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Item Difficulty and Item Characteristics in Technology Tests in the Netherlands

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Abstract
Since 1993 technology is a compulsory subject in the curriculum of the first two years of secondary education in the Netherlands. Cito, Institute for Educational Measurement, is commissioned for the assessment of this curriculum. Pilot surveys in schools are used as a method for development items and tests and provide information for reference data for the tests.

In 1999 Cito investigated item difficulty in relation to item characteristics, like subject domain, types of items and required skills of the students. Four subjects, including technology, were involved in the project. In this paper item difficulty is described in relation to item characteristics for the subject technology. The tentative outcomes of the research project show differences between students in relation to the subject domain of the items, the level of structure of the items and the required problem solving strategy of the students.

Technology in the Netherlands
Since August 1993 all Dutch schools for secondary education started a new course, called Basic Education. It was one of the greatest reforms since the start of the present system in 1968. The new core curriculum consisting of 15 subjects has become compulsory for all pupils between the ages of 12 and 15 years.

Technology as a part of the core curriculum is a new subject. The core objectives of this subject are recently revised. (Procesmanagement Voortgezet Onderwijs, 1997) There are 19 objectives divided into three domains:

Domain A. Technology and society.
Technology in everyday life, industry (production plant), professions.
Environmental aspects of technology.

Domain B. Technical products and systems
Materials: properties of materials in relation to functionality of products.
Energy: transport and transformations of energy.
Information: communication systems, control systems, analogue and digital.
Manipulating (computer controlled) models.

Domain C. Designing and making products.
Strategies in problem solving.
Design techniques (sketching, drawing).
Processing materials and evaluating products.

Since the implementation of the new curriculum much attention is paid to the following four topics:

• technology and society
• technology and the computer
• design skills and strategies for problem solving
• thinking in systems.

The core objectives for technology are formulated without any indication of the level of achievement. The problem of teaching to a mixture of pupils of varying level of competency is solved by the possibility of choosing text books or other resources specially written for one or a combination of two types of schools. Differences between text books and resources do not affect the contents of the core objectives but affect teaching methodology only. Educational publishers have developed 14 different textbooks for technology. There are few teachers who work with self-developed texts and materials.

Cito
In the Netherlands the National Institute for Educational Measurement (Cito) is commissioned for the assessment of the core curriculum. Cito has developed national tests for the curriculum according to the core objectives of each subject in the curriculum. Tests are approved by the Ministry of Education, Culture and Science and are compulsory for all schools.

For the subject Technology every year one of the following alternatives will be released:

1. A combination of a written test and a practical skills test (two periods).
2. A combination of a written test and a functional product test (six periods).

Research
Tests are developed in a first version and are tried out in a random selection of schools. The items of the written test are tried out with a large number of pupils (each item is pretested with about 200 pupils), the practical parts of the tests are pretested on a smaller scale (each test is pretested in two or three forms). The data of these pretests is the base for the construction of the final versions of the tests. Pretest-data is not only used for the construction of tests, but are also used for further investigation.

In 1998 Cito has administered a pretest with two goals: first an investigation to the level of students’ achievement as a part of the evaluation of the new curriculum by the Inspectorate of the government. Secondly the data of this pretest is used to analyse the relation between item difficulty and item characteristics.

Evaluation
The evaluation of the new curriculum has taken place in the years 1998 and 1999. The results are published in a general report (Inspectie van het onderwijs, 1999–1) and a number of special reports for the separate subjects of the curriculum (Inspectie van het onderwijs, 1999–2). The evaluation of the subjects is based on the contents of the subject, teacher’s behaviour in the classroom, co-operation in the school and student's achievements. For each of these topics the outcomes of the investigations are compared with previously formulated standards. The technology report shows that most schools have not more than 80% of the core objectives in their curriculum, the teacher’s behaviour fits the standard, the level of co-operation is below the standard and that students aged 12 to 14 years achieve slightly lower than the level that is expected by their teachers and other experts.

Item difficulty and item characteristics
The second goal of the 1998 pretest was to investigate the relation between item difficulty and item characteristics.

The first generation of technology tests (1995) for the new curriculum consisted of a test of one level for all students. Afterwards tests were released in two or more variants. To give schools and teachers assessment tools appropriate to their particular situation, at the moment tests are released as item clusters of different difficulty. More and more item – and test developers need suitable concepts for the construction of items and tests of different level of difficulty. For this reason the department of Basic Education of Cito started a research project in order to investigate in the first place the relation between item difficulty and item characteristics and secondly the possible interactions between item characteristics, students of different ability and item difficulty.

Item difficulty is usually described in terms of the proportion of students with a positive score on the item or, in an item response model, the ability that is necessary to achieve a positive score with a certain chance of success. The hypotheses of the investigation is that there is a relation between the difficulty of items and the characteristics of items, as subject domain, types of items and the required skills of the students. Four subjects, including technology, were involved in the project.

For technology a set 46 items, covering the whole range of core objectives, were pretested with about 2000 students in the second year of secondary education. With statistical analysis the intrinsic difficulty of items is compared with the psychometrical difficulty of items. To define the intrinsic difficulty of an item the following item characteristics were written down:

1. the domain of knowledge and skills, according to the domains of the core objectives;
2. types of items, like multiple choice questions and questions that ask students to make a drawing, to fill in a table, to make a choice from alternatives, to name example(s) and to explain a working principle.
3. does the item contain the ingredients for the solution (is the answer a question of information processing) or does the item appeal to the knowledge of technological concepts?

Psychometrical difficulty is represented as the difficulty parameter from the One Parameter Logistic Model (Eggen and Sanders, 1993).

Results
The results of the project are published in a report. (Kuhlemeier, et al, 1999) The results show that:

1. items from subject domain A (technology and society) are relatively easy for all students
items from subject domain B (technical products and systems) and C (designing and making products) are more difficult for all students.

3. item characteristics can be written in order of increasing difficulty: fill in a table – make a choice – draw – name examples – explain – multiple choice

2. items that make appeal to the knowledge of technological concepts are relatively difficult.

The items given below are examples of items that are relatively difficult.

Example 1: At the entrance of a super market there is a gate. When you pass the gate it opens automatically. Explain the working principle of the gate.

[Insert Figure 1]

Example 2: A bicycle computer measures velocity and distance of a bicycle. Every time a magnet on a spoke of the front wheel of the bicycle passes a switch on the fork a signal is transmitted to the computer. The computer calculates velocity and distance. To install a bicycle computer you have take account of:

A. the circumference of the wheel
B. the number of spokes of the wheel
C. the number of speeds of the bicycle
D. the position of the magnet on the spokes.

Conclusion

Items from subject domain A (technology and society) are frequently related to technological concepts from all-day-life and they are for this reason relatively easy for all students. To construct items of less difficulty in tests one has to give clear instructions for the format of the answer.

Technology is a practical subject in schools in the Netherlands. Much attention is paid to learning of practical skills like drawing, designing and making products and practical investigation of properties of materials. Little part of the time is spent to learning of and working with technological concepts.

Practical skills (domain C) in the technology curriculum do not merely consist of manipulative skills but are a combination of cognitive and manipulative skills. This accounts for the outcome that items from domain C are relatively difficult to all students.

References