



# Designing a test to measure misconception about energy conservation

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# THE PURPOSE OF THIS TALK

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

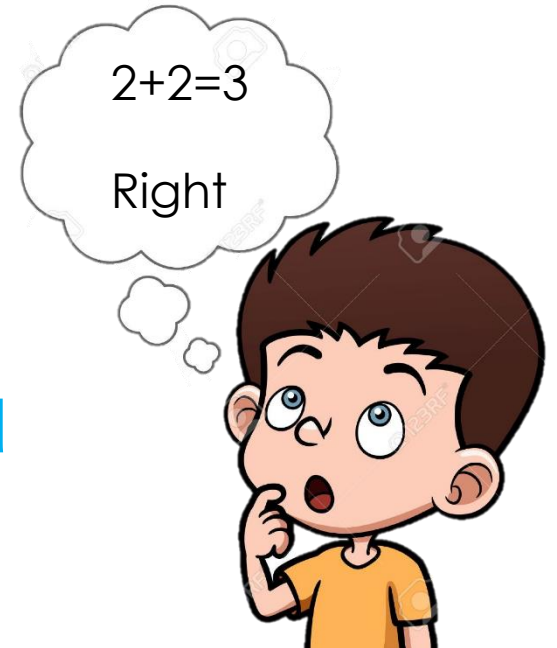
# INTRODUCTION

This might be what happens to students after we teach them.

Understand  
It  
correctly



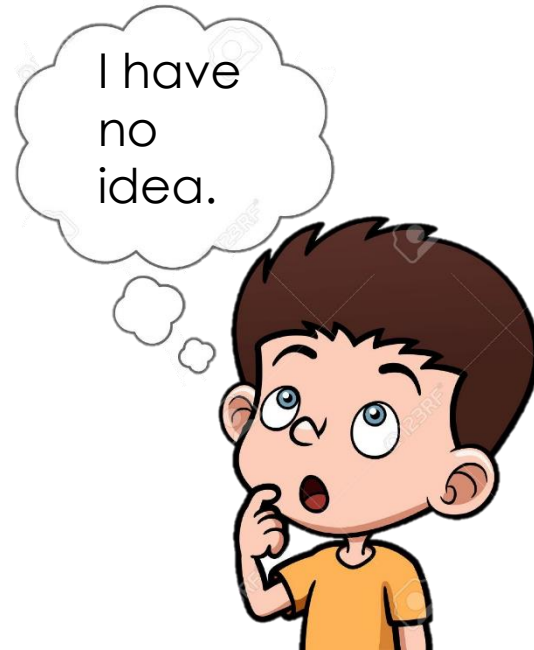
Do not  
understand



# INTRODUCTION

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



# HOW PEOPLE DESIGN THE TEST

## Interview test



[www.pixabay.com](http://www.pixabay.com)

## Ordinary multiple-choice test



<http://scalar.usc.edu/>

## Open-ended test



<http://www.oxbridgeapplications.com/>

## One-tier to five-tier test

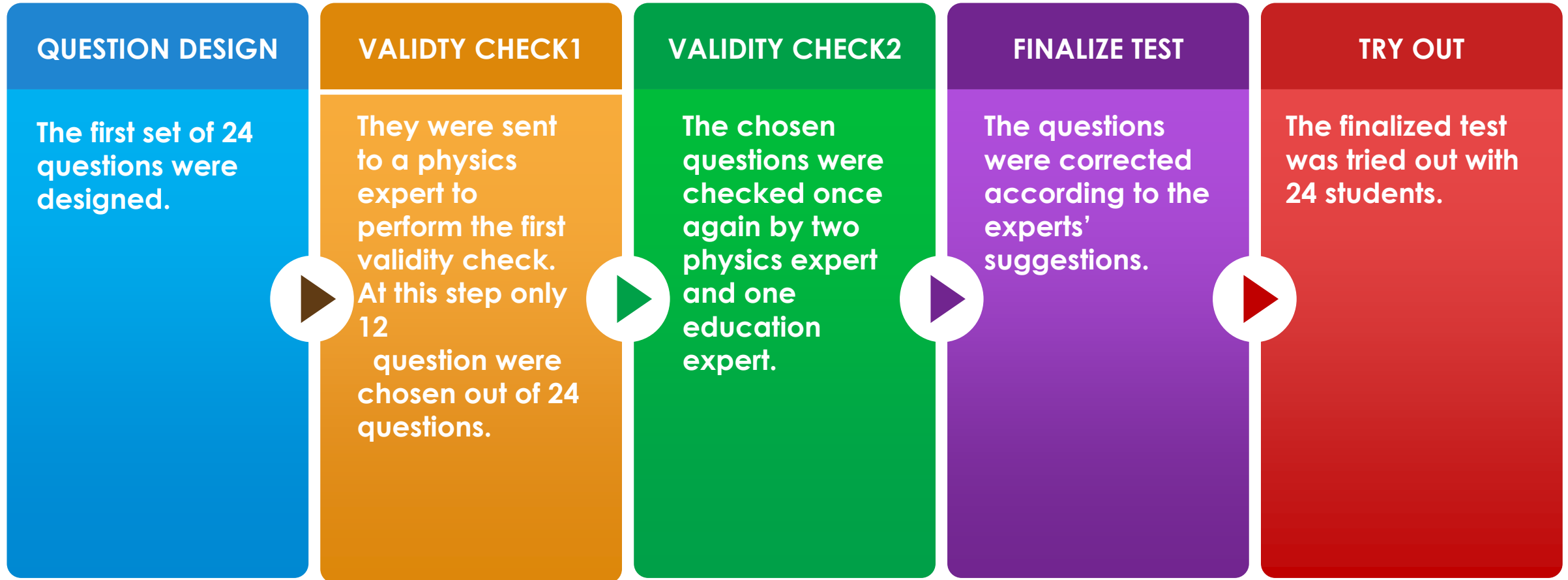
First tier 1.

