The attitude of pupils towards technology

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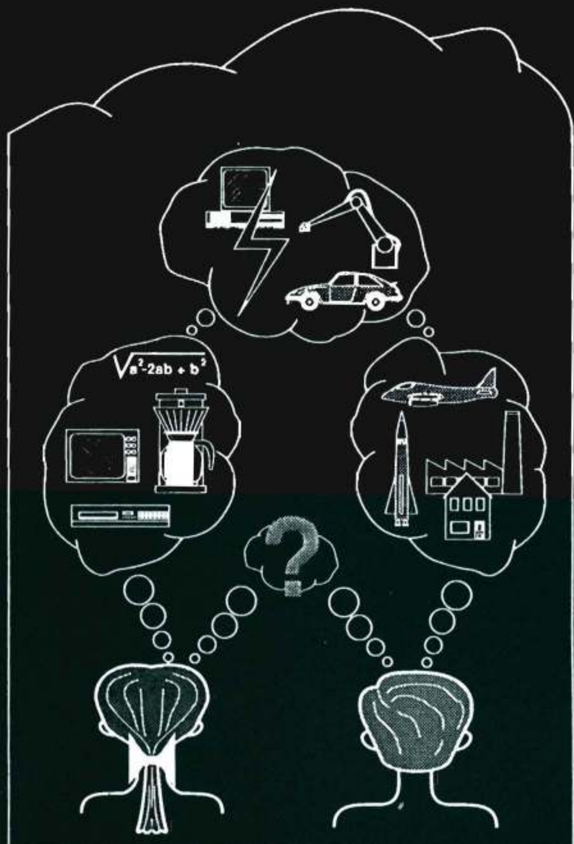
THE ATTITUDE OF PUPILS TOWARDS TECHNOLOGY



Falco de Klerk Wolters

THE ATTITUDE OF PUPILS TOWARDS TECHNOLOGY

PROEFSCHRIFT

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aan mijn ouders

CONTENTS

CHAPTER 1

RESEARCH FRAMEWORK AND PROBLEM STATEMENT

'No one can deny, of course, that, in certain respects, modern technology is brilliantly successful. Certainly, the modern massproduced automobile is a technological triumph- up to a point. The dividing line between succes and failure is the factory door. So long as the automobile is being constructed, it is a technological succes. The numerous parts are designed, shaped, fitted together- and the whole assemblage works. However, once the automobile is allowed out of the factory into the environment, it is a shocking failure. It then revails itself as an agent which has rendered urban air carcinogenic, burderned human bodies with nearly toxic levels of carbon monoxide and lead, embedded pathogenic particles of asbestos in human lungs, and has contributed significantly to the nitrate pollution of surface waters' (B. Commoner, Technology and the Natural Environment, in: *Changing Attitudes toward American Technology*, Thomas Parke Hughes (ed.), 1975, p. 61. Reprinted from *The Architectural Forum*, 130, June 1969, 69-73).

Introduction

The aim of the first chapter is to introduce the theme of this study 'pupils' attitude towards technology'. The theme links with developments in society (section 1.1) and the worldwide introduction of technology as a school subject in general education (section 1.2). In section 1.3 the problem statement and research questions are formulated. An historical outline of the attitude study and the content of this dissertation are discussed in the sections 1.4 and 1.5.

1.1 Developments in society

In our society technology has an important position. Technology is affecting our life more and more. We find ourselves faced with both positive and negative aspects of technology.

There has been technology as long as there has been human beings. We may posit that in the past technology was as indispensible as it is now. But the characteristic of present developments is the great speed at which technological changes come about and new techniques are introduced, and also the social consequences they have.

Our entire body of knowledge is increasing fast. It can be demonstrated that this body of knowledge is doubled every 5 to 10 years. As a consequence of this 'explosion of knowledge', which mainly set in after the second World War, our society has changed from being industry-based to being information-based.
It is essential for education to react to these developments. If the Netherlands want to keep pace with international developments, dispersion of technological knowledge is necessary (Commissie Dekker 1987). The danger of technological illiteracy is very great if, in education, technical training is not given to all pupils. In the Netherlands pupils in general education do not receive technical training. Schüssler (1987) calls this 'the imbalance of education'. Despite the great social importance of technology, so far little of it can be traced in the curriculum of schools for general education. This does not contribute to a greater interest in the choice of a technical or technically oriented vocational education.

If we look at this technical vocational education, we can determine that the participation of girls in the Netherlands, as in most countries, has a low score. It may be a question of girls having a less positive attitude towards technology. Research shows that the poor participation of girls in science and technology education, is accounted for by affective rather than cognitive grounds (Rennie 1988). 'The imbalance of education' and 'the backlog of girls in technology' are not very favourable for an economy in which the demand for people with a technical training is increasing strongly. We see this situation in many countries and the concern that accompanies it is also international. To mention just one example, in the investigations in Britain that have looked at factors influencing recruitment of technological and industrial occupations, the importance of pupils' attitudes has been frequently underlined (Page 1980). British predictions suggest that there will be a damaging shortfall in qualified applicants for jobs in the growing technology industries in Britain. It was anticipated that between 1984 and 1989 there would be a 56% overall increase in the science graduates required by the new technology industries in Britain. According to Breakwell (1986), given the decline in the birthrate in the 1960s, and the advent of stricter entry requirements for degree places, the only serious source of this new generation of technologists are those who would traditionally have opted for arts or humanities degrees - and these are predominantly women.

1.2 Technology as a school subject

The societal developments mentioned above justify the introduction of technology as a separate subject in general education, as intended for the Netherlands by the Minister of Education in a Bill now before Parliament (April 1989). Technology as a school subject in general education teaches pupils to understand better the technological world around us. But education in technology can also contribute to the development of a more positive attitude towards technology. In the Netherlands, and also abroad, the demand for technology as a school subject, both in primary and in secondary education, has increased considerably. Many countries around us have introduced the subject already. In the Netherlands the process proceeds with great difficulty and it may take years before technology is taught to all pupils. Because technology as a school subject has no tradition and there is a lot of indistinctness about the contents of the subject, research and curriculum development are important. It is in this context that we have carried out research into pupils' opinions about and attitudes towards technology. To develop the education in technology in such a way that it gives pupils a fairly balanced concept of technology, it is necessary to know what the pupils' attitude is at the beginning of technology education. Little research has been done in this field. A lot of research has been done into the pupils' attitude towards science (Schibeci 1984), far less into the pupils' concept of science, and very little into the pupils' concept of and attitude towards technology (Angele 1976, Breakwell et al 1986, Page et al 1980, Nash et al 1984).

1.3 Problem statement and research questions

We would like to contribute to the development of technology in education by doing research into attitudes towards technology among young people. The main argument we use to justify this research is that it permits and facilitates curriculum development that is more student-centered than subject matter-centered. It confronts pupils' views, interests and needs with the views of others, e.g. experts (Mottier 1986, Todd 1986). In view of the various (affective) choices boys and girls make it is important to pay attention to the differences in the attitude of boys and girls. This resulted in the following (general) problem statement for this research:

What is the attitude of boys and girls towards technology?

As part of the project Physics and Technology (1984-1988) Raat and De Vries (1985) investigated the attitude towards technology among a specific target group: pupils of 13 to 15 years old in avo-vwo[1]. This group of pupils did not have technology education. The attitude towards technology was investigated by means of a questionnaire. Pupils could express their opinions on items representing various aspects of technology. The chosen aspects of technology were derived from interviews with the pupils. The questionnaire was not built up with (attitude) scales and no distinction was made between affective, cognitive and conative components of the attitude towards technology. From the scores on items of the questionnaire it appears that this group of pupils has a positive attitude towards technology, but that their concept of technology is rather limited (see also page 9). Furthermore differences between boys and girls are found: boys have a more positive attitude towards technology than girls and boys have a broader concept of technology than girls (Raat and De Vries 1985). The results of this research were used for the development of course material.

The study of Raat and De Vries resulted in two general questions:

1. do the results also hold for pupils of other age groups and other school types?
2. is it possible to use the questionnaire abroad to measure the attitude towards technology?

In this dissertation one can find answers on these questions. Three research questions in this thesis are derived from the first general question, and one research question from the second general question. The research questions are described below.

1.3.1 Research questions 1-3

The first general question can be answered if an attitude instrument is developed with which subsequently the attitude towards technology is measured among a target group of 10 to 18 year-olds in various representative schooltypes. For this purpose the social psychological notion attitude has to be split up into (measurable) components. This was not done in the original questionnaire. It is common practice to distinguish three components in an attitude: affection (feeling), cognition (knowledge) and conation (behaviour). Mostly an attitude is only measured by way of the affective component (a.o. Bynner 1978). In the case of a specific attitude-object this would be possible. The attitude towards a broad and diffuse notion like technology cannot be meaningfully

[1] an explanation of the Dutch abbreviations is given in Appendix 1

described without insight in the concept of technology pupils have (the cognitive component).

The operationalization of these three components of the attitude may be realized by developing reliable and valid scales. These scales should represent the three attitude components affection, cognition and conation. The scales should also represent the various dimensions that can be distinguished with reference to the notion 'technology'. The attitude towards 'technology' is not one-dimensional. The possible existence of more dimensions in the attitude towards technology appears from the 'aspects of technology' that Raat and De Vries (1985) found among 13 to 15-year-olds (e.g. 'interest in technology', 'importance of technology', 'diversity of technology').

We supposed that at the age of 10 pupils are only beginning to have a concept of technology. Therefore we took this age as a 'starting point' for our research.

The first research question can then be formulated as follows:

1. *Is it possible to develop an instrument with which we can measure among pupils from 10 to 18 years old:*
   a) the affective, cognitive and conative attitude components of the attitude towards technology, and,
   b) the various dimensions of techology in the attitude towards technology?

The development of a reliable and valid attitude instrument for pupils from the age of 10 to 18 years old is described in chapter 3. The instrument consist of AB- and C-scales that describe the Affective/Behavioral and Cognitive attitude components. The pupils of 10 to 18 years old are classified in different groups. The most important classifying criterion is boys and girls. In addition we can follow the development of the attitude towards technology with age. This results in the second research question:

2. *Is it possible to describe the affective, cognitive and conative components and the dimensions of the attitude towards technology for pupils from 10 to 18 years old?*

A description of the results of the empirical research is given in chapter 4.

The use of attitude scales in educational research is closely related to the increasing interest in the affective objectives of education. This can be regarded as a counterpart of a type of education that emphasizes mainly cognitive achievements (Kremers 1980). Affective objectives in education are also important because:

1. affective objectives determine (together with the cognitive objectives) the individual's capacity to participate effectively in society;
2. it is supposed that in order to attain cognitive success pupils must also have a 'positive' attitude towards the subject in question. However, the correlation between attitudes and achievement is rather weak (Moore 1987b).

The objects of attitude measurements in educational research are e.g. school subjects, the school and studying. This appears from surveys by, among others, Buitenhuis (1982), Gray (1984) and Shaw (1967).

We can distinguish the following applications of attitude measurements for educational purposes:

1. the supply of information to institutions and organizations for the sake of curriculum development and the making of choices in policy;
2. as an expedient for teachers to evaluate their own teaching on affective outcomes;
3. as an expedient for pupils in the choice of their exam subjects (Van den Bergh and De Klerk Wolters 1987).

In this study we are primarily concerned with the first application: the supply of information to institutions and organizations. During the research in the field (technology teachers) the question arose to develop an instrument that could be used by (technology) teachers in their classes for evaluation or assessment purposes. Such an instrument should be 'user-friendly'.

With this instrument teachers should be able to evaluate the affective outcomes of a technology program by carrying out a measurement both at the beginning and at the end of a technology education program. Erickson (1988) calls this kind of measurement 'affective measurement'. It should also be possible to use the instrument for assessment: teachers want to know the pupils' attitude towards technology when entering a type of education. This request results in the third research question:

3. *Is it possible to develop an attitude instrument that can be used by technology teachers for assessment and evaluation purposes?*

The description of the development and evaluation of a classroom instrument to measure the attitude towards technology is given in chapter 5.

1.3.2 Research question 4

The second question, whether the questionnaire of Raat and De Vries (1985) can be used abroad, was answered at the so-called PATT conferences. PATT means Pupils' Attitude Towards Technology. In the framework of these conferences an instrument has been developed that can be used internationally to measure the attitude towards technology among pupils of 13 to 15 years old. The development of this instrument is not explicitly described in this dissertation. But, we do want to discuss the results and the relevance of the PATT research more extensively. This results in the fourth research question:

4. *What are the results of the PATT research and what is the relevance?*

An answer to this question will be given in chapter 6.

1.4 Historical outline of the attitude research

For two reasons it is meaningful to indicate the main lines along which the attitude study has developed in the period from early 1986 to late 1989. Firstly to indicate the framework of people with whom and the projects within which the research has been carried out. Secondly to indicate that in the course of the four years a number of changes could have taken place in the conceptualization and operationalization of the concept attitude and the determination of the relevant predictors (or independent variables) of the attitude towards technology.

The attitude study has been carried out in the Department of Physics Education at the Faculty of Technical Physics of the Eindhoven University of Technology. Until August 1987 the attitude study was an independent study in the project Physics & Technology (P&T). Later on the study was continued as an attitude research component in the project 'Girls, Physics and Technology' (in Dutch: MEisjes Natuurkunde en Techniek, abbreviated to MENT). The first period, in the project P&T, was mainly a stage of instrument development. In the second period, in the MENT-project, measurements were carried out and the classroom instrument was developed.

The period from January 1986 to September 1987

The foundation for the attitude research in the Netherlands and abroad has been laid in the project Physics & Technology, of which dr. M. J. De Vries was project leader and prof. dr. J. H. Raat was supervisor. The aim of the project was to develop course material for physics, for the lower part of avo-vwo, in which elements of technology are integrated. To achieve this De Vries investigated (1) characteristics of technology that can be integrated in education, (2) the concept of and the attitude towards technology of pupils who did not have any technology lessons yet and (3) experiences of pupils with reference to the developed course material. De Vries formulated the following characteristics of technology:

1. technology is a feature of human activities,
2. matter, energy and information are the pillars of technology,
3. there is a mutual influence between technology and natural sciences,
4. the three most important technical skills are:
   a. design technical products,
   b. making technical products,
   c. using technical products,
5. there is a mutual influence between technology and society.

From this study it became evident that pupils of avo-vwo have an incomplete and a distorted concept of technology, and that this applies to a greater extent to girls than to boys. It appears that after technology lessons the pupils have a better concept of technology (De Vries 1988).

Two partial results of the research in the project P&T were of importance to the development of the attitude instrument.

1. The questionnaire that was used to measure the attitude towards technology of pupils of 2 avo-vwo was taken as a starting point. This questionnaire, translated into English, was discussed at the first PATT-conference in 1986. This resulted in adjustments and changes in the original questionnaire. In order to be able to make comparisons, both in the Dutch study and in the studies abroad the questionnaire was kept intact as far as possible.
2. The description of technology by means of five characteristics appears to be a quite useful frame of reference. At the moment these characteristics are finding acceptance in technology education at primary school and secondary school (Van der Laan 1988, Werkgroep BASTEC 1988, Ontwikkelingsgroep Techniek 1989).

The first two PATT-conferences were important for the development of the instrument. At the first PATT-conference (March 1986) it was decided to construct separate scales, beside the existing scales, with which the concept of technology could be measured on the basis of the five characteristics of technology from the project P&T. During the second PATT-conference (April 1987) the attitude instrument has been evaluated and improved on some minor points. Since this conference the instrument has not been changed.
The norms of the scales that we use in this study (see chapter 3 for the development of the scales) are derived from research in the project P&T and the PATT-project. These norms determine what is meant by a 'positive' or 'negative' attitude and a 'good' concept of technology. A 'positive' attitude means that the scores of pupils on the scales are on the positive side. That is on a 5-point answering scale a (mean) score below 3. It means that pupils agree that technology is: 1. interesting (e.g. pupils agree with a statement that they like to read technological magazines), 2. for boys as well as for girls, 3. not difficult and 4. important. A 'good' concept of technology means that pupils answer the items of a 2-point answering scale according the description of technology in five characteristics. It means that pupils agree that: 1. there is a relation between technology and society and technology and humans, (e.g. pupils agree that technology is as old as mankind), 2. there is a relation between technology and sciences, 3. there are certain skills involved in technology and 4. matter, energy and information are the pillars of technology.

The period from September 1987 to November 1989

From September 1987 the attitude research was carried out in the MENT-project. The MENT-project is an emancipation project that has as its aim to make technology and physics more attractive to girls. This is done by means of research, the developing of course material and information for teachers. Prof. dr. J.H. Raat started the MENT-project and was leader of the MENT-project until July 1988, afterwards dr. G. Verkerk became projectleader.
In the period '87-'89 attitude measurements have been carried out among pupils of 4 havo-vwo and 1 mbo, and also among pupils of groep 7 and 8 basisschool. In this period a classroom instrument called the Technology Attitude Scale or TAS has also been developed (1987), evaluated and revised (1988-'89). The evaluation and revision was carried out by drs. R. Coenen-van den Bergh.

1.5 Contents of the dissertation

In chapter 2 the concepts 'attitude' and 'technology' and the theory and practice of the measurement of attitudes are discussed. Furthermore a survey is given of research into attitudes towards science and technology. In chapter 3 we describe the development of the research instrument and its psychometric properties. In chapter 4 we report the measurements among the three age groups: 10 to 12-year-olds, 13 to 15-year-olds and 16 to 18-year-olds. The results are described by formulating and testing ten assumptions about the attitude towards technology among 10 to 18-year-olds. In chapter 5 we describe the development, evaluation and revision of the TAS. In chapter 6 we describe the results of the international PATT-research and its relevance for technology education. The conclusions and recommendations of this research are taken up in chapter 7.

Appendix 1 gives an overview of the English translation of the Dutch abbreviations of schooltypes. Appendix 2 is an overview of the items that were used in the development of the AB-scales. The questionnaires that were used in the measurements are given in appendix 3. The manual used in the 'drawing-research' by students is published in appendix 4. The manual accompanying the Technology Attitude Scale for technology teachers is published in appendix 5. In the appendix 6 several statistics are presented.

An outline of the different parts of the study is given in figure 1.1.

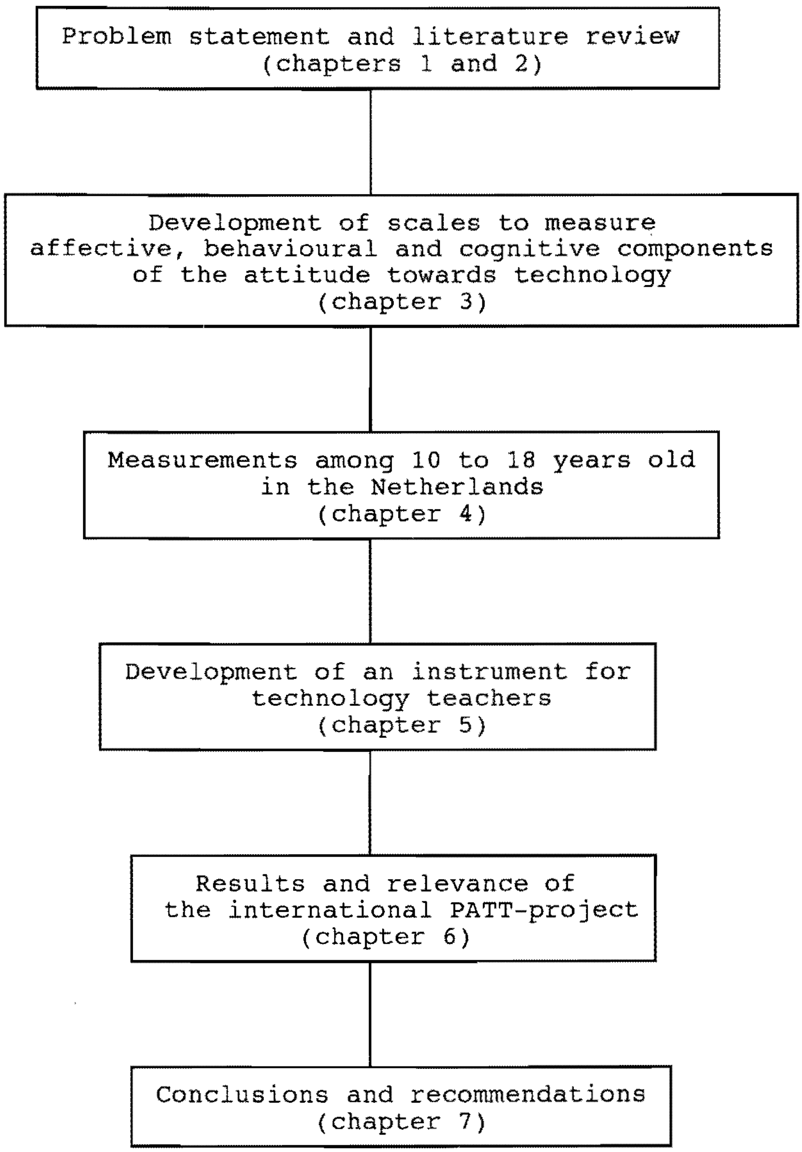

Figure 1.1 Outline of different parts of the study

CHAPTER 2

RESEARCH INTO THE ATTITUDE TOWARDS SCIENCE AND TECHNOLOGY

'The affective domain in science education - the area of interests, attitudes and values - is considered a vital area by many in the science education community. Some argue (pragmatically) that a 'positive' affective climate is a prerequisite for 'positive' student achievement. Others argue (ideologically) that the affective domain is more important than the cognitive domain, and that the science educators should direct an appropriate amount of effort in this area' (R.A. Schibeci 1985, p. 21).

Introduction

It is a feature of modern science curricula that they emphasize affective outcomes of pupils' and students' learning. It is largely for this reason that there is now a substantial body of research literature devoted to aspects of pupils' attitudes towards science. About 30 attitude studies in science education are reported every year (Moore 1984). There is, however, hardly any literature on research into attitudes towards technology. In a survey of literature we shall therefore not confine ourselves only to attitudes towards technology, but we also pay attention to attitudes towards science.

The results of a large body of literature on attitude research is limited. According to Schibeci (1984), Gardner (1975) and Haladyna and Shaughnessy (1982) this is due to: lack of a theoretical framework, use of invalid attitude instruments, conducting studies over too brief periods and use of simplistic experimental designs.

In this chapter we shall first indicate (briefly) what we mean by the concept 'technology' (2.1). Subsequently we shall enter into the the concept 'attitude' and the measuring of this concept (2.2). In the last section we shall discuss the most important results of research into attitudes towards science and technology (2.3).

2.1 Definition of technology

The object of our research is the attitude towards technology. What do we mean by here by 'technology'?

In this research we shall link up with the description that De Vries (1988) gives of the concept technolgy. Rather than giving a definition De Vries formulates five characteristics on the basis of literature studies and consultation of experts. These characteristics are the following:

1. technology is a feature of human activities.
   Three consequences of this are:
   a. there is a relation between a person's view of mankind and the world, and this person's view of technology,
   b. technology belongs to both men/boys and women/girls,
   c. technology, just like mankind, is passing through a historical development;
2. matter, energy and information are the 'pillars' of technology;
3. there is a mutual influence between technology and science. This influence concerns both the methodology of technology and science and the technological and scientific knowledge;
4. the three most important skills in technology are:
   a. design skills,
   b. practical-technical skills (making, producing),
   c. skills in handling technical products;
5. there is a mutual influence between technology and society.

The description in characteristics of De Vries links up with earlier definitions of technology (Mottier 1988). For a more detailed description of the five characteristics of technology we refer to De Vries (1988).

When we are talking about 'attitude towards technology' we are not referring to technology as a school subject, but to technology as a societal phenomenon. For education it yields the advantage that it offers a guiding framework for curriculum development. It is this broad view of technology that we work with in this research and that we use as a reference.

2.2 Defining and measuring attitudes

2.2.1 Definition of attitudes

A great deal has been written about the meaning of the social psychological concept attitude. Several authors point to 1918 as origin of attitude as a modern concept (Shrigley et al 1988). They indicate a study by Thomas and Znaniecki in 1918 in which attitudes are used as an explanation for changes in lifestyle of Polish immigrants in the U.S.

Attitudes did not become important in educational research until it was possible for people to measure them. In 1929 Thurstone developed a method to measure attitudes by means of scales. In 1932 Likert developed a more practical method of measuring attitudes by means of scales. To this day Thurstone and Likert scales rank among the most important techniques for measuring attitudes.

We describe the concept attitude on the basis of various characteristics that are relevant to our research.

1. Evaluative quality and the three component-model

Central to the concept of attitude is our like or dislike: the evaluative quality. Some consider evaluation the sole element in its definition (Edwards 1957, Shaw and Wright 1967, Fishbein and Ajzen 1975, Mueller 1986). However, attitudes are more than reflections of affective dispositions. Attitudes also comprise elements of knowledge and behaviour. Affection, cognition and conation are the three generally accepted subconcepts of attitude. Each is related to attitude, but to different degrees (Shrigley et al 1988). We can describe the three component-model as follows:

- the affective component: someone has certain (positive or negative) feelings with reference to the object,
- the cognitive component: someone has formed a concept on the basis of knowledge and experience,
- the conative or behavioural component: someone has the intention or inclination to a certain behaviour towards the object.

The three component-model takes us back to the almost generally accepted and longest valid definition of Allport from 1935:

> 'An attitude is a mental and neural state of readiness, organized through experience, excerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related' (Allport 1935, p. 810).

Attitudes are certain inclinations or 'dispositions' to react in a positive or negative way to objects or situations (Summers 1977, Bynner 1978). Shaw and Wright's conceptualization of 'attitude' is a derivative of Allport's definition:

> 'We believe that an attitude is viewed as a set of affective reactions towards the attitude object, derived from concepts or beliefs that the individual has concerning the object, and predisposing the individual to behave in a certain manner toward the object' (Shaw and Wright 1967, p. 13).

According to Schibeci (in Lehrke et al 1985) the conceptualization of 'attitude' by Shaw and Wright is a guiding framework for educational researchers. If we translate this to our research, a simple definition of the attitude towards technology could be:

> 'a certain feeling with reference to technology, based on a certain concept of technology, and that carries with it an intention to behaviour in favour of or against technology'.

In figure 2.1 it is shown how each of the three components of the attitude towards technology -affective, cognitive and behavioural- manifests itself in various observable forms of behaviour. The figure has been adapted from a diagram presented by Triandis (1971) and Bynner (1978).

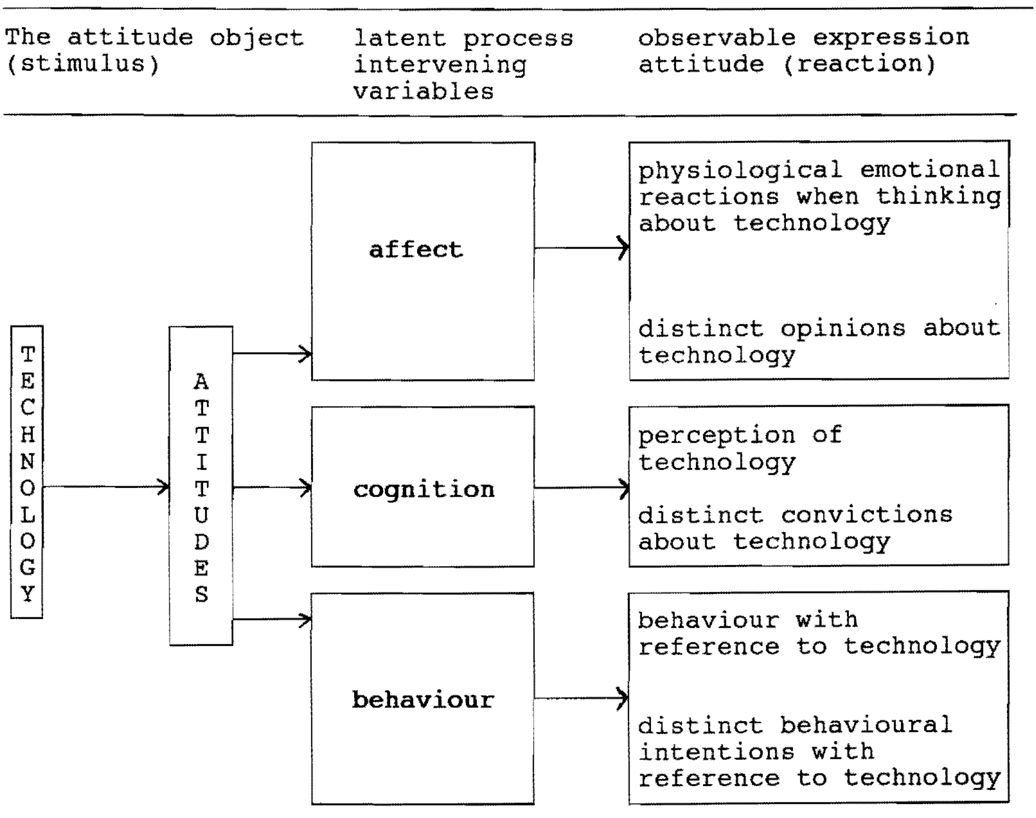

Figure 2.1 The three components of the attitude towards technology

2. Relations between attitudes and cognitive learning

In general, attitudes have 'temporal stability'. That is, they are enduring enough to be stable but transient enough to be changed (Shrigley et al 1988). Naturally the object itself plays an important part in the possibility of learning and changing. The more specific the subject, the easier it is to learn and to change attitudes towards this subject. For a broad object like technology this is certainly not the case.

There are several 'attitude-change' theories and approaches. Oskamp (1977) mentions: functional approaches, learning approaches, consistency theories, dissonance theories and perceptual approaches. The 'cognitive dissonance theory' and the 'social learning approach' are often mentioned in literature. The theory of the 'social learning model' is based on the assumption that people adopt behaviour by imitation. This is done by means of observations of living elements (parents, family) and of symbolic elements (media). This process is a passive one. The 'cognitive dissonance theory' is based on the assumption that human beings cannot tolerate inconsistency. This means that whenever inconsistency exists in a person, he/she will try to eliminate or reduce it. The theory states that dissonance (psychological inconsistence) exists whenever one cognitive element conflicts with another cognitive element (Zimbardo et al 1970). The 'cognitive dissonance theory' is said to occur if we have to choose between two equally attractive courses of action. To overcome the dissonance, the subject re-evaluates the alternatives such that the chosen one becomes more attractive. However, the theory has no predictive value.

3. Relations between attitudes and behaviour

Attitudes are only one category of factors that influence behaviour (Rodenburg 1980). The relation between attitudes and behaviour is far less strong than is often assumed. Research into the relation attitude-behaviour shows that this relation is weak but consistent. A literature review by Schuman and Johnson (1976) suggests that the consistency between attitude and behaviour is high enough to confirm the causal forces between attitude and behaviour (Shrigley et al 1988).

