

# Strengths and Weaknesses of Dutch Students in Science Literacy and Their Attitude towards Science

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# Outline of this presentation

1. Identification of science-items that are difficult or easy for Dutch students in comparison with students in seven neighbouring OECD-countries
2. Identification of explanatory factors of the relatively negative attitudes of the Dutch students towards science-subjects
3. Comparison of the intended changes in the Dutch curricula for science-subjects with the PISA framework in order to find out whether these intended changes could be expected to serve as a remedy against the identified weaknesses.



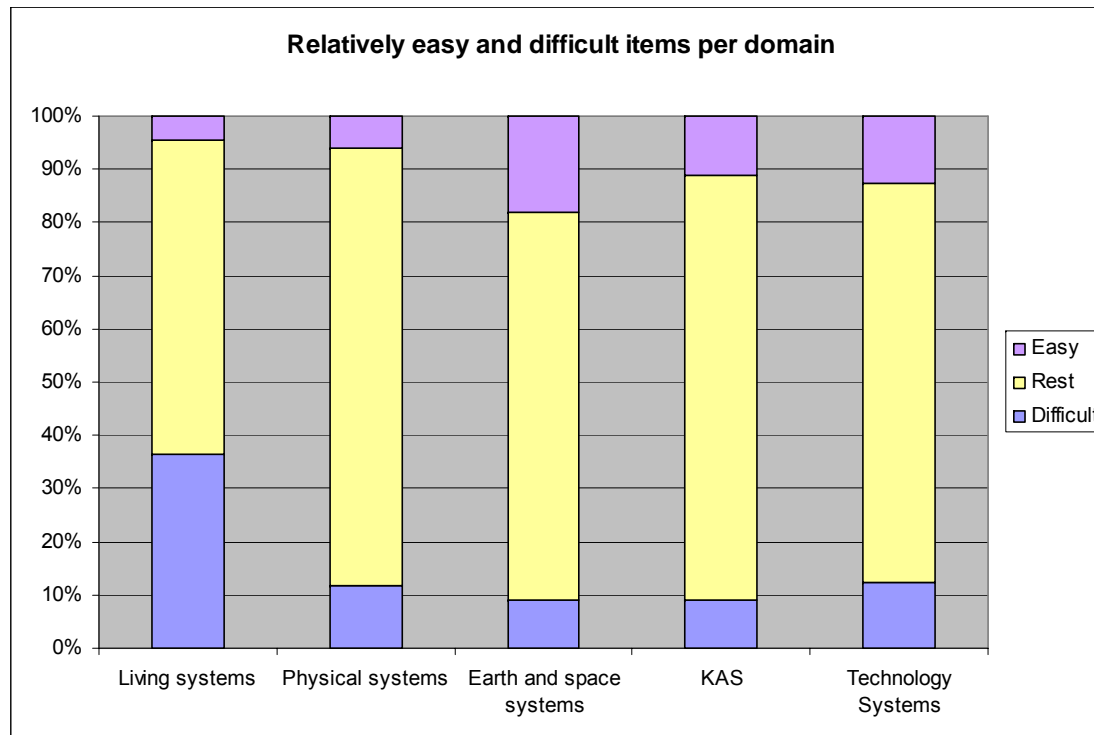
## Definition of 'relatively' easy and difficult

- Average p-values were calculated for The Netherlands and seven Western-European countries: UK, Germany, Belgium, Denmark, Sweden, Norway and Finland
- Differences in p-values between The Netherlands and the average were normalized into z-scores
- Z-scores of  $\geq +1.0$  were defined as 'relatively easy' while Z-scores of  $\leq -1.0$  were defined as 'relatively difficult'