Second tier A.

Third tier B.

See [1-3, 5-10] for further information

# OVERVIEW OF OUR PROCESS



# 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**



# THE DESIGN OF THE TEST

Learning outcomes	Level of knowledge						Total
	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	
1. Definition and description of the elastic potential energy. The gravitational potential energy, kinetic energy	1	3	0	3	0	0	7
1	✓						1
2		✓		✓			2
3		✓					1
4		✓		✓			2
5				✓			1
12	✓	✓					2

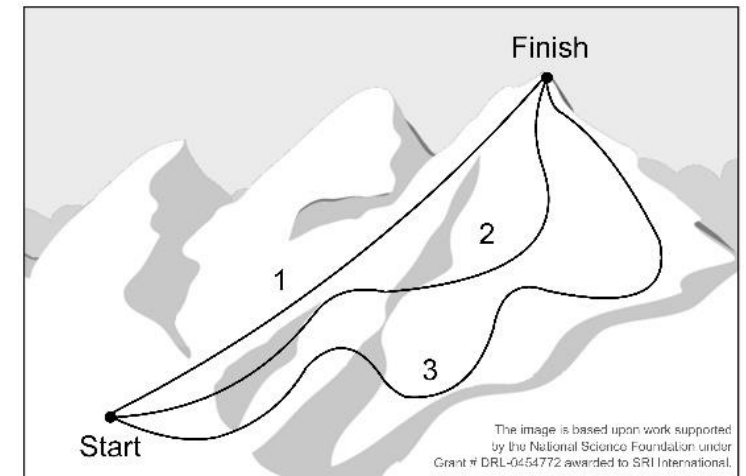
Learning outcomes	Level of knowledge						Total
	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	
2. Describes the energy accumulated in the various positions of the objects from the energy conservation law in everyday life.	2	4	2	3	1	0	12
6		✓					1
7			✓	✓			2
8	✓	✓					2
9		✓		✓			2
10				✓			1
11			✓		✓		2