4. Relations with associated concepts

The concept 'attitude' becomes more understandable if we place it opposite to opinions (idea) and ideology (value) (Rodenburg 1980). Everybody has hundreds of opinions, dozens of attitudes and several ideological notions. There are differences between opinions, attitudes and ideologies with regard to number, durability and concreteness. Opinions are rather specific and concrete, whereas attitudes have a 'wider' extension. An ideology goes even further and is a comprehensive outlook on mankind and society. Many opinions with regard to a specific social phenomenon together form a more or less coherent whole: an attitude. Several attitudes of the same person form together a more or less coherent whole: an ideology. Shaw and Wright (1967) also made a distinction between belief (opinion), attitude and value (ideology). Beliefs are clearly cognitive in nature. Beliefs do not have an affective element. Thus a belief is the acceptance of a proposition that is held without emotional commitment. If an affective element is present, an attitude exists. Values are generally best regarded as being more enduring than attitudes. Attitudes include the affective reactions which form part of the valuing process. Oskamp (1977) writes that values are 'important life goals or standards of behaviour for a person'.

Bynner (1978) indicates that an attitude is a kind of hinge between personality features (motives) and the social context (values) on the one hand, and the final behaviour on the other.

Attitudes and interests are connected and are often used interchangeably (for example during the 12th IPN Symposium 'Interest in Science and Technology Education' Kiel, 1984 (Lehrke et al 1985). Interests are no more than part of the attitude. We regard interests as representative of the affective attitude component.

5. Relations with explanatory factors

According to McMillan (1980) the following factors play a part in the developing of attitudes by pupils:

1. factors from the pre-school period: attitude of parents, the pupils' self concept,
2. factors with reference to the teacher: enthusiasm, popularity, the attitude towards a subject and the marking-system are some factors that might determine the attitude of pupils towards a subject. There is supposed to be a relation between a positive class climate and positive attitudes. In any case the teacher plays an important part.

However, as yet there are no generally valid theories to explain the forming of attitudes.

2.2.2 The measurement of attitudes

In figure 2.1 we can see that attitudes can only be deduced from what a person says or does, that is in an indirect way. One must therefore choose behaviours which are acceptable as bases of inference (Summers 1977). Cook and Selltiz (in Summers 1977) have made a classification of ways in which attitudes can be measured. Five main groups are distinguished:

1. measures in which the material from which inferences are drawn consist of self-reports of beliefs, feelings, behaviour, etc. towards an object;
2. measures in which inferences are drawn from observed overt behaviour toward the subject;
3. measures in which inferences are drawn from the individual's reactions to, or interpretations of, partially structured material relevant to the object;
4. measures in which inferences are drawn from performance of objective tasks where functioning may be influenced by disposition towards the object;
5. measures in which inferences are drawn from psychological reactions to the object.

According to Cook and Selltiz (1977) self-reports are by far the most frequently used method. Extensive surveys of measurement techniques related to attitudes towards science are given by Gardner (1975) and Munby (1983a and 1983b). From these surveys it becomes evident that in most attitude research some kind of instrument is involved. Gardner distinguishes nine different techniques and/or instruments, most of which are indeed self-report techniques. According to Kremers (1980) self-reports (questionnaires) are the most reliable and valid way to measure attitudes. Through careful instrument construction, bias caused by social desirability and faking can be averted to some extent. Important in this context is a test situation that is not threatening and in which the confidentiality of the answers is secured. The most important (and most often used) scaling techniques in attitude research are:

1. Thurstone scales,
2. Likert scales,
3. Guttman scales,
4. Semantic Differential scales

First, these four techniques are described shortly. Then the 'theory and practice' of Guttman's and Likert's techniques are described in greater detail because they were used in this research.

Thurstone scales

A Thurstone scale is made up of about twenty independent statements of opinion about a particular issue. Each statement has a numerical scale value existing of its average position on the continuum from expert judgements. A person's score is calculated by adding the values of the statements with which he agrees. An example of a short Thurstone scale about 'Attitude toward open housing' (from Zimbardo et al 1970):

Scale value	Statement
Least favourable	
1.5	a. A person should refuse to rent to anyone he doesn't like
3.0	b. Federal laws enforcing open housing should apply only to public housing, not to private neighbourhoods
4.5	c. Local governments should publicly urge people to engage in fair housing practices
6.0	d. Only in extreme cases of discrimination in housing should there be some sort of legal intervention
7.5	e. A person must rent to the first eligible applicant, regardless of race, colour or creed.
Most favourable	

Likert scales

The Likert scale is made up of a series of opinion statements about some issue. Each statement reflects either a favourable or an unfavourable opinion and the respondent is asked to react within a range from strongly agree to strongly disagree. The statements or items of a scale are repeated indicators of a subject's position on an (unknown, latent) underlying theoretical concept or attribute. The series of items that is initially presented to the respondents contains up to a maximum number of 25; the final scale will usually contain between 5 and 15 items. The Likert scale is a 'summated scale'. It means that the score of scale is the sum of the individual itemscores. An example of one opinion statement and the responses:

'I like playing soccer'

Rating value	
1.	a) strongly agree
2.	b) agree
3.	c) undecided
4.	d) disagree
5.	e) strongly disagree

Guttman scales

The Guttman scale model also consists of statements about an issue on which respondents express their opinion. In Guttman scales there are usually only two possible answers. The model according to which the scales are constructed is essentially different from the Likert scale model. It is assumed that the items differ in degree of difficulty, and that, as a consequence, they measure different amounts of an attribute. Thus, the 'degree of difficulty' is the difficulty of scoring 'yes' in reaction to an opinion statement. If few reactions are 'yes', the statement is difficult. If a respondent answers an item just correctly (or accepts), because he has exactly the amount of the attribute that is expressed by that item, the model implies that all easier items will also be answered correctly and that no items that are more difficult will be answered correctly. Items that differ in degree of difficulty or abstraction or in level of acceptation (see the example) must show a corresponding answering pattern. Guttman scales are constructed according to this model. The score of a respondent is the number of items that is answered correctly. The number of stimuli is determined by the object, for attitudinal statements only 4 to 7 items. An example (from Swanborn 1982):

a. if it were possible I would go to another college; yes/no
b. I would rather leave today than tomorrow; yes/no
c. if I had known everything, I would never have come here; yes/no
d. I would advise my acquaintances that want to become social workers to come and study here; yes/no
e. do you like college; yes/no

The continuum runs from d-a-b-e-c.

Semantic Differential scales

The three methods just described attempt to measure attitudes by having people indicate the extent of their agreement with various opinion statements. In contrast to this approach, Osgood has studied attitudes by focusing on the meaning that people give to a word or concept. The scale consists of a word or phrase representing an attitude object which is followed by a list of bipolar adjectives. These adjectives lie at the opposite ends of a seven-point scale, and the respondent marks a position on each scale for each adjective pair. The number of contrasting pairs mostly varies between 8 and 15, the number of stimuli depends on the object that is to be studied; sometimes there is only one stimulus. For example, the meaning of the concept 'integration' is measured by ratings of it on a set of semantic scales (from Zimbardo et al 1970):

good ---------------------- bad
strong--------------------- weak
fast ---------------------- slow
active--------------------- passive

Applications of Likert and Guttman scales

Likert scales are by far the most used in attitude measurements. This is probably for practical reasons. The Likert scales can easily be constructed, this as opposed to the Thurstone scales, and they often yield an acceptable reliability and validity. As 'self-report' instruments they are quite simple to use and they are not time consuming. In this way attitudes of large groups can be measured. Likert scales yield higher reliabilities with fewer items than Thurstone scales (German 1988).

That is why the choice of Likert scales for our research was an obvious one.

The criticism on many attitude researches by means of Likert scales that has been expressed by Schibeci (1984), Munby (1983a and 1983b) and Gardner (1975) concerns the quality of the researches themselves and not really the technique that was used. According to Munby many researchers pay too little attention to the ascertainment of the reliability and validity of the instrument. On the basis of an investigation of 204 attitude instruments Munby concluded that only six had a 'fresh determination of reliability'. According to Munby (1983a) 'proper instrument development is such an exacting task that the development of a valid and reliable instrument should be considered worthy of dissertation requirements. The usual situation is that an instrument is developed in order to use it'. So the method that was developed by Likert and the standard procedures to construct Likert scales are not a point of criticism for Schibeci, Munby and Gardner.

Aikenhead (1988) does have serious doubts about the use of Likert scales. He used four methods to assess students beliefs about STS topics (STS = Science-Technology-Society), among which was a Likert scale. He discovered that, compared with other methods, Likert-type methods are 'inaccurate'. These 'other' methods are: 'paragraph responses' (small essays based on statements), 'interviews', and 'multiple choice questions' (questions that are drawn up in a way similar to Thurstone's method). However, these three methods are time-consuming and not suitable for large-scale research. Nevertheless his research is an (unspoken) recommendation to use, apart from the usual Likert scales, other methods in attitude research.

A generally accepted methodology in the constructing of attitude scales and of Likert scales in particular is given by Gardner (1975). The choice of methodology is significant because the validity and reliability of a questionnaire depend critically on the principles and techniques used in its construction. Guidelines that Gardner recommends are:

1. the specification should avoid confusion between different theoretical constructs. If more than one construct is to be included in a single instrument, each should be identified and separately scored;
2. there should be elimination of defective items such as those that combine two or more different perceptions;
3. there should be some means of filtering out influences of respondent knowledge (of technology) from attitudes towards it;
4. refinement of the instrument should be directed toward obtaining reasonable internal consistency;
5. instrument stability should be established through a test-retest technique;
6. factor analyses should be used to validate the scales.

We have already indicated that the Guttman scale-model is essentially different from the Likert scale-model. In the practice of attitude research both scale-models often lead to the same conclusions (Swanborn 1982). The Guttman scales and their probabilistic versions, Mokken scales and Rasch scales are appropriate in research with a cognitive type of statements. This means statements representing various amounts of an attribute. The reliability and validity of Guttman scales is ascertained in a way different from that of Likert scales. The model is based on the idea that items, in a fixed order (which often has to be determined first), require monotonously increasing amounts of a mental disposition, in order to pass them succesfully. Strictly speaking, in this original deterministic version, each violation (i.e.: passing a certain item but not passing an easier one) should lead to the rejection of the model. In practice, however, the model is accepted if the proportion of violations is not excessively high; 15-20% (which corresponds to REP[1]= .85, REP= .80) is considered acceptable. In its probabilistic version, developed by R.J. Mokken (1970), there is a legitimate place for violations. Violations are evaluated here with regard to their probability to occur by chance, i.e. under the assumption of independency of the items. The smaller the number of violations, compared with their corresponding probabilities to occur by chance, the more

[1] reproduction coefficient

acceptable the model is (Mokken 1970, Swanborn 1982).

2.2.3 Scaling techniques and the three component-model: possiblities to operationalize 'attitude towards technology'

In section 2.2.1 we defined the concept 'attitude' by means of the three component-model. In section 2.2.2 we discussed current methods to measure attitudes. The logical step to take next is operationalization: with which methods/techniques do we measure the affective, cognitive and behavioural components of the attitude towards technology?
According to Zimbardo et al (1970) the affective component can be measured by means of physiological responses or verbal statements of like and dislike, while the cognitive component should be measured by self-ratings of belief or disbelief or by the amount of knowledge which a person has about some topic. The behavioural component could be measured by direct observations of how the person behaves in specific stimulus situations.

In practice we see that attitudes are mostly measured by means of verbal expressions of the affective component and not of the cognitive or behavioural component. Sometimes the fact that the affective component gives the most important indication is advanced as a reason for this. After all, the affective component indicates the essential principle in terms of which the individual orders the world around him/herself (Bynner 1978).

Depending on the broadness and the complexity of a subject it seems useful to measure not only the affective component but also the cognitive component of the attitude. The attitude object in this study, technology, is so broad and little specific that we cannot confine ourselves to measuring merely the affective component. In order to carry out a more meaningful attitude measurement regarding technology it is necessary to know what concept pupils have of technology (De Vries 1988). De Vries goes on (p. 9) 'It is no use to people to know that a pupil has a positive attitude towards technology if one does not know which concept this pupil has of technology'.

Furthermore it is meaningful to represent the behavioural component in an attitude measure towards technology too. This increases the relevance of the results. We see no reason why this should necessarily be done by means of observation. Attitude statements usually contain examples that refer to behaviour.

2.3 Results of research into attitudes towards science and technology

2.3.1 Research into attitudes towards science

As we have indicated above much research has been done into attitudes towards science and relatively little into attitudes towards technology. To present the results of measurements of attitudes towards science we use meta-analyses of Schibeci (1984), Gardner (1975) and Moore (1984). The most important studies into the attitudes towards technology will be described separately (Angele 1976, Nash et al 1984a, Breakwell et al 1985 and Knulst et al 1988).

The importance accorded to the affective domain has resulted in a very large effort, particularly on the influence of a host of variables on science-related attitudes. A large number of attitude objects have been studied. More objects are directly related to school and are therefore of a rather specific nature. Examples of this are: physics, biology, mathematics, science instruction, science teaching, science issues (energy, pollution) and science teachers. Less attention is given to more abstract objects like 'science and society' and 'science as an institute'. Even the 'scientist' himself/herself is not often chosen as an attitude object (Schibeci 1984). If results of science attitudes studies are summarized one has to bear in mind that it mostly concerns attitudes towards 'school' subjects. This is in contrast to the general concept of technology in this study.

With reference to the relevant variables we distinguish 'predictors' and 'determinants'. By predictors we mean variables that can predict the attitude towards science. By determinants we mean variables that describe the object. We make this distinction because in this research we are first of all interested in determinants and less in predictors. In literature more attention is given to predictors than to determinants.

Schibeci (1984) and Gardner (1975) describe in their meta-analyses which factors correlate with the attitudes towards science. We give a survey of them in table 2.1.

Table 2.1 Survey of predictors and their influence in 'science attitude research'

PREDICTORS	INFLUENCE
-Other educational variables:	weak
1. achievement	weak
2. intelligence	weak
-Personality variables:	strong (limited evidence)
3. anxiety	strong (limited evidence)
4. open-mindedness	strong (limited evidence)
5. self-concept	strong (limited evidence)
-Sex:	strong
6. physics	strong
7. biology	strong
-Structural variables:	moderate, indirect
8. grade level	moderate
9. socio-economic status	moderate, indirect
10.religious background	moderate, indirect
11.cultural background	moderate, indirect
12.geography (urban-rural)	moderate, indirect
-School variables:	strong (limited evidence)
13.class behaviour	strong (limited evidence)
14.classroom climate	strong (limited evidence)
-Curriculum and instructional variables	unclear
15.curriculum material	unclear
16.instructions to school students	unclear
17.instructions to undergraduate students	unclear
18.instructions to student teachers	unclear
19.inservice training	unclear

According to Schibeci the results are disappointing. School and curriculum predictors give few significant correlations. Structural variables appear to have only an indirect influence on the attitude. It appears that student attitudes to science decline with increasing level. Personality predictors seem to be important but little research has been done regarding them. The only thing that can be established with some certainty is that cognitive predictors have only a limited influence on the attitude and that the predictor sex has a great influence.

There are hardly any studies in which various predictors have been used. Therefore little can be said about the relative importance of the predictors. An exeption is Haladyna et al (1983), who checked no less than 142 predictors, but the sample of this study was so small that hardly any conclusions could be drawn. They do however confirm the possible importance of personality and school predictors. The contribution of Haladyna et al is of a theoretical importance. They integrate the possible predictors in a clear model, see figure 2.2. Three groups are distinguished in the predictors of the attitude towards science: 'learning environment', 'teacher' and 'student'. This is the contential component of the model. Haladyna et al also distinguishes a 'focus' component: exogenous or endogenous. Predictors are exogenous when they are 'givens' and cannot be manipulated in the schooling process. Examples of this are: age, sex, structural variables. On the other hand there are endogenous variables which can be manipulated and may produce changes in attitudes. These variables reside within the schooling process.

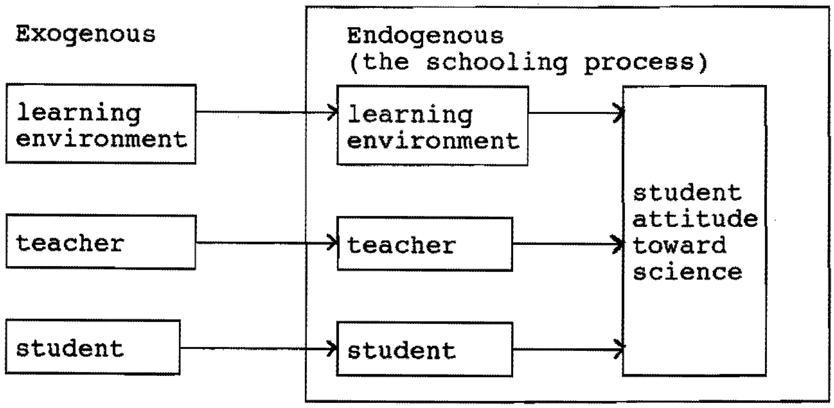

Figure 2.2 Model of attitude predictors, Haladyna et al (1983).

If we recapitulate the research into attitude towards science it becomes evident that:

1. there is criticism on the quality of the attitude research, particularly on the development of the instrument (a.o. Munby 1983a and 1983b);
2. a multitude of science objects is studied, there is little attention for the 'determination' of these objects. This is of course understandable, when the object is a specific one;
3. many different predictors are studied. Of these predictors only for 'sex' the importance has been empirically established. 'Personality' and 'school' seem to be important (Schibeci 1984, Gardner 1975);
4. there are hardly any studies in which the relative influence of more than one predictor is studied (Haladyna et al 1983);
5. a number of obvious predictors are hardly or not at all studied: the teacher's attitude towards technology, the media (Schibeci 1984);
6. from the few longitudinal or cross-sectional studies in which the attitude is studied in time, it becomes evident that the attitude towards science becomes less positive.

This appears to be the case specially for girls (Schibeci 1984);

7. little is known about the duration of a change in attitude as a result of for example a new curriculum (Schibeci 1984).

2.3.2 Results of studies into attitudes towards technology

The number of studies in which attitudes towards technology of young people are explicitly investigated is rather limited. This appears, among other things, from an online literature study of ERIC, PSYCINFO and DISSERTATION ABSTRACTS in 1985 and 1988.

A great number of researchers have studied attitudes towards 'science and technology education'. These investigations are mainly concerned with school subjects - and of these the science subjects - and they are therefore less relevant to the aim of our research.

There are researchers who have studied aspects of the attitude towards technology and/or have been focused on girls or grown-ups only. Here, without aiming at completeness, studies into attitudes towards technology and into aspects of attitudes towards technology are discussed. A survey is given in table 2.2.

Table 2.2 Survey of research into attitudes towards technology

1. Attitudes towards technology among young people:
   - Angele -FRG- (1976),
   - Page and Nash -UK- (1980),
   - Allsop -UK- (1986),
   - Grant and Harding -UK- (1987),
   - Streumer -The Netherlands- (1988).

2. Aspects of attitudes towards technology among young people:

2.1 Interest in technology of young people:
   - Weltner et al -FRG- (1980),
   - Ormerod and Wood -UK- (1983),
   - Smail and Kelly -UK- (1984),
   - Lie and Sjoberg -Norway- (1984),
   - Hoffman and Lehrke -FRG- (1986),
   - Johnson and Murphy -UK- (1986),
   - De Leeuw -The Netherlands- (1986).

2.2 Concept of technology among young people:
   - Moore -UK- (1987a).
   - Cornelissen and Van der Laan -The Netherlands- (1987),
   - Scholtens -The Netherlands- (1988),

3. Attitudes towards aspects of technology among young people:

3.1 Attitudes towards modern technology among young people:
   - Breakwell et al -UK- (1985,1986),
   - Jaufmann et al -FRG- (1986).

3.2 Attitudes towards computers, computers and information theory among young people:
   - Moore -UK- (1984),
   - Crombach et al -The Netherlands- (1986).

3.3 Attitudes and interests towards 'science and technology education':
   - Lehrke -FRG- (1985).

4. Concept of technology among adults:
   - University of Technology Delft -The Netherlands- (1984),
   - Sociaal Cultureel Planbureau (Knulst and Van Beek) -The Netherlands- (1988).

5. Attitudes towards technology among teachers:
   - Van den Bergh and De Vries -The Netherlands- (1986),
   - Rennie -Australia- (1987a),
   - Symington -Australia- (1987).

1. Attitudes towards technology among young people

In the Bundes Republik Deutschland Angele (1976) did a small-scale research into the knowledge of and the attitude towards technology among 500 pupils. In this research technology is regarded as a broad and general construct. The attitude measurement was carried out by means of Likert questionnaires. The attitude of the pupils appears to be moderately positive. The concept that pupils have of technology appears to be highly determined by electric equipment, means of transport and computers. It appears that there is a positive correlation of .34 between an attitude towards technology and knowledge of technology (including experience with and handling of technology). Angele suspects that there is a causal relationship with the variable 'experience with technology'. Furthermore it appears from the research that boys, as opposed to girls, have a more positive attitude, more knowledge and insight and substantially more experience. Girls who have equal technical experiences have an equal attitude towards technology, but less knowledge and insight. Angele explains this last difference not by a difference in intelligence, but by 'ein durch Generationen geprägtes, geschlechtsspezifisches Rollenverhalten bei Mädchen (wie umgekehrt bei Jungen), das die Motivation für kognitive Leistungen im Bereich der Technik negativ beeinflüsst'.

In England Page and Nash (1980) did a large scale attitude research among almost 10.000 14-year-old pupils. The survey arose from 'the obvious need for a systematic survey of pupils' attitudes to technology and industry and the study of some factors influencing those attitudes'. The researchers considered a Likert scale the best method to study attitudes on a large scale. On the basis of interviews with pupils of 13 to 16 years old a Likert instrument with four sub-scales was constructed:

1. statements thought to be representative of an attitude to technology and technologists,
2. statements thought to be representative of an attitude to careers in industry,
3. statements thought to be representative of an attitude to technical training and education on a tertiary level,
4. statements thought to be representative of an attitude to technology as a new school subject.

These four sub-scales are not exhaustive of the possible range of attitudes, but according to the researchers they do contain the most important attitude dimensions of the attitude towards technology. In the construction the procedure of Gardner (see section

2.2.2) was followed. The reliability of the scale has been established by means of the 'internal consistency method'. What this method boils down to is that it is checked whether items with a similar contential meaning also show a similar answering pattern. Cronbach's alpha, a measure that calculates all possible correlations between pairs of items, gives an indication of the internal consistency of a scale. The validity has been established by means of 'criterion variables' such as the choice of science subjects or technology education. The results of the research were:

1. boys have a more positive attitude towards technology than girls,
2. the study of physics, chemistry and Craft-Design-Technology subjects is associated with favourable attitudes towards technology,
3. girls in single-sex schools have a more positive attitude towards technology than girls in mixed schools,
4. there are high percentages of pupils that have a positive attitude towards a technological career but a deficient set of exam subjects for such a career,
5. a relation between attitudes and geographical dispersion of pupils has not been proven.

In continuation of the research by Page and Nash research has been done by Allsop et al (1986) in the framework of the Oxford Education Research Group (OERG) Technology project. In this project it was investigated which factors play a part in the choice of technology as an exam subject. The majority of student felt uninfluenced in their option decision regarding the technology course, but the most common influences cited were parents and career interest. Again significant differences between boys and girls were found: girls are less interested than boys.

Grant and Harding (1987) investigated attitudes towards technology in the framework of the Girls and Technology Education (GATE) project. They criticize the research of Page and Nash and the PATT-research. They think the assumptions (of OERG and PATT) that the 'more favourable' and 'more positive' attitudes of boys are the more desirable ones and by implication that the negative attitudes (of girls) are wrong, are misconceptions. They did a small-scale study among 79 boys and 63 girls from the fourth grade secondary school. According to Grant and Harding girls do not have a more negative attitude towards technology than boys, but girls would think in a more differentiated way about technology than boys, because they consider technology more in all its complexity than boys do. Research by means of Likert scales may lead to the wrong conclusions because the neutral answering categories are more often used by girls than by boys.

Streumer (1988) carried out two curriculum assessment studies: The Technology Entering Behaviour Study and The Technology Assessment Study. The object of the first study was to assess entering behaviour of 1.530 12/13-year-old students with reference to the objectives for the school subject Technology. Three types of tests were used: knowledge, skills and attitudes. The character of the tests were mainly cognitive and not affective. The results of the first study show that the results of the tests can be explained by 1. 'achievement level' (the higher school achievement the higher the scores on the tests) and 2. 'sex' (boys did better than girls). There was no significant correlation between the testscores and 'urbanization' and 'profession of parents'. The object of the second study was to assess the achievement of 1.832 14/15-year-old students with reference to the objectives for the subject Technology. Tests were developed to measure achievement in knowledge, skills and attitudes. The attitude-test was based on the attitude instrument that is discussed in this dissertation. In general the scores on the tests improved after having technology education. Sex was again the most important independent variable to explain testscores. Girls score lower than boys on all the test, independent of whether the subject technology was studied or not. Streumer concludes that the subject technology does not reduce boys' and girls' differences in technical knowledge, skills and attitudes. Having a technical hobby is also an important predictor. The profession of the parents (technical or not) does not influence the scores on the tests.

2. Aspects of attitudes towards technology among young people

2.1 Interests in technology of young people

Little research has been done into interests in technical subjects. Most of the time this was done in the framework of the school subject physics (see Mottier 1988). Weltner (1980) investigated the interests of 11 to 16-year-olds in physical subjects (for example the magnetic field versus the compass or induction versus the generator). Pupils appear to be interested more in technical subjects than in physics itself. This applied to both girls and boys. Girls are more interested in natural phenomena, boys more in electrical equipment. From a subsequent study by Hoffman and Lehrke (1986) it appears that these interests decrease in the course of years, when technology is taught in the framework of the subject physics. From a study by Ormerod and Wood (1983) it also appears that 10-year-old boys and girls have different interests: girls are more interested in 'nature studies' and boys are more interested in 'Space and Tomorrow's World'[2]. From an investigation by Lie and Sjoberg (1984) it becomes evident that pupils of 11 to 13 years old are interested in the atomic bomb and its effect, in the operation of everyday equipment (camera, telephone, radio, television). Girls are more interested in food and health and boys in computers, space travel and car engines. From extensive studies carried out by Smail and Kelly (1984) in the framework of the English GIST-project (GIST=Girls Into Science and Technology) it becomes evident that girls' interests mostly lie in the human body (biological subjects) and boys' interests mostly in physically mechanical subjects. Among 11-year-old pupils these differences in 'attitude' diverge more than the cognitive differences. Johnson and Murphy (1986) give a survey of British attitude researches towards physics in which the interest in technical subjects was investigated as well. Girls appear to have less experience in the handling of technical subjects and they are less interested.

Finally, in the framework of the MENT-project De Leeuw (1986) investigated the interests in technology (equipment), physics and society, the own body and natural phenomena (10 subjects each). The study was done among 200 pupils of 13 to 15 years old. The 10 subjects chosen by the largest number of pupils are established. From this study it appears that boys are more interested in technology and equipment, girls more in natural phenomena. With reference to physics and society and their own body the differences between boys and girls are small (De Leeuw 1986).

The conclusion of this group of studies is as follows (see also De Leeuw 1986):

1. girls are interested in:
   - phenomena in their living environment, natural phenomena in particular, aesthetical aspects play an important part in this;
   - the influence of physics/technology on society, aesthetical aspects play an important part in this;
2. boys are more than girls interested in:
   - technology, machines and electricity.

[2] name of TV-program

2.2 Concept of technology among young people

Hardly any research has been done into the concept that young people have of technology.

Moore (1987a, 1988b) has investigated by means of drawings, and later on by means of a 'Technology Picture Questionnaire (TPQ)' what concepts 10 to 12-year-old pupils have of technology. Drawings mainly give information on associations with technology. From the results of the study with the drawings and the TPQ it appears that being engaged in technology is associated with 'inventing things', 'improving things', 'doing something with electricity'. Certain technical activities are not considered to be technical when they are not difficult or not important (e.g. the repairing of the leg of a chair, the developing of a tasty sauce). Electricity and computers are very much associated with technology.

Cornelissen and Van der Laan (1988) investigated to what extent 31 boys and 31 girls of about 9 years old already have a concept of technology and to what extent they themselves can indicate their interest in technology. The study was done in the form of interviews. In spite of the fact that at primary schools no literature on technology is available the primary school children that took part in the research have a clear concept of technology. The children indicate a total number of 362 activities they would like to know more about. These activities were divided as follows:

computer	91 (66 boys + 25 girls)
tv/video	59 (32 boys + 27 girls)
electricity	46 (26 boys + 20 girls)
engines	45 (29 boys + 16 girls)
sound equipment	30 (13 boys + 17 girls)
space travel	29 (14 boys + 15 girls)
technical lego	17 (16 boys + 1 girl)
telephone	9 (5 boys + 4 girls)

The interest in technical things is great. Boys are twice as good as girls in indicating their interests.

Scholtens (1988) studied the concepts girls have of technical studies at university. The sample consisted of 335 girls who visited the information day of the University of Technology in Twente. These girls regard technical studies at university as long and difficult studies with which one can easily build a career and achieve well. These girls have doubts about the possibilities to work with people or to do something for another human being. They also have doubts about the personal benefit of technical study. The general judgement of a technical study is rather neutral. On technical physics they think most negatively. They think it is not a very social study with an indistinct job-prospect.

3. Attitudes towards aspects of technology among young people

3.1 Attitudes towards modern technology among young people

Among 534 first year students Breakwell et al (1986) investigated whether there is a relationship between economic and/or political values and attitudes towards modern technology. Thus, conservatism was supposed to be related to positive attitudes. The construct 'attitude towards technology' was investigated as well. To start with the last part attitudes towards technology appear to be differentiated and weak. The factor analyses revealed five very weakly correlated dimensions: the appraisal of the general benefits of new technology, the acceptance of its inevitable development, the desire for a technical or industrial training, the concern with so-called green issues, and the response to video games. From the study it becomes evident that attitudes towards technology are an integral part of a wider technological framework. According to this study conservatism is related to positive attitudes towards technology. With the exception of 'green issues' there are strong gender differences.

In the framework of INIFES (Internationales Institut für Empirische Sozialforschung) Jaufman et al (1986) investigated the attitude of youngsters (15 to 18 years old) towards modern technological developments. From the research it appears that there is no fear of technological developments. Girls, however, have a far less positive judgement on modern technological developments than boys have.