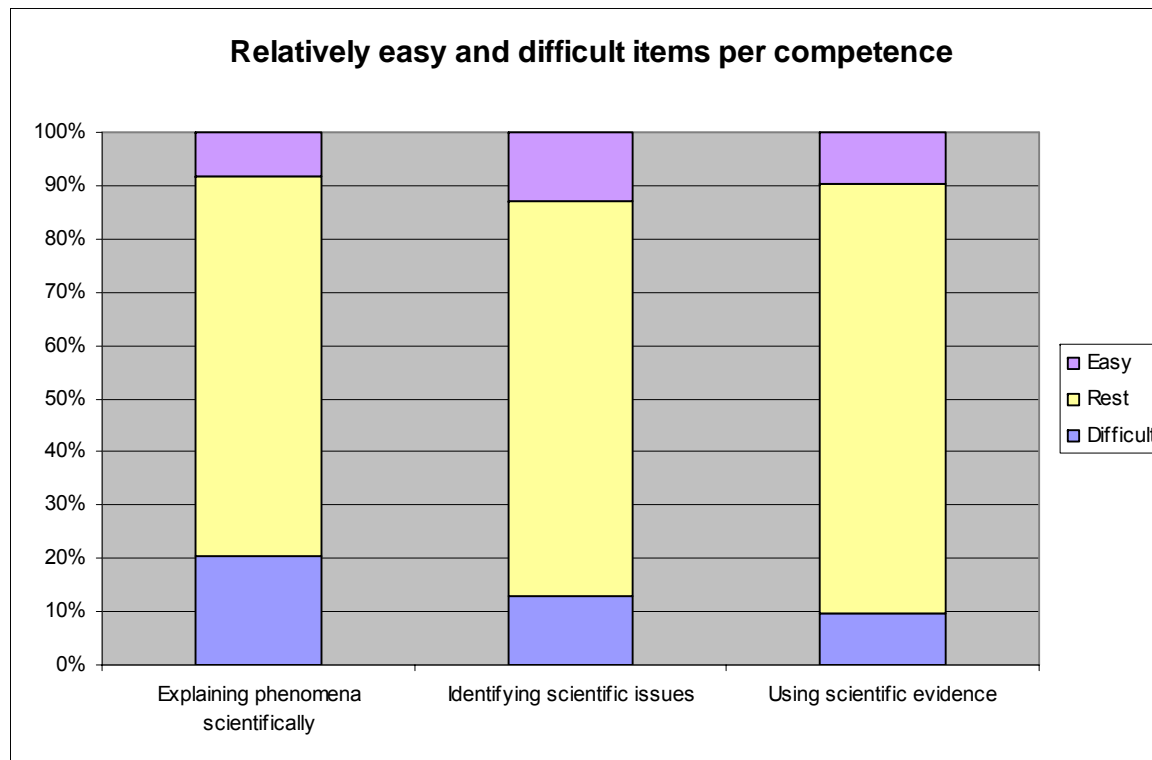
# Difficult or Easy Items for Dutch Students: Domains

- 36 % of the items in the domain 'Living systems' are relatively difficult for Dutch students. Most of these items are part of the subject 'Biology'. The same is true for German students. However, Finnish students find 27 % of these items relatively easy.



# Difficult or Easy Items for Dutch Students: Competencies

- One fifth of the items within the competence 'Explaining phenomena scientifically' are relatively difficult for Dutch students. The same is true for German students.



# Difficult or Easy Items for Dutch Students: Other Characteristics (1)

- **Reading graphs and tables:**
  - Dutch as well as Belgian students find it relatively difficult to answer questions with only text (without graphs and tables). Swedish and Danish students do a quarter to one fifth of these items relatively well.
- **Global answers rewarded:**
  - If global answers to open-ended questions are rewarded, Dutch students do very well. However, if a specific answer is requested, they do relatively poorly.



## Difficult or Easy Items for Dutch Students: Other Characteristics (2)

- **Short, relevant introduction:**
  - Dutch students are equally good at finding the answer to a question in a short, relevant text as students in neighbouring countries. However, if an introduction is long or does not contain relevant information for the item, Dutch students get distracted by the text and do relatively poorly.

# Difficult or Easy Items for Dutch Students: Summary

- **What Dutch students do relatively well:**
  - Finding information in a graph or table
  - Answering open-ended questions where global answers are rewarded
- **What Dutch students do relatively poorly:**
  - Answering questions with a long and/or irrelevant introduction
  - Answering questions in the domain 'Living systems'
  - Answering open-ended questions when specific answers are requested
  - Explaining phenomena scientifically, especially within the domain 'Living systems'