# THE DESIGN OF THE TEST

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

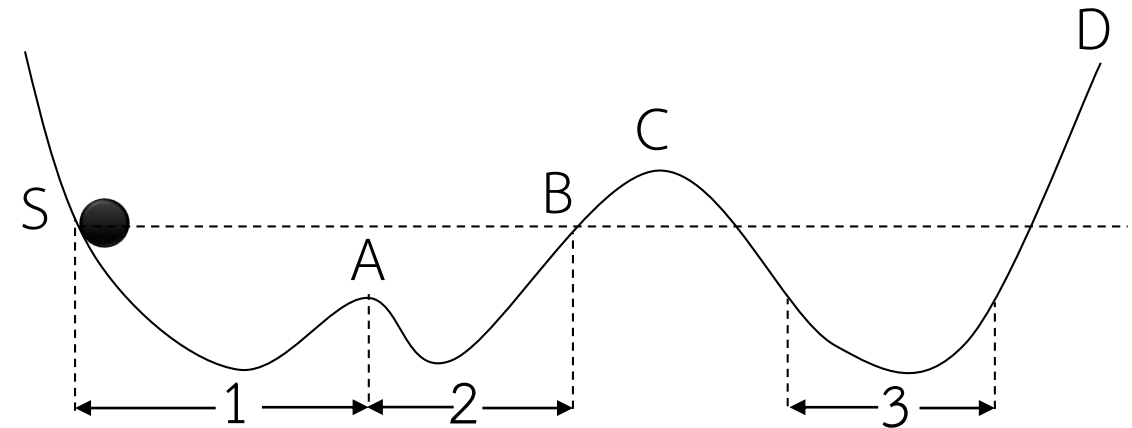


☐ Guess

# THE DESIGN OF THE TEST

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 \_\_\_\_\_

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Confidence level



☐ Sure



☐ Uncertain

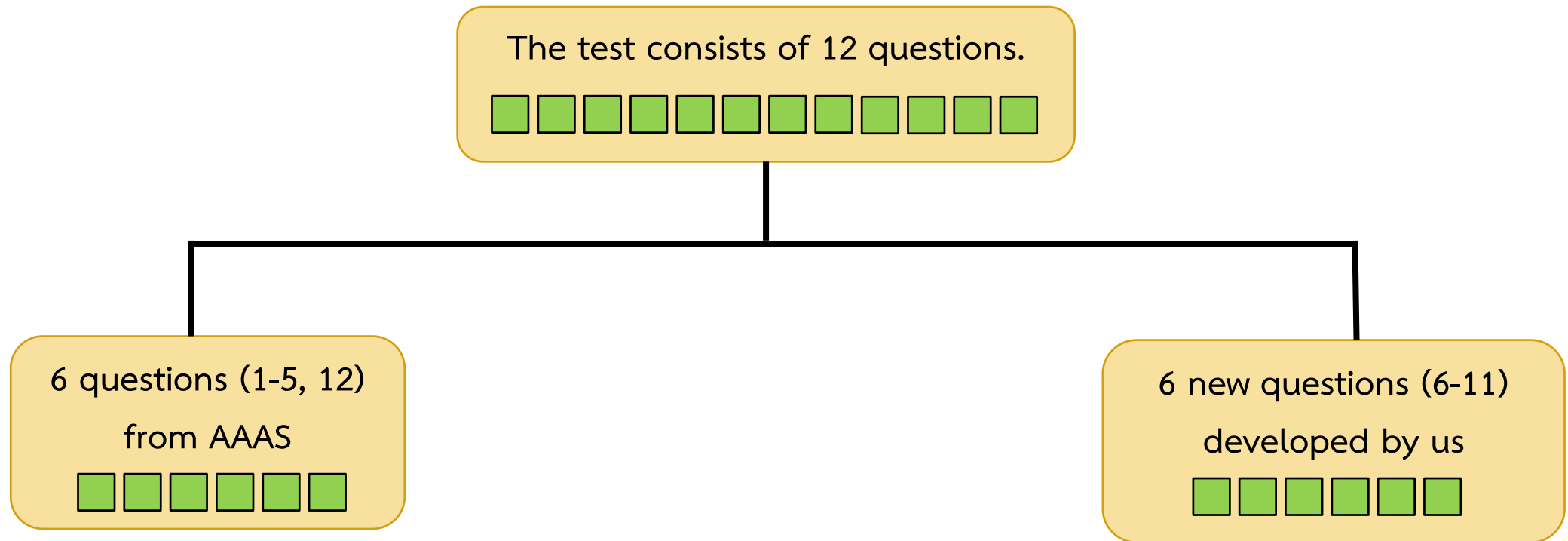


☐ Guess

# VALIDITY CHECK 1

- 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.

# VALIDITY CHECK 1



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

ข้อสอบ	ระดับความสอดคล้อง		
	สอดคล้อง (+1)	ไม่แน่ใจ (0)	ไม่ สอดคล้อง (-1)
พลังงานในรูปแบบต่าง ๆ			
1. นักเรียนสามารถบอกนิยามและอธิบายค่าของพลังงานศักย์ยืดหยุ่น พลังงานศักย์โน้มถ่วงและพลังงานจลน์ได้			
ข้อ 1. พลังงานในการเคลื่อนที่ของวัตถุ (พลังงานจลน์) ขึ้นอยู่กับอะไรต่อไป (การจำ)			
ก. มวลของวัตถุแต่ไม่ขึ้นอยู่กับอัตราเร็วของวัตถุ			
ข. อัตราเร็วของวัตถุแต่ไม่ขึ้นอยู่กับมวลของวัตถุ			
ค. ทั้งมวลและอัตราเร็วของวัตถุ*	✓		
ง. ทั้งมวล ความเร็วของวัตถุและความเร่งเนื่องจากแรงโน้มถ่วงของโลก			

- 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).

# FINALISING THE TEST

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.