3.2 Attitudes towards computers and information theory of young people

Moore (1984) investigated the attitude towards computers and robots. First he developed a Likert questionnaire for this purpose. The attitude is split up in dimensions: School, Leisure, Career, Employment, Social Aspects, Threat of computers, Future, Lifestyle of people who work with computers. Important explaining variables for the atittude towards computers are in this study: 'gender' and 'experience with computers at home'. Moore also investigated whether or not classroom activities of teachers of information theory are of influence on the attitude towards computers. This turns out not to be the case here (Moore 1988a). Moore points out that the absence of a strong classroom effect (the effect of teacher behaviour) on pupils' attitudes may be linked to the low level of teacher qualifications and training.

Crombach et al (1986) developed a scale for measuring attitudes towards computers.

The Likert-type scale consists of five dimensions: Enjoyment, Fear, Self-Concept, Relevance, Sex-typing. In the empirical study among 1.200 pupils of 13/14 years old gender differences were found (boys scored more postive). According to Crombach et al the affective component consists of the dimensions Enjoyment and Fear. The cognitive component consists of the dimensions Self-concept and Relevance.

3.3 Attitudes and interests towards 'science and technology education'

During the IPN/UNESCO conference in Kiel in 1984 a good survey was given of the results on interests in technology and science education (Lehrke et al 1985). First of all it strikes the attention that students tend to lose interest in science over time. For many students in many countries, science is a subject which is initially liked but which comes to be disliked and discontinued. Secondly males are more interested in science than females, males are more likely to be interested in physics and technology, females in biology and social science subjects. Females study science for intrinsic interest rather than for career purposes. Females tend to perceive science as more difficult. Males are more likely to hold negative stereotypes about females who study science. Thirdly it appears that there is no strong relationship between ability and interest. Fourthly the teacher may have a strong influence on students.

During the conference in 1984 science and technology were not separated and together they fell under one heading (science), which was quite common. At the moment more attention is paid to technology education (see for example the 4th International IOSTE Symposium on World Trends in Science and Technology Education in 1987 in Kiel, where technology education was a separate theme).

4. Concept of technology among adults

In 1984 the University of Technology Delft (Instituut voor Psychologisch Marktonderzoek) investigated the opinion of the general public on technology. The result of this research was that the group that took part in the investigation obviously had little knowledge of technical developments. The concept of technlogy is one-sided, viz. computer and communication technology. They hardly have a notion of the importance of technology.

In 1988 a study was published by the Sociaal Cultureel Planbureau (Knulst and Van Beek 1988) on the knowledge of and the attitude towards the following technological applications of the people of the Netherlands (over age 16): nuclear energy, automation, environmental technology, computer technology, military technology, DNA-technology, communication technology and test-tube babies. The research was carried out among 2.037 people.

The results are:

1. a majority (62%) counts himself/herself among the frequent users of information columns in the media on technological innovations. Yet it appears that only a small minority of the Dutch people belong to the insiders, as far as technology is concerned;
2. the attitude towards technology is moderately positive. But where various fields of application are concerned people tend to have different attitudes. They think positively about environmental technology, communication and computer technology, and automation. The attitude is negative with reference to DNA-technology, test-tube babies and nuclear energy, military technology is considered to be the most negative of all;
3. three theories about the forming of attitudes have been tested. First of all the relationship with ideologies has been investigated (cf. Breakwell 1986). Variables are the left-right spectrum, materialists versus post-materialists and thirdly technocracy versus anti-technocracy. The results confirm that an ideology can be a fair explanation of attitudes towards technology (and the applications in particular). Conservatism, materialism and technocracy often go together with a favourable judgement of technology.

   A second theory, the 'familiarity theory', assumes that the more familiar one is with technology, the more positive one's attitude towards technology will be. In this research the familiarity theory remains an explanation for attitudes (unknown, unloved).

   A third theory that was tested is the 'diffusion theory'. Acceptation of technological innovations should follow a predictable pattern, in which young and educated people should come first. According to this study this theory is untenable.

5. Attitudes towards technology among teachers

Rennie (1987a) investigated the attitude towards technology among 94 science teachers and she found that the attitude was fairly positive. It appeared moreover that these

teachers have a limited concept of technology, which may be interpreted as a view that technology is dependent upon science. Therefore they have less attention for the historical aspects and societal influences on science and technology. An example of this is the fact that physics teachers often regard technology as applied physics.
Van den Bergh and De Vries (1986) investigated the attitude towards technology of 295 teachers of various subjects by means of a Likert attitude questionnaire. The results are similar to those of Rennie. These teachers too display a fairly positive attitude towards technology. According to this research the teachers (and the teachers of physics in particular) have a good concept of technology.
Symington (1987) investigated what concept of technology 70 primary school teachers have. To investigate the concept of technology a list of subjects from the technology domain was presented to the teachers. The teachers had to indicate the subjects that were related to technology. Only one third of the teachers associates all items with technology. According to Symington most technology teachers have a popular view of technology: technology as a 'world of wonders'.

We can summarize the research into the attitudes towards technology as follows:

1. So far hardly any research has been done into attitudes towards technology, taken as a general concept. From the few results it appears that pupils have a (moderately) positive attitude towards technology. The concept of technology turns out to be poor. Gender seems to be the most important predictor for differences in attitude. Other important predictors are: ideologies and familiarity with technology.
2. If technology is taken as a school subject it appears that boys like technology more than girls, and further that the interest of both boys and girls decreases in the course of school time.
3. From research that was done among adults (and teachers) it becomes evident that most of them have a fairly positive attitude towards technology. The concept of technology on the other hand is rather limited.

CHAPTER 3

INSTRUMENT DEVELOPMENT

'Although I am a firm believer in the usefulness of conventional measuring instruments, I also accept their limitations. Because they are designed for use with large groups, they may fail to tell us much about the idiosyncratic patterns of interest that individuals may display. Because they call for responses to verbal statements, students can 'fake' their replies to make them socially acceptable' (Gardner 1985, p. 12).

Introduction

In this chapter the development of the attitude instrument is described. The instrument was used in the Dutch research into attitudes towards technology of pupils of 10 to 18 years old and in the international PATT-project. The development of this instrument was started from a pilot questionnaire of De Vries, consisting of 78 items, with which he investigated the attitude towards technology of pupils from 2 avo-vwo.

The questions we wanted to answer in the development of the questionnaire were:

1. is it possible to develop attitude scales, based on De Vries' questionnaire, that measure the attitude towards technology for 10 to 12-year-olds (basisschool), 13 to 15-year-olds (2 lbo and 2 avo-vwo) and 16 to 18-year-olds (1 mbo and 4 avo-vwo)? (De Klerk Wolters and De Vries 1986);
2. is it possible to develop one instrument on the basis of the 78-item questionnaire and to measure with this instrument the attitude of 13-year-old pupils towards technology in several countries? If not, can we come to 'one' basic instrument with (inter)national adjustments? (Raat and De Vries 1986).

Both in the Netherlands and in an international context people have been working on an instrument to measure the attitude towards technology with.

Here we discuss how the instrument was developed in the Netherlands but we shall not discuss in detail the development of an international instrument. We only state that both questions have been answered affirmatively. In the development of an instrument for pupils of 10 to 18 years old we used the findings of the PATT-project. An important result of the first PATT-conference in 1986 was the decision to measure the affective-behavioural components of the attitude towards technology and the cognitive component of the attitude towards technology seperately. This was taken over in the Dutch research.

In section 3.1 we describe the development of the scales that measure the affective-behavioural components, or AB-scales and in section 3.2 the development of scales that measure the cognitive component, the C-scales. The conclusion, the reliability and validity of the scales, is written in section 3.3.

In outline we followed the method of Gardner (1975) in the instrument development. This means that explicit attention is given to scale construction, formulation of items, instrument consistency and stability (see also section 2.2.2).

To come to a logical description of the development of the attitude instrument the following three stages are distinguised:

1. the design stage,
2. the test stage,
3. the execution stage.

The 'design stage' is the stage in which the instrument is made ready for testing on the basis of theoretical and empirical data. The 'test stage' is a stage in which it is checked by means of statistical techniques whether the instrument is reliable and valid and, if necessary, how it should be adjusted. The 'design' and the 'test stage' together form the pilot stage.

The 'execution stage' is the stage in which the instrument is actually used to carry out the measurements for which it was designed. In this stage certain features of the instrument come up that have to be taken into account in the processing of the results. Refinements will then be made afterwards.

3.1 The development of the Affective/Behavioural attitude scales

3.1.1 Design stage

In the design of an instrument for pupils of 10 to 18 years old we started from the items in De Vries' questionnaire.

The most important reasons for doing so were:

1. the results of the study by De Vries among 2.631 pupils in 2 avo-vwo are valid and reliable (Raat and De Vries 1985);
2. the questionnaire contains an extensive item pool for a number of relevant aspects of technology;
3. the possibility to compare results.

De Vries did an explorative study among 13 to 15-year-olds. He did this by means of interviews and written questions about technology. Using statements made by pupils in the interviews and in the written questions, he distinguished eight aspects of technology (see table 3.1). These aspect are the 'theoretical constructs' of his questionnaire.

Table 3.1 Aspects in the attitude towards technology among 13 to 15-year-olds

1. broadness of the concept of technology,
2. interest in technology,
3. importance of technology,
4. difficulty of technology,
5. sex-role pattern in technology,
6. technical professions,
7. good and bad consequences of technology,
8. creativity in technology.

For each of these aspects Likert scales were formulated. Pupils could answer on a 5-point-scale: 'totally agree', 'agree', 'don't agree, don't disagree', 'disagree', 'totally disagree'. He subsequently verified by means of factor analysis to what extent these aspects measure different dimensions in the attitude towards technology. A number of aspects appeared to be built up of more factors. The first aspect 'broadness' is divided into two factors: 'diversity of technology' and 'historical development of technology'. The aspect 'interest' appears to consist of more than one factor too: 'general interest', 'acquaintance with technology', 'technology as a hobby' and 'technology at school'.

In the design- and test stage a similar procedure was followed, viz. a combination of explorative research with a (testing) factor analysis. We did explorative research among 10 to 12-year-olds and 16 to 18-year-olds to find aspects in the attitude towards technology. We subsequently operationalized these aspects in Likert-items. Afterwards we tested these items in a pilot study. The goal of the instrument development was the constructing of scales that measure dimensions of the attitude towards technology. In figure 3.1 we summarize this procedure for developing an instrument.

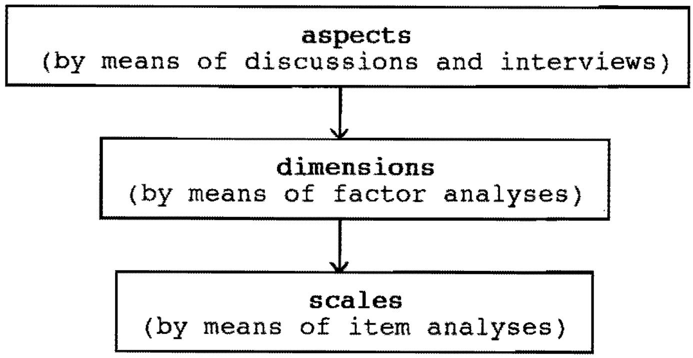

Figure 3.1 Outline of instrument development

Aspects of technology among 10 to 13-year-olds

With pupils of groep 7-8 we did not try to find new aspects of technology, but we investigated which of the aspects that De Vries found among 13 to 15-year-olds, are relevant to 10 to 12-year-olds. We did this by discussing the items of De Vries' questionnaire with pupils of groep 7. First this was done in class and afterwards with groups of intellectually 'good' and 'weak' pupils. From these discussions it becomes evident that a number of items (and also aspects) have a degree of difficulty that is too high. This might lead to so-called 'expert errors'. These are errors in measurement caused by asking questions that assume a greater extent of expertise than the respondent in fact masters (Segers 1983). It concerns mostly items that refer to the aspects 'generality of the concept of technology' and 'creativity'. On the basis of the discussions with the pupils a number of measures were taken with reference to De Vries' questionnaire that reduce the possibility of 'expert errors':

1. a separate answering category 'don't know' was added. This category had to be functional for answers about which pupils cannot make a statement for cognitive reasons. It was prevented thereby that the answering category 'don't agree, don't disagree' (the middle of the answering scale) would be used as an escape category, whereas this answer takes a neutral position on the scale (Swanborn 1982);
2. several items of De Vries' questionnaire have been removed because their level of

abstraction was too high (C19, J6, K1)[1] and some items were added that are equal in content to those items that might cause difficulties (C8, C9, C11, D8, J4, J5);

3. after answering the pilot questionnaire pupils had to indicate the meaning of possible 'difficult words' such as economy, developing countries, designing and creativity.

Aspects of technology among 16 to 18-year-olds

To find out whether the attitude towards technology among older pupils is determined by aspects other than the theoretical aspects and dimensions from De Vries' research, we administered an open-ended questionnaire to a group of youngsters starting from 15/16 years old (see table 3.2). The pupils from mavo and gymnasium classes have physics as an exam subject. The majority of the partaking group consisted of boys.

Table 3.2 Respondents open-ended questionnaire about technology

	(n) girls	(n) boys
4 mavo	10	14
4 gymnasium	8	12
1 mts	1	12
1 physics (univ. of techn.)	-	9
Total	19	47

The students were asked to give their opinion on the following subjects in essay-form:

- the meaning of the word 'technology',
- the role for girls in technology,
- the influence of technology on our society,
- the difference between physics and technology,
- the interest in technology,
- the role of creativity in technology.

We assumed that these subjects would be representative of possible attitude dimensions in this age group. To find out whether there are any other aspects at the end of the questionnaire it was asked whether the pupils considered the presented subjects relevant to technology and whether there are any other important (subjects) aspects of technology that should be mentioned. The results are summarised below.

[1] see Appendix 2

(1) Aspects of technology

Naturally the last question was the criterion for formulating new aspects in the attitude towards technology or not. In general the subjects that came up were considered to be relevant to technology. Only one or two pupils mentioned other subjects, mostly an application he/she considered important (space travel, information technology). These students' answers did not lead to the assumption that new aspects in the attitude towards technology would have to be formulated. Some adjustments were necessary though. Items were added on the aspects 'physics and technology' (K2, K3) and on 'education and career in technology' (F7, G6, G7, G8), because these were not sufficiently represented in the original questionnaire.

(2) opinions on technology

For most students technology means 'making something' and 'repairing something'. Making something is thought to be creative, some pupils from the gymnasium even think that technology is equivalent to creativity.

Pupils are distinctly positive about girls in technology, students of technology remarkably often mention 'electronics' as being very suitable for girls.

For the students the motivation for going to a technical school lies more in the field of interest than in the field of a favourable career perspective. The same applies to the choice of physics as an exam subject. Pupils choose physics because they like it.

Both students and pupils realize that physics and technology are related, but the mutual relationship between physics and technology is hardly distinguished by students, they see it as a difference between theory and practice.

Students consider technology to be important, technology is associated with progress and the making of improvements. Particularly in the answers of students at the (Eindhoven) university of technology the positive answers are predominant ('technology is at the service of mankind and is therefore always positive'). The notion that technology in itself is 'nothing' (so neither positive nor negative) comes forward with several pupils from the gymnasium.

On the basis of the empirical data from research among 13 to 15-year-olds by De Vries and on the basis of preliminary research among 10 to 12-year-olds and 16 to 18-year-olds eleven aspects are distinguished in the attitude towards technology of 10 to 18-year-olds. In table 3.3 a survey of the aspects of technology is given.

Table 3.3 Aspects in the attitude towards technology among 10 to 18-year-olds

```
 1. Interest in technology (15 items)
 2. Role pattern in technology (11 items)
 3. Consequences and importance of technology (19 items)
 4. Creativity and technology (10 items)
 5. Difficulty of technology (8 items)
 6. Technical professions and career (7 items)
 7. School and technology (8 items)
 8. Diversity and technology (11 items)
 9. Acquaintance with technology (9 items)
10. Developing countries and technology (6 items)
11. Physics and technology (3 items)
```

A survey of the items belonging to these aspects and the way they have been used in the pilot studies, is presented in Appendix 2. From the survey it becomes evident that all aspects and items for the age group from 10 to 18 are relevant. Three different questionnaires have been used in the pilot study:

- a questionnaire for groep 7-8 basisschool and 2 lbo,
- a questionnaire for 4 avo-vwo,
- a questionnaire for first-year students of mts/hts/tu,

(De Klerk Wolters and De Vries 1986).

In the formulation of new items we took into account the guidelines for the construction of Likert-items (see a.o. Swanborn 1982, Erickson et al 1988). This means, among other things, no cognitive or factual items, short and simple formulation of the items, both positive and negative formulation of items (no double negations).

3.1.2 Testing aspects of technology

In the test stage the aspects in the attitude towards technology are validated by means of factor analysis. We call this scale identification. Subsequently the attitude scales are determined by means of item analysis. In the test stage participating school types were from the target groups of the research i.e. groep 7-8 basisschool, 2 lbo, 4 avo-vwo and 1 mts/hts/tu. Altogether 997 pupils from 22 school participated. In the table below (3.4) the number of boys and girls per type of school is presented. Apart from lbo the school types show a 'normal' division of the number of boys and girls. (The national ration of boys and girls in lbo is 3:2).

Table 3.4 Sample pilot study

school type	boys	girls	total
1. basisschool	97	126	223
2. 2 lbo	328	52	380
3. 4 avo-vwo	96	75	171
4. 1 mts/hts/tu	197	26	223
total	718	279	997

Scale identification

A widely used method to identify scales is factor analysis (a.o. Bohrnstedt 1977, Swanborn 1985). There is clear scale identification if:

1. a group of items that belong to one factor (with factor loadings > .30) can be named (interpreted) well and show face validity with an aspect;
2. such a factor gives an essential contribution to the total variance of the entire questionnaire.

From the point of view of comparability it is important that common scales also consist of common items.

Factor analyses have been carried out by means of SPSS(6-9). In such analyses factorization takes place on the basis of common variance and the unique part is left out. This gives information on the common variance of a theoretically known number of dimensions (aspects). In the chosen factor analysis it is not important for (one) factor(s) to include as much variance as possible (Principle Component Analyses), but to show the theoretical directions of the variance. This is possible when the factors are rotated (Goddard 1976).

The results of the factor analyses present a fairly clear picture. In table 3.5 we indicate the dimensions that have been identified. The percentages of explained variance refer to orthonogal factor analysis with a varimax-rotation. A varimax-rotation attempts to minimize the number of variables that have high loadings on a factor. This should enhance the interpretability of the factors. The maximum number of factors was restricted to the number of aspects in each questionnaire.

We expected the oblique rotations to give a somewhat better idea of the attitude dimensions, because some dimensions are theoretically related (for example: interest in technology and consequences of technology). However, the oblique factor solutions resulted in the same grouping of variables as did the orhtogonal rotation and gave practically identical percentages of explained variance to the orthogonal ones.

Table 3.5 Potential attitude dimensions per type of school (based on varimax factor rotations)

potential dimension	school	% of explained variance
(1) interest in technology	basisschool	27
	2 lbo	29
	4 avo-vwo	30
	1 mts/hts/tu	24
(2) role pattern in technology	basisschool	12
	2 lbo	13
	4 avo-vwo	15
	1 mts/hts/tu	10
(3) consequences of technology	basisschool	10
	2 lbo	8
	4 avo-vwo	12
	1 mts/hts/tu	10
(4) difficulty of technology	basisschool	8
	2 lbo	10
	4 avo-vwo	5
(5) practical knowledge of technology	basisschool	5
	2 lbo	10
	4 avo-vwo	8
	1 mts/hts/tu	8
(6) creativity and technology	4 avo-vwo	5
(7) diversity of technology	1 mts/hts/tu	15

The results indicate that there are four common potential attitude dimensions in order of importance: interest, role pattern, consequences and difficulty. Compared with the aspects in table 3.2 a number of changes can be indicated:

1. several aspects appear to be combined: 'profession', 'school', and 'acquaintance' are combined with 'interest';
2. several aspects are hardly or not at all validated: 'diversity' and 'creativity';
3. there is a new dimension 'practical knowledge', but there is a strong overlap with the first factor 'interest'.

That the aspects 'diversity' and 'creativity' are not validated may be due to the fact that these aspects are measuring more 'knowledge' than 'affection'. Particularly the items of 'diversity' are more 'representing' than 'indicating' in nature. The potential dimension 'practical knowledge' is, as far as interest is not measured, not an attitude scale either.
The fact that some aspects of technology, with a more cognitive nature, were not validated, was an important reason to decide to measure the affective and cognitve components of the attitude towards technology seperately.
Here we will deal with the construction of Affective/Behavioural scales (AB-scales). In section 3.2.2 with the construction of the Cognitive-scales (C-scales).

Scale construction

To find out what items could best fit into a scale, we looked at the following statistical criteria:

1. factor loadings: load as high as possible on one factor (preferably higher than .30), and low loads on the other factors;
2. Item-total-correlations or R(it)-values: no low (preferably greater .20) or negative correlation with the total scale score;
3. item sensitivity: a variance higher than 1;
4. difficulty: no more than 30% 'don't know' answers;
5. scale homogeneity: Cronbach's alpha (α) greater than .60;
6. scale sensitivity: indicating predicted differences between subgroups.

Because comparability was an important requirement in this research, we also paid attention to the fact that all school types met these (statistical) requirements as far as possible. The item selection was also attuned to the way scale construction took place in an international context (PATT). These results mainly refer to the formulating and selecting of items with 'content validity' with AB-scales.

(1) Factor loadings

In table 3.6 we give the highest loadings on the four factors. The item numbers refer to the numbers in Appendix 2.
The items of the 'interest factor' appear to be rather homogeneous; they refer to 'technology in spare time', 'technology at school', and as 'profession', and finally to 'acquaintance with technology'. The second common factor is 'role pattern'. The items

display the aptitude of boys and girls for a technical training and profession. A third factor is 'consequences of technology'. This factor indicates the importance and the consequences of technology. In spite of a large item pool the factor 'consequences' appears to be rather weak as a potential attitude dimension. What strikes the attention is that this weakness applies to lbo and basisschool. The fourth common factor is 'difficulty'. This factor mentions the difficulty and accessibility of technology as a training and profession.

(2) R(it)-values

Several items have extremely low (or even negative) R(it)-values and they are therefore unreliable. They will not be used in the final scales. The items concerned are: B6, C3, C15 and D1.

(3) Sensitivity of the items

We investigated which items have a low variance and whether this is acceptable. Normally items with a low variance are of little value in an attitude scale (Swanborn 1982). For reasons related to scale content it may still be meaningful to retain an item (Moore 1984). Only 1 item appears to have a variance that is too low for all school types (C13: *Technology is very important in life*). There are 7 items of which the variance is too low for the older pupils (4 avo-vwo and 1 mts/hts/tu) (see table 3.7).

Table 3.6 Loadings on the factors 'interest', 'role pattern', 'consequences' and 'difficulty'

factor	basis school (n=223)	2 lbo (n=380)	2 avo-vwo* (n=2.631)	4 avo-vwo (n=171)	techn. schools (n=223)
interest					
A1	.24	.41	.47	.52	.45
A6	.45	.66	.70	.73	.50
A7	.60	.42	.63	.72	.55
A8	.60	.53	.74	.53	.50
A10	.78	.66	.79	.80	.61
A11	.63	.51	.74	.77	.47
A13/16	.30	.20	.35	.60	.30
A14	.56	.45	.70	.80	.64
A15	.52	.50	.60	.74	.20
I7	.32	.30	.31	.43	.15
I8	.43	.40	.46	.54	.27
F1	.61	.32	.62	.69	
G1	.62	.68	.73	.78	
G4	.40	.45	.46	.43	
role pattern					
B1	.40	.57	.56	.32	.65
B2	.38	.60	.47	.42	.60
B3	.60	.66	.70	.46	.72
B4	.37	.38	.43	.52	.13
B5	.59	.71	.64	.67	.30
B6	.22	.10	.30	.03	.39
B7	.57	.50	.57	.18	.61
B8	.54	.52	.64	.67	.10
consequences					
C1	.37	.20	.29	.51	.52
C3	.22	.14	.54	.65	.55
C4	.12	.10	.36	.19	.12
C5	.20	.13	.35	.23	.25
C7	.26	.43	.26	.47	.30
C13	.25	.42	.51	.63	.41
C15	.20	.01	.10	.01	.51
C17	.50	.43	.50	.73	.56
difficulty					
D1	.30	.45	.20	.24	
D2	.48	.32	.38	.30	
D5	.36	.30	.47	.50	
D6	.45	.36	.43	.58	
D8	.22	.42	.20	.24	

* From Raat and De Vries (1985).

Table 3.7 Items with a variance < 1

item	basis school	2 lbo	4 avo-vwo	technical schools
C13	.86	.77	.50	.49
C1	*	.71	.81	.74
C15	*	*	.65	.83
B1	*	*	.69	.94
B2	.72	*	*	*
A1	*	*	*	.86
E6	*	*	.92	.90
E8	*	.95	*	*
I9	*	*	.96	.64

* item variance > 1

(4) Degree of difficulty of the items

With pupils from 2 lbo, and even more at basisschool, we expected difficulties with abstract words or formulations. In the test stage these difficulties could be removed by using the extra answering category 'don't know'. It became evident that there indeed were some difficulties. Both pupils from lbo and from basisschool appeared to have difficulties (as was expected) with items containing the following words: 'creative', 'western countries', 'developing countries', 'economy', 'designing'. Parallel items with a simpler formulation appear to be too difficult as well. Items of a cognitive nature (e.g. *'Making a dress is technology'*) also yield high percentages on the 'don't know' answering category (> 30%).

The word 'technology' appears to be difficult for the youngest group of pupils (groep 7 and 8 basisschool) and this makes the danger of 'socially desired answers' very real. By technology many pupils mean 'the way to do something well' like for example football-technique. It appears that the questionnaire (80 items) is not only too difficult, but also too long. On the whole it takes pupils from basisschool one hour to fill out the questionnaire. Girls have far greater difficulties with the questionnaire than boys.

The aforementioned difficulties do not occur with the items from four common attitude dimensions. Only the concept 'technology' remains difficult. Therefore it is desirable to give a short introduction to 10-year-olds.

(5) Homogeneity

The central measure to determine the homogeneity of a (potential) scale is Cronbach's alpha. In the table below (3.8) the alpha-values of the scales that remain after item-selection on the basis of the aforementioned considerations are presented. Most values are over .60, which means that we can conclude that the potential scales are sufficiently homogeneous.

Table 3.8 Cronbach's alpha for potential scales

scale	basis school (n=223)	2 lbo (n=380)	4 avo-vwo (n=171)	techn. school (223)	number of items
interest	.84	.82	.92	.81	13
role pattern	.70	.76	.70	.76	7
consequences	.50	.50	.67	.70	6
difficulty	.60	.64	.60		7

(6) Sensitivity of the scales

Is it possible for a scale to measure assumed differences between groups of pupils? If expected differences in attitude between groups of which we know the behaviour are not found, a scale will be of little value (Moore 1984). We assumed that boys have a more positive attitude towards technology than girls, and we also assumed that pupils from technical schools score more positively than pupils from secondary general schools. The results of t-tests confirm this assumption. As an illustration we give the differences between boys and girls from 4 avo-vwo in table 3.9 and in table 3.10 the differences between pupils from technical schools and those from 4 avo-vwo. All differences shown are significant in a two-sided test (with $p < .05$). The possible scale scores vary between 1.0 and 5.0, in which 1.0 is the most positive and 5.0 is the most negative score. The empirical scale score is realized by adding up the pupils' scores on the scale items and then divide it by the number of scale items and the number of pupils. For the items that are formulated negatively the scale scores are reversed.

$$x = \frac{\sum_{1}^{n} \sum_{1}^{k} x_{ij}}{n.k}$$

(x = scale score, x_{ij} = score of pupil i on item j, n = number of pupils, k = number of items in a scale)

Table 3.9 Mean scores and standard deviations of boys and girls from 4 avo-vwo

scale	boys (n=96)		girls (n=75)	
	x	sd	x	sd
interest	2.4	.6	3.3 *	.7
role pattern	2.1	.4	1.7 *	.4
consequences	2.2	.4	2.4 *	.3
difficulty	2.1	.4	2.5 *	.4

* $p < .05$

Table 3.10 Mean scores and standard deviations of pupils from technical schools and from 4 avo-vwo

scale	technical schools (n=223)		4 avo-vwo (n=171)	
	x	sd	x	sd
interest	2.2	.4	2.8 *	.6
sex	2.3	.4	1.9 *	.4
consequences	2.0	.4	2.3 *	.4

* $p < .05$

Final scales

It appeared to be possible to identify four common attitude dimensions for pupils from 10 to 18 years old. These scales measure the affective and behavioural components of the attitude towards technology and not the cognitive component of the attitude towards technology.

We selected a number of suitable items for scales. For the sake of uniformity items have been added to all potential scales up to a minimum of 10 items per scale.

The potential scale 'interest' is rather heterogeneous with respect to behavioural aspects (leisure, school, career). We decided to confine the interest scale to technology as a leisure activity and to add the separate scales 'school' and 'career'. These scales are not found empirically, but were added on the basis of considerations regarding scale content. In table 3.11 we give a short description of each scale for the sake of 'content validity'. During the PATT-conferences the newly formulated items have been tested by experts in the field of technology education for their content validity with the scale description.

Table 3.11 Description of AB-scales

scale	description	example item
INTEREST (10 items)	The extent to which pupils and/or students would like to be involved in technically oriented activities outside school	If there was a hobby club about technology I would certainly join it
ROLE PATTERN (10 items)	The extent to which girls and boys are suited for technology as training and profession	A girl can very well have a technical job
CONSEQUENCES (13 items)	The economic, social and political effects of technology	Technology will be good for the future of this country
DIFFICULTY (10 items)	The difficulty and accessibility of technology as a school subject, the way it is experienced by pupils	Technology is only for bright people
SCHOOL (10 items)	The position of technology in the school curriculum	Technology lessons are important
CAREER (10 items)	The pupils' views on a career in technology	I would enjoy a job in technology later

3.1.3 Execution stage

In the execution stage the AB-scales are used with the aim to describe the affective and behavioural components of the attitude towards technology. In table 3.12 a survey is given of the items and scales that have been used in the attitude research. After each item it is mentioned in which school type it was used. 24 Of the 78 original items in De Vries' questionnaire remained, these are mentioned under (3). Only 17 items offer a possibility to compare the attitude towards technology of all pupils from 10 to 18 years old. This can be done for the scales INTEREST, ROLE PATTERN, CONSEQUENCES and DIFFICULTY and the sum scale AFFECT.