## Question 4: MARY MONTAGU S477Q04

### Characteristics of this item:

- Domain 'Living Systems'
- Competency 'Explaining Phenomena Scientifically'
- An introduction irrelevant for answering the specific item
- An open-ended question for which a specific answer is requested
- An item without tables or graphs



now you know

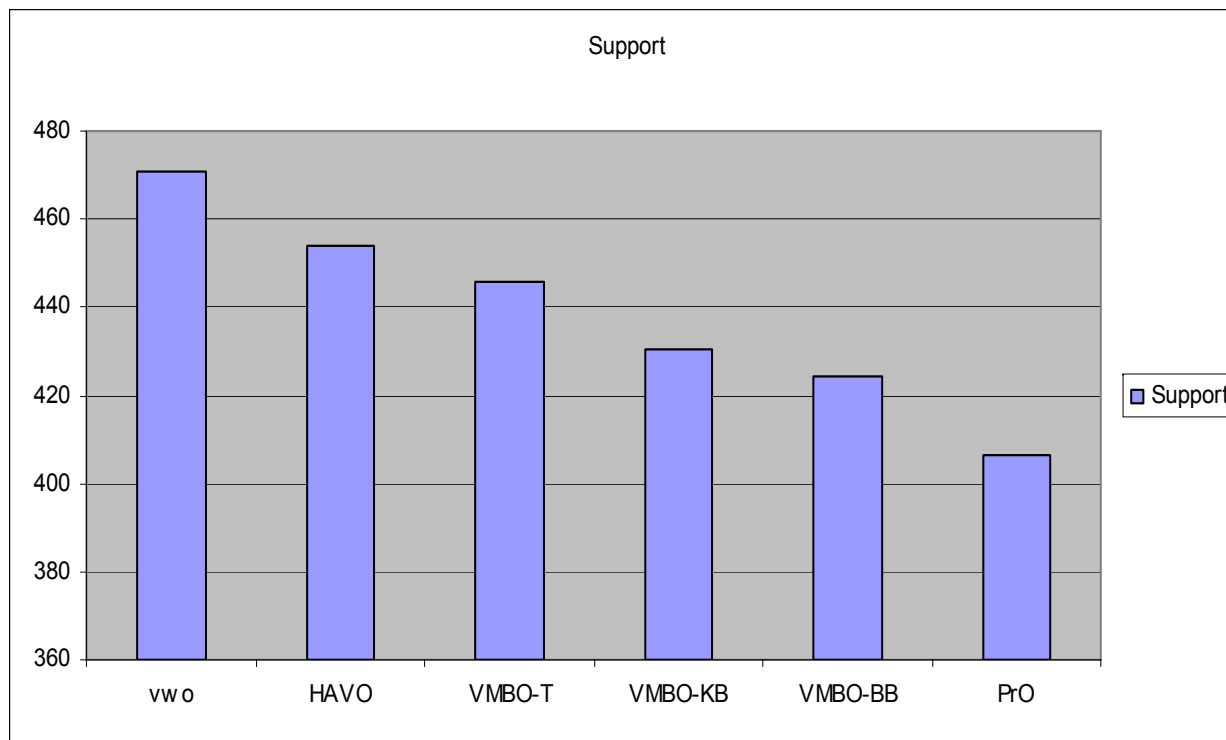
### Characteristics of this item:

- Domain 'Earth and Space Systems'
- Competency 'Explaining Phenomena Scientifically'
- An introduction irrelevant for answering the specific item
- An open-ended question for which global answers are rewarded
- An item with graphs. However, these are irrelevant for answering the specific item



