A METHODOLOGICAL PATTERN FOR CREATION OF E-TESTS AND ITS APPLICATION IN TEACHING PHYSICS

Z. Raykova, M. Atanasova, S. Hadzhikoleva, E. Hadzhikolev
INTRODUCTION

• **Methodological patterns** have been more and more widely used in pedagogy in the last couple of years. They are a **useful tool to get acquainted with pedagogical experience** as well as organize teacher’s work.

• One of the **challenges** that a teacher encounters is **creating tests to check the learner’s knowledge**. The tests themselves should be **in accordance with specific learning objectives**, which are often specified by state educational documentation, with the type of educational content, the psychophysiological and other features of the students.

• Physics lays in the basis of contemporary technological society. **Physics achievements bring to the development of other sciences and discoveries**, which could be applied in different fields of industry and everyday life. That’s why **physics education is of great importance**. It is **characterized by its specifics, which defines the teaching and learning methods as well as the evaluation ways of students’ achievements**.
INTRODUCTION

• The purpose of this presentation is to share our experience in building a model to create didactic tests about evaluation of students in secondary schools.

• In the offered methodic model, we emphasize two basic directions: using Bloom’s cognitive taxonomy (the revised one since 2001) and using generalized teaching plans to study the separate structural components of physics knowledge - physics phenomenon (object), quantities, law and device.

• We have given specific examples when studying electrostatics by 16-year-old students from a Bulgarian secondary school.
BLOOM’S TAXONOMY

• Cognitive Bloom’s Taxonomy is one of the most commonly used in pedagogy. According to it, the cognitive domain consists of six levels - Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. They are arranged in a hierarchal order from the simplest to the most complicated.

• Bloom’s Taxonomy was revised in 2001 by Anderson and Krathwohl. Their version is recognized as The revised Taxonomy. The changes made are related to the names and sequence of the cognitive levels, as it follows: Remembering, Understanding, Applying, Analyzing, Evaluating and Creating. In the present article, the revised version of Bloom’s Taxonomy has been used.
When constructing testing materials, the majority of teachers (more than 70%) form the questions and grade the students based only on the first two evaluation levels, which is not correct and one-sided process.

This does not stimulate the development of higher order thinking skills. The students do not acquire expertise to transfer skills and knowledge, critical thinking and problem solving.

When generating test items (questions and tasks) in the common case, it is connected with different question structures.
## Constructing Test Items Based on Bloom’s Taxonomy

<table>
<thead>
<tr>
<th>Bloom’s cognitive levels</th>
<th>Example test items</th>
</tr>
</thead>
</table>
| 1. Remembering           | - Which is the unit of measure for physical quantity...?  
                          | - Give a definition of the physics law...  
                          | - Give a definition of the concept...  
                          | - How do you call a physics phenomenon (object) that is realized when...?  
                          | - Write down the symbol for physical quantity...  
                          | - Provide the name of the physics device for...  
                          | - Which sign of the phenomenon ... do you know? |
| 2. Understanding         | - What is the physics meaning of the quantity...?  
                          | - Write down the validity conditions of the law...  
                          | - What are the conditions for a phenomenon ... to be carried out?  
                          | - Find example to apply the law ... in practice.  
                          | - Describe the components of the ... device structure.  
                          | - What is the principle of work of the ... physics device?  
                          | - Explain the mechanism to conduct a phenomenon...  
                          | - Explain the applying of the ... law for ... in practice.  
                          | - Describe the working principle of the ... device. |
| 3. Applying              | - Give examples for the practical application of the law...  
                          | - Give examples for different physical quantities ..., which are important in the practice.  
                          | - Give examples for the conditions in which a physics value ... is carried out.  
                          | - Describe several applications of the phenomenon...  
                          | - Describe the usage of the ... device.  
                          | - Write down the rules needed to work with a ... physics device. |
### CONSTRUCTING TEST ITEMS BASED ON BLOOM’S TAXONOMY