Table 3.12 Survey of the AB-scales with their items: (1)=basisschool, (2)=2 lbo, (3)=2 avo-vwo, (4)=4 avo-vwo, (5)=1 mbo

AB-scale		school
INTEREST		
I1	I am not interested in technology	(1)(2)(3)(4)(5)
I2	I like to read technological magazines	(1)(2)(3)(4)(5)
I3	If there was a hobby club about technology, I would certainly join it	(1)(2)(3)(4)(5)
I4	There should be less TV- and radio-programmes about technology	(1)(2)(3)(4)(5)
I5	When something about technology is discovered I want to know more about it	(2)(3)(4)(5)
I6	I enjoy repairing things at home myself	(1)(2)(3)(4)(5)
I7	I would like to know more about computers	(2) (4)(5)
I8	I think visiting a factory is boring	(2) (4)(5)
I9	I think machines are dull	(2) (4)(5)
I10	A technical hobby is boring	(2) (4)(5)
ROLE PATTERN		
R1	A girl can very well have a technical job	(1)(2)(3)(4)(5)
R2	Boys are able to do practical things better than girls	(1)(2)(3)(4)(5)
R3	A girl should not become a car mechanic	(1)(2)(3)(4)(5)
R4	Boys know more about technology than girls do	(1)(2)(3)(4)(5)
R5	Girls prefer not to go to a technical school	(2)(3)(4)(5)
R6	Girls think technology is boring	(2)(3)(4)(5)
R7	Girls are well able to operate a computer	(4)(5)
R8	Boys are more capable of doing technical things than girls	(2) (4)(5)
R9	More girls should work in technology	(2) (4)(5)
R10	Technology is as difficult for girls as it is for boys	(3)
CONSEQUENCES		
C1	Technology will be good for the future of this country	(2) (4)(5)
C2	I think technology is a threat to modern society	(4)(5)
C3	Technology is very important in life	(1)(2)(3)(4)(5)
C4	Technology makes everything work better	(1)(2)(3)(4)(5)
C5	Everyone needs technology	(1)(2)(3)(4)(5)
C6	I think computers are helping to make the world a better place	(1) (4)(5)
C7	Technology has brought more good things than bad	(1)(2)(3)(4)(5)
C8	The world would be a better place without technology	(1)(2)(3)(4)(5)
C9	Technology makes a country less prosperous	(2) (4)(5)
C10	Because technology causes pollution we should make less use of it	(2) (4)(5)
C11	Technology causes large unemployment	(4)(5)
C12	Technology is the subject of the future	(2)(3)(4)(5)
C13	We are letting technology change the world to quickly	(4)(5)

DIFFICULTY						
D1	To understand something of technology you have to do a difficult training course	(1)	(2)	(3)	(4)	(5)
D2	You have to be clever to study technology	(1)	(2)	(3)	(4)	(5)
D3	Technology is only for bright people	(1)	(2)	(3)	(4)	(5)
D4	It is not so difficult to work with a computer*					
D5	You have to be strong for most technical jobs		(2)		(4)	(5)
D6	To study technology you have to be talented		(2)		(4)	(5)
D7	You can study technology only when you are good at both mathematics and physics		(2)		(4)	(5)
D8	Technology does need a lot of mathematics		(2)		(4)	(5)
D9	Everybody can study technology		(2)		(4)	(5)
D10	Everybody can have a technical job		(2)		(4)	(5)
SCHOOL						
S1	At school you hear a lot about technology			(3)		
S2	I would not like to learn more about technology at school	(1)		(3)		
S3	Technology lessons are important				(4)	
S4	I would rather not have technology lessons at school	(1)		(3)	(4)	
S5	Technology at home is not something school should teach about				(4)	
S6	I should be able to take technology as a school subject				(4)	
S7	There should be more education about technology	(1)			(4)	
S8	Technology should be compulsory for all pupils				(4)	
S9	Technology lessons help to train you for a good job				(4)	
S10	Not everyone needs technology lessons at school				(4)	
CAREER						
CA1	I will probably choose a job in technology	(1)			(4)	
CA2	Working in technology is quite dangerous*					
CA3	I will not consider a job in technology				(4)	
CA4	I do not understand why anyone would want a job in technology	(1)			(4)	
CA5	I would enjoy a job in technology later	(1)			(4)	
CA6	I would like a career in technology later				(4)	
CA7	Working in technology would be boring	(1)	(2)	(3)	(4)	
CA8	Most jobs in technology would be boring	(1)	(2)	(3)	(4)	
CA9	Working in technology would be interesting				(4)	
CA10	With a technical job your future is ensured*					

* item not used (low reliability)

The AB-scales that were used in this research (see chapter 4) turned out to be sufficiently homogeneous. Table 3.13 gives a survey of the alpha values for the main school types of the research. The scales for basischool, which, compared with the other school types consisted of the smallest number of items, turned out to be sufficiently homogeneous as well.

Table 3.13 Cronbach's alpha of the AB-scales

scale	basis school (n=2.050)	2 lbo (n=2.349)	4 avo-vwo (n=1.250)	1 mbo (n=1.170)
INTEREST	.78(k=5)	.76(k=10)	.86(k=10)	.83(k=10)
ROLE PATTERN	.70(k=4)	.77(k=9)	.82(k=9)	.74(k=9)
CONSEQUENCES	.59(k=5)	.65(k=9)	.79(k=13)	.73(k=13)
DIFFICULTY	.60(k=3)	.56(k=8)	.66(k=9)	.66(k=9)
SCHOOL	.81(k=5)	---	.78(k=9)	---
CAREER	.80(k=5)	---	.91(k=8)	---
Total	.82(k=25)	.79(k=27)	.90(k=58)	.79(k=41)

The stability of the AB-scales became evident from a repeated measurement among 45 pupils from groep 8, who filled out the questionnaire twice, with a period of 9 months in between. The productmoment correlations between the test and the retest are presented in table 3.14.

Table 3.14 Test-retest coefficients AB-scales (n=45)

INTEREST	.75(k=5)
ROLE PATTERN	.71(k=4)
CONSEQUENCES	.83(k=5)
DIFFICULTY	.61(k=3)
SCHOOL	.81(k=3)
CAREER	.80(k=5)

By means of factor analysis it was investigated in the execution stage to what extent the assumed attitude dimensions could be validated. The results show a clear pattern. The first factor is a factor that accounts for an average of 50% of the variance and consists of the scales INTEREST, SCHOOL and CAREER. Then there is a second factor that contains the items of the scale ROLE PATTERN and accounts for an average of 20% of the variance. The third factor contains items from the scale CONSEQUENCES and accounts for an average of 15% of the variance. The items of the fourth scale, DIFFICULTY, occur in all school types of the research as the fourth factor and they account for an average of 10% of the total variance.

To get an impression of the interrelationship of the scales a survey of the Pearson correlation-coefficients of the scale scores is given in table 3.15. As an example the data from groep 7-8 from basisschool are taken.

Table 3.15 Pearson correlations between scales (on the basis of data basisschool: n=2.050)

	(1)	(2)	(3)	(4)	(5)	(6)
(1)INTEREST	1.0	-.12	.21	.20	.63	.63
(2)ROLE PATTERN		1.0	.10	.21	-.10	-.10
(3)CONSEQUENCES			1.0	.10	.26	.26
(4)DIFFICULTY				1.0	.17	.13
(5)SCHOOL					1.0	.68
(6)CAREER						1.0

* All correlations are significant ($p < .05$)

The correlations, which are also illustrative of other age groups, and even for data from abroad (Moore 1987), show that there are rather strong relations between INTEREST, SCHOOL and CAREER. The relationship of the scales CONSEQUENCES and DIFFICULTY with other scales is weak, but positive. The scale ROLE PATTERN correlates even negatively here. But the significant correlation coefficients suggest this scale does measure an important part of the whole attitude.

3.2 The development of the Cognitive attitude scales

3.2.1 Design C-scales

In the design stage of the C-scales the five characteristics of technology, as described by De Vries (1988), have been used. For each characteristic of technology items of a 'true-false' format have been formulated. Pupils could answer from one of the categories: 'agree', 'disagree' and 'don't know'. The scoring procedure was as follows: 1 point for a 'correct' answer, 0 points for a 'wrong' or a 'don't know' answer.

We tried to operationalize the characteristics of technology at a certain level of abstraction. This means that we did not ask for concrete knowledge of technology, but for aspects that are related to the characteristics of technology. In fact we were measuring passive knowledge this way. We give an example by way of illustration. In the measurement of knowledge carried out by Streumer, Doornekamp and Van Bommel in the framework of the Technology Entering Behaviour Study (Streumer et al 1986), it is asked, among other things, *'What fuel do nuclear power stations use to generate energy?'*, whereas in this instrument there is a question *'I think that technology has little to do with our energy problem'*. The first question asks for concrete information on energy (active knowledge of technology), in the second item respondents are asked whether they are aware of the relationship between technology and energy (passive knowledge of technology/concept of technology). The C-scales are not concerned with empirically established scales (like the AB-scales), but with a priori determined groups of questions that operationalize a characteristic of technology. Table 3.16 gives the 'scale descriptions' with the items belonging to them. We distinguish four potential scales: SOCIETY, SCIENCES, SKILLS and PILLARS. The potential scale SOCIETY operationalizes two characteristics of technology 'Technology and society' and 'Technology and mankind'.

Table 3.16 C-scales: description and potential items

1.	**SOCIETY:** Technology is directed and controlled by man and intervenes in all parts of society
SO1	With reference to technology I mostly think of machines.
SO2	With respect to technology I mostly think of dealing with equipment.
SO3	In my opinion technology is not very old.
SO4	Technology is as old as mankind.
SO5	Technology has a large influence on people.
SO6	In everyday life I have a lot to do with technology.
SO7	Technology is far away from my daily life.
SO8	The government can have influence on technology.
SO9	Technology is meant to make our lives more comfortable.
SO10	Only technicians are in charge of technology.
2.	**SCIENCES:** The difference between technology and the natural sciences and their mutual influence
SC1	I think physics and technology are related.
SC2	To me technology and science are the same.
SC3	Elements of physics are rarely used in technology.
SC4	I think technology is often used in physics.
SC5	Biology and technology have nothing in common.
SC6	There is a relation between chemistry and technology.
3.	**SKILLS:** To Design (creativity) and practical skills are part of technology
SK1	In technology you can seldom use your imagination.
SK2	In technology you can think up new things yourself.
SK3	You need not be technical to invent a new piece of equipment.
SK4	Manual dexterity is part of technology.
SK5	In technology you handle tools.
SK6	In technology there is little opportunity to think up things yourself.
SK7	In technology there are less opportunities to do things with your hands.
4.	**PILLARS:** There are three pillars or dimensions in technology: matter, energy and information
P1	I think technology has little to do with our energy problem.
P2	I think technology is more part of computers than of computer programs.
P3	I think the transformation of energy is also part of technology.
P4	When I think about technology I mainly think of computer programs.
P5	Processing materials is an important part of technology.

3.2.2 Construction of C-scales

To find out whether valid scales can be made out of items that represent characteristics of technology, we carried out factor analyses and reliability analyses. These did not yield satisfactory results. Factor analyses did not lead to the identification of items that were supposed to correlate. And the item analyses indicated that the homogeneity of separate scales is too low (α < .60). Also among older pupils the homogeneity of the 28 items together appears to be rather low: for 4 avo-vwo .73 and for 1 mbo .78.

This way it would be impossible to construct scales for 10 to 18-year-olds. The reason for this may be the fact that the 'Likert scale model' does not apply to this type of instrument. In the Likert scale model items are repeated measurements of a latent attribute. But here we are dealing with items tapping *various amounts* of a disposition. A more appropriate scale model, therefore, is the Mokken scale model. This is a probabilistic version of the Guttman model. On the basis of theoretical considerations we decided therefore to construct Mokken scales instead of Likert scales. This was not done in the pilot stage, as with the attitude scales, but afterwards in the execution stage.

Guttman scale analysis

On the data from 4 avo-vwo and 1 mbo a traditional Guttman scale analysis was executed by means of the SPSS-program GUTTMAN. For each of the scales the 'reproduction coefficient' (REP) was calculated. This value has a maximum of 1 if all answers conform to the scale model. This happens when all questions are answered according to the pre-set degree of difficulty. If the percentage of violations is not higher than 15% a scale is called 'valid' (Summers 1977). By way of illustration we give in table 3.17 the REP-coefficients of the four test scales on the basis of data from pupils in 4 avo-vwo and 1 mbo.

Table 3.17 REP-coefficients of the C-scales

scale	4 avo-vwo (n=1.250)	1 mbo (n=1.170)
SOCIETY	.73	.73
SCIENCE	.81	.80
SKILLS	.83	.82
PILLARS	.79	.79

Although the results are not optimum (the coefficients are all below .85), the results seem to confirm the assumption that a Guttman scale model is more suitable than a Likert scale model.

Mokken scale analysis

The Mokken scale model is a probabilistic version of the Guttman scale model. It is based, for each pair of items i and j, on the relation between the observed number of violations of the model, F(o), in the sense Guttman understood violations, and the number of violations expected, F(e), under the assumption of independency. For items i and j, the scale characteristic H(ij) is defined as: $H(ij)=1-F(o)/F(e)$. The key concept here, is double monotony: the items order the subjects according to their amount of the disposition; the subjects, in turn, order the items according to their degree of difficulty. The notion of probability, therefore, is an increasing chance to pass a fixed item as the amount of the disposition increases (and the reverse as it decreases); and, with a fixed amount of the disposition, an increasing chance to pass items with decreasing degrees of difficulty (and the reverse as the degree increases). By means of three H-coefficients we can check the model:

- the coefficient H(ij) for each pair of items;
- the coefficient H(i) for each item i in relation to all other items;
- the coefficient H for the scale as a whole.

To construct valid scales first of all for obvious reasons negative H(ij)'s are removed, subsequently the items have to be chosen so that the H(i)- and H-coefficients are over .30 (Mokken 1970, Swanborn 1982). The result of the scale construction is summarized in table 3.18. In this table a survey of items and scales with the optimum H(i)- and H-coefficients is presented.

Table 3.18 H(i)- and H-coefficients in Mokken scale analysis

scale	basis school (n=2.050)	2 lbo (n=2.349)	4 avo-vwo (n=1.250)	1 mbo (n=1.170)
	H(i)-coefficients			
SOCIETY				
SO2	+.14	+.35	+.37	+.37
SO1	+.14	+.25	+.33	+.33
SO7	+.25	+.22	+.31	+.35
SO5	+.21	+.32	+.43	+.44
H-coeff.	+.20	+.30	+.36	+.37
SCIENCE				
SC5		+.36	+.34	+.33
SC6		+.21	+.31	+.32
SC3		+.33	+.40	+.43
SC1		+.36	+.57	+.49
H-coeff.		+.32	+.37	+.38
SKILLS				
SK1		+.30	+.42	+.34
SK5		+.33	+.46	+.33
SK6		+.30	+.26	+.33
SK7		+.33	+.37	+.33
H-coeff.		+.32	+.39	+.33
PILLARS				
P2		+.07	+.14	+.29
P1		+.18	+.16	+.31
P5		+.17	+.18	+.22
P3		+.24	+.31	+.38
H-coeff.		+.17	+.19	+.30

For the pupils of 2 lbo, 4 avo-vwo and 1 mbo we checked all the items (28), for pupils of groep 7-8 basisschool we checked only some items of the characteristics SOCIETY and SKILLS. We may posit that for 2 lbo, 4 avo-vwo and 1 mbo passable Mokken scales can be constructed (except for PILLARS). For pupils from basisschool the concept instrument does not seen to be very well suited. Items may still be used in a 'descriptive' sense, though.

3.3 Conclusion: the reliability and validitity of the AB- and C-scales

In this chapter we have described the development of the attitude instrument. Conclusions regarding reliability and validity are made on the basis of data from the pilot study and the measurements.

Reliability

By reliability we mean the degree to which a particular test or instrument provides trustworthy or consistent measures (Erickson 1988). By means of Cronbach's homogeneity coefficient alpha the internal consistency or homogeneity of the attitude instrument was checked for all groups subject to this research. Cronbach's alpha is equivalent to split-half reliability (Swanborn 1982). The measurement of the stability, by means of a repeated measurement, was only carried out among a small group of pupils from basisschool.

The results point out that the six AB-scales (Likert scales: INTEREST, ROLE PATTERN, CONSEQUENCES, DIFFICULTY, SCHOOL and CAREER) are sufficiently homogeneous and stable.

The alpha values for the four C-scales together are above .70 for all research groups (except for basisschool). However, for seprate C-scales the alpha values are very low (on the whole between .40 and .60).

From a theoretical point of view it is better to consider the C-scales as a number of Mokken scales, instead of Likert scales. The Mokken scales operationalize characteristics of technology: SOCIETY, SCIENCE, SKILLS, PILLARS. For three scales (SOCIETY, SCIENCE and SKILLS) the theory is confirmed. It appears that these scales are fairly reliable (H-coefficients > .30). It also appears that this does not apply to the scale PILLARS. For pupils from basisschool it is not possible to develop valid and reliable Mokken scales.

Validity

1. Content Validity

By this form of validity we mean the representativity of the content of the items as regards the attitude towards technology. This type of validity is concerned with the question whether the concepts 'attitude' and 'technology' are sufficiently operationalized. This cannot be proven empirically and it can only be established by judgement (face validity). Cronbach (1971) calls content validity a matter of judgement instead of correlation.

As regards the concept 'attitude' the affective, cognitive and behavioural components recur in the instrument.

With reference to the concept 'technology' the affective and behavioural components are operationalized from the pupils and students themselves. The instruments are constructed on the basis of explorative research: interviews and open-ended questionnaires on technology. Because pupils, younger ones in particular, often think that technology is 'the way to do something' (for example technique for playing the piano or playing football) we explained in the heading of the questionnaire that we did not mean this interpretation. No further information was given on the meaning of technology. During the research interviews were held, essays were written and open-ended questions were answered too. These did not show any new aspects in the attitude towards technology. As regards the cognitive attitude component we started from several characteristics of technology that are generally accepted in the Dutch system of technology education.

The PATT-conferences (with experts in the field of technology education and research) turned out to be a useful forum for judging the different attitude scales on content validity. Items that improved the representativeness of scales were adopted, others were removed.

2. Concurrent Validity

This form of validity is judged by checking to what extent the results correspond with available criterion data (Drenth 1975). In the main research among pupils from groep 7 -8 and from 4 avo-vwo the variable 'AMBITION' was used as a criterion variable (see

Chapter 4). The AB- and C-scales both turned out to be significant predictors of 'AMBITION'. For pupils from groep 7-8 the correlation with the (total score on the) AB-scales is .72 and with the (total score on the) C-scales .30. For pupils from 4 avo-vwo this is .60 and .33 respectively.

The results of comparable attitude investigations (see Chapter 2) are in agreement with the results of this research (see Chapter 4): young people have a positive attitude towards technology, but boys have a more positive attitude towards technology than girls.

3. Construct Validity

By construct validation research we mean the empirical research into the meaning of the hypothetical concepts of the research (De Zeeuw 1983). In this research factor analyses have been used for the validation of the theoretical aspects in the attitude towards technology. Kerliner (1973) calls factor analysis the strongest means to establish this type of validity. The factor analyses carried out in the attitude research confirm that there are a number of attitude dimensions. From the results of the PATT-research it also appears that the same attitude dimensions turn up time and again.

Results of research into the attitude towards computers (Crombach et al 1986, Moore 1984, Klopper et al 1989) and mathematics (Kremers 1981, Martinot 1986) show similar factors/dimensions.

In an English PATT-study by Moore (1987a) it is shown that interscale correlations for the scales INTEREST, ROLE PATTERN, CONSEQUENCES, SCHOOL and CAREER are less than the geometric mean of the corresponding pair of scale alpha reliability values. He concludes that it is reasonable to suppose that the scales measure different constructs (see Guilford 1973). This applies to the Dutch data as well.

CHAPTER 4

RESULTS OF THE SUB-STUDIES

> '...that the differences in attitude between the groups may be based, at least in part, on the degree to which students seperated in their minds the technological process from its manifestations, use and impact. The endorsing students appeared to dissociate the technological process from its implications, and judged it alone, relatively positively. The critical students perspective was more 'holistic', seeing technology as inextricably bound to issues surrounding and relating to it, resulting in a relatively negative appraisal of it' (Nash et al 1984, p. 171).

Introduction

In this chapter an answer is given to the second research question of this dissertation: 'How to describe the affective, cognitive and conative components of the attitude towards technology and dimensions in the attitude towards technology for pupils from 10 to 18 years old?'. We opted for a cross-sectional approach. With the attitude instrument we carried out measurements that aimed to be representative of three age groups. In 1986 studies were carried out among 13 to 15-year-olds in 2 lbo, in 1987 among 16 to 18-year-olds in 4 avo-vwo and 1 mbo and in 1988 among 10 to 12-year-olds in groep 7-8 basisschool. In addition to this written instrument we also used alternative methods to obtain information on the attitude towards technology. These alternative methods are more small scale in nature than the written questionnaires. They include interviews and drawings with 10 to 12-year-olds, essays with 13 to 15-year-olds and open-ended questions with 16 to 18-year-olds.

In section 4.1 the common design of the sub-studies is described. This gives an account of the choice of variables we used in the description of the attitude towards technology. In section 4.2 the size and composition of the three samples are indicated. In section 4.3 the results of the measurements with the attitude instrument are described. In section 4.4 the results of the alternative methods are mentioned. In section 4.5 the conclusion is given by summarizing the results of the tests.

4.1 Design of the sub-studies

The second research question will be answered by formulating and testing ten assumptions. These assumptions are based on the results of research discussed in section 2.3.

The following assumptions are tested:

1. boys have a more positive attitude towards technology than girls, (variable: GENDER);
2. pupils that have a technical ambition have a more positive attitude towards technology than pupils that do not have a technical ambition, (variable: AMBITION);
3. pupils with a positive technical self-concept have a more positive attitude towards technology than pupils without a positive technical self-concept, (variable: KNOWLEDGE);
4. pupils with a technical home environment have a more positive attitude towards technology than pupils from a non-technical home environment, (variable: HOME);
5. pupils of a 'higher' school type, or choosing for a 'higher' school type, have a more positive attitude towards technology than pupils of a 'lower' school type, or choosing for a 'lower' school type, (variable: SCHOOL TYPE and SCHOOL CHOICE);
6. pupils that like school have a more positive attitude towards technology than pupils who do not like school, (variable: SCHOOL EXPERIENCE);
7. the teacher's attitude towards technology influences the attitude towards technology of his/her class, (variable: TEACHER ATTITUDE);
8. a good concept of technology is positively correlated with a positive affection towards technology, (variable: CONCEPT);
9. the attitude towards technology is rather stable and changes very little between 10 and 18, (variable: AGE);
10. pupils have an incomplete and narrow concept of technology.

The assumptions 1-9 are tested by means of written questionnaires, assumption 10 by means of essays, drawings, interviews and open-ended questions. First the design of the written questionnaire is described (section 4.1.1) and then the design of the descriptive methods (section 4.1.2).

4.1.1 Design of the written questionnaires

In the choice of the variables with which we tested the assumptions, the model of Haladyna (1983) discussed in section 2.3.1 played a part. The pupils' attitude towards technology is a resultant of various factors, such as pupils' characteristics, teachers' characteristics, home environment and the school. It is not the intention of this research to develop and test a descriptive model. The aim is to give a description of the affective, cognitive and behavioural components of the attitude towards technology, and for this a number of relevant variables are used. These variables are a condition because a single score on a scale is not meaningful. Moore (1988c) speaks of 'comparative studies' when information is gathered by comparing the scores of groups.

What we are concerned with is how the score of one group differs from the score of another group, the norm group. The norm group may be an external group, as with the TAS where a teacher compares the class score with the national norm (see chapter 5), or a group within the research group itself. The primary objective of norm-referenced measurement is separating students with regard to some variable (Erickson 1988). A number of these variables are common to all three sub-studies (SEX, AGE) several others were used in a single sub-study (SCHOOL EXPERIENCE). The choice of a variable is related to an assumption to be tested that it will be discriminating. In table 4.1 a survey of the variables used in the sub-studies is given.

Table 4.1 Survey of variables and samples in the sub-studies

independent variables	samples*
pupils' attributes	
1. GENDER	1,2,3,4,5
2. AGE	1,2,3,4,5
3. AMBITION	1,4
4. KNOWLEDGE	1
5. CONCEPT	1,2,4,5
home	
6. HOME	
a. PARENTS' PROFESSION	1,2,3,4,5
b. TOOLS	1,4,5
c. TOYS	1,4,5
d. FAMILY	1,4,5
school	
7. TEACHER ATTITUDE	1
8. SCHOOL TYPE	1,2,3,4,5
9. SCHOOL CHOICE	1
10. SCHOOL EXPERIENCE	1

dependent variables	samples
Cognitive component of the attitude towards technology: CONCEPT	
Cognitive-scales (C-scales):	
11. SOCIETY	1,2,4,5
12. SCIENCE	2,4,5
13. SKILLS	1,2,4,5
14. PILLARS	2,4,5
Affective and Behavioural component of the attitude towards technology: AFFECT	
Affective/Behavioural-scales (AB-scales):	
15. INTEREST	1,2,3,4,5
16. ROLE PATTERN	1,2,3,4,5
17. CONSEQUENCES	1,2,3,4,5
18. DIFFICULTY	1,2,3,4,5
19. SCHOOL	1,4
20. CAREER	1,4

* 1 = groep 7-8 basisschool (age 10-12)
2 = 2 lbo (age 13 -15)
3 = 2 avo-vwo (age 13-15)
4 = 4 avo-vwo (age 16-18)
5 = 1 mbo (age 16-18)
(see APPENDIX 1 for explanation Dutch terms)

We shall briefly explain the assumptions 1-9 with the accompanying variables.

General explanation of the assumptions and variables:

What is a 'positive' attitude and what is a 'good' concept of technology? (see also section 1.4) We express both in a quantitative way: that is, as scores on scales. When we are talking about a 'positive' score on the AB-scales this could mean two things:

1. the score on the AB-scales is below the neutral point of the scale (3),
2. the score of a group is significantly more positive than that of the other (norm)group.

With the scores on the C-scales too we make a distinction between an absolute and a relative score. A 'good' score on the C-scales is obtained when the questions are answered 'correctly'. By 'correctly' we mean 'in agreement with a characteristic of technology'.

Specific explanation of the assumptions and variables:

1: GENDER

Studies with reference to the attitude towards technology show that boys have a more positive attitude towards than girls (Angele 1976, Page and Nash 1980, Allsop 1986, De Vries 1988). The mean scores of boys and girls are compared by means of t-tests.

2: AMBITION

This variable was used not only as a criterion variable (see section 3.3), but also as a predictor variable. The variable was only measured among pupils of basisschool and avo-vwo, because these pupils have not yet chosen a technical training, this as opposed to pupils in lbo and mbo. In the questionnaire for 16 to 18-year-olds the variable is operationalized by means of two questions: *'I have the ambition to chose a technical profession later on'* and *'I have chosen physics as an exam subject'*. For 10 to 12-year-olds: *'I want to go to a technical school later on'* and *'Later on I want a technical profession'*. Two values are attributed to the variable: "1" = technical ambition, when both questions are answered positively and "0" = non-technical ambition when one or both questions is/are answered negatively. By means of t-tests scale scores of pupils with and without technical ambition are compared.

3: KNOWLEDGE

This variable measures the perceived knowledge of technology among 10 to 12-year-olds. This is measured by means of two questions: *'I think that I know quite a lot about technology'* and *'What I know about technology I: read myself, saw on TV, heard from my parents, from brothers/sisters, from friends, at school'* or *'I don't know how I got to know it (more than one answer possible)'*. When pupils think of themselves as knowing a lot about technology and they can also point out where they found this knowledge this variable has the value "1" = knowledge of technology and if one of the questions is answered negatively the value is "0" = no knowledge of technology. By means of t-tests pupils with and without percieved knowledge of technology are compared.

4: HOME

The variable HOME was also measured by means of more than one question. The variable has two values: the value "1" for a technical home environment and "0" for a non-technical home environment. Their home environment is technical if:

1. the profession of the father or mother (or supporters) is technical, and
2. there are 'many' tools at home, and
3. the pupil has brothers and/or sisters that are 'good' at technology (or does not have any brothers or sisters at all), and
4. the pupil plays or played with technical toys.

The questions 2, 3 and 4 are judged by the pupils themselves. The classification into technical and non-technical professions was carried out afterwards. A profession is classified as 'technical' if it can be said with some certainty that a technical training (lts/mts/hts/tu) was necessary. By means of t-tests pupils with and without a technical home environment are compared.

Although the relation between HOME and the attitude towards technology is obvious, there is little empirical evidence to prove it. From a study by Streumer et al (1986) it appears that the parents' profession does not have any influence on the technical knowledge of 12 to 14-year-old pupils. From the research by De Vries (1988) it appears also that the parents' profession has little effect on the attitude towards technology. In studies by Nash (1984) and Moore (1984) however a positive relation is found: between technical parents and the attitude towards technology and between the attitude towards computers and use of a home-computer at home respectively.

5: SCHOOL TYPE and SCHOOL CHOICE

For each age group we compared the school types and the school choices, assuming that by means of the variables SCHOOL TYPE and SCHOOL CHOICE we are measuring the general level of knowledge (avo versus vwo) or specific technical knowledge (technical versus non-technical education). Level of knowledge, both general and specific, may be of influence on the attitude towards technology. The SISS-research (Second International Science Study) showed that the school type attended by a pupil is a predictor of science attitudes (Pelgrum and Plomp 1986). A positive relation between 'general school level' and the attitude towards technology has been proven by De Vries (1988). The fact that specific (advanced) knowledge has a positive influence on the attitude towards technology we know from a study by Knulst and Van Beek (1988). By means of t-tests the scores of pupils of different school types are compared.

6: SCHOOL EXPERIENCE

This variable was measured by means of an attitude scale consisting of four statements in which way pupils experience school. By means of t-tests pupils with a positive and and a negative school experience are compared. Subsequently the SCHOOL EXPERIENCE scale score is correlated with the scores on the AB- and C-scales.

The relation between SCHOOL EXPERIENCE and the attitude towards technology has not been investigated before. Haladyna et al (1983) found that 'Schoolenvironment' and 'Classenvironment' predict science attitudes rather well.

7: TEACHER ATTITUDE

Only for pupils of basisschool could it be investigated whether the attitude of the teacher influences the class attitude, because at a later age pupils no longer have a regular teacher. The variable TEACHER ATTITUDE was measured by means of an instrument used by Van den Bergh and De Vries (1986) to measure the teachers' attitude towards technology. The correlation between the teachers' scale score and the class' scale score is calculated.

A possible positive influence of a teachers' science attitudes on the pupils' science attitudes appears from research by Haladyna et al (1983).

