Designing a test to measure misconception about energy conservation

Mr. Chinapat Mongkholsiriwattana

Department of Physics, Faculty of Science, King Mongkut’s University of Technology Thonburi
E-mail: apcentre@hotmail.com
The aim of this talk is to design and create a test to measure the misconception about conservation of energy of the Thai high school students.
This might be what happens to students after we teach them.

Understand it correctly

Do not understand

2+2=3
Right
What we want to find out is what it does imply when the students do not understand.

Lack of knowledge

Misconception

But it turns out your are wrong!
WHAT IS MISCONCEPTION?

• Prior knowledge of students ➔ Preconceptions

• Conflict with the scientific view are called misconceptions.

• Why misconception is important?

Misconceptions may deeply penetrate into students and it causes the resistance when one would like to correct them (resist changing).

• What are different between misunderstanding and lack of knowledge?

  ✓ Misunderstanding means you get it wrong due to the wrong preconception.

  ✓ Lack of knowledge means you get it wrong because you do not have information about it

See [13-15] for further information
HOW PEOPLE DESIGN THE TEST

Interview test
www.pixabay.com

Open-ended test
http://www.oxbridgeapplications.com/

Ordinary multiple-choice test
http://scalar.usc.edu/

One-tier to five-tier test
First tier 1.
Second tier A.
Third tier B.

See [1-3, 5-10] for further information
OVERVIEW OF OUR PROCESS

QUESTION DESIGN
The first set of 24 questions were designed.

VALIDITY CHECK1
They were sent to a physics expert to perform the first validity check. At this step only 12 questions were chosen out of 24 questions.

VALIDITY CHECK2
The chosen questions were checked once again by two physics experts and one education expert.

FINALIZE TEST
The questions were corrected according to the experts' suggestions.

TRY OUT
The finalized test was tried out with 24 students.
THE DESIGN OF THE TEST

• The test will be three-tier type,

• Look up the previous misconception test,

• Design **24 questions** based on **learning outcomes and Bloom’s taxonomy**
  - Some questions were adapted from AAAS Science Assessment
  - Some questions were created on our own
### Learning outcomes

<table>
<thead>
<tr>
<th>Level of knowledge</th>
<th>Remembering</th>
<th>Understanding</th>
<th>Applying</th>
<th>Analyzing</th>
<th>Evaluating</th>
<th>Creating</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Definition and description of the elastic potential energy. The gravitational potential energy, kinetic energy</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>7</td>
</tr>
<tr>
<td>4</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>✓</td>
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<tr>
<td>10</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>7</td>
</tr>
<tr>
<td>11</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>7</td>
</tr>
<tr>
<td>12</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>7</td>
</tr>
</tbody>
</table>

### THE DESIGN OF THE TEST

<table>
<thead>
<tr>
<th>Level of knowledge</th>
<th>Remembering</th>
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<th>Applying</th>
<th>Analyzing</th>
<th>Evaluating</th>
<th>Creating</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Describes the energy accumulated in the various positions of the objects from the energy conservation law in everyday life.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>12</td>
</tr>
</tbody>
</table>
4. Three hikers take three different paths to the top of a mountain, Paths 1, 2, and 3. The hikers are all the same height and weight. When all of the hikers are at the finish point at the top of the mountain, which hiker will have the greatest amount of gravitational potential energy?
A. The hiker who took Path 1
B. The hiker who took Path 2
C. The hiker who took Path 3
D. The gravitational potential energy is the same for all of the hikers.
Figure from (http://www.assessment.aaas.org)

Reason __________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Confidence level

☐ Sure  ☐ Uncertain  ☐ Guess
9. If released the object position S prediction that an object will climb up. Where is the highest position. When the rails without air resistance, friction and power loss to the system.

A. Position A  B. Position B
C. Position C  D. Position D

Reason ___________________________________________________________
______________________________________________________________
______________________________________________________________
______________________________________________________________

Confidence level

- 😊 Sure
- 😲 Uncertain
- 😞 Guess
• The test was checked by a physics expert at KMUTT university

• The redundant questions (measure similar content of physics) were crossed out

• Only 12 questions were chosen. This 12 questions were yet based on the learning outcomes we would like to diagnose.
The test consists of 12 questions.

6 questions (1-5, 12) from AAAS

6 new questions (6-11) developed by us

Article 1 of (Herrmann-Abell, C. F., & DeBoer, G. E., 2010)

Article 4 of (Singh, C., & Rosengrant, D., 2001)

Article 2-3, 5, 12 of (http://www.assessment.aaas.org) [17]
VALIDITY CHECK 2

- Sent to the three experts to check for quality and content validity.
  - Physicists
  - Education
- Calculate the IOC index (Index of item objective congruence)

Index IOC was 1.0 which was greater than 0.50 (Sirichai Kanjanawasi 2556).
The IOC index shows a high content validity.

IOC is 1.00 on all questions.

The questions were corrected according to the guidance from the experts.

1. Adjust the language to follow Bloom’s Taxonomy
2. Shorten the lengthy sentences
3. Edit diagrams
4. Modify the chart for clarity.
Check the reliability by calculating Cronbach's alpha coefficient (SPSS).

Twenty-four 10th grade students.

Calculating Cronbach's alpha coefficient for each tiers:

1. The first tier: the knowledge,

2. The second tier: the reasons

3. The third tier: the confidence of answer

<table>
<thead>
<tr>
<th>Part of test</th>
<th>tier 1</th>
<th>tier 2</th>
<th>tier 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5,12 adapted from AAAS</td>
<td>0.21</td>
<td>0.70</td>
<td>0.92</td>
</tr>
<tr>
<td>6-11 newly developed</td>
<td>0.68</td>
<td>0.50</td>
<td>0.94</td>
</tr>
<tr>
<td>1-12 all</td>
<td>0.70</td>
<td>0.77</td>
<td>0.91</td>
</tr>
</tbody>
</table>
CONCLUSIONS

• The exam is an index of IOC equal to 1.00 more than 0.50
• Cronbach's alpha coefficient every tiers more than 0.50
• This test can separate the children into three groups.
REFERENCE


Thank you for your attention

Time for questions
EXAMPLE HOW TEST WORK?

• Understanding group
  First tier correct -> second tier correct -> third tier “sure”

• Lack of knowledge group
  First tier correct or incorrect -> second tier correct or incorrect -> third tier “uncertain or guess”

• Misconception group
  First tier correct or incorrect -> second tier incorrect -> third tier “sure”
Find the **Subject** to adopt.

**Before first year students** in university.

**Energy** The children's lack of knowledge most.
Reliability
Bloom’s Taxonomy

Bloom believes that teaching to be successful and effective. The aim must be clearly defined. Humans are learning in three aspects

1. Cognitive Domain

2. Affective Domain

3. Psychomotor Domain
THE DESIGN OF THE COGNITIVE TEST

The aim of the study, Anderson and Krathwohl (Revised Bloom's Taxonomy) consists of six levels.

1) Remembering
2) Understanding
3) Applying
4) Analyzing
5) Evaluating
6) Creating

In the first, Total of 24 questions.