# TRY OUT THE TEST

Check the **reliability** by calculating **Cronbach's alpha coefficient (SPSS)**



Twenty-four 10<sup>th</sup> 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

Part of test	tier 1	tier 2	tier 3
1-5,12 adapted from AAAS	0.21	0.70	0.92
6-11 newly developed	0.68	0.50	0.94
1-12 all	0.70	0.77	0.91

# CONCLUSIONS

QUESTION DESIGN

VALIDITY 1

VALIDITY 2

FINALISING

TRY OUT

- 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

- [1] Turgut, Ü. Gürbüz, F. and Turgut, G. 2011. "An Investigation 10<sup>th</sup> Grade Students' Misconceptions About Electric Current". **Procedia Social and Behavioral Sciences**. Vol. 15, pp. 1965-1971.
- [2] Almahdi Ali Alwan, 2011. "Misconception of heat and temperature among physics student". **Procedia Social and Behavioral Sciences**. Vol. 12, pp. 600-614.
- [3] Fatma Türker, 2005. **Developing a Three-Tier Test to Assess High School Students' Misconception Concerning Force and Motion**. Turkey.
- [4] Derya Kaltakci Gurel, 2015. "A Review and Comparison of Diagnostic Instruments to Identify Students' Misconceptions in Science". **ISER Publications**. Vol. 11(5), pp. 989-1008.
- [5] Goldberg, F. M. & McDermott, L. C. 1986. "Student difficulties in understanding image formation by a plane mirror". **The Physics Teacher**. Vol. 24(8), pp. 472-481.
- [6] Langley, D., Ronen, M., & Eylon, B. S. 1997. "Light propagation and visual patterns: preinstruction learners' conceptions". **Journal of Research in Science Teaching**. Vol. 34(4), pp. 399-424.
- [7] Hestenes, D., Wells, M., & Swackhamer, G. 1992. "Force Concept Inventory". **The Physics Teacher**. Vol. 30, pp. 141-158.
- [8] Tsui, C. Y. & Treagust, D. 2010. "Evaluating secondary students' scientific reasoning in genetics using a two-tier diagnostic instrument". **International Journal of Science Education**. Vol. 32(8), pp. 1073- 1098.
- [9] Arslan, H. O., Cigdemoglu, C., & Moseley, C. 2012. "A three-tier diagnostic test to assess pre-service teachers' misconceptions about global warming, greenhouse effect, ozone layer depletion, and acid rain". **International Journal of Science Education**. Vol. 34(11), pp. 1667-1686.



# REFERENCE

- [10] Sreenivasulu, B. & Subramaniam, R. 2013. "University students' understanding of chemical thermodynamics". **International Journal of Science Education**. Vol. 35(4), pp. 601-635.
- [11] Barrass, Robert. 1984. "Some Misconceptions and Misunderstandings Perpetuated by Teachers and Textbooks of Biology". **Journal of Biology Education**. Vol18, pp. 201-205.
- [12] Harrison, A. G., Grayson, D. J. & Treagust, D. F. 1999. "Investigating a grade 11 student's evolving conceptions of heat and temperature". **Journal of Research in Science Teaching**. Vol. 36(1), pp. 55-87.
- [13] Driver, R. 1989. "Students' conceptions and the learning of science". **International Journal of Science Education**. Vol. 11, pp. 481-490.
- [14] Tytler, R. 2002. "Teaching for understanding in science: Student conceptions research, and changing views of learning". **Australian Science Teachers Journal**. Vol. 48(3), pp. 14-21.
- [15] Widodo, A., Duit, R. & Müller, C. 2002. "Constructivist views of teaching and learning in practice: Teachers' views and classroom behavior". **The National Association for Research in Science Teaching**, New Orleans.
- [16] Young and Freeman. 2008 **University Physics with modern physics 12<sup>th</sup> ed**. San Francisco; Adam Black.
- [17] Assessment.aaas.org [Internet]. New York: AAAS Science Assessment 2008 [update 2016 Feb 24; cited 2015 Nov 5]. Available from: [http:// Assessment.aaas.org/](http://Assessment.aaas.org/).
- [18] Anderson, L.W., Krathwohl, D.R., Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., Wittrock, M.C. 2001. "A Taxonomy for Learning, Teaching, and Assessing: A revision of Bloom's Taxonomy of Educational Objectives. **New York: Pearson**. Allyn & Bacon.



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”



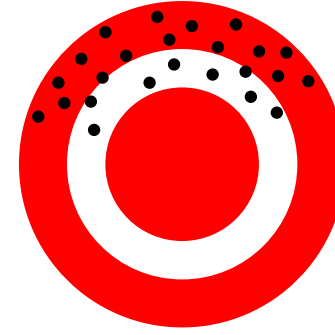
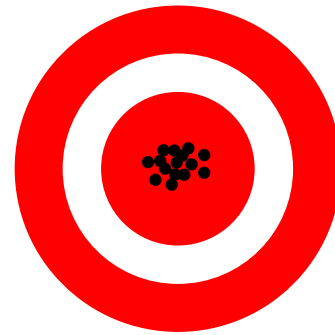
# FIND THE SUBJECT

Find the Subject to adopt.

Before first year students in university.

Energy The children's lack of knowledge most.

# Reliability





# TAXONOMY OF EDUCATIONAL OBJECTIVES

## **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.