8: CONCEPT

The variable CONCEPT of technology is measured by means of the C-scales SOCIETY, SCIENCE, SKILLS, PILLARS. This variable was used both as a dependent and as an independent (predictor) variable. As a dependent variable it was used to describe the cognitive attitude component. As an independent variable it was used to investigate the relation between the cognitive and the affective attitude components (CONCEPT and AFFECT). The last relation is particularly important from an educational point of view. After all, a positive correlation between the concept of technology and the affection towards technology may mean that by improving the concept of technology we are capable of improving the attitude towards technology. From investigations by Nash (1984), Breakwell et al (1985) and Knulst and Van Beek (1988) it appears that there is a positive relation between the concept of technology and the attitude towards technology. The relation between affection and cognition (achievement) in science attitude studies is positive but weak (Ormerod 1986, see also Table 2.1). The relation between the AB and C-scales is investigated by means of (partial) correlation analysis and path analyses.

9: AGE

From attitude theories we know that attitudes are long-lasting. Breakwell (1985) showed that attitudes towards modern technology are stable and hardly subject to change. In this study we can compare the scale scores that are based on common items, for three age groups. By means of multiple comparison methods the differences between scale scores of age groups are tested for significance (Kirk 1968).

Structure of the questionnaire

The questionnaires used in the sub-studies have a common structure:

1. an introduction explaining that by technology we do not mean 'technique' (football technique, the way you do something), how the questions have to be answered and that the questionnaire is anonymous and that there are no right or wrong answers,
2. general questions about age, sex, parents' profession etc.,
3. the attitude items with five answering categories,
4. the concept items with three answering categories.

The questionnaires are presented in Appendix 3.

4.1.2 Design of the descriptive research

We did not confine ourselves to the written test described above because:

1. it appears that the concept instrument can hardly be used (is too difficult and not reliable) when used among 10 to 12-year-olds,

2. essays, interviews and drawings give spontaneous information, particularly on the concept of technology.

From studies by De Vries (1988) and Angele (1976) we know that pupils have a limited concept of technology. We assumed that this would also be the case for older and younger age groups.

The results of alternative methods can be looked upon as an addition regarding the results of the attitude instrument, but they can also be used as a validation of the attitude instrument. Although this instrument is sufficiently reliable and valid there are still some disadvantages with reference to the use of attitude scales (see section 2.2). We shall briefly discuss the alternative methods that were used.

1. Drawings and interviews among 10 to 12-year-olds

From a study by Moore (1988b) it appeared that it is possible to get insight into the concept of technology among young pupils by means of drawings. Moore analyzes the drawings in two ways. First of all by an open analysis, in which an inventory is drawn up of all elements of a drawing and subsequently these are categorized. Secondly an analysis in which the drawings are inspected for the presence of a proiri formulated characteristics of technology. Moore says that there is one disadvantage with reference to drawings: 'It remains to be investigated whether the frequency of occurrence of a concept in the drawings matches the pupils' strength of feeling about the same idea in a written test' (Moore 1988b). That is why we used also individual conversations on technology apart from the drawings. These interviews were held by fifteen students from three pabo's. Their task consisted of:

1. giving the drawing assignment in class,
2. drawing up an inventory of the contents of the drawings,
3. having short interviews with the pupils,
4. reporting the results.

To prepare the students in the best possible way a manual was written and instructions were given at the three pabo's. The objectives of the manual and the instructions at the pabo's were threefold:

1. the students themselves had to have a good concept of technology,
2. the students had to know what attitudes are and how they are measured,
3. the students had to be able to carry out the investigation according to a number of

steps. The manual is taken up in Appendix 4.

2. Essays among 13 to 15-year-olds in 2 lbo

During the project P&T it appeared useful to have pupils writing essays to gather additional information on the concept of technology. In this project 88 essays of pupils from 2 avo-vwo were analyzed. Spontaneous associations with technology appear from the results: electricity, computers, transport, equipment and machines (Van Wersch 1985, De Vries 1988).

Pupils in 2 avo-vwo were given the following assignment: 'What is technology? Most people have rather different opinions on technology. Write on one or two pages what you think of technology'.

In the analysis of the essays a method used by Henerson was followed (Henerson 1978). What this method comes to is drawing up an inventory of and subsequently categorizing the elements of opinions that occur in the essays. The result of the categorization is a datamatrix of a manageable size. Subsequently insight is gained into the students' concept of technology by means of frequency analysis of the elements. This method has also been used in the P&T and PATT-project (PATT-newsletter no. 1, 1987).

3. Open-ended question among 16 to 18-year-olds in 4 avo-vwo and 1 mbo

As a part of the written questionnaire we asked the pupils of 16 to 18 years old to give as complete a definition of technology as possible: 'Describe as best as you can what you mean by technology'. This assignment was given at the beginning of the questionnaire. The pupils' definitions were judged by means of the characteristics of technology as formulated by De Vries (1988). On the basis of the presence of these characteristics in the definition a score was calculated.

4.2 The composition and size of the samples

The schools that have been invited to take part in the study, were randomly selected from address lists of all Dutch primary and secondary schools. For instance, 300 basisscholen have been chosen at random from an address list of 8.400 basisscholen. Schools could take part in the research with one or two intact classes. In table 4.2 a survey of the response is given.

4.2 Frequencies of response on written tests

school types	invited schools (freq.)	positive reactions (freq.)	negative reactions (freq.)	no reactions (freq.)
basisschool	300	133	113	54
2 lbo	230	83	56	91
1 mbo	70	29	23	18
4 avo-vwo	60	23	25	12

For each of the three age groups of the research (10-12 years, 13-15 years and 16-18 years) the final samples for the written test were composed so that they are representative of (1) the most important school types and (2) the ratio of boys and girls in these school types. With sufficient participation of schools we selected on geographical distribution and the size of the municipality. With reference to the sample size we assumed that there would be a reliable sample if we had at least 900 respondents per age group. We then assume that on a 5-point-scale, with a mean standarddeviation of 1, the mean score of the sample will not deviate more than ± 0.1 from the mean score of the population. We can calculate the sample size if we choose a significance level of .05. Because results are analysed on individual level rather than on class level, 900 is the absolute minimum. This in order to meet the requirements of sample independence of the sample individuals.

Table 4.3 gives a survey of the composition and the proportion of the various samples. For completeness the sample size of the research in 2 mavo-havo-vwo is also given (De Vries 1988).

Table 4.3 Sample size of the written tests

	boys(n)	girls(n)	total(n)
10-12 year:			
groep 6	21	36	57
groep 7	487	459	946
groep 8	513	534	1.047
13-15 year:			
2 lts	1.169	26	1.195
2 lhno	31	565	586
2 leao	50	82	132
2 sglbo	115	309	424
2 mavo	678	834	1.512
2 havo	138	119	257
2 vwo	183	117	300
2 mavo-havo-vwo	263	273	536
16-18 year:			
1 mts	391	8	399
1 mdgo	52	273	325
1 meao/mmo	202	245	447
4 havo	263	253	516
4 vwo	434	307	741

The number of pupils that took part in the essays and interviews is shown in table 4.4. The drawings research was carried out by 15 students from 3 different pabo's.

Table 4.4 Sample sizes of alternative methods

method	2 lts		2 lhno		basisschool	
	b(n)*	g(n)**	b(n)	g(n)	b(n)	g(n)
essays	61	1	57	1	--	--
drawings	--	--	--	--	139	124
interviews	--	--	--	--	60	60

* b(n)= number of boys, ** g(n)= number of girls

4.3 Results of the written tests

In this section the results are given of the written questionnaire with the objective to test the 9 assumptions described in section 4.1.1. To test the assumptions, t-tests and (partial) correlation analyses have been carried out. In the t-tests we have used a one-tailed or two-tailed analysis, depending on the prediction of the direction of the bias, (e.g. boys have a more positive attitude than girls: one-tailed critical region). The scale scores for the six AB-scales vary between 1.0 and 5.0, in which 1.0 is the most positive attitude and 5.0 the most negative attitude. The scale scores for the C-scales vary between 0 and 1 and they are based on the number of correct answers, in which a 'correct' answer is given 1 point and an 'incorrect' or 'don't know' answer is given 0 points.

4.3.1 Boys and girls

Table 4.5 represents the results of t-tests on the scale scores of boys and girls of different age groups.

Table 4.5 Differences boys-girls on scale scores

scale	basisschool (10-12y)		4 avo-vwo (16-18y)	
	boys	girls	boys	girls
INTEREST	2.3	3.0 *	2.4	3.1 *
ROLE PATTERN	2.0	1.6 *	2.1	1.9 *
CONSEQUENCES	2.3	2.4 *	2.2	2.5 *
DIFFICULTY	2.3	2.4 *	2.9	2.9
SCHOOL	2.1	2.6 *	2.9	3.1 *
CAREER	2.0	2.6 *	2.4	3.1 *
SOCIETY	---	---	.62	.52 *
SCIENCE	---	---	.75	.71 *
SKILLS	---	---	.72	.71
PILLARS	---	---	.70	.63 *
	2 lbo (13-15y)		**1 mbo (16-18y)**	
	boys	girls	boys	girls
INTEREST	2.3	3.0 *	2.4	3.2 *
ROLE PATTERN	2.5	2.2 *	2.5	2.0 *
CONSEQUENCES	2.2	2.6 *	2.3	2.7 *
DIFFICULTY	2.3	2.1 *	2.8	2.3 *
SOCIETY	.50	.36 *	.62	.49 *
SCIENCE	.48	.33 *	.65	.49 *
SKILLS	.72	.65 *	.76	.71 *
PILLARS	.57	.45 *	.72	.56 *

* $p < .05$

The results indicate that boys have significantly more positive scores on most AB-scales and on all C-scales. From this we can conclude that boys have a more positive affection towards technology and also a better concept of technology than girls. However, we can make some comments on this conclusion.

First of all girls score consistently more positively than boys on the scale ROLE PATTERN. Secondly it appears that girls in lbo and mbo score more positively than boys on the scale DIFFICULTY. Because boys mostly take the technical streams and girls the non-technical streams it seems that technology is considered to be more difficult the more one has to do with it at school. Finally, and this appears from the score frequencies on the answering categories (see Appendix 6.1) girls more often answer 'neutral' or 'don't know' than boys. This has a negative effect on the girls' scale scores. Compared with boys the attitude towards technology is less negative than might be expected from the scale scores. For some scales (CONSEQUENCES, DIFFICULTY) girls score even less negatively than boys. This does not apply to the scales INTEREST, SCHOOL and CAREER, in which girls choose the negative answering category more often. This uncertainty in answering indicates that we have to be careful when drawing conclusions. Rennie (1988) has the following explanation for the fact that girls rather often answer neutrally to statements on technology:

1. girls do not have an opinion because they are indifferent to and unconcerned with the subject,
2. girls are insecure, are not self-confident and opt for the safe middle category,
3. girls have mixed feelings about technology, they cannot decide on the basis of a short statement, they need more information.

According to Grant and Harding (1987) the third explanation is the reason that girls choose more neutrally (see also section 2.3). Probably all three the explanations are true. Moreover they agree with current psychological theories in which it is posited that compared with boys girls are less secure and have more sense of complexity too (Head 1980).

4.3.2 Technical ambition

Table 4.6 compares the scores of pupils with and without technical ambitions. Here it concerns pupils that have not yet chosen technical training.

Table 4.6 Scores of pupils with (tA+) and without (tA-) technical AMBITION

Scale	basisschool (10-12y)		4 avo-vwo (16-18y)	
	tA+(n=259)	tA-(n=482)	tA+(n=340)	tA-(n=430)
INTEREST	1.8	3.2 *	2.1	3.2 *
ROLE PATTERN	2.0	1.7 *	2.2	2.2
CONSEQUENCES	2.1	2.4 *	2.2	2.5 *
DIFFICULTY	2.2	2.4 *	2.9	2.9
SCHOOL	1.5	3.1 *	2.6	3.5 *
CAREER	1.5	3.6 *	1.8	3.4 *
SOCIETY	---	---	.66	.50 *
SCIENCE	---	---	.80	.67 *
SKILLS	---	---	.75	.62 *
PILLARS	---	---	.72	.62 *

* $p < .05$

From the results it appears that pupils with technical ambitions score significantly more positively on the AB-scales and higher on the C- scales. This does not apply to the scale ROLE PATTERN. The group tA+ contains more boys than girls and the group tA- contains more girls than boys. So the variable TECHNICAL AMBITION interferes with sex. That is the reason why we checked whether 16 to 18-year-old girls that did not choose a technical vocational training might possibly have technical ambitions. This appears to be the case for 10% of the girls. These girls (with tA+) score more positively on all AB-scales and higher on all C-scales than girls without technical ambitions (tA-).

4.3.3 Perception of technical knowledge

The 10 to 12-year-old pupils with perceived KNOWLEDGE of technology (tK+) and without perceived KNOWLEDGE of technology (tK-) are compared. The group tK+ can also indicate who they got their information from (parents, TV etc.). The group tK+ consists of 449 pupils, 351 boys and 98 girls. Table 4.7 shows how these two groups score on the six AB-scales.

Table 4.7 Scores of pupils with (tK+) and without (tK-) KNOWLEDGE of technology

scale	basisschool (10-12y)	
	tK+ (n=449)	tK- (n=358)
INTEREST	2.0	3.1 *
ROLE PATTERN	1.9	1.8
CONSEQUENCES	2.2	2.6 *
DIFFICULTY	2.3	2.5 *
SCHOOL	1.8	2.9 *
CAREER	2.3	3.2 *

* p < .05

The results show that the tK+ group scores significantly more positively on the AB-scales than the tK- group. Again the scale ROLE PATTERN is an exception.

The sources of information that are mentioned most often by the 10 to 12-year-old pupils are presented in table 4.8. What strikes the attention is the high classification of 'parents, and the relatively low classification of 'school'. This indicates that home environment is important to the forming of knowledge and attitudes among 10 to 12-year-olds.

Table 4.8 Scources of information for technical knowledge among 10 to 12-year-olds

sources	boys (n=1.021)	girls(n=1.029)
parents	549 (53.8%)	487 (47.3%)
television	443 (43.4%)	377 (36.6%)
books/magazines	365 (35.7%)	185 (18.0%)
school	255 (25.0%)	307 (29.8%)
brothers/sisters	155 (15.2%)	202 (19.6%)
friends	213 (20.9%)	72 (6.9%)

4.3.4 Home environment

We compared the scores of pupils with a technical HOME (tH+) and pupils with a non-technical HOME (tH-). Both groups consisted of approximately the same number of boys and girls. The requirement for belonging to tH+ or tH- are formulated rather 'strictly' by the researcher. As a consequence of this the subgroups are of limited sizes. Table 4.9 gives a survey of the results.

Table 4.9 Scores of pupils with (tH+) and without (tH-) technical HOME

scale	basisschool (10-12y)		4 avo-vwo (16-18y)	
	tH+(n=204)	tH-(n=1182)	tH+(n=83)	tH-(n=176)
INTEREST	2.4	2.7 *	2.3	2.9 *
ROLE PATTERN	1.7	1.7	2.1	2.3 *
CONSEQUENCES	2.3	2.4	2.2	2.5 *
DIFFICULTY	2.3	2.4	2.8	2.9
SCHOOL	2.2	2.5 *	2.7	3.1
CAREER	2.7	2.8	2.1	2.8 *
SOCIETY	---	---	.67	.57 *
SCIENCE	---	---	.78	.72
SKILLS	---	---	.74	.69
PILLARS	---	---	.73	.62 *

* $p < .05$

The differences on the scales INTEREST, SCHOOL and CAREER and SOCIETY and PILLARS are significant. However, on other scales there are no significant differences between tH- and tH+.

The conclusion is that there is only partly evidence to suggest that pupils with a technical home environment have a more positive attitude towards technology than pupils without a technical home environment.

4.3.5 School type

While comparing the school types, we differentiated for each age group 'higher' education with 'lower' education and technical training with non-technical training. In tables 4.10 and 4.11 the results are given. In table 4.10 in the first column the scores of pupils from basisschool who opt for mavo-lbo or for havo-vwo are compared. In the other columns the scores of pupils from 2 mavo and 2 vwo and 4 havo and 4 vwo are presented. The scale scores of pupils from 2 mavo and 2 vwo are based on item scores from the study of Raat and De Vries (1985).

Table 4.10 Scale scores of pupils of different ages from various general school types (1)

scale	10-12 year		13-15 year	
	mavo-lbo (n=662)	havo-vwo (n=900)	2 mavo (n=1.512)	2 vwo (n=360)
INTEREST	2.6	2.7	2.8	2.8
ROLE PATTERN	1.8	1.7	2.1	2.0
CONSEQUENCES	2.3	2.3	2.1	2.2
DIFFICULTY	2.4	2.4	2.4	2.2 *
SCHOOL	2.4	2.4	---	---
CAREER	2.7	2.9 *	---	---

	16-18 year	
	4 havo (n=516)	4 vwo (n=741)
INTEREST	2.9	2.5 *
ROLE PATTERN	2.2	2.2
CONSEQUENCES	2.5	2.3 *
DIFFICULTY	2.8	3.0 *
SCHOOL	3.2	2.9 *
CAREER	3.0	2.5 *
SOCIETY	.53	.61 *
SCIENCE	.67	.77 *
SKILLS	.70	.72 *
PILLARS	.63	.69 *

* $p < .05$

The variables SCHOOL TYPE and SCHOOL CHOICE are not discriminating variables for the affective attitude component where 'high' and 'low' school types are concerned (table 4.10).

Among 16 to 18-year-old pupils the variable is discriminating: pupils from vwo score more positively on the AB-scales and higher on the C-scales than pupils from havo. In table 4.11 we compare pupils in technical training with pupils not in technical training.

Table 4.11 Scale scores of pupils of different ages of various vocational school types (2)

scale	13-15 year		16-18 year	
	lto (n=1.194)	lhno/leao (=1.031)	mto (n=339)	mdgo/meao (n=772)
INTEREST	2.3	3.0 *	2.2	3.1 *
ROLE PATTERN	2.5	2.2 *	2.5	2.2 *
CONSEQUENCES	2.2	2.6 *	2.2	2.6 *
DIFFICULTY	2.3	2.2 *	2.8	2.6 *
SOCIETY	.50	.37 *	.64	.52 *
SCIENCE	.49	.34 *	.65	.58 *
SKILLS	.72	.66 *	.78	.71 *
PILLARS	.58	.46 *	.73	.60 *

* $p < .05$

As could be expected the pupils in a technical training score more positively on the AB-scales and higher on the C-scales than colleagues of the same age on a non-technical training course (table 4.11). The differences in the scale scores are equally large for both age categories.

4.3.6 School experience

The pupils from basisschool (age 10-12) with a positive and a negative SCHOOL EXPERIENCE (S+ and S-) are compared. This variable was not measured among other age groups. Pupils from the group S+ score "2" or lower on a 5-point scale (very positive) and pupils from S- score "4" or higher (very negative). Table 4.12 gives the results of this comparison.

Table 4.12 Scale scores of pupils with positive (S+)and negative (S-) school experience

scale	basisschool	
	S+ (n=428)	S- (n=165)
INTEREST	2.6	2.7
ROLE PATTERN	1.6	1.8 *
CONSEQUENCES	2.3	2.4
DIFFICULTY	2.4	2.3
SCHOOL	2.5	2.5
CAREER	2.4	2.5

* $p < .05$

The assumption that a positive school experience would result in a more positive attitude towards technology is not confirmed.

4.3.7 Teachers' attitude towards technology

We measured the attitude towards technology of 90 teachers of classes that took part in the research among 10 to 12-year-old pupils, by means of five scales measuring the affective and behavioural components: interest, role pattern, consequences, difficulty, curriculum, and four scales measuring the cognitive component of the attitude towards technology: society, skills, science and pillars. The items for these scales were taken from the instrument developed by Van den Bergh and De Vries. Their instrument investigated the attitude towards technology of teachers in secondary education (Van den Bergh and De Vries 1986). The meaning of the scales is the same as that of the scales that were used among pupils. The questionnaire is shown in Appendix 3.5.
Table 4.13 presents the scores on the scales and their alpha reliability coefficients.

Table 4.13 Scale scores of teachers

scale	male (n=83)	female (n=7)	α
interest	2.7	3.0	.80
role pattern	1.8	1.5	.82
consequences	2.3	2.6	.76
difficulty	2.4	2.3	.78
curriculum	2.6	2.1	.85
society	.69	.78	.61
skills	.93	.97	.70
science	.81	.83	.61
pillars	.70	.89	.61

The internal consistency of the questionnaire (see table 4.13) is good, with all alpha's >.60.
The scores indicate that there is a rather positive attitude towards technology, because they are below the neutral point of 3.0. The teachers' concept of technology is a good one, because the scores on the cognitive scales are relatively high. The lowest scale scores are on the scale society (questions about the relationship technology and society).
The crucial point is whether attitude scores of the teachers are related to attitude scores of their pupils. The teachers' scores consist of the scores for the nine scales. The class

scores consist of the mean class scores on the scales INTEREST, ROLE PATTERN, AFFECT (the total scores on AB-scales) and CONCEPT (the total score on the C-scales). The correlations between these class scores and their teacher scores are presented in table 4.14.

Table 4.14 Correlations between teacher attitude scores and class attitudes (mean scores)

scale teachers (n=90)	pupils (n=2.050) INTEREST	ROLE PATTERN	AFFECT	CONCEPT
interest	.08	.10	.09	-.11
role pattern	.15	.20*	.18*	.12
consequences	.20 *	.18*	.19*	.13
difficulty	.13	.11	.11	.06
curriculum	.13	.19*	.17	-.18*
society	-.05	-.07	.01	.08
science	.01	-.12	-.08	.01
skills	.13	.01	.11	.14
pillars	.12	.13	.12	.15

* $p < .05$

Inspection of table 4.14 shows that the correlations are too weak to draw any conclusions about the assumed relation between the teachers' and the class' attitude towards technology. As there are hardly any significant correlations, the attitude of the teacher is probably without effect on the class' attitude.

4.3.8 The relation between AB- and C-scales

By means of correlation analysis the relation between the concept of technology and the affection towards technology is checked for three school types: 2 lbo, 1 mbo and 4 havo-vwo. In table 4.15 the Pearson correlations between the total scores on the AB-scales and the C scales and the partial correlation coefficients between each sub scale and the total score on the AB- and C-scales are given. These second correlations are partial in order to correct for the possible influence of unintended sub scales. The unintended sub scales would become control variables if their influence on the correlation were not taken into account.

Table 4.15 Correlations between AFFECT (AB-scales) and CONCEPT (C-scales) by school types

scales	school type		
	2 lbo	1 mbo	4 havo-vwo
	Pearson correlation coefficients		
AFFECT x CONCEPT	-.41*	-.31*	-.41*
	partial correlation coefficients		
SOCIETY x CONCEPT	-.22*	-.23*	-.32*
SCIENCE x CONCEPT	-.05	-.05	-.12*
SKILLS x CONCEPT	-.18*	-.06*	-.06*
PILLARS x CONCEPT	-.09*	-.11*	-.12*
INTEREST x AFFECT	-.30*	-.36*	-.12*
ROLE PATTERN x AFFECT	-.01	-.04	-.11*
CONSEQUENCES x AFFECT	-.29*	-.10*	-.05
DIFFICULTY x AFFECT	-.10*	-.05	-.10*
SCHOOL x AFFECT	---	---	-.09
CAREER x AFFECT	---	---	-.11

* $p < .05$

From table 4.15 two conclusions may be drawn:

1. there is a positive relation between the concept of technology and the affection towards technology: the better the concept of technology the more positive the affection towards technology (the correlations are negative because the scores on the AB-scale are more positive as the values are getting lower),
2. there is a positive relation between 'technology and society' and the affection towards technology and interest in technology and concept of technology; further correlations between scales are weak.

To find the direction of the relation between AFFECT and CONCEPT we tested a pathmodel for 4 havo-vwo. To determine the causality we first of all determined, by means of multiple regression analysis, the relative influence of the variables in the investigation on the attitude towards technology. The total influence of the variables is 40%. In order of importance they are: GENDER (20%), AMBITION (12%), CONCEPT (7%), and SCHOOL TYPE and HOME (1%). On the basis of these results we tested a path model by means of the variables GENDER, CONCEPT (C-scales) and AFFECT (AB-scales). See figure 4.1.

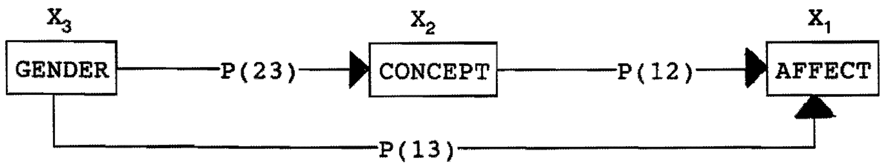

Figure 4.1 Path diagram GENDER, CONCEPT and AFFECT

By means of the SPSS program REGRESSION two regression equations were resolved to estimate the three path coefficients. The first equation concerns the regression of X_2 on X_3 and the second equation concerns the regression of X_1 on X_2 and X_3. These equations lead to the regression coefficients that are estimators for the path coefficients. The result is given in figure 4.2. From this it appears that the the total covariation between CONCEPT and AFFECT (=-.41, see table 4.15) may be split up into a causal part (-.34) and a non-causal part (-.07). Moreover, it appears from the model that apart from X_3 there are other major latent influences on X_1 and X_2. See figure 4.2.

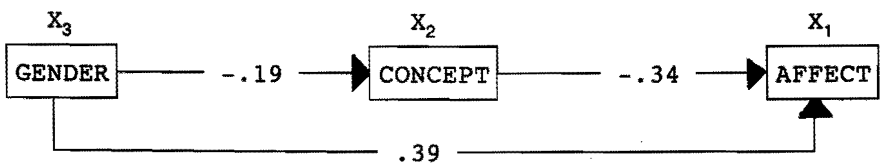

Figure 4.2 Path coefficients GENDER, CONCEPT and AFFECT

4.3.9 The comparison of age groups

One of the objectives of the attitude research is the comparison of pupils of various age groups. Because of the common items in the AB-scales it is possible to compare the scores of the three age groups and of the school types.

With these comparisons we have to realize that here it is not a longitudinal study, so that we have to be careful in interpreting attitude changes with age.

In the comparison of the mean scores on attitude scales for various age groups and school types F-tests and multiple comparison methods were used (by means of the program ONEWAY/SPSS). In tables 4.16, 4.17 and 4.18 the differences on the scale scores between groups (age groups and school groups) are presented. The scale score (x) is the mean total score of items from the scales INTEREST, ROLE PATTERN, CONSEQUENCES and DIFFICULTY (x 100). The three age groups and the twelve school types are in order of positive (low score) to negative (high score). The hypothesis that the age groups and the twelve school types of the research have the same means was tested by means of the F-tests. It appears that in all cases this hypothesis can be rejected ($F_{prob.} < .01$). The question is for which differences are the scale scores significantly different. To determine this significance we used the Scheffé multiple comparison test. The Scheffé method is the most conservative of all multiple comparison tests, it requires the largest difference between means for significance (Kirk 1968, Norusis 1988).

Table 4.16 Differences between mean scale scores: ages

	mean	group 1	group 2	group 3
group 1 (10-12 year)	228	-		
group 2 (13-15 year)	232	4*	-	
group 3 (16-18 year)	252	24*	20*	-

* p < .05 (Scheffé test)

From table 4.16 it becomes evident that the differences between the three age groups are significant. At an older age the attitude towards technology is less positive. The reason for this could be that pupils at a later age think in a more carefully balanced way about technology.

Table 4.17 Differences in mean scores of school types: boys

	school	mean	1	2	3	4	5	6	7	8	9	10	11	12
1	2 havo	217	-											
2	b.s.	223	6	-										
3	2 vwo	226	9	3	-									
4	2 mavo	227	10	4	1	-								
5	2 lts	228	11	5	2	1	-							
6	1 mts	233	16	10	7	6	5	-						
7	4 vwo	244	27*	21*	18*	17*	16*	11	-					
8	2 leao	248	31	25	22	21	20	15	4	-				
9	4 havo	249	32*	26*	23*	22*	21*	16	5	1	-			
10	1 mdgo	250	33*	27	24	23	22	17	6	2	1	-		
11	2 lhno	252	35	29	26	25	24	19	8	4	3	2	-	
12	1 meao	253	36*	30*	27*	26*	25*	20	9	5	4	3	1	-

* p < .05 (Scheffé test)

Table 4.18 Differences in mean scores of school types: girls

	school	mean	1	2	3	4	5	6	7	8	9	10	11	12
1	1 mts	231	-											
2	2 vwo	234	3	-										
3	b.s.	237	6	3	-									
4	2 mavo	237	6	3	0	-								
5	2 havo	242	11	8	5	5	-							
6	2 lts	247	16	13	10	10	5	-						
7	4 vwo	247	16	13	10	10	5	0	-					
8	2 lhno	247	16*	13	10*	10*	5	0	0	-				
9	1 mdgo	250	19	16	13*	13*	8	3	3	3	-			
10	2 leao	251	20	17	14	14	9	4	4	4	1	-		
11	1 meao	258	27	24*	21*	21*	16	11	11	11	8	7	-	
12	4 havo	260	29	26*	23*	23*	18	13	13*	19	9	2	9	-

* p < .05 (Scheffé test)

Ages corresponding with school types in table 4.17 and 4.18:
10-12: basisschool (b.s.)
13-15: 2 lts, 2 lhno, 2 leao, 2 mavo, 2 havo, 2 vwo
16-18: 1 mts, 1 mdgo, 1 meao/mmo, 4 havo, 4 vwo

From the comparisons in tables 4.17 and 4.18 it appears that many differences are not significant, not even relatively large differences. This last aspect is related to the fact that the sample size of some of the groups is relatively small (mts-girls/lhno-boys). The results indicate that pupils from 'economic' and 'care' studies have the least positive attitude towards technology. This applies to both boys and girls.

In Appendix 6.2 the mean scores on the four attitude scales of boys and girls of the various school types are presented.

Differences between boys and girls

Are the differences between boys and girls at the age of 16-18 equally large as those at the age of 10-12? From tables 4.16, 4.17 and 4.18 it becomes evident that at a later age the scores become somewhat less positive. However, the changes are relatively small, so that it seems that attitudes are rather stable.

A confirmation of this can be found in table 4.19 where the differences between boys and girls of the age groups 10-12, 13-15 and 16-18 are compared. In the table two values are given. The first value AD (Absolute Difference) indicates the absolute difference between the mean scale scores. The second value CD (Corrected Difference) gives a corrected difference, in which deviations from the means are taken into account. A positive AD or CD value means a higher score for girls, a negative AD or CD value means a higher score for boys[1].

---

[1] The absolute difference AD between the scale scores is calculated according to $(x_b-x_g)100$. The second value, which is printed in brackets, indicates the difference in scale score corrected for standard deviations: $CD = ((x_b/s_b)-(x_g/s_g))100$. This value is different from the Standardised Sex Difference (SSD) that is used by Smail (1984). The SSD is based on the score differences divided by the standard deviation of the entire group. This value is independent of the scale on which one measures. A disadvantage of this value is that it does not take into account sufficiently the present differences in standard deviation between the girls' scores and the boys' scores. Because the standard deviation for girls on all scales is smaller than that for boys we did not use SSD but CD.