<table>
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<th>Example test items</th>
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| 4. Analyzing             | - Describe how is the ... law applied for...?  
                          | - What do you know about the history of finding the ... law?  
                          | - How is the physical quantity ... connected with other quantities?  
                          | - What is the relation between the basic physical quantity ... and its derivatives?  
                          | - How is physical quantity ... measured?  
                          | - Make a comparison between possible manners to measure physical quantity...  
                          | - Is there a common formula which describes the relation with the physical quantity...  
                          | - Describe a method to analyze the phenomenon...  
                          | - Describe some of the positive/negative sides of the phenomenon...  
                          | - Is the ... phenomenon connected with other physics phenomena? Define this relation. |
| 5. Evaluating            | - Which signs are characteristic to the phenomenon given?  
                          | - What is the application of the ... law?  
                          | - Which of the given ways of measure is correct?  
                          | - Which of the given quantities describe the ... phenomenon?  
                          | - Are there any other phenomena connected to the ... (given one)?  
                          | - Define the conditions in which the ... phenomenon is good/harmful for the people. |
| 6. Creating              | - Give the needed rules to work with the ... device?  
                          | - Describe the ... physics object/device/quantity/law by scheme/picture. |
TEST ITEMS FOR EVALUATION OF THE BASIC STRUCTURAL ELEMENTS OF THE PHYSICS KNOWLEDGE

• The evaluation process of the learning levels of physics phenomenon, interconnections, laws and devices should be in accordance with their specific characteristics.

• In the next tables, the most common structural elements (phenomenon, quantities, law and device) are shown as well as example test items, which can be constructed about them based on Bloom’s Taxonomy.
Physics phenomenon

• *The process of studying a physics phenomenon consists of a number of different activities* related to the phenomenon itself and its application.

• *All that includes the following*: finding out the phenomenon signs; providing the conditions in which it happens, or getting familiar with the results from such research; studying quantities and laws, which describe the phenomenon; clarifying the phenomenon connection with other physics phenomena; getting familiar with different applications of the phenomenon, etc.
# Physics phenomenon

<table>
<thead>
<tr>
<th>Basic characteristics</th>
<th>Sample test items</th>
<th>Examples from electrostatics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of the phenomenon (object)</td>
<td>- How is the phenomenon called, which...? (remembering) &lt;br&gt;- Which of the given phenomena is related to...? (understanding) &lt;br&gt;- Tell which is the phenomenon, which...? (remembering)</td>
<td>1. How is the phenomenon called, in which on the surface of a metal sample put in a uniform electrostatic field are induced charges?  &lt;br&gt;a) dielectric polarization  &lt;br&gt;b) interaction between electrical charges  &lt;br&gt;c) electrostatic induction  &lt;br&gt;d) surface currents (remembering)</td>
</tr>
<tr>
<td>Phenomenon signs</td>
<td>- Which of the given signs is typical for the ... phenomenon? (analysis)  &lt;br&gt;- Describe the external signs of the phenomenon... (remembering)</td>
<td>2. What is the phenomenon which electrostatic screening is based on? (understanding)</td>
</tr>
<tr>
<td>Definition</td>
<td>- Give the definition for the phenomenon of ... (remembering)  &lt;br&gt;- Which of the given definitions is correct? (analysis)</td>
<td>1. What is characteristic for electrostatic interaction:  &lt;br&gt;a) opposite-sign charges are attracted  &lt;br&gt;b) like-sign charges repulse  &lt;br&gt;c) the bigger the distance between stationary charges, the smaller the interaction power between them  &lt;br&gt;d) the interaction power between stationary point charges depends on the size of the charges at one and the same distance (analysis)</td>
</tr>
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</table>

1. How is the phenomenon called, in which on the surface of a metal sample put in a uniform electrostatic field are induced charges?

   - a) dielectric polarization
   - b) interaction between electrical charges
   - c) electrostatic induction
   - d) surface currents (remembering)

