different related subjects such as Mathematics, Physics, Chemistry and Biology. Time required to introduce new concepts should also be one of the important elements of such research. The results of such research will be introduction into a reform in science education. That will let the students easier and better to overcome the concepts in Physics and other sciences, because a lot of them are interconnected.

A very important moment is the choice of the teachers that will perform classes. There have to be provided regulations that will regulate the choice of the teacher to teach the appropriate classes.

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## МИСКОНЦЕПЦИИ ОД ФИЗИКА ВО СЕДМО ОДДЕЛЕНИЕ

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**Апстракт:** Зборовите и поимите кои се употребуваат во науката мора да бидат прецизни, јасни, еднозначни и точни. Многу често се користат странски зборовим кои поради ограничувањата во преводот и неадекватноста, воведуваат нејаснотии. Во процесот на поучување, многу наставници се трудат да одговорат на обврските на реализирање на обемената наставна програма, не обрнувајќи внимание на квалитетот на стекнатото знаење и покрај тоа што една од главните цели во наставата е учениците да се здобијат со квалитетни и коректни знаења и да можат тие да ги користат во нови ситуации. Се разбира, важен момент е и развивањето на способностите на ученикот за искажување на своите мислења и знаења.

Ова истражување има за цел да открие колку учениците од седмо одделение ги разбираат физичките поими и кои се најчестите мисконцепции. За таа цел на учениците им беше даден прашалник, во кој беа наведени повеќе физички поими. Учениците можеа да одбираат помеѓу “прв пат слушам за овој поим” и “сум слушал за овој поим”. Од друга страна, од нив се бараше да го објаснат поимот. За таа цел им беше дозволено да користат формули, цртежи, зборови и се друго што ќе им помогне да го објаснат поимот. Тие можеа да го објаснат дури и преку единиците или постапката за мерење на соодветната физичка величина.

Резултатите покажуваат дека, преку 95 % од учениците слушнале за маса, но само 13,8 % од нив успеваат некако да го објаснат. Нешто е подобра состојбата со поимите за агрегатна состојба и инерција (го објаснуваат околу една третина од учениците). Поимот за густина го објаснуваат само 6,9 % од испитаниците.

Исто така се појавуваат и некои стандардни, но и некои нестандартни мисконцепции: маса-тежина, забрзување-движење со голема брзина, волумен-облик на телото, патека-изминат пат.

Извори на овие мисконцепции се предзнаењата во текот на наставата по математика во пониските години од основното образование, чиј корен треба да се бара во недоволната подготвеност на тие наставници. Овој проблем може да дојде до израз уште повеќе со евентуалната несоодветност на наставниците по Природа, Природни науки и Природни науки и техника. Овој резултат укажува на големата важноста на наставникот. Извор на мисконцепции се и грешките во учебниците, како онаа за тежиште. Еден од поголемите проблеми е и сиромашниот физички речник на учениците, но и речник воопшто.