Table 4.19 Differences in scale scores between boys and girls

scale	school: basis-school (10-12)	2 lbo (13-15)	2 avo-vwo (13-15)	4 havo-vwo (16-18)	1 mbo (16-18)
	Absolute Difference (AD)				
INTEREST	-67	-84	-91	-61	-72
ROLE PATTERN	40	33	38	15	40
CONSEQUENCES	-15	-26	-16	-26	-35
DIFFICULTY	-8	6	-11	3	0
AFFECT	-13	-18	-19	-17	-17
	Corrected Difference (CD)				
INTEREST	-134	-120	-138	-94	-131
ROLE PATTERN	-8	31	-14	34	52
CONSEQUENCES	-69	-102	-42	-157	-131
DIFFICULTY	-38	12	-36	3	-59
AFFECT	-69	-82	-90	-59	-33

n.b. a positive difference means girls score more positive
a negative difference means boys score more positive

At the age of 10-12 the differences are as large as at the age of 16-18 according to table 4.19. The correcting of the score differences has some striking effects, particularly for the CONSEQUENCES scale, where the standard deviations of girls are much smaller than that of boys. The consequence of this is that corrected values lead to far greater differences between boys and girls than the absolute values.

It can be concluded that in the three age groups 10-12, 13-15 and 16-18 a difference in attitude between boys and girls is more related to differences in (the attitude dimensions) INTEREST and CONSEQUENCES, than to DIFFICULTY and ROLE PATTERN.

4.4 Results of the descriptive research

4.4.1 Drawings and interviews among 10 to 12-year-olds

By means of drawings and interviews we investigated the concept of technology among 10 to 12-year-olds. This part of the research was carried out in cooperation with students from pabo's. Children in their classes made drawings and some had individual interviews on technology (see Appendix 4 and 6.4). The children made 263 drawings. An inventory and a categorization of the elements of the drawings has been made. The elements of the drawings were categorized by the pabo students in five categories: 1. products, 2. processes, 3. judgements, 4. place indication and 5. fantasy.

For each of these categories we calculated the reliability of the results of each students. For this purpose a random selection of 20 drawings was analyzed once more by the researcher. The extent of agreement between both results is expressed in a coefficient. This measure for 'inter-rater reliability' is called Kappa-coefficient (κ) (Cohen 1980). The results for the categories are:

κ (product) = .78,
κ (fantasy) = .72,
κ (proces) = .67,
κ (place) = .65,
κ (judgements) = .51.

Only the last category 'judgements' has an inter-rater reliability less then .65.

In table 4.20 we give a survey of the absolute and relative frequencies with which elements occur in the drawings. In one drawing more than one element may occur. When an element occurred less than twice in all drawings it was not listed in the table.

The frequencies are suggesting that boys and girls mostly associate technology with equipment: computers and electrical equipment. Boys however also associate technology with vehicles: particularly cars, aeroplanes and space craft (rockets, satellites). Boys and girls draw relatively few people. Because it is much easier to draw a technological product than a person, it can not be concluded that pupils only think of products and not of persons in relation to technology. What strikes the attention is that when boys draw people this is always a man and girls draw as many men as women.

It is likely that not only associations but also desirabilities appear from the drawings. This appears from the (not reliable) results of the category 'judgements' in which girls show that technology can be harmless, fun and easy as well.

Subsequently short interviews on technology were held with 60 boys and 60 girls. The questions were about 1. the relation technology-mankind and technology-society, 2. the

relation technology-science, 3. the relation technology and skills and finally 4. a number of short questions on the attitude towards technology.
In appendix 6.4 we give the answers to the questions in tables. We summarize the results, in this section. With reference to the relation technology and society it appears that pupils have a limited concept of technology. Most boys and girls immediately think of equipment with reference to technology, only a small number think of human beings (which is in line with the results of table 4.20). They have a rather poor view of their involvement in technology in daily life, more than half of them think they have little or nothing to do with technology. Only few children realize that technology has existed since mankind. They do not see that many people are involved in technology. They find it hard to mention a few 'technical' professions. After 'car mechanic', 'computer expert' and 'electrician' they stop very quickly. As many as 40% of the girls cannot mention a technical profession. Boys score significantly better than girls on three of the four questions on the relation technology-society. The relation technology-science is explored by questions about school subjects that are important for technology. The major part of the girls (39%) cannot mention any subjects. School subjects that are mentioned most often are: arithmetics, mathematics, craft, language and drawing. Most pupils realize that doing things with their hands, inventing and repairing are part of technology, but the repairing of a flat tyre is less 'technical' than working on a computer. The answers to the attitude questions confirm the results of the attitude scales. The differences between boys and girls are even larger than we could suspect on the basis of the scale scores. Compared with girls, boys think that technology is significantly more fun, they want significantly more technology at school and significantly more often they want to work in technology later on. There are no major differences between boys and girls with reference to the evaluative questions. Both think that technology is important, but they also think it is difficult. This last aspect does not agree with the positive scale scores on the scale DIFFICULTY. What is striking as regards these evaluative questions is that boys answer in a more differentiated way than girls. We can conclude that 10 to 12-year-old pupils have a limited concept of technology. They think technology is important and difficult. Boys have a better, more differentiated, concept of technology and are more interested in technology than girls.

Table 4.20 Results of drawing analyses: absolute and relative frequencies

categories and elements	boys (n=139)		girls (n=124)	
	abs.	%	abs.	%
PRODUCTS:				
- radio, tv, video, cd	41*	29.5**	46	40.7
- domestic equipment	15	10.8	20	16.1
- non-electrical equipment	15	10.8	9	7.2
- computer	47	33.8	48	38.7
- robot	6	4.3	6	4.8
- cars	17	12.2	12	9.7
- plane	32	23.0	7	5.6
- boat	8	5.8	2	1.6
- space travel	18	12.9	3	2.4
- bike	3	2.1	5	4.0
- tools	2	1.4	2	1.6
- machines	8	5.8	9	7.2
- building	14	10.1	2	1.6
- rest	9	6.5	12	9.7
PROCESS:				
- a man is busy	20	14.4	12	9.7
- a woman is busy	1	0.7	11	8.9
- something is being made	17	12.2	14	11.3
- something is being invented	2	1.4	3	2.4
- something is being repaired	2	1.4	2	1.6
EVALUATION:				
- dangerous	17	12.2	5	4.0
- not dangerous	20	14.3	30	24.2
- difficult	19	13.7	13	24.2
- easy	10	7.1	15	12.1
- important	35	25.1	19	15.3
- unimportant	5	3.6	4	3.2
- nice/interesting	25	17.9	22	17.7
- not nice/boring	--	--	6	4.8
PLACE INDICATION:				
- school	10	7.1	11	8.9
- factory(workplace)	31	24.5	18	14.5
- home	52	37.5	75	60.4
- street	28	20.1	15	12.0
- space	24	17.2	3	2.4
FANTASY:				
- future	19	13.7	6	4.8
- daily life	69	49.6	81	65.3
- old technology	4	2.9	3	2.4

* 41 boys are drawing radio's, tv's etc.
** 29.5% = 41/139x100

4.2.2 Essays of 13 to 15-year-olds

An analysis has been made of 120 essays on technology, written by 58 pupils from lhno and 62 pupils from lts. After an inventory had been drawn up and a categorization had taken place the analysis resulted in a matrix of 35 elements that can be divided into five categories (see also section 4.1.2). These five categories are: 1. products, 2. process, 3. value-judgements, 4. professions and 5. comprehension of technology. Each pupil/essay could score only once on one of the elements of the groups.

No inter-rater reliabilty was assessed for each group separately. But the results of the essay analysis in the PATT-reseach of Australia (see section 6.3) showed convergence in the naming of the elements and groups (concurrent validity). In table 4.21 the results of the essay analysis are presented.

We can conclude about the results of the essay analysis:

1. boys and girls strongly associate technology with products. Girls have a more narrow concept of technology, they mainly see technology as computers and electricity, whereas boys distinguish more products of technology;
2. neither boys nor girls mention aspects of the process-side of technology very often. Boys score a little better than girls;
3. boys and girls think technology is important, but boys mention the negative aspects more often. Apparently girls consider technology to be something that is particularly suited to boys. Both boys and girls say little about the difficulty/easiness of technology;
4. with reference to technology boys think more of professions than girls;
5. boys and girls think that technology is something modern. Boys are more differentiated than girls in this respect.

Table 4.21 Results of essay analyses: absolute and relative frequencies

categories and elements	boys (n=62)		girls (n=58)	
	abs.	%	abs.	%
PRODUCTS:				
- electricity	5*	8**	17	29
- electrical equipment	12	19	26	45
- non-electrical equipment	3	5	2	4
- buildings	5	8	1	2
- computers/robots	16	26	19	33
- machines	8	13	13	9
- transport	29	47	16	28
PROCES:				
- working with tools	4	7	1	2
- testing	1	2	-	-
- design	3	5	-	-
- inventing	3	5	-	-
- knowledge of materials	3	5	-	-
- to learn how things work	3	5	3	5
- making/repairing	5	8	1	2
- a way of working	5	8	1	2
EVALUATION:				
- positive	41	66	25	42
- negative	20	32	2	4
- easy	1	2	-	-
- difficult	3	5	5	9
- only for man	-	-	20	35
- man + woman	-	-	6	10
- nice/interesting	13	21	2	4
- not nice/boring	1	2	-	-
- nice schoolsubject	13	21	15	26
- boring schoolsubject	-	-	7	12
PROFESSION:				
- technical professions	11	18	-	-
- non-technical professions	1	2	-	-
- a technical father	1	2	-	-
CONCEPT OF TECHNOLOGY:				
- sport	4	7	-	-
- reading-painting-music	2	3	-	-
- animals	1	2	-	-
- modern technology	41	66	33	57
- old technology	5	8	-	-
- third world technology	1	2	-	-

* 5 boys mention 'electricity' in their essays
** 8% = 5/62x100

4.3.3 Definition of technology among 16 to 18-year-olds

Pupils of 4 havo-vwo and 1 mbo were asked 'Describe as well as you can what you mean by technology'. We scored the answers on the basis of characteristics of technology that have been discussed in section 2.1. The scoring criteria are presented in table 4.22.

Table 4.22 Scoring criteria for definitions of technology

1. Technology and Society	"0" points	if technology is regarded as a product, separate from mankind;
	"1" point	no remark;
	"3" points	technology is a cause of progress in society;
	"5" points	man is at the centre of technology;
2. Technology and Science	"0" points	technology is physics, chemistry, etc.;
	"1" point	no remark;
	"3" points	relationship between natural science and technology;
	"5" points	mutual relationship between natural science and technology;
3. Technology and Skills	"0" points	certain skills are not taken as part of technology;
	"1" point	no remark;
	"3" points	technology is making /reparing something, etc.;
	"5" points	design process (design, testing, using, adjusting);
4. Matter	"1" point	no remark;
	"3" points	examples of matter;
	"5" points	abstraction to a pillar of technology;
5. Energy (see Matter)		
6. Information (see Matter)		

The scoring method is reliable. The Kappa-coefficient which expresses the extent of agreement between coders (Cohen 1980) is .84. In table 4.23 we present the results for 4 havo-vwo and 1 mbo.

Table 4.23 Frequencies of scores on characteristics of technology

points	society	science	skills	matter	energy	info.
	havo-vwo (n=1.257)					
0	208	5	3	0	0	0
1	875	1.123	602	1.214	1.210	1.247
3	145	92	603	36	37	9
5	29	37	49	7	10	2
	mbo (n=1.171)					
0	180	13	8	1	1	1
1	857	1.141	548	1.153	1.134	1.170
3	112	17	598	12	31	0
5	22	0	17	2	5	0

The results indicate that none of the four characteristics of technology occurs very often in the answers of 16 to 18-year-olds. The score "1" occurs most often. Only with reference to 'skills' do pupils often mention that technology is 'making something'. On the basis of these results we can conclude that 16 to 18-year-olds do have a narrow concept of technology.

4.5 Conclusion: testing of the assumptions

Assumption 1:

Boys score more positively on most AB-scales than girls. Only on the scale ROLE PATTERN do girls score more positively. On the scales INTEREST, SCHOOL and CAREER the differences are the greatest, on the evaluative scales DIFFICULTY and CONSEQUENCES differences are smaller. On these scales girls score the neutral category more often than boys. From the interviews and essays we cannot conclude that girls make this choice because they think in a more differentiated way about technology. Boys score better on the C-scales than girls, showing boys have a better concept of technology than girls have.

The conclusion is that we can confirm the first assumption: boys have a more positive attitude towards technology than girls.

Assumption 2:

Pupils with technical ambitions score more positively on the AB-scales and better on the

C-scales. We can conclude that pupils with technical ambitions have a more positive attitude towards technology than pupils without this technical ambition. The variable is also discriminating for girls that take a non-technical training.

Assumption 3:
Pupils with a positive technical self-concept score more positively on the AB-scales. As regards the affective and behavioural component of the attitude towards technology we can confirm the assumption.

Assumption 4:
Although pupils with a technical home environment score more positively on the AB-scales and better on the C-scales than pupils with a non-technical home environment, the differences are too small to be able to confirm the assumption.

Assumption 5:
Pupils from technical trainingcourses, score more positively on the AB-scales and better on the C-scales than pupils from non-technical training. This shows they have a more positive attitude towards technology. The assumption that pupils of 'higher' types of education (vwo) have a more positive attitude towards technology than pupils of 'lower' types of education (mavo) is not confirmed.

Assumption 6:
Pupils with a more positive school experience do not score more positive and/or better on the AB- and C-scales than pupils with a negative school experience. The variable does not discriminate for the attitude towards technology, we cannot confirm the assumption.

Assumption 7:
There is a weak positive relationship between the teachers' attitude towards technology and the class' attitude towards technology. This, however, is too weak to be able to confirm the assumption.

Assumption 8:

There is a clear positive relationship between the cognitive attitude component (CONCEPT) and affective behavioural attitude components (AFFECT). From a path model it becomes evident that the direction of this relationship works mainly from the cognitive towards the affective attitude component. We can confirm the assumption and conclude that when pupils have a better concept of technology their attitude towards technology is more positive.

Assumption 9:

(Naturally) older pupils score better on the C-scales than younger pupils. The scores on the AB-scales do not appear to be very different for various age groups. The differences between boys and girls at the age of 10-12 are as large as on the age of 16-18. This confirms the assumption that the attitudes towards technology are rather stable.

Assumption 10:

From interviews, essays and open ended questions on technology it became evident that pupils of 10 to 18 years old have a limited concept of technology.

CHAPTER 5

THE DEVELOPMENT AND EVALUATION OF THE TECHNOLOGY ATTITUDE SCALE

'Generally speaking, we think of educational evaluation as having two distinct and useful purposes- the evaluation of student outcomes and the evaluation of the instructional program. Clearly, both have significance when considering affective education', (H.J. Rokusek 1984, p. 162).

'On a broader ideological level, it is possible to question the need for all students to have a particular positive or negative attitude toward science, technology or any part of life and the environment. Helping students to develop their own informed but not uniform attitudes may have to be both the aim and the limit of our teaching' (J. Moore 1987b, p. 263).

Introduction

In this chapter the third research question is answered: 'How to develop an attitude instrument that can be used by teachers for assessment and evaluation purposes?'.

This question was raised by teachers themselves. During conferences at which the attitude research was discussed Dutch and foreign teachers asked whether it would be possible for them to administer the questionnaire in their own classes and process it themselves. Teachers are accustomed only to measuring knowledge and skills. They do this as part of the summative evaluation of their teaching. The teachers' question is: 'Can we measure also the attitude towards technology of our pupils?'

Various considerations may play a part in this:

1. they want to know their pupils' attitudes and concepts when entering a particular type of education (=assessment),
2. but also what the effect is of a certain teaching method or didactic approach on the attitude towards technology and the concept of technology (=evaluation).

An instrument that can be used by teachers will have to meet two requirements: first of all it has to be reliable and secondly it has to be user-friendly. For this purpose a short version of the attitude questionnaire has been developed, which we called the TAS (= Technology Attitude Scale) and a manual has been written. To find out whether there were any problems related to the use of the TAS an evaluation has been carried out.

It is the objective of the TAS that teachers can check independently the attitudes of their pupils in his/her class towards technology. Therefore a short questionnaire is administered to the class and with help of the manual the teacher has to be able to process and interpret the results of a class measurement. We reduced the affective attitude scales but retained the whole of the cognitive attitude scales, because the latter were rather short already. In section 5.1 the development of the shorter questionnaire is described and in section 5.2 the manual of the TAS.

5.1 Reducing the questionnaire

For the reduction of the AB-scales, reliability criteria of Fraser (1982) in the reduction of Classroom Environment Scales, were used. Van de Sijde et al (1987) developed a short version of the Learning Environment Scale in a similar way. The criteria we used are:

1. the selected items must be part of the first and second version of the questionnaire in view of an optimum availability of standard data and also in view of the continuity of the research,
2. internal consistency: which is enhanced by removing items with small item-rest correlation (i.e. correlations between item score and total score of the rest of the scale),
3. concurrent validity: has been investigated by means of correlations between the long versions and the short versions (the higher the better),
4. discriminant validity: has been investigated by calculating the mean correlation of a scale with the other scales,
5. face validity: preference was given to items with reasonable face validity,
6. a balance between positively and negatively formulated items.

To select items for a reduced questionnaire we analyzed not only data from the Netherlands, but also available data from other countries, namely Denmark, Finland, France, Kenya and Poland. For these countries the results regarding concurrent validity, discriminant validity and internal consistency are presented in table 5.1.

It appears to be possible to reduce the attitude scales to 26 items. If we look at the results from these six countries we may conclude that:

1. there is strong support for concurrent validity of the short forms and this suggests

that the use of short forms is likely to produce results that are quite similar to those obtained by using the long forms. The 34 calculated correlations between long/short forms vary between .81 and .95,

2. a reduced questionnaire does not result in worsening the internal consistency. (It may be pointed out, though, that the internal consistency is low in Kenya and in Poland.),
3. the last two columns of data in table 5.1 show that the values of the mean correlation of a scale with the other scales are quite similar for the long and the short forms. This suggests that the discriminant validity of the short form of each scale is comparable to that of the corresponding long form.

Table 5.1 Concurrent and discriminant validity of the AB-scales

scale	correlation with entire scale	int. consist. (α) long	short	mean corr. with scales long	short
Denmark (n=152)					
INTEREST	.92	.73	.67	.42	.37
ROLE PATTERN	.94	.79	.69	.13	.12
CONSEQUENCES	.89	.65	.68	.34	.28
DIFFICULTY	.87	.53	.65	.15	.11
SCHOOL	.86	.71	.72	.43	.43
CAREER	.90	.83	.85	.46	.38
Finland (n=180)					
INTEREST	.93	.79	.74	.46	.45
ROLE PATTERN	.92	.73	.70	.07	.11
CONSEQUENCES	.91	.74	.76	.42	.40
DIFFICULTY	.91	.68	.69	.30	.29
SCHOOL	.93	.78	.79	.47	.47
CAREER	.95	.85	.82	.52	.46
France (n=234)					
INTEREST	.90	.65	.62	.35	.33
ROLE PATTERN	.91	.75	.75	.68	.10
CONSEQUENCES	.87	.69	.62	.25	.27
DIFFICULTY	.89	.62	.59	.09	.09
SCHOOL	.90	.70	.69	.38	.36
CAREER	.95	.80	.75	.39	.37
Kenya (n=244)					
INTEREST	.88	.57	.48	.35	.32
ROLE PATTERN	.88	.60	.46	.19	.12
CONSEQUENCES	.81	.56	.47	.35	.25
DIFFICULTY	.84	.49	.46	.16	.12
SCHOOL	.81	.53	.54	.35	.28
CAREER	.83	.55	.42	.37	.29
Poland (n=400)					
INTEREST	.88	.61	.59	.35	.27
ROLE PATTERN	.89	.49	.45	.13	.13
CONSEQUENCES	.87	.68	.66	.25	.24
DIFFICULTY	.91	.47	.54	.13	.11
SCHOOL	.82	.51	.49	.32	.30
CAREER	.92	.64	.58	.35	.31
the Netherlands (2 lbo, n=2.469)					
INTEREST	.89	.76	.73	.17	.15
ROLE PATTERN	.89	.77	.70	.15	.12
CONSEQUENCES	.88	.65	.57	.16	.12
DIFFICULTY	.85	.56	.55	.13	.10

The second part of the TAS, the 28 items from the C-scales remained the same. In table 5.2 the alpha values of the questionnaire (four C-scales) are presented for the six aforementioned countries.

Table 5.2 Reliabilities (Cronbach's alpha) of the combined C-scales

countries	n	α
Denmark	152	.78
Finland	180	.91
France	234	.74
Kenya	244	.61
Poland	678	.71
the Netherlands	2.469	.74

For the purpose of this questionnaire the alpha-values are rather low. Moreover, the alpha-values for the individual C-scales are even lower: < .50.

We may conclude that the first requirement, that the TAS is reliable enough, is met as far as the AB-scales are concerned, but not so satisfying where it concerns the C-scales.

5.2 The manual accompanying the TAS

The design of the TAS manual is based on a manual of the 'Wiskunde Belevingsschaal' (WBS, equivalent to Mathematics Attitude Scale). The WBS consists of four scales: Pleasure, Difficulty, Interest and Relevance and it was developed by the CITO (Dutch Institute of Educational Measurement). During the development of the manual for the WBS there was care for the user-friendliness of the instrument for teachers. In the WBS manual one finds an extensive explanation of the meaning and the use of the scale. Before the final version was made an extensive evaluation took place (Martinot 1986).

5.2.1 First version of the TAS-manual

The manual contains the following aspects:

- the objective of the TAS,
- the six AB-scales and the four C-scales,
- the administration of the TAS in the class,
- the calculation of class scores or group scores,
- the interpretation on the basis of norm data.

To speed up the processing sheets with answer models and score forms were developed. The results of a class can be compared with norm data calculated on the basis of national samples. In the manual were taken up tables with norm data for 2 avo-vwo and 2 lbo. The manual is presented in appendix 5.

5.2.2 Evaluation of the first version of the TAS-manual

There were ten technology teachers taking part in the evaluation of the TAS-manual. They used the TAS and afterwards filled out a question form to evaluate the TAS. The reactions of these teachers were processed by Coenen-van den Bergh (1989). In general their experiences are positive. They think it is important that such an instrument exists and consider it a good starting point to get to know their pupils' opinions, certainly because technology is a new subject. All teachers think the division of the scales is relevant and meaningful. It was clear how the TAS should be administered in class and this did not cause any difficulties. There were no problems with the calculation of class scores, only two teachers thought it was difficult. The execution, however, did cause some practical difficulties. For most teachers appeared to have difficulties with working with the answer models. On the whole it took teachers too much time to calculate the scores (two to three hours for one class). The interpretation of the results on the basis of norm data is clear and meaningful to most teachers. One teacher says that he cannot do anything with the results, others mention various fields of application. Most of them use the results during the lessons to take into account their pupils' concept of technology. Another application is a class discussion on the various views of technology. All teachers but one consider it important that the TAS is spread on a large scale.

5.2.3 Second version of the TAS-manual

On the basis of the evaluation a second version of the TAS was developed. This version contains worked out examples to makc the 'manual' processing clearer. The answer models were improved as well. Wherever possible statistical phrases like median and standard deviation were avoided. Because the processing of the data was very time-consuming Coenen-van den Bergh (1989) developed a computer program with which teachers can process the pupils' scores. After the pupils' scores have been entered by the teacher the computer program indicates the mean scale scores. It also indicates whether and to what extent the class score deviates from the norm data and how the class score could be interpreted.

5.3 Conclusion

It appeared to be possible to develop an instrument that can be used by teachers in class. For this purpose short versions of the six AB-scales and a manual have both appeared to be functioning well. Because the results can be processed by means of a computer the TAS is accessible for technology teachers. The TAS is already a permanent component in the programme of two teacher training institutes. It appears that most (starting) teachers are hardly aware of the starting situation of pupils in their subject. Especially in technology the differences are substantial, because of the prominent role of highly varying out-of-school experiences. Under the influence of the training they do realize that there are differences between pupils, from a cognitive as well as from an attitudinal point of view (Deysselberg 1988). However, the TAS still has some disadvantages:

1. the reliability of the four concept scales is doubtful, because the shorter and more reliable (Mokken) scales are not used (see chapter 3), but only the full first version of the concept scales. At this point the TAS needs to be improved;
2. on the basis of the available data more norm data can be provided, divided into gender, age, school types and even into foreign data;
3. the TAS is not suited for use at an individual level, the instrument is not reliable enough for this. A possible extension of the TAS with elements from the Fukuyama profile, with which pupils can get some ideas about their career opportunities (Deysselberg 1988), must be rejected for this reason.

CHAPTER 6

THE RESULTS AND THE RELEVANCE OF PATT

> 'In Kenya, when you talk about technology, the tendency is to be understood as referring to communication and technology of education departments, or to a laboratory technologist or vaguely to be referring to something related to engineering. The thruth is, technology still presents a big problem with its meaning to a majority of people. To those with some understanding of it, there is a tendency to detest working in its field because it has no ready answers, neither does it have right or wrong answers. And due to the poor understanding of technology, the tendency is to get some resistence in curriculum innovation to include technology education' (R.J.A. Kapiyo 1988, p.280).

Introduction

The fourth and last research question is: 'What are the results of the PATT research and what is its relevance?'. PATT stands for 'Pupils' Attitude Towards Technology' and it is the name of an international research project started in 1985 by Raat and De Vries. They invited researchers to translate and use the questionnaire they had developed. The response to this was large. This can be explained by the little interest there had been up to that time at an international level in technology in general education and in technology research in technology education in particular.

Four international conferences have been held in Eindhoven, at which the results of PATT-research have been discussed. From the third conference onwards the accent of these conferences has shifted from the pupils' attitude research to curriculum development. The main theme of the third conference was 'Basic Principles of School Technology' (PATT-3 1988) and of the fourth conference 'Teacher Education for School Techology' (PATT-4 1989). If we look at the research designs carried out in the framework of PATT we can distinguish four types of research:

1. *pilot studies* with the original 78-item questionnaire. It was the aim of the pilot studies to determine the reliability and validity and to develop an instrument with attitude scales on the basis of the results (PATT-1 1986),
2. *survey studies* with the PATT instrument consisting of six affective-behavioural attitude scales (AB-scales) and four cognitive attitude scales (C-scales). It was and is the aim of these studies to describe the attitude towards technology of pupils (PATT-2 1987 and PATT-3 1988),

3. *essay studies* on technology. It is the aim of the essay studies to categorize the contents of essays in order to describe the understanding pupils have of technology (PATT-2 1987 and PATT-3 1988),
4. *effect studies*, these are studies in which technology programmes are evaluated by means of pre- and post-tests with the attitude scales (PATT-4 1989).

Effect studies did not start until spring 1989 and results are not available yet (De Klerk Wolters et al 1989). The results of PATT-studies will be discussed on the basis of the first three research types. In the presentation of the results we confine ourselves to four countries: Australia, France, India and Poland, because these countries vary considerably from a social-geographical point of view and because the research that was carried out there is representative of PATT research in other countries. As a reference we use the reports of the PATT conferences. Table 6.1 gives a survey of research types the four countries chose.

Table 6.1 Survey of PATT-research in four countries

	pilot	survey	essay
Australia	+	-	+
Poland	+	+	+
France	-	+	-
India	-	+	+

To value the relevance of PATT for technology education we asked the participants in the PATT research to answer the following three questions:

1. What are the main results of your PATT research?
2. What is the relevance of your research? Are the results used in one way or another?
3. What do you think of your results in an international perspective? Is it possible to draw comparisons between the results of countries?

The results of PATT research are discussed in the sections 6.1 - 6.4. In section 6.5 the relevance of PATT is discussed.

6.1 Results of the pilot studies

The reliability and validity of the 78-item questionnaire was tested in ten countries: in Australia, Belgium, Canada, Hungary, Kenya, Nigeria, Poland, Sweden, the United

Kingdom and the U.S.A. (state Georgia). An average number of 200 pupils took part in the pilot studies. We checked the data from all partaking countries by means of the following statistical procedure:

1. frequency analysis to check the normality and response set of individual items,
2. correlation analysis to find the reliability of the questionnaire by means of the item-total correlations (with Cronbach's alpha as a central criterion),
3. factor analysis to find the construct validity of potential attitude scales (Raat et al 1986).

The results from Australia, Belgium, Canada, Hungary, Sweden, UK and USA show that the questionnaire is sufficiently valid and reliable. The alpha values of the entire list of 78 items are on average above .85 and moreover, construct validity has been shown for at least four attitude scales: 1. INTEREST 2. ROLE PATTERN 3. CONSEQUENCES and 4. DIFFICULTY. For the reliability and validity of the data from Poland, Nigeria and Kenya there was found less empirical evidence. On the basis of the empirical results an international instrument was made.

Pilot study in Australia

The pilot study was carried out by Parker and Rennie (1986). The sample consists of 109 boys and 117 girls of about 13 years old. The sample is representative for pupils living in a metropolitan area (Perth) as regards academic ability and socio-economic status. The pupils have a limited background in science and technology education. The analysis focussed on the item characteristics and scale dimensionality.

The item responses show a remarkable answering pattern. Of the 78 items 27 items show a mode of 3, the midpoint, whereas 13 items had a mode of 1 or 5, the extremes of the response choices. See table 6.2 for a survey of some answers.

Table 6.2 Response Characteristics in percentages for some items about technology (Australia)

item	respons category					Mean
	SA (1)	A (2)	UD (3)	D (4)	SD (5)	
Technology is very important in life.	45	41	12	2	0	1.72**
In everyday life you do not have to do much with techn.	7	24	26	27	16	3.23
A hundred years ago there was no technology.	12	14	31	22	21	3.28*
I do not know what the word technology means.	11	16	22	34	17	3.31**
To design an appliance is not a part of technology.	1	5	38	31	25	3.73*
I cannot list many technical jobs.	11	26	27	23	13	3.02**

* p < .05, ** p < .01: boys' mean is significantly more positive than girls' mean on these items

According to Parker and Rennie the high percentage of undecided responses does not only indicate a lack of opinion, but also lack of awareness, as many of these items relate to the nature of technology. Table 6.2 shows that pupils plainly think that technology is important, but also that they have little understanding of technology. The results of the pilot study also indicate that generally boys are more aware of, more interested in, and have more experience in technology than girls. On the item *'I would like to work in technology later'* the mean score for boys is 2.7 and for girls 3.2. Both boys and girls find it difficult to make a choice. But at the age of 15 career-related decisions have to be made. According to Parker and Rennie this research shows the need for a separate subject 'technology' in the secondary school curriculum, so that pupils get a more balanced concept of technology.