2. What is the phenomenon which electrostatic screening is based on? (understanding)
## Physics phenomenon

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| **Conditions to observe (carry out) the phenomenon** | - What are the conditions to observe the ... phenomenon? (remembering)  
- Which of the given conditions is necessary to observe the ... phenomenon? (understanding)  
- Write down the necessary conditions in order to observe the ... phenomenon. (remembering) | 1. In order to have electrostatic interaction, it is necessary:  
a) the charges to be stationary  
b) the charges to be with like-signs  
c) the charges to be with opposite signs  
d) the charges to be placed in a vacuum (understanding)  
2. When an uncharged conductor is placed in a uniform electrostatic field created by positive (negative) charge on its surface:  
a) only uncompensated positive charges appear  
b) only uncompensated negative charges appear  
c) both uncompensated positive and negative charges appear  
d) electrical charges don’t appear (applying) |
| **Examples and demonstration of the phenomenon** | - Demonstrate the ... phenomena. (creating)  
- Give an example for the ... phenomenon. (understanding)  
- Which of the given examples are related to the ... phenomenon? (analysis) | 1. Positive electrical charge, which is put in a uniform electrostatic field, influenced by electric force starts moving:  
a) in the direction of the field lines and increase its speed  
b) in the opposite direction of the field lines and decreases its speed  
c) in the direction of the field lines and decreases its speed  
d) in the direction opposite of the field lines and increases its speed (analysis)  
2. Next to the ball T of a non-charged electroscope, a negatively electrified rod gets closer without touching it. The electrosopic leaves 'L' open. Define what are the charges induces upon the ball T and the leaves 'L'. (understanding) |
Physics phenomenon

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| **Physics values which describe the phenomenon** | - Which value describes the ... phenomenon? (remembering)  
- Which of the given values is connected to the ... phenomenon? (analysis) | 1. Which of the values describes the decrease of the electric field in a dielectric? (remembering)  
2. Which of the given values is connected to the ... phenomenon? (analysis) |
| **Laws which describe the phenomenon** | - Which law describes the ... phenomenon? (remembering)  
- Which of the given laws describes the ... phenomenon? (analysis) | 1. Which is the law describing the interaction between stationary point charges? (remembering)  
2. Which of the given laws describes electrostatic interaction? |
| **Phenomenon connections with other phenomena** | - What other phenomena is this phenomenon ... connected? (understanding)  
- Which of the given phenomena are connected with the ... phenomena? (analysis) | 1. Which of the electrostatic phenomena does not have electrostatic character?  
   a) dielectric polarization b) electrostatic induction  
c) electrostatic screening d) dispersion (analysis)  
2. Which of the given phenomena is not connected with electrostatic induction?  
   a) electrostatic screening b) electrostatic protection  
c) grounding d) repulsion of like-sign charges (analysis) |
# Physics phenomenon

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| **Explaining the phenomenon** | - Give a definition of the ... phenomenon (understanding)  
- Make a scheme to explain the ... phenomenon (creating)  
- Make a presentation to explain the ... phenomenon. (creating) | 1. The charges which move freely in metal are:  
a) electrons b) holes c) positive ions d) negative ions (understanding)  
2. Between the plates of a charged flat air condenser is introduced a dielectric D. Which of the figures shows correctly polarizing of the dielectric? (analysis) |
| **Phenomenon application in everyday life and nature** | - Give at least two applications of the ... phenomenon. (understanding)  
- Which of the given applications is not connected with the ... phenomenon? (analysis)  
- Explain how the ... phenomenon is used in the device. (understanding) | 1. The phenomenon electrostatic induction explains:  
a) northern lights b) rainbow  
c) iron shaving attraction by a magnet  
d) electrostatic screening (understanding)  
2. Which of the following situations describes the dielectric polarization phenomenon?  
a) Deviation of the compass arrow when electric current flows into a conductor next to it  
b) Attracting fine iron shavings by a magnet  
c) Forming sodium and chlorine ions when salt is dissolved in water  
d) Attracting small paper pieces from an electrified plastic ruler (analysis) |
| **Historical data when studying a phenomenon** | - The name of which scientist is related to studying the... phenomenon? (remembering)  
- Make a presentation about studying the ... phenomenon. (creating) | 1. Describe how the Faraday cage works. (creating)  
2. Who discovered the lightning rod? (remembering)  
3. Which of the scientists given is not connected to electrostatic phenomenon study?  
a) Coulomb b) Faraday c) Franklin d) Calvin (analysis) |
Physical quantity

- Physical quantity is a physical characteristic of an object or phenomenon, which possibly can be measured or counted, and the result to be compared with a similar characteristic of another object.