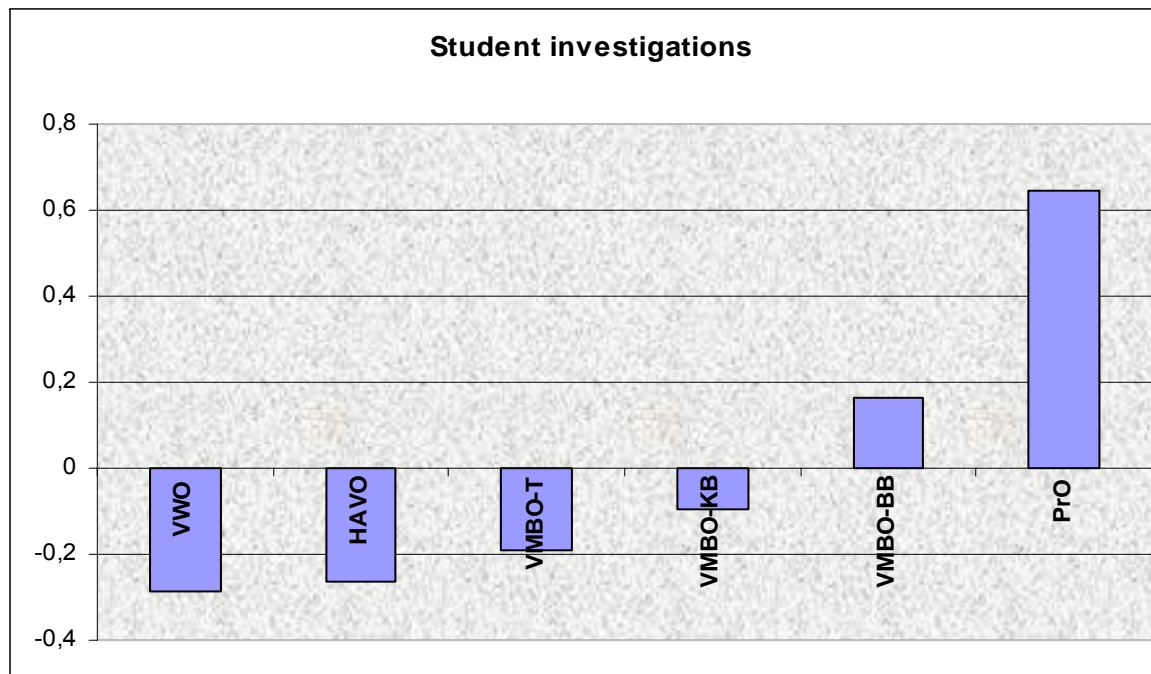
# Dutch Students' Attitudes Towards Science-Subjects

Interest in and support for science-subjects differs between Dutch school-types. It mainly shows the same pattern as the scores on the science-scale. Explanations for these attitudinal scales differ per school-type.



# Dutch Students' Attitudes Towards Science-Subjects: An example

The occurrence of 'student investigations in the classroom' correlates negatively with support for science-subjects. The explanation lies in the below pattern. The school-types run from mainly theoretical education to mainly practical (vocational) education. Therefore, 'student investigations in the classroom' is not a correct predictor for 'attitudes towards science' overall.



# Improving Attitudes Towards Science-Subjects

- To learn how attitudes towards science-subjects can be improved, analyses have to be done for each school-type separately
- Within general theory-oriented education, it might help to make the lessons more 'hands-on' and context-based
- Within vocational education, other aspects have to be found to improve attitudes towards science-subjects



# Changes in Dutch Science-Curricula: General

- **General:**
  - More attention will be paid to context (even more than at the moment), a critical and explorative attitude and interconnection between science-subjects
  - Not earlier than in upper secondary education, when students have already chosen a programme with or without science-subjects, attention is given to 'knowledge about science' and motivation for science-subjects
- **Lower secondary:**
  - Attention will be paid to theories and models of electricity, sound, light, movement, energy and materials
  - Attention will be paid to build and functioning of the human body




# Changes in Dutch Science-Curricula: Upper Secondary Education (1)

- **Chemistry:**
  - Attention is paid to importance, impact and relevance of chemistry in nature, industry and society
  - Attention is paid to the development of interest and pleasure in the subject 'chemistry'
  - Attention is paid to the development of knowledge about occupations in the area of chemistry
- **Biology:**
  - Attention is paid to the development of a way of thinking and working on evolution, form-function, systematic and empirical analytical thinking
  - Attention is paid to aspects of competencies: knowledge, skills, attitudes and normative competencies.



# Changes in Dutch Science-Curricula: Upper Secondary Education (2)

- **Physics:**
  - Core-concepts are  interaction, energy, materials, space and time
  - More attention will be paid to materials, earth & space, life-processes and modern physics
  - Less attention will be paid to optics
  - More attention will be paid to the interconnection between subjects, especially between physics and mathematics.
  - A better transition is aimed at from lower to upper secondary education.



# Changes of Dutch Science-Curricula: Summary

- The changes focus on:
  - Even more context-based education
  - More positive attitudes towards science-subjects
  - Interconnection between science-subjects and lower and upper secondary education
  - More attention to living systems in both lower-secondary education and ‘Physics’ in upper-secondary education.
- Will these changes do away with the ‘weaknesses’ of Dutch students?
  - It is hoped that literacy will improve for the domain ‘Living systems’, the competency ‘Explaining phenomena scientifically’ and attitudes towards science-subjects.