From the factor analysis it becomes evident that a number of clear dimensions can be distinguished in the attitude towards technology. A factor reflecting interest is most important. This factor explains 30.5% of the variance. Other factors were named: 'scope of technology' 14.2% of the variance, 'sex differences' 8.3% of the variance, 'consequences of technology' 7.5% of the variance and 'difficulty of technology' 4.7% of the variance. Cronbach's alpha of the 78 items is .86.

Pilot study in Poland

The study was carried out by Szydlowski (1986). The sample consists of 100 boys and 100 girls of 13 years old from the city of Poznan. It appears that a literal translation of the questionnaire leads to difficulties. This particularly applies to the negatively worded items. The item-total correlations are low (on average below 0.20) and also the Cronbach's alpha for 78 items is relatively low (0.79). The results of the factor analysis indicate that there are three factors that can be named fairly well: 'interest in technology', 'consequences' and 'importance of technology' and 'role pattern'. These three factors account for 35% of the total variance.

6.2 Results of the survey studies

The instrument developed after the first PATT conference and still used consists of six scales measuring the affective and behavioural components of the attitude towards technology: INTEREST, ROLE PATTERN, CONSEQUENCES, DIFFICULTY, CURRICULUM and CAREER, and four scales measuring the cognitive component of the attitude towards technology: SOCIETY, SCIENCE, SKILLS and PILLARS. With this new instrument, presented for the first time in PATT-Newsletter No. 01, research was carried out in thirteen countries: Belgium, Denmark, Finland, France, India, Italy, Kenya, Nigeria, Mexico, Poland, Portugal, Surinam and the United Kingdom. During the PATT-2 conference (1987) these scales were evaluated. The experiences with this new instrument were positive, be it that a number of methodological problems were noticed:

1. there is still insufficient evidence for the reliability and validity of the cognitive attitude scales,
2. the ROLE PATTERN scale correlates very weakly or sometimes even negatively with the other affective scales,
3. there is no uniformity in the formulation of the statements; some formulations are in the 'I-form' and others are formulated in general terms,
4. some statements cannot be translated without changing the original statement. Sometimes translations cause double negations in statements (i.e. in Polish), which pupils find very difficult (Raat et al 1987).

In spite of the methodological deficiencies it was decided at the PATT-2 Conference (1987) that no major changes would be made in the AB- and C-scales, because changes would harm the continuity of the PATT-research. It was also posited that the instrument is not a 'test instrument' but a 'descriptive instrument'. This choice had consequences for the continuation of the PATT research. It is not possible to compare the results of countries in a quantitative way, as in the IEA Second Science Study for example. This is because the cultural differences between African, East European and Western countries are too large. The attitude instrument does provide the opportunity to describe the attitude towards technology among youngsters for each country separately. For countries that are very similar from a cultural point of view cross cultural comparisons can be made (for example amongst East European countries). It is against this background that one has to judge the results that are obtained with the instrument in the period after PATT-1 (1986).

Due to the aforementioned methodological difficulties essays on technology were used in the PATT research in addition to questionnaires.

Survey studies from France, India and Poland are discussed next.

Survey study in France

In 1986/1987 Terlon (see Coenen-van den Bergh 1987) carried out a small scale study among 234 pupils (122 girls and 112 boys) of 13/14 years old from the second form of secondary general education. The pupils did not have technology in education. The purpose of the study was to get information about the validity and the reliability of the attitude scales and to describe the attitude towards technology and investigate the possible influence of some background variables on the attitude towards technology. The dependent variables of the study were the ABC-scales. The independent variables were: gender, parents' level of education, parents' professions, family situation, the use of toys in childhood, influence of parents on motivation for school, pupils' self-assessment and selfconcept. Furthermore it was checked whether there were any differences between pupils from rural and pupils from urban areas.

In table 6.3 the mean scores on the ABC-scales are presented and the reliability coefficient alpha of each scale is given.

Table 6.3 Boys' and girls' mean scores on ABC-scales and Cronbach's alpha (France)

scale	boys (n=112)	girls (n=122)	α
INTEREST	2.3	2.7*	.65
ROLE PATTERN	2.3	1.8*	.75
CONSEQUENCES	2.5	2.6	.68
DIFFICULTY	2.7	2.6	.62
SCHOOL	2.6	2.9*	.71
CAREER	2.6	3.1*	.83
SOCIETY	.49	.42*	.59
SCIENCE	.39	.34*	.50
SKILLS	.59	.59	.48
PILLARS	.60	.48*	.42

* sign. difference ($p < .05$)

The results of the French pupils of 13 to 15 are very similar to the ones we found among Dutch pupils of 13 to 15 (see table 4.5): boys scoring more positively than girls on the AB-scales INTEREST, CURRICULUM and CAREER and better on the C-scales SOCIETY, SCIENCE and PILLARS. Girls score more positively than boys on the scale ROLE PATTERN. On the scales CONSEQUENCES and DIFFICULTY the differences between boys and girls are not significant. The data on reliability and validity are also similar to the Dutch results: acceptable alpha values for the AB-scales and low alpha values for the C-scales. The construct validity was checked by means of factor analysis. The items from the AB-scales are divided into four factors: a broad interest factor that accounts for 44.7% of the total variance, a role pattern factor that accounts for 21.3% of the total variance, a consequences factor that accounts for 10.2% and finally a factor difficulty that accounts for 8.8% of the variance. The four cognitive attitude scales are not validated empirically by means of factor analysis.
Of all the independent variables in the study the variable gender is the only one that correlates significantly with the scores on the attitude scales. There is a significant correlation between the total scores of the AB- and C-scales (r = -.35), which means that a good score on the C-scales is related to a positive score on the AB-scales.

Survey study in India

Rajput (1987, 1988) carried out two PATT studies in India. The first study concerned an attitude research among 625 pupils of about 14 years old from the city of Bhopal (capital of Madhya Pradesh). In this investigation he used the attitude scales and essays

(Rajput 1987). The second study concerned an attitude research among 1.167 pupils of 16 (on average) in the state of Madhya Pradesh. For this investigation Rajput used the original 78-item questionnaire that was discussed during PATT-1 (Rajput 1988). Both studies are summed up.

1. Investigation among 14-year-olds

The pupils that took part in the study were from various socio-economic groups of the urban area of Bhopal. None of them had had technology lessons at school. It was the aim of the study to gain insight into the attitude towards technology. The hypotheses to be tested was that pupils would have an incomplete concept of technology and that this would be different for boys and girls.

The results of the concept questionnaire (C-scales) confirm the hypotheses that girls have a less differentiated concept of technology than boys. From the response characteristics it becomes evident that boys choose neutral more often than girls. Boys more often have 'no concept' instead of a 'wrong concept'.

By means of chi-square tests it was investigated whether boys and girls score differently on the items of the AB-scales INTEREST, ROLE PATTERN, DIFFICULTY, CONSEQUENCES, CURRICULUM, CAREER. By way of illustration we present the results of 4 items from the INTEREST-scale in table 6.4.

Table 6.4 Response characteristics for some interest items (India)

	response category (abs.)					
items*	SA (1)	A (2)	UD (3)	DA (4)	SDA (5)	χ^2
1.boys	178	64	21	5	4	
girls	168	52	4	2	0	14.24**
2.boys	127	106	18	14	8	
girls	111	88	11	11	6	.86
3.boys	27	27	30	106	83	
girls	31	26	18	82	71	3.28
4.boys	22	19	28	93	111	
girls	9	4	29	132	53	65.92**

* the corresponding items are:
1. When something new is discovered I want to know more about it.
2. I like to read technological magzines.
3. I am not interested in technology.
4. A technical hobby is boring.

** sign. difference (p < .001)

Rajput calls the differences between boys and girls marginal. Yet there are 48 items (out of 60) on which boys and girls differ significantly. Boys score significantly more positive than girls on all scales except for the scale ROLE PATTERN. Rajput thinks that the attitude towards technology is remarkably positive. According to him this reflects the high status of technology and technical professions in India at the moment. He thinks that the concept of technology is rather limited, certainly if technology is seen as something passive (knowledge based).

2. Investigation among 16-year-olds

The study was carried out by means of the original 78-item questionnaire that was discussed during PATT-1 and not by means of the AB- and C-attitude scales that were developed later. This was a deliberate choice. Studying the concept of technology (by means of the concept questionaire) is according Rajput too complicated and foredoomed to failure, certainly in the rural parts of India. According to Rajput this is related to the fact that conceptualization is a higher mental process than feelings and reactions. Rajput points out that in developing countries, other than in developed countries, an attitude precedes a concept.

The aim of the study is a projection of gender and social setting over attitudinal differences to technology. With the independent variable 'social setting' is meant the rural and urban environment in Madhya Pradesh that may be relevant to attitudes towards technology.

> As in other developing countries the researcher has to be present at the time of administration. This because the post does not function and the questionnaire itself may cause many difficulties. Some items appear to be totally unfamiliar to pupils and others are not understood because of language problems. In India, apart from Hindi, there are at least 15 official languages, and there are dialectal variations every 15 kilometres. Furthermore students in rural areas are not familiar with filling out questionnaires.

Because the original questionnaire did not consist of scales Rajput himself made a number of item-groups: I. Importance, II. Nature, III. Interest, IV. Competency, V. Prospects and VI. Global Significance. As in the first study he first investigates the influence of independent variables (boys-girls and rural-urban) by means of chi-square tests. The scores on individual items of: 1. urban boys and girls, 2. rural boys and girls,

3. rural boys and urban boys, and 4. rural girls and urban girls are compared. Although rather a lot of statistically significant differences on item scores are shown (for each of the groups that are to be compared: 22, 17, 27 and 26 out of 78 respectively), differences that in fact do point at differences in attitude, the general conclusion of Rajput is that sex and social setting have a minor effect on the attitude towards technology. In his opinion the technological movement virtually revolutionalized the entire Indian social spectrum.

Survey studies in Poland

In Poland more than one survey study has taken place. The studies have been carried out by Szydlowski and his coworkers Dudziak, Oleniacz and Grodzka-Borowska (1987, 1988). By Ogar (1987) a limited study has been carried out with the concept instrument.

1. Survey studies with AB-scales

With the six AB-scales studies were done among 13 to 14-year-olds (elementary school) and among 16 to 17-year-olds (high school). The scale scores are presented in table 6.5.

Table 6.5 The scores on AB-scales (Poland)

scale	elementary school (n=400)	high school (n=400)
INTEREST	2.59	2.72
ROLE PATTERN	2.95	3.01
CONSEQUENCES	2.24	2.12
DIFFICULTY	3.04	3.02
SCHOOL	2.30	2.95
CAREER	3.07	3.06

No significant difference ($p > .05$) was found on the attitude scales for these two age groups. The scale scores point at neutral attitudes towards technology. From the score distribution from High School students it appears that the attitude is not as neutral as the scale scores lead us to suspect. Both in the negative and in the positive response groups high percentages occur. See table 6.6 for this.

Table 6.6 The distribution of the answers for AB-scales of High School Students (Poland)

		distribution (%)		
scale	mean	1-2	3	4-5*
INTEREST	2.72	52	17	31
ROLE PATTERN	3.01	36	19	45
CONSEQUENCES	2.12	70	17	13
DIFFICULTY	3.02	27	24	39
SCHOOL	2.95	42	23	35
CAREER	3.06	34	30	36

*
1-2: strongly agree/agree (positive attitude)
3: undicided (lack of opinion)
4-5: disagree/strongly disagree (negative attitude)

An explanation of this may be the composition of the sample. This consists of student of physics-mathematics and students that are taking social studies. This is confirmed by the results of t-tests on the scores of individual items: the school profile appears to have an effect on the scores, with students from the physics/mathematics profile having a more positive attitude. Sex appears to be even more important than schoolprofile. Parents' profession appears to have no effect on the scores.

2. Survey studies with C-scales

With the C-scales two investigations, independently of one another, have been carried out; one by Dudziak and one by Ogar. In both cases it concerned pupils of 13 to 15 years old. The scale scores are presented in table 6.7.

Table 6.7 Scores on C-scales in two Polish studies

scales	first study		second study
	boys (n=61)	girls (n=91)	(boys + girls)* (n=321)
SOCIETY	.66	.61	.63
SCIENCE	.60	.69	.65
SKILLS	.60	.68	.56
PILLARS	.61	.55	.58

*No data available of boys and girls

The scores of the two studies do not differ significantly ($p > .05$), which points at concurrent validity. It strikes the attention that on the whole girls score better than boys on the concept items. However, the differences are not significant ($p > .05$). Furthermore it is striking that compared with the Netherlands and France (and also with other countries that are not specified here) the scale scores are high. This probably indicates the long tradition of technology in education, particularly by way of the subject 'Work and Technology'. This subject is already taught for two hours a week in grades 4-8 of primary education (ages 10-14).

Both researchers use the individual item scores and not the scale scores in the presentation of the results. On the basis of the item scores conclusions are drawn concerning the existing curriculum 'Work and Technology'. Thus Polish researchers think that the questions referring to the pillars of technology are answered badly because this is not sufficiently emphasized in the 'Work and Technology' curriculum.

6.3 Results of essay studies

In the first PATT Newsletter an outline was given for the analysis of essays on technology. The method was used in the essay study among pupils from 2 lbo. What it comes down to is that first elements of the answers are categorized in a manageable matrix. Furthermore it is suggested to check relevant associations by means of chi-square tests. We discuss the results of the essay analyses in Australia, India and Poland.

Essay study in Australia

Rennie (1987b) analyzed 212 essays on technology. Without any information in advance 13-year-olds were asked to write down in ten minutes what they meant by technology. Considerable care was taken in the development of the category system in order to avoid the possibility of imposing a structure on the essays. The 212 essays were divided into batches. A first batch to establish an initial framework for analysis, a second batch was used as 'check sample' and a third batch was then analysed using a final classification system. A representative sample of essays from the first batch was examined independently by two coders, who developed a preliminary inventory, which was later checked by other coders using another part of the batch. The check sample was again independently analyzed by two coders. Agreement between the coders was complete. The system consists of four levels. The lowest level are the individual elements that are mentioned in the essays. These are combined into groups and main groups. The highest level are so-called dimensions: the 'Product dimensions', the 'Process dimension', the 'Social dimension', and an 'Incorrect concept' of technology'. The Product dimension comprises the groups: electrical equipment, computers, buildings, etc. The Process dimension comprises: using knowledge, skills, exploration, industry, and the Social dimension: societal aspects, attitudes. Only an extremely small number of essays was classified as 'incorrect': only 1%. The Incorrect dimension includes wrong concepts like 'technology is a recent thing', 'technology did not exist before technology', 'technology is intelligence', etc., and don't know answers.

In table 6.8 a survey of the results per dimension for three school types is given. The results indicate that a quarter of the responses were categorized into the Product dimension and over a third into the Process and Social dimensions. This pattern is the same for the three school types. It is striking that no regular differences between boys and girls are found.

Table 6.8 Distribution of essay-responses by dimensions and school (Austalia)

dimension	urban private		urban government		rural government		
	boys	girls	boys	girls	boys	girls	total
Product	85	98	28	39	41	47	338
	28%	29	26	32	23	25	27
Proces	121	134	41	31	66	72	465
	40	40	38	25	37	38	37
Social	97	102	37	52	71	70	429
	32	30	35	42	40	37	35
Incorrect	2	5	1	1	1	1	12
	1	2	1	1	1	1	1
total	305	339	107	123	179	191	1.244

Note: Figures on each second line are the colom percentages of responses in each dimension

If we compare the results of the Dutch and the Australian essay analysis it strikes the attention that the dimensions (or categories) that are the result of categorization are the same in both investigations. A difference is 13-year-olds in Australia mention the process-side of technology more often than the Dutch (2 lbo) pupils.

Essay study in India

Rajput (1987) investigated 125 essays on technology. They were written by 13 to 15-year-olds. He too made categorizations the way it was suggested in the PATT Newsletter. There are, however, no frequency data. From the analysis it becomes evident that boys have visualized the concept of technology from five dimensions:

1. technology as a branch of knowledge,
2. technology as an offshoot of scientific laws,
3. technology as a practical base improving our daily life,
4. technology as a technique helping in the operation of machines,
5. technology as the process to save time, money and energy.

Girls show a more narrow concept of technology in their essays and visualized technology from three dimensions:

1. technology refers to science,
2. technology is a practical knowledge,
3. technology is that process which saves our time.

Rajput considers the idea that technology is 'an abstract body of knowledge' is a narrow concept of technology.

Girls and boys think differently about the advantages and disadvantages of technology. Girls put the advantages in a narrow perspective: they show concern for their personal needs in the home and around. Boys look at the advantages of technology in a wider social area. Girls are more aware of the disadvantages of technology than boys. Girls associate both individual and international problems with the disadvantages of technology.

Essay studies in Poland

Essays on technology have been analyzed by Dudziak (1987) and Oleniacz (1988). The sample consists of 13 to 15-year-olds (264 essays) and of 16 to 18-year-olds (202 essays). The aim of the studies was to find out what the word 'technology' means to the students. In the essays three questions had to be answered:

1. what do you think technology is,
2. is technology important or not,
3. is technology good or bad in itself?

An inventory was drawn up of the answers to the first question and afterwards the answers were categorized into groups and concepts the way it was suggested in the PATT Newsletter. The concepts are comparable with dimensions (Australian categorization) or main groups (Dutch categorization). Both for 13 to 15-year-olds and for 16 to 18-year-olds there appear to be four concepts that reflect what they mean by technology. These are:

1. research and creative work: this refers to inventing and improving existing technology products,
2. technology products: electronic devices, home equipment, computers, machines, transport, etc.,
3. technology as science: this comprises all remarks in which technology is regarded as a science, or as an application of exact science,
4. technology as a school subject, this technology concept includes remarks that technology is a school subject: 'Work and Technology' or 'Physics'.

In tables 6.9 and 6.10 the results are presented in the form of percentages that indicate how often a concept occurs in the essays.

Table 6.9 Frequencies of essay-responses of 13 to 15-year-olds in percentages (Poland)

concepts	boys (n=134)	girls (n=130)
Research	56	43
Product	90	64
Science	26	46
Schoolsubject	3	15

Table 6.10 Frequencies of essay-responses of 16 to 18-year-olds in percentages (Poland)

concepts	boys		girls	
	A (n=26)	B (n=25)	A (n=71)	B* (n=80)
Research	36	36	27	44
Product	90	81	89	92
Science	84	36	71	42
Schoolsubject	12	23	23	25

* A = mathematics and physics profile
B = humanistic profile

The tables show that Polish students strongly think of products with reference to

technology. There is little difference between boys and girls in this respect.
Also technology is often associated with research and science. This applies to a greater extent to students of mathematics and physics than to students of social studies. It strikes the attention that in the essays there is no mention of the relation between technology and mankind or between technology and society. The essays appear to be a reflection of the current Polish definition of technology, in which technology is regarded as a means of production and as an applied science.
From the answers to the questions 2 and 3 (on the consequences of technology) it appears that 100% of the students associates technology with development and progress. Only 25% of the students mentions negative aspects of technology: viz. pollution and arms race. 3% of the respondents claimed that the development of technology may be an indirect cause of unemployment in capitalistic countries.

6.4 Discussion of the results

The PATT research mainly has a descriptive character. The analysis of the data at the item-level, the way this was done in Poland and India, is an expression of this. The attitude instrument is used as a normal questionnaire and not as an instrument with attitude scales. This seems to be acceptable for the non-western countries, because there is hardly any data on the reliability and validity of the questionnaire. In these instances the original questionnaire is as informative as the attitude scales that were developed later on.

For the developed countries like Australia, France and the Netherlands, the attitude instrument seems to be reasonably reliable and valid. The use of scales rather than items is appropriate.
If we look at results (eg. of the French and Dutch study; table 4.5 and 6.3) it is striking that the scale scores in different countries are very much alike. It seems as if pupils in developed countries have more or less the same attitude towards technology. The scores on the six AB-scales vary between 2 and 3 and they point at a positive attitude towards technology. The scores on the four C-scales are low, which point at a narrow concept of technology. Gender is an important variable that western countries have in common for the explanation of differences in attitude. Both in an affective and in a cognitive sense boys have a more positive attitude than girls.

The differences in attitude between boys and girls are less evident in the essays. From the analysis of essays in Australia, India, the Netherlands and Poland it appears that the concept of technology among pupils is determined by three dimensions of technology:

1. product dimensions: technology regarded as a collection of products,
2. process dimension: technology is a collection of knowledge and skills,
3. social dimension: evaluative aspects of technology.

6.5 Relevance of PATT studies 1986-1989

What meaning can we place on PATT studies so far? What did it yield for technology education? PATT researchers have been asked to indicate the most important research results and their relevance and also to discuss possibilities for international comparisons. In table 6.11 a survey is given of researchers responding to this request.

Table 6.11 PATT researchers and type of their study

name	country	type of PATT study
1. S. Galvan	Mexico	pilot
2. P.J. Williams	Zimbabwe	survey
3. J.S. Rajput	India	survey, essay
4. T.A. Balagun	Nigeria	pilot, survey, essay
5. R.J.A. Kapiyo, F. Otieno	Kenya	pilot, survey, essay
6. H. Szydlowski, G.Dudziak	Poland	pilot, survey, essay
7. J. Ogar	Poland	survey
8. U. Riis	Sweden	pilot, survey
9. L. Rennie, L. Parker	Australia	pilot, survey
10. J.L. Moore	England	survey
11. I. Natali	Italy	survey
12. E.A. Bame, W.E. Dugger	U.S.A.	pilot, survey

From the reactions it becomes evident that the results of PATT studies play a role on two levels: politics-policy-wise and educational.

1. *Politics-policy-wise*

   The research supplies the arguments for the introduction and/or maintaining of a subject technology in general education. PATT research sees to it that policymakers become aware of the differences in concept of technology and attitude towards technology of boys and girls in particular. Rajput: 'Presently an attempt is being made to prepare a fertile land for this new subject, so that there should not be much difficulty in bringing technology as a separate subject, PATT will work as a green signal'. Riis: 'the subject "general technology" will run a risk of being eliminated, a risk which can be avoided by pointing to the PATT-results'.

2. *Educational implications*

2.1. curriculum development

In the design and developing of new technology curricula certain preconceptions of technology and interests in technology of pupils are taken into account more explicitly than before. Balogun says: 'It enabled us to carry out some kind of formative evaluation, and evaluation of antecedents- with particular reference to the pupils, of the introductory technology that is being introduced into Nigerian junior secondary schools'.

2.2 curriculum evaluation

The instrument is used or will be used for the evaluation of existing technology programs. The PATT instrument is used for this purpose because it is not grafted onto technology programs, but is general in nature. It is possible to investigate whether the attitude towards technology is affected positively by a technology program (a new curriculum, an inservice training). Rennie: 'The PATT-questionnaires have been found very useful as a basis for the evaluation of West Australian programs. PATT research has been an important factor in helping to first- raise awareness of problems and issues, second- help to establish a statistical data base for describing these issues and third- assist in monitoring changes and interventions'.

Some of the respondents endorse the opinion that international comparisons with these instruments are difficult. Dudziak and Szydlowski say: 'We did some comparisons. The conclusion may be that it is difficult to compare and have valuable results as regards details'. Others think that it is possible to compare the results. Riis, as member of the Swedish national committee for the IEA second science study since 1985, says: 'certainly possible, but extremely expensive and time-consuming, if done with careful planning and scrupulous treatment of data and thorough analysis of curricula'. Most of the respondents think that it is only possible to compare the countries that have the same cultural background. Moore and Rennie are drawing some conclusions from the results of the Western countries. They believe that the scale scores between the Western countries in particular differ so little, that it may be concluded that from an international point of view pupils have the same attitude towards technology. This attitude is, according to Moore, similar to the attitude towards science: 'Both (science and technology) show many common features in different countries and cultures, both show slow change(s) with pupil-age, and well-understood gender-differences. The known features of the stability of pupils' (erroneous) scientific beliefs will also apply to their erroneous, incomplete or biased views of technology, its uses and its effects'.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

Introduction

In this chapter firstly the conclusions of the study are presented by answering the four research questions formulated in chapter 1 and discussing the output of the study.
The output of this attitude study can already be found in several applications in technology education. We confine ourself to the Netherlands.
Also recommendations are presented. Recommendations that follow directly from this study can also be looked upon as research outputs.
In paragraph 7.1 the answers on the research questions are given. Applications of the attitude study in the Netherlands are described in section 7.2. The rècommendations following from this study are discussed in paragraph 7.3.

7.1 Answers to the four research questions

The problem statement of the study is 'What is the attitude of boys and girls towards technology?' In order to be able to answer this more general question we formulated four research questions. The first two research questions were directly deduced from the problem statement:

- research question 1:

  'Is it possible to develop an instrument with which we can measure among pupils from 10 to 18 years old:

  a) the affective, cognitive and conative attitude components of the attitude towards technology, and,

  b) the various dimensions of technology in the attitude towards technology?

- research question 2:

  'Is it possible to describe the affective, cognitive and conative components and dimensions of the attitude towards technology for pupils from 10 to 18 years old?'

The research questions 3 and 4 are related indirectly to the problem statement. Question 3 refers to the possiblity to provide technology teachers with an instrument that measures the attitude towards technology in the class. The fourth research question deals with the international extension of the attitude research in the PATT-project.

- research question 3:
  'Is it possible to develop an attitude instrument that can be used by technology teachers for assessment and evaluation purposes?'
- research question 4:
  'What are the results of the PATT research and what is the relevance?'

Answer on research question 1

The development of the instrument is based on an existing 78-item questionnaire developed and used by De Vries. This original questionnaire consists of statements representing various aspects of technology. The questionnaire was developed for a specific target group: pupils of 13 to 15 years old belonging to 2 avo-vwo. Based on this questionnaire we developed an instrument for the broader target group of 10 to 18-year-olds. It consists of six scales measuring the affective and behavioural components of the attitude towards technology (so called AB-scales) and four scales measuring the cognitive component of the attitude towards technology (so called C-scales). The proces of developing AB- and C-scales out of the 78-item questionnaire can be explained by the following steps.

The steps in the development of AB-scales are:

1. collect information about 'aspects of technology' in the mind of the pupils, by interviews and open questionnaires,
2. formulate items (either from the 78-item questionnaire or new items) to operationalize 'aspects of technology',
3. test these 'aspects of technology' and items and identify potential attitude scales using factor analysis,
4. construct final attitude scales using item analysis.

The names of the AB-scales are: INTEREST, ROLE PATTERN, CONSEQUENCES, DIFFICULTY, SCHOOL, CAREER.

The steps in the development of C-scales are:

1. describe technology in five characteristics,
2. formulate items for each characteristic,
3. construct final attitude scales using Mokken scale analysis.

The names of the C-scales are: SOCIETY, SCIENCE, SKILLS, PILLARS.

The results of the scale development are six AB-scales and four C-scales that can be used among 10 to 18-year-olds. Depending on the target group common and unique items can be used. The common items are necessary to make comparisons between age-groups.

Answer on research question 2

With the AB- and C-scales measurements took place among three age groups: 10 to 12-year-olds, 13 to 15-year-olds and 16 to 18-year-olds. To make the scores on the scales meaningful, we have compared different groups of pupils that were defined and separated by variables, (GENDER, AMBITION, KNOWLEDGE, SCHOOL CHOICE, TEACHER ATTITUDE, HOME ENVIRONMENT). The choice of each variable is related to assumptions to be tested (at the $p=.05$ level). This resulted in following conclusions:

- 'boys' have a significantly more positive attitude towards technology then 'girls',
- pupils with 'technical ambition' have a significantly more positive attitude towards technology then pupils without 'technical ambition',
- pupils with a positive 'technical self-concept' have a significant more positive attitude towards technology then pupils who do not have a positive 'technical self-concept',
- pupils with a technical 'home environment' have significantly more positive scores on the scales INTEREST, SCHOOL and CAREER and a better score on the scales SOCIETY and PILLARS than pupils with a non-technical 'home environment',
- there is no significant difference between pupils of 'higher' types of education (vwo) and 'lower' types of education, pupils of technical types of training have a (significant) more positive attitude towards technology then pupils from non-technical types training,
- there is no significant difference between pupils with a positive 'school experience' and a negative 'school experience',
- there is a positive (but not significant) relation between 'teachers' attitude towards technology' and the 'class' attitude towards technology',
- there is a significant positive relation between 'concept of technology' and 'affection towards technology',
- the attitude towards technology is rather stable among age groups. Attitudinal differences between boys and girls are at the age of 10-12 as large as at the age of 16-18.

Because parts of the AB- and C-scales are not useful when used among 10 to 12-year-olds and also because spontaneous information about the concept of technology is lacking for the whole group, additional methods were used. These methods, based on drawings, interviews (age 10-12), essays (age 13-15) and open-ended questions (age 16-18), were used to test the assumption that pupils have a narrow and incomplete concept of technology. This assumption is confirmed and leads to the following conclusions:

- with reference to technology, pupils of age *10 to 12-years* think mostly of equipment and something modern. In their opinion only very few people in society are concerned with technology. They do not recognize their personal involvement in technology. From interviews it becomes clear that boys have a broader concept of technology and think in a more differentiated and balanced way of technology than girls;
- pupils of *13 to 15-years* also associate technology strongly with products. Boys and girls think technology is something modern. Neither boys nor girls often mention spontaneuosly aspects of the process side of technology. On the whole boys have a broader concept of technology than girls. Compared to girls, boys are more likely to mention a technical profession.
- there is almost no correspondence between the concept of technology of *16 to 18-year-old* students and the five characteristics of technology, except for the characteristic 'technology and skills'. Based on this result, it is possible to conclude that students of this age also have a narrow concept of technology.

Answer to research question 3

Essentially the answer is given by taking two steps:

1. developing a reliable short version of the attitude-instrument, called the Technology Attitude Scale or TAS,
2. developing a manual accompanying the TAS.

Following these steps, an instrument, the TAS, has been developed that can be used by teachers. The TAS has been used and evaluated by ten technology teachers; their reactions were positive. To shorten the time required to work out class results a computer program was developed.

Answer to research question 4

In the PATT research we distinguish four types of studies: pilot-, survey-, essay- and effect studies. We chose to describe the results of four countries: Australia, France, India and Poland. Their results are respresentative for a number of other countries as well.