- The basic components which have to be learned by the students are: symbol; relation with other physical quantities; units of measurement (basic and derivatives); ways of measuring the quantity; physics methods of measurement; examples of the physical quantity use, etc.
### Physical quantity

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| **Symbol**            | - What is the symbol of the quantity...? (remembering)  
                        - How is the quantity which ..., called? (remembering)  
                        - Which of the given quantities is used for ...? Which of the symbols is used? (understanding) | 1. Which of the symbols is used for the physical quantity “electrostatic potential”?  
                       a) E b) φ c) ε d) ρ (remembering)  
                       2. Which of the quantities is used for energy description of electrostatic field?  
                       a) intensity b) dielectric constant  
                       c) potential d) electric charge (remembering) |
| **Definition**        | - Give a definition for ... (remembering)  
                        - Tell which of the definitions (formulae) is correct. (analysis)  
                        - Form the definition with the words given (analysis) | 1. Give a definition of electric field potential. (remembering)  
                       2. Which of the given formulae defines the intensity of electric field? (remembering)  
                       a) \( E = \frac{F}{q} \) b) \( E = Fq \) c) \( E = \frac{\mathcal{W}}{q} \) d) \( E = qU \) |
| **Relation with other quantities**  | - Write down the formula which shows the relation between ... (remembering)  
                        - Choose the formula which shows the relation between ... (analysis)  
                        - Make a graphic which shows the relation between ... (creating) | 1. Which of the formulae shows the relation between intensity of homogenous electric field and its potential in a specific point? (remembering)  
                       a) \( E = Uq \) b) \( E = \frac{U}{d} \) c) \( E = \frac{d}{U} \) d) \( U = \frac{E}{d} \) |
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| **Unit of measurement (basic and derivatives)** | - Which is the basic measurement unit for the physical quantity of ...? (remembering)  
- Choose the basic measurement unit for the physical quantity of ... (analysis)  
- Change the given physical quantity from a derivative unit of measurement into the basic one. (applying) | 1. Which of the given units measures electric charge?  
a) kV b) MΩ c) mC d) W (analysis)  
2. What does the “nano” (n) prefix mean when used with units of measurement for physical quantity?  
a) 10^3 b) 10^-3 c) 10^-6 d) 10^-9 (remembering) |
| **Ways of measurement (demonstrations, knowledge of physics measurement methods)** | - Describe ways to measure ... (remembering)  
- Which of the given pictures describes a device that measures ...? (analysis) | 1. A student studies the dependency of pressure between the air condenser plates and the accumulated charge upon them. The data is presented in the table below:  

<table>
<thead>
<tr>
<th>P (kV)</th>
<th>E (V)</th>
<th>Q (C)</th>
<th>C (μF)</th>
<th>F (N/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.1</td>
<td>0.9</td>
<td>0.4</td>
<td>0.5</td>
<td>0.6</td>
</tr>
</tbody>
</table>

2. What is the capacity of the studied condenser?  
a) 0.1 mF b) 0.1 μF c) 0.1 nF d) 0.1 pF (analysis) |
| **Examples** | - Giving specific examples of the physical quantity ..., which are important for ... (analysis) | 1. What does the physical quantity of relative dielectric constant is one (1) mean? (understanding) |
| **Historical data** | - Who is the scientist related to the physical quantity ... introduction? (remembering) | 1. Whose scientist’s name is related to piezoelectric effect study?  
a) Pierre Curie b) Marie Curie  
c) Nicola Tesla d) Coulomb (remembering) |
Physics law

• *Knowledge of physics laws is one of the basic tasks in physics science.*

• *The law describes a necessary, essential, stable and repetitive connection between the quantities,* which describe the phenomena, processes and conditions of objects.

• *The basic characteristics of this structural element of the physics knowledge are:* physics phenomenon, which is characterized by a specific law; the connection between which quantities (phenomena) it relates to; which are the validity conditions of the law; what are the application limits of the law; different manners to express the law (by explanation, table, graphics or in an analytical way); experiments by which the law validity is demonstrated; examples of using the law in practice, etc.
## Physics law

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</table>
| **Physics phenomenon that characterizes the law and the relationship between which physical quantities (phenomena) does the law describe** | - Which physics phenomenon does the law ... characterize? (remembering) | 1. Coulomb's law describes:  
   a) the interaction between stationary point charges  
   b) electric current in electrolyte  
   c) electric current in gas environment  
   d) dielectric polarization (analysis) |
| **Conditions for the law validity** | - What are the conditions for the validity of the law ...? (understanding) | 1. Which of the conditions given can Coulomb's law be applied?  
   a) interaction of stationary charges  
   b) interaction of point charges  
   c) the interaction of point charges happens only in material environments  
   d) electrostatic interaction happens between moving charges in electric field (understanding) |
| **Application limits** | - What are the application limits of the law ...? (applying) | 1. In which of the following conditions Coulomb's law applications is not correct?  
   a) interaction of the charges in vacuum  
   b) interaction of the charges in dielectric  
   c) interaction of charged bodies with a bigger size  
   d) interaction of like charges (understanding) |
| **Describing the law by: words, tables, graphics, and analysis** | - Describe the law ... by: words, tables, graphics, and analysis. (creating)  
   - Which physical quantities does the law ... connect? (analysis) | 1. Write down Coulomb's law. (remembering)  
   2. The interaction between which two stationary charges can be calculated with the formula:  
      a) \( F = k \frac{q^2}{r^2} \)  
      b) \( F = k \frac{C}{r^2} \)  
      c) \( F = \frac{q^2}{kr^2} \)  
      d) \( F = k \frac{r^2}{q^2} \) (analysis) |
## Physics law

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<tbody>
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<td>Experiments by which the validity of the law can be demonstrated.</td>
<td>- What experiments can the law ... be demonstrated by? (evaluating)</td>
<td>1. In the experimental proof of his law, Coulomb used which of the following devices:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a) scales b) spectrometer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) stopwatch d) ammeter (remembering)</td>
</tr>
<tr>
<td>Explanation of the law based on contemporary scientific theories.</td>
<td>- Explain the law based on ... contemporary scientific theories. (applying)</td>
<td>1. According to its meaning related to development of the electromagnetic theory, Coulomb’s law is:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a) fundamental</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) a consequence of basic law</td>
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<tr>
<td></td>
<td></td>
<td>c) principle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) none of the answers (remembering)</td>
</tr>
<tr>
<td>Examples when the law is used in practice, including scientific predictions</td>
<td>- Give examples when the law ... is used in practice, including scientific predictions. (applying)</td>
<td>1. How will the interaction force change between two stationary point charges if the size of one of them is decreased by 2 times as the distance is the same?</td>
</tr>
<tr>
<td></td>
<td>- Do the following problem ... (applying)</td>
<td>a) it will increase 2 times</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) it will decrease 2 times</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) it will increase 4 times</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) it will decrease 4 times (applying)</td>
</tr>
<tr>
<td>Historical data when the law was discovered</td>
<td>- Find historic data when the law ... was discovered. (understanding)</td>
<td>1. Describe Coulomb’s experiment to prove the law of interaction between stationary point charges. (creating)</td>
</tr>
</tbody>
</table>
Physics device

• Physics devices can be distinguished by their use, structure and principle of work.

• The students must acquire knowledge of the safety measures when working with the device as well as its application in practice.
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<tbody>
<tr>
<td><strong>Use of the device</strong></td>
<td>- What is the use of the ... device? (remembering)</td>
<td>1. What is the use of the electroscope?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a) measuring electrical charges</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) measuring electrical current</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) preserving electric energy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) grounding (analysis)</td>
</tr>
<tr>
<td><strong>Basic structure (scheme)</strong></td>
<td>- Which are the basic components of the ... device? (remembering)</td>
<td>1. Why is it necessary for the electroscopic leaves to be put in a glass pot and be isolated from the environment? (understanding)</td>
</tr>
<tr>
<td></td>
<td>- What is the use of each component? (understanding)</td>
<td>2. Draw a scheme when an electroscope is charged by induction. (creating)</td>
</tr>
<tr>
<td></td>
<td>- Draw the basic scheme of the ... device. (creating)</td>
<td></td>
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<tr>
<td></td>
<td>- Indicate the separate components on the model. (understanding)</td>
<td></td>
</tr>
<tr>
<td><strong>Working principle</strong></td>
<td>- Explain the working principle of the ... device. (understanding)</td>
<td>1. The principle of the electroscope work is based on:</td>
</tr>
<tr>
<td></td>
<td>- Which is the phenomenon the ... device work is based on? (analysis)</td>
<td>a) repulsion of like-sign charges</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) attraction of like-sign charges</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) attraction of opposite sign charges</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) compensation of charges (understanding)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Explain the working principle of the electroscope. (understanding)</td>
</tr>
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# Physics device

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| **Use in practice**   | - Where is the ... device used? (remembering)  
- Which of the given situations is the ... device used in? (analysis) | 1. A negatively charged rod gets closer to the electroscopic ball without touching it. What kind of charges are induced upon the leaves of the electroscope?  
   a) on one of them – positive, on the other one – negative  
   b) on both of them – negative  
   c) on both of them – positive  
   d) the leaves are electrically neutral (applying) |
| **Safety measures**    | - What are the rules to use the ... device? (creating)  
- What are the consequences of incorrect ... device use? (understanding) | 1. Explain the meaning of the technical term “dielectric breakdown”. (understanding) |
| **Historical data**    | - Write an essay of how the ... device was found? (creating)  
- The name of which scientist is related to the development of the ... device? (remembering) | 1. What is the story related to the “Faraday cage” device? (remembering)  
2. The name of which scientist is connected to the discovery of the lightning rod?  
   a) Faraday  
   b) Coulomb  
   c) Ampere  
   d) B. Franklin (remembering) |
**METHODOLOGICAL PATTERN TO CONSTRUCT E-TESTS**

- **Constructing evaluation tests** by the teacher is an activity which could be analyzed as being organized by a sequence of activities, which fully or partially repeat when tests with different objectives and learning content are being generated.

- **Constructing tests** to check and evaluate students’ knowledge would require teachers perform specific activities in a certain sequence. This is a process, which is repeated multiple times in the same frame and can be easily summarized as a technological and educational model.

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**Planning**
- Defining the testing objective
- Defining the structural elements of the learning content, which will be tested as well as Bloom’s cognitive levels

**Constructing test items**
- Constructing test items
- Specifying metadata

**Technical formatting**
- Choosing and arrangement of test items
- Modelling basic characteristics of the test

**Test evaluation**
- Testing with a group of learners
- Correction in the test items

**Specifications of the test**
- Making specifications of the test including learning group, deadline and time performance of the test, and others.
METHODOLOGICAL PATTERN TO CONSTRUCT E-TESTS - Planning

• The testing objective is defined at this stage.

• The purpose of the test could be analysis of the learners’ knowledge at the beginning of the learning process, following the learning process progress, identifying any difficulties while learning the educational content, estimating the results of the learning process, etc.

• The next activity is specifying the structural elements of the learning content, which will be evaluated. Each of the identified structural elements should be related to the specific Bloom’s cognitive level, which will be checked and evaluated.
METHODOLOGICAL PATTERN TO CONSTRUCT E-TESTS - Constructing test items

• The test items should be constructed by using suitable question structures as well as being in accordance with the planned test parameters.

• Metadata describing each test item should be indicated. Metadata makes it easy to reuse a test item. They can be used by software applications for automated generation of online tests by preliminary given criteria.

• Metadata include the following information: type of the structural element of knowledge; the evaluated knowledge subject; Bloom’s cognitive level; a specific group of learners (school year, age, or any other characteristic).
METHODOLOGICAL PATTERN TO CONSTRUCT E-TESTS - Technical formatting of the test

• The technical formatting of the test includes the choosing and arrangement of the tasks and questions in the test.

• Special characteristics of the test are being modelled including the visualization sequence of the testing questions and their answers; whether the latter have been arranged in a certain sequence or arbitrary, if it’s allowed for the student to go back to a previous question, etc.
METHODOLOGICAL PATTERN TO CONSTRUCT E-TESTS - Test evaluation

• In order to remove the test weaknesses, the test items have to be approbated.

• At this stage, approbation with a group of learners is conducted. The purpose is to define the time performance of the test, to identify badly-formed, too easy or too difficult items. Corrections in the test items are made if needed.
METHODOLOGICAL PATTERN TO CONSTRUCT E-TESTS - Specifications of the test

• When *making the specifications of the test*, the teacher should meet the requirements of the State educational standards, which show the level of knowledge learning, their size and content.

• *At this stage, the specific group is described, deadline and time of the test performance*, filling in *instructions for the tested students and evaluation criteria*. 
CONCLUSION

• In this paper, a *methodology to construct e-tests is offered*. Its aim is to offer a manner of evaluation of the basic physics knowledge structural elements by constructing test items based on Bloom’s Taxonomy. In order to use the test items multiple times and dynamically generate tests, each of the test items is described by metadata.

• The created model can be *reproduced in different physics sections* as well as be *applied by teachers from other natural sciences* when evaluating students’ knowledge from various ages. The model offers a *good opportunity for a unified methodology when constructing physics didactic tests based on homogenous models* (structural elements of physics knowledge) as well as it is a *constructive base to generate test items*. 