Based on the results of the studies in these four countries and our Dutch study, the following conclusions about the results of PATT can be drawn:

1. as a result of the pilot-studies an attitude instrument has been developed, consisting of ten scales: INTEREST, ROLE PATTERN, CONSEQUENCES, DIFFICULTY, SCHOOL, CAREER, SOCIETY, SCIENCE, SKILLS and PILLARS. The target group are pupils of 13 to 15-years;
2. guidelines for the analysis of essays about technology have been developed to give researchers the opportunity to do essay-studies;
3. the attitude instrument that is developed is more reliable in Western countries then in East European and in Third World countries;
4. because of translation problems on the one hand and large cultural and educational differences on the other hand, it seems difficult to draw any comparative conclusion from the scores in various countries;
5. survey studies show that, in general, the scores on the six AB-scales are on the positive side, indicating that pupils have a positive attitude towards technology;
6. comparison of the scale scores of the Western countries suggest that the attitude towards technology of pupils is about the same in each of these countries;
7. in most countries 'gender' is an important variable in explaining the differences in the results of the scales: boys have a more positive attitude towards technology than girls;
8. from the results of analyses of essays in Australia, India, the Netherlands and Poland it appears that the pupils' concept of technology is determined by three dimensions of technology:

   1. technology regarded as a collection of products,
   2. technology as a collection of knowledge and skills,
   3. evaluative aspects of technology.

The relevance of PATT can be seen at two levels.

1. Politics-policy-wise because it supplies the arguments in support of introducing and/or maintaining of the subject technology in general education.
2. Educational because it gives pupil-centred information to take into account when building new curricula, and it provides the criterea to evaluate the affective outcomes of existing programs.

7.2 Applications of the results

One of the main results of this study is: 'when pupils are offered a broad and balanced concept of technology there is a chance that pupils will get a more positive feeling about technology'. This is in particular important for girls. By a balanced concept of technology we mean 'one that takes into account the five characteristics of technology'.

In the Netherlands there is a growing interest in technology education. Up to the present time, technology education is almost only offered to those students who opt for a specific vocational technical training. This implies that there is no technology education at the primary level (age 4-12) and general secundary level (age 12-18). At the moment technology education is entering in primary, secondary and tertiary education (teacher training). At all these levels technology programs are being developed that are based on the five characteristics of technology.

The working group BASTEC (BASisschool en TEChniek; primary education and technology) is developing course material for primary school teachers and students. In the material there is extensive attention to the differences in attitude towards technology between boys and girls at an early age (Raat and Siegers 1989).

In the latest curriculum proposals for technology at secondary schools of the Instituut voor Leerplanontwikkeling (SLO; Dutch Foundation of Curriculum Development) there is more attention for the differences in attitudes towards technology between pupils than before. Pre-conceptions of technology are taken into account (Instituut voor Leerplanontwikkeling 1988). There is some evidence that pupils who followed the new technology programme have a broader concept of technology and a more positive feeling about technology than pupils who did not follow the program (Huijs 1989).

In the programs of the technology teacher training colleges in the Netherlands there is explicit attention to differences in conception of technology and attitudes towards technology among pupils and among teachers. Two examples are given:

1. the in-service training, called 'Basiscursus techniek 1988/1989' (a.o. in Tilburg), starts with a basic module in which concepts of technology among teachers and pupils are explored. The main goal of this basic module is the developing of a balanced concept of technology (Deysselberg 1988),
2. the part-time training program at the Dutch Pedagogical Technological College, called 'Leerplan Deeltijdopleiding Techniek 1989/1990' (a.o. in Eindhoven) is based on the description of technology in five characteristics developed by De Vries (1988). The general features and principles of technology, problem solving and creativity play an important part in the projects that are included in the program (Peters et al 1989).

7.3 Recommendations

Emancipation and sex-equity

1. *Technology education should start at a young age.*

   Already at the age of 10 we have noticed differences between boys and girls in the attitude towards technology. The differences between boys and girls are not changing at a later age, they show a stable pattern.

   From the viewpoint of attitude formation it is important to make girls (and boys) more familiar with technology at an early age, certainly before 10 years of age. This means that technology education should not only be taught at secondary level but also at primary level.

2. *Technology education should be offered in such a way that a broad concept of technology is taught.*

   A good (or broad and differentiated) concept of technology is positively related to a positive feeling towards technology. This means that characteristics of technology, especialy the relations 'Technology and society' and 'Technology and humans', should receive considerable attention in technology education programs.

Technology Attitude Scale (TAS)

3. *The Technology Attitude Scale should be used by technology teachers.*

   It may be useful for technology teachers to know what their pupils think of technology and also to be able to evaluate the affective outcomes of their programs.

The fact that technology, when introduced, is a new subject can be an additional reason to use the TAS.

Pupils' Attitude Towards Technology (PATT)

4. *PATT research should continue in the coming years.*

   In several countries, like the Netherlands, the PATT research gave a valuable contribution in promoting the subject technology and improving the technology curriculum by making it more 'pupil-centred' and less 'subject matter-centred'.

5. *PATT should stimulate large scale cross-cultural research.*

   It is possible to analyze the data of countries with similar conditions. For example, the results of a large scale study in seven states in the U.S.A. could be compared with the results of the Dutch study. The relative weakness of the C-scales should be the subject of an additional study. Maybe the C-scales could be improved by treating them as Guttman- or Mokken scales.

Future research

6. *An 'attitude towards technology-causal-model' should be developed and tested.*

   The results of this study give indications about variables that explain the attitude towards technology. These are variables like 'GENDER', 'HOME', 'SELF-CONCEPT', 'TEACHER ATTITUDE'. Together with some newly formulated variables these variables could be used in a LISREL design. The aim of this study should be to determine predictors of the attitude towards technology.

7. *Girls' neutral answering pattern should be studied.*

   The results of this study show that girls have a less positive attitude towards technology than boys. This less positive attitude can be explained partly by the fact that girls more often than boys opt for 'neutral' answer categories. From this research it is not clear wether they think in a more 'differentiated' way than boys or that their attitude is really less positive. Results of interviews with 10 to 12-year-olds suggest the latter option is the right one. It is recommended that this difference be further explored by interviewing older girls and boys (age 15-18).

8. *Effect-studies should be designed*

In the Netherlands, but also abroad, there is a need to continue the attitude research with 'effect studies'. The aim of effect studies is to evaluate the affective outcomes of (new) technology programs in education. This should be done in pre- and post test designs.

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SUMMARY

School education in technology is lagging behind the fast technological changes seen elsewhere in society during the last decade. In the Netherlands, as in many other countries, technology is being introduced as a seperate subject, to overcome this deficiency. The subject is meant for all 12 to 15-year-olds. In primary education too (age 4 to 12) more attention is now paid to technology.
It is important to take into account pupils' interests, opinions and needs when developing the subject technology. In particular, groups of boys and groups of girls may be expected to show different feelings towards technology. To measure these affective aspects an instrument was developed and with it measurements have been carried out among pupils aged 10 to 18-years. The broad aim of the study is to contribute to technology in education.

In *chapter 1* the research framework is discussed. The starting point of this study is an attitude study of De Vries (1988) among pupils of 13 to 15 years old. In that study an attitude questionnaire, consisting of 78 items, was developed and used. The items correspond with several aspects of technology. The questionnaire however is not based on scales. Further, no explicit distinction is made between cognitive, affective and conative components. The scores on the items indicated that boys and girls think differently about technology: boys have a more positive attitude towards technology and also a better concept of technology than girls. It remained to be investigated whether the questionnaire developed by De Vries could be used among other target groups. Part of the present study gives an answer to this question and can be considered as a follow up of the work of De Vries.
The problem statement of the study is: *What is the attitude of boys and girls towards technology?*
Four research questions have been formulated which should give an answer to this problem statement:

1. *Is it possible to develop an instrument with which we can measure among pupils from 10 to 18 years old:*
   a) the affective, cognitive and conative components of the attitude towards technology, and,
   b) the various dimensions of technology in the attitude towards technology?
2. *Is it possible to describe the affective, cognitive and conative components and dimensions of the attitude towards technology for pupils from 10 to 18 years old?*
3. *Is it possible to develop an attitude instrument that can be used by technology teachers for assessment and evaluation purposes?*
4. *What are the results of the PATT research and what are their relevance?*

The focus of this thesis is on instrument development and on measurements among 10 to 18-year-olds. Furthermore we will describe how an instrument was developed that can be used by technology teachers. Finally, attitude research in the international PATT-project is discussed.

In *chapter 2* the theoretical context of the study is discussed. In this thesis we use the concept of 'technology' as defined by De Vries (1988):

1. technology is a feature of human activities,
2. matter, energy and information are the 'pillars' of technology,
3. there is a mutual influence between technology and sciences,

4. the three most important skills in technology are:
   a. design skills,
   b. practical-technical skills (design, making, producing),
   c. skills in handling technical products,
5. there is a mutual influence between technology and society.

With reference to the concept of 'attitude' we distinguish three attitude-components:
- an affective (or feeling) component,
- a cognitive (or knowledge) component,
- a conative (or behavioural) component.

In an instrument measuring the 'attitude towards technology' these three attitude components should be represented. The Likert scale model is a useful model to measure the affective and conative components of the attitude. The Guttman scale model and its probabilistic version, the Mokken scale model, are useful to measure the cognitive attitude component.

There is relatively little research into 'the attitude towards technology'. On the contrary much research literature is available about research into 'the attitude towards science'. These studies mostly concern attitudes towards a specific school subject like physics or mathematics. Meta-analyses of attitudes towards science show insufficient attention to instrumentation. Most science attitude instrument reports lack information regarding the reliability and validity. Important predictors of attitudes towards science are: 'gender' and 'personality'. After one or more school years attitudes towards science subjects tend to become less positive.

Studies into attitudes towards technology show that in general pupils have a positive attitude towards technology. This means that pupils are interested in technology and also think that technology is important. Girls attitudes towards technology are less positive than boys attitudes towards technology. Practically nothing is known about the concept pupils have of technology. Among adults 'knowledge about technology' and 'ideology' are reasonable predictors of attitudes towards technology.

In *chapter 3* we describe the instrument development. By instrument development we mean the construction of reliable and valid atittude scales. A distinction is made between scales measuring Affective and Behavioural components of the attitude towards technology on the one hand (so called AB-scales) and scales measuring the Cognitive components of the attitude towards technology on the other hand (so called C-scales).

Development of AB-scales:

First it is investigated whether 'aspects of technology', which are operationalised in the questionnaire of De Vries are also relevant among other age groups (age 10-12 and age 16-18). Interviews were held among 10 to 12-year-olds and open questionnaires were used among 16 to 18-year-olds. The results indicate the 'aspects of technology' from the questionnaire of De Vries are also relevant among younger and older age groups. It was necessary to make changes only at the item level.

Aspects of technology among 10 to 18-year-olds are:
- interest in technology,
- role pattern in technology,
- consequences and importance of technology,
- creativity in technology,
- difficulty and accessibility of technology,
- careers and professions in technology,
- technology at school,

- diversity of technology,
- knowledge of technology,
- technology and developing countries,
- science (physics) and technology.

Secondly it is investigated which of these eleven aspects of technology are 'dimensions' in the attitude towards technology among 10 tot 18-year-olds. Three questionnaires were constructed: one for pupils of the basisschool and 2 lbo, one for students of 4 avo-vwo and one for first year students of technical school (mts/hts/tu natuurkunde). Results have been analysed by means of factor analysis. The results of the factor analysis show that the age groups have four attitude dimensions in common:

1. interest in technology,
2. role pattern in technology,
3. consequences of technology,
4. difficulty of technology.

Starting from the existence of these four dimensions, six AB-scales are constructed. The interest dimension was split in three scales in order to accent the conative aspect of the scales: technology in leisure time, technology at school and technology as a career. The names of the six AB-scales are:

1. INTEREST,
2. ROLE PATTERN,
3. CONSEQUENCES,
4. DIFFICULTY,
5. SCHOOL,
6. CAREER.

In the construction of the AB-scales (selection of items), the following statistical criteria were used:

- factor loadings > .30,
- R(it)-values > .20,
- item variance > 1,
- % don't know answers < 30,
- Cronbach's alpha > .60.

Significant differences in scale scores of students from technical and non-technical training institutions were required to demonstrate sensitivity of the scales.

The instrument that was developed proved to be sufficiently reliable during the measurements on the age groups. Homogeneity coefficients (Cronbach's alpha) and stability coefficients (test-retest correlations) are acceptably high. The existence of the four common attitude dimensions is demonstrated by factor analyses, proving construct validity. The AB-scales correlate .60 with a criterion variable 'technical ambition'. The scales predict 'ambition' quite well and this provides evidence of concurrent validity. In the development of the scales (especially with reference to item formulation) we started from opinions and statements of the pupils themselves. Therefore we may assume content validity.

The AB-scales thus developed were able to measure the affective and behavioural parts of the attitude of pupils towards technology. A positive attitude means that pupils think (feel) that technology is interesting, important, not difficult and for boys and girls as well.

Development of C-scales:

Based on the five features of technology, mentioned earlier, items have been formulated. In contrast to the AB-scales, pupils' pre-knowledge of technology was not taken into

account in the formulation of the items. The items have a different level of difficulty, caused by abstraction. Four scales were designed and tested:
1. SOCIETY,
2. SCIENCE,
3. SKILLS,
4. PILLARS.
Two features of technology, the relation technology-society and the relation technology-human beings, are operationalised in the scale SOCIETY.
For pupils aged 13-18, the four scales appeared to fit well in a Mokken scale model with H-coefficients > .30. For 10 to 12-year-olds the C-scales appeared to be too difficult and hence not reliable.
The C-scales measure pupils' concept of technology. If pupils answer the items 'correctly', they have a 'good' or 'broad' view of technology. This means that their concept of technology corresponds with the five features of technology.

In *chapter 4* the results of the measurements among 10 to 12-year-olds, 13 to 15-year-olds and 16 to 18-year-olds are described. In addition to written questionnaires, more descriptive methods were used: among 10 to 12-year-olds drawings and interviews, among 13 to 15-year-olds essays and among 16 to 18-year-olds open-ended questions. Ten assumptions have been formulated and tested. The conclusions are:
1. boys score significantly more positively on the AB-scales than girls, with the exception of ROLE PATTERN. Boys also score significantly higher on the C-scales. Girls opt more often than boys for the neutral answering category. The results of the essays and interviews among 10 to 15-year-olds suggest that girls do not think of technology in a more differentiated way than boys. The conclusion is that boys have a more positive attitude towards technology than girls;
2. pupils with technical ambition score significantly more positively on the AB-scales and significantly higher on the C-scales than pupils without technical ambition;
3. pupils with a positive technical self-concept score significantly more positively on the AB-scales than pupils without a positive technical self-concept;
4. pupils with a technical home environment score significantly more positively on the AB-scales INTEREST, SCHOOL and CAREER and significantly higher on the C-scales SOCIETY and PILLARS than pupils without a technical home environment;
5. pupils from technical training score more positively on the AB-scales and higher on the C-scales than pupils from non-technical training. There are no differences in scores between pupils of 'higher' types of education (vwo) and 'lower' types of education (mavo);
6. pupils with a more positive school experience do not score more positive and/or better on the AB- and C-scales than pupils with a negative school experience;
7. there is a weak positive relation between the attitude of the teacher towards technology and the attitude of the class towards technology;
8. there is a significant positive correlation between the scores on the C-scales and the AB-scales. The direction is from the cognitive towards the affective attitude component. Pupils with a broad concept of technology have a more positive attitude towards technology;
9. older pupils score higher on the C-scales than younger pupils. The scores on the AB-scales are not different for various age groups. The differences in scale scores between boys and girls at the age of 10-12 are as large as at the age of 16-18. This means that the attitude towards technology is rather stable in time;

10. - from the interviews and drawings it appears that 10 to 12-year-olds, consider technology as something modern, and mainly with electrical equipment. The pupils do not see their own involvement in technology and believe that only a few people deal with technology. Boys have a broader concept of technology than girls;
   - the essays, written by 13 to 15-year-olds demonstrate a strong focus on the product side of technology and a weak focus on the proces side of technology;
   - compared with the five features of technology, pupils of 16 to 18-year-olds have a narrow concept of technology. In their definition of technology only one feature of technology, technology and skills, is mentioned often.

The development of a class instrument is described in *chapter 5*. Technology teachers can use this instrument, the Technology Attitude Scale or TAS, to measure the attitude towards technology of their own class.
The teachers appeared to need a short questionnaire, that is easy to administer and score. Therefore the research questionnaire was shortened. This did not have serious consequences for the reliability and validity.
A manual was written, in which the use of the TAS is explained. In this manual norm scores, deduced from the results of the main study, are given. The TAS and its manual have been used and evaluated by ten technology teachers. Based on their reactions the manual was improved. A computer program to speed the calculation has been developed.

In *chapter 6* the results and the relevance of the international PATT-project are discussed. PATT (Pupils' Attitude Towards Technology) started in 1986 with a study of the possible use of the 78-item questionnaire abroad. Between 1986 and 1989 four conferences took place in Eindhoven, where the results of PATT-studies were discussed.
In the PATT-research four types of studies can be distinguished:
1. pilot studies: these are studies about the reliability and validity of the original 78-item questionnaire;
2. survey studies: these are studies with an instrument developed on the base of the results of the pilot studies. The aim is to describe the attitude of pupils towards technology in a country. It consists of six AB-scales and four C-scales;
3. essay studies: these are analyses of essays about technology, aimed to study the concept of technology;
4. effect studies: these are studies in which the AB- and C-scales are being used to evaluate the affective outcomes of technology education programs. This is done in pre- and post-test designs. These studies started at the beginning of 1989.

The results of PATT studies are discussed by presenting the results of studies of four countries that are a cross-section of the studies that include Western-, Developing- and East-European countries: Australia (L.Rennie, L. Parker), France (C. Terlon), India (R.S. Rajput) and Poland (H. Szydlowski, G. Dudziak).
The following conclusions have been drawn from the results:
- the AB- and C-scales are more reliable and valid in Western than in East European and Third World countries;
- cross cultural comparisons of the results are hampered by translation problems (e.g. the word 'technology'), different educational systems and strongly divergent research conditions;
- the scores of pupils on the AB-scales are on the positive side (below the neutral point), which means a positive attitude towards technology;

- comparison of the scale scores of the Western countries suggest that the attitude towards technology of pupils is about the same;
- in most countries 'gender' is an important variable in explaining differences in the results of the scales: boys have a more positive attitude towards technology than girls;
- from the results of the essay analyses in Australia, India, the Netherlands and Poland it appears that the pupils' concept of technology is determined by three dimensions:
  - technology regarded as a collection of products,
  - technology as a collection of knowledge and skills,
  - evaluative aspects of technology.

To study the relevance of the PATT studies we asked twenty-eight PATT researchers in what way their results have been used. Researchers from eleven countries reacted to this request: Australia, England, India, Italy, Kenya, Mexico, Nigeria, Poland, Sweden, USA and Zimbabwe. Respondents from these countries indicates that the relevance of the results can be seen at two levels:

1. politics-policy-wise because it supplies the arguments for introducing and/or maintaining of the subject technology in general education;
2. educational because it gives pupil-centered information to take into account when building new curricula, and it provides the criteria to evaluate existing programs on the affective outcomes.

In *chapter 7* the conclusions and recommendations of the study are presented. The conclusions are given by discussing the answers to the four research questions obtained in the study. The output of the study is described by mentioning some recent applications in technology education. Recommendations are given with respect to emancipation, the TAS, PATT and future research.

SAMENVATTING

Het onderwijs in techniek is achtergebleven bij de snelle technologische veranderingen van de laatste decennia. In Nederland, evenals in veel andere landen, probeert men deze achterstand in te halen door het vak techniek in te voeren in het onderwijs voor alle 12- tot 15-jarigen en ook door in het basisonderwijs aandacht aan techniek te geven. Bij het ontwikkelen van een vak techniek dient men rekening te houden met de interesses, meningen en behoeften van leerlingen ten aanzien van techniek. Verwacht mag worden dat hiervoor met name tussen jongens en meisjes verschillen zullen bestaan. Om deze affectieve aspecten te peilen is er een attitude-instrument ontwikkeld. Hiermee zijn metingen verricht bij 10- tot 18-jarigen. Het doel van de studie is een bijdrage te leveren aan het vak techniek in het onderwijs.

In *hoofdstuk 1* wordt het onderzoekskader van de studie besproken.
Het uitgangspunt van dit onderzoek vormt een attitude-onderzoek dat De Vries in 1985 uitvoerde onder 2 avo-vwo leerlingen. In dat onderzoek werd een vragenlijst gebruikt met 78 uitspraken of items over verschillende aspecten van techniek. Aan de vragenlijst lag geen schaalconstructie ten grondslag, hoewel een aantal groepen van items met behulp van factoranalyse zijn gevalideerd. Ook werd er door De Vries geen expliciet onderscheid gemaakt tussen affectieve, cognitieve en conatieve attitude-componenten. Uit het onderzoek van De Vries blijkt jongens een beter beeld van techniek hebben dan meisjes, ook is de houding ten aanzien van techniek bij jongens positiever dan bij meisjes.
In het kader van deze studie is onderzocht of de vragenlijst van De Vries ook bij andere leeftijdsgroepen gebruikt kan worden. Deze studie kan daarom als een vervolg op het onderzoek van De Vries worden beschouwd.
De probleemstelling van het onderzoek luidt: *Wat is de attitude van jongens en meisjes ten aanzien van techniek?*
Er zijn vier onderzoeksvragen geformuleerd die een antwoord moeten geven op deze probleemstelling:

1. *Hoe kan een instrument ontwikkeld worden waarmee bij leerlingen van 10 tot 18 jaar de affectieve, cognitieve en conatieve attitude-componenten van de attitude ten aanzien van techniek, en de verschillende dimensies van techniek in de attitude ten aanzien van techniek gemeten kunnen worden?*
2. *Hoe kunnen de attitude-componenten en techniek-dimensies van de attitude ten aanzien van techniek beschreven worden bij leerlingen van 10 tot 18 jaar?*
3. *Hoe kan een attitude-instrument ontwikkeld worden dat techniekdocenten in de klas kunnen gebruiken voor 'assessment' en evaluatie doeleinden?*
4. *Wat zijn de resultaten en de relevantie van het PATT-onderzoek?*

In dit proefschrift wordt de instrument-ontwikkeling en de meting bij 10- tot 18-jarigen beschreven. Ook wordt beschreven hoe een instrument is ontwikkeld dat geschikt is voor gebruik door docenten techniek in de klas. Tenslotte wordt de internationale uitbreiding van het attitude-onderzoek in het PATT-project besproken.

In *hoofdstuk 2* wordt het theoretische kader van het onderzoek besproken.
In deze studie hanteren we het begrip 'techniek' zoals dat door De Vries (1988) wordt gedefinieerd. Hij omschrijft het begrip techniek in vijf kenmerken:

1. techniek is een kenmerk van menselijk handelen,
2. materie, energie en informatie zijn de bouwstenen van techniek,

3. er bestaat een wederzijdse beïnvloeding tussen techniek en natuurwetenschappen,
4. de drie belangrijkste vaardigheden in de techniek zijn het ontwerpen, maken en gebruiken van technische produkten,
5. techniek en de samenleving beïnvloeden elkaar wederzijds.

Aan het begrip 'attitude' onderscheiden we drie componenten:
- een affectieve (of gevoels-)component,
- een cognitieve (of kennis-)component,
- een conative (of gedrags-)component.

In een instrument dat de 'attitude ten aanzien van techniek' meet, dienen deze drie attitude-componenten vertegenwoordigd te zijn. Het Likertschaalmodel is een geschikt model om affectieve en conatieve componenten van de attitude te meten. Het Guttmanschaalmodel en de probabilistische versie hiervan, het Mokkenschaalmodel, zijn geschikt om de cognitieve attitude-component te meten.
Er is tot nu toe relatief weinig onderzoek verricht naar attitudes ten aanzien van techniek. Daarentegen bestaat er wel veel onderzoeksliteratuur over attitudes ten aanzien van 'science' en 'science and technology'. Het gaat daarbij veelal over de attitude van leerlingen ten aanzien van een schoolvak. Uit meta-analyses over attitudes ten aanzien van 'science' komt naar voren dat de instrumentatie gebrekkig is: veelal ontbreekt het aan voldoende gegevens over de betrouwbaarheid en validiteit. Belangrijke voorspellers voor attitudes ten aanzien van 'science' zijn sexe en persoonlijkheid (openheid, zelfbeeld). Opvallend is dat de attitude ten aanzien van een schoolvak, zoals natuurkunde of biologie, in de loop van een schooljaar minder positief blijkt te worden.
Onderzoeken naar attitudes ten aanzien van techniek tonen aan dat leerlingen een positieve attitude hebben. Dit betekent dat men techniek interessant en belangrijk vindt. Meisjes hebben een minder positieve attitude ten aanzien van techniek dan jongens. Over het beeld van techniek bij jongeren is weinig bekend. Bij volwassenen zijn 'bekendheid met techniek' en 'ideologie' redelijke voorspellers van attitudes ten aanzien van techniek.

In *hoofdstuk 3* beschrijven we de ontwikkeling van het instrument.
Onder instrument-ontwikkeling verstaan we het construeren van betrouwbare en valide schalen. We hebben een onderscheid gemaakt tussen enerzijds schalen die de affectieve en conatieve componenten van de attitude ten aanzien van techniek meten, zogenaamde AB-schalen, en anderzijds schalen die de cognitieve component van de attitude ten aanzien van techniek meten, de zogenaamde C-schalen.

Ontwikkeling van AB-schalen:
Allereerst is onderzocht of de aspecten van techniek die in de vragenlijst van De Vries voorkomen ook relevant zijn bij andere leeftijdsgroepen (10- tot 12-jarigen en 16- tot 18-jarigen). Met 10- tot 12-jarigen zijn gesprekken gevoerd. Bij 16- tot 18-jarigen zijn open vragenlijsten afgenomen. De resultaten geven aan dat de aspecten uit de vragenlijst van De Vries ook relevant zijn bij jongere en oudere leeftijdsgroepen. Wel vond er op item-niveau een aantal wijzigingen plaats. Aspecten van techniek bij 10- tot 18-jarigen zijn:
- interesse in techniek,
- rolpatroon in de techniek,
- gevolgen en belang van techniek,
- creativiteit in de techniek,
- moeilijkheid en toegankelijkheid van techniek,
- technische beroepen en carrière,
- techniek op school,

- diversiteit van techniek,
- bekendheid met techniek,
- ontwikkelingslanden en techniek,
- natuurwetenschap en techniek.

Vervolgens is onderzocht welke van deze elf aspecten van techniek, dimensies in de attitude ten aanzien van techniek zijn bij 10- tot 18-jarigen. Er zijn drie vragenlijsten gemaakt: één voor leerlingen van groep 7 en 8 basisschool en 2 lbo, één voor leerlingen van 4 avo-vwo en één voor eerste jaars studenten mts, hts en tu-natuurkunde. De scores op de items zijn geanalyseerd met behulp van toetsende factoranalyse. De resultaten tonen aan dat er vier gemeenschappelijke attitude-dimensies zijn:

1. interesse in techniek,
2. rolpatroon in techniek,
3. gevolgen van techniek,
4. moeilijkheid van techniek.

Uitgaande van deze vier dimensies zijn er zes AB-schalen geconstrueerd. Voor de dimensie interesse in techniek zijn drie aparte schalen geconstrueerd om het conatieve aspect van de attitude te accentueren, namelijk: techniek in de vrije tijd, techniek op school en techniek als beroep. Deze zes AB-schalen kregen de volgende namen:

1. INTEREST,
2. ROLE PATTERN,
3. CONSEQUENCES,
4. DIFFICULTY,
5. SCHOOL,
6. CAREER.

Bij het construeren van de AB-schalen (selecteren van de items) zijn de volgende statistische criteria gehanteerd:

- factorladingen > .30,
- R(it)-waarden > .20,
- item varianties > 1,
- Cronbach's alpha > .60,
- % weet-niet antwoorden < 30, en

verder moesten voorspelbare attitude-verschillen tussen leerlingen van technische en niet technische scholen aantoonbaar zijn.

De zes AB-schalen blijken voor de leeftijdsgroep 10-18 jaar voldoende betrouwbaar te zijn. Cronbach's alpha is voor de schalen, die bij metingen zijn gebruikt, acceptabel en verder blijkt de stabiliteit goed te zijn, gelet op hoge test-hertest coëfficiënten.

Dat er sprake is van begripsvaliditeit wordt bevestigd door factoranalyses. Deze tonen de aanwezigheid van de attitude-dimensies keer op keer aan. De AB-schalen blijken goede voorspellers voor ambitie om later de techniek in te gaan. De hoge correlatie tussen de AB-schalen en de criterium-variabele 'technische ambitie' (r=.60 bij 4 avo-vwo leerlingen), duidt op concurrente validiteit. We gaan er van uit dat er sprake is van inhoudsvaliditeit, omdat we bij het ontwikkelen van de schalen (en dan met name bij het formuleren van uitspraken) zijn uitgegaan van meningen en uitspraken van de leerlingen zelf. Daarnaast is in de instructie van de vragenlijst uitgelegd dat het niet om techniek gaat in de zin van 'iets goed kunnen', zoals bij voetbaltechniek. Verder zijn de items door deskundigen beoordeeld tijdens de PATT-conferenties.

Met de AB-schalen wordt gemeten welke houding leerlingen ten aanzien van techniek hebben. Omdat deze houding meer-dimensionaal is, hoeft deze niet eenduidig negatief of positief te zijn. Een (eenduidig) positieve houding ten aanzien van techniek betekent dat leerlingen techniek interessant vinden (INTEREST), techniek belangrijk vinden

(CONSEQUENCES), techniek niet (te) moeilijk vinden (DIFFICULTY) en verder betekent het dat meisjes net zo geschikt voor techniek worden gevonden als jongens (ROLE PATTERN).

Ontwikkeling van C-schalen:
Op grond van de eerder genoemde vijf kenmerken van techniek zijn items geformuleerd. Daarbij is niet uitgegaan van de bij leerlingen aanwezige voorkennis van techniek. De items hebben een verschillende moeilijkheidsgraad, veroorzaakt door verschillen in abstractie. Er zijn vier schalen ontworpen:
1. SOCIETY,
2. SCIENCE,
3. SKILLS,
4. PILLARS.

Twee techniekkenmerken, de relatie 'techniek-mens' en de relatie 'techniek-samenleving' zijn in de schaal SOCIETY geoperationaliseerd. De items uit de schalen blijken redelijk goed te voldoen aan het Mokkenschaalmodel. De H-coëfficiënten liggen > .30. Voor 10- tot 12-jarigen blijken de C-schalen onvoldoende betrouwbaar.
Met de C-schalen kan gemeten worden welk beeld leerlingen van techniek hebben. Als de leerlingen de items juist beantwoorden dan spreken we van een 'goed' of 'breed' beeld van techniek. Dat is dan een beeld van techniek dat overeenkomt met de vijf kenmerken van techniek.

In *hoofdstuk 4* worden de resultaten van metingen bij drie leeftijdsgroepen (10-12, 13-15 en 16-18 jaar) besproken.
Er zijn echter niet alleen schriftelijke vragenlijsten gebruikt. Ook zijn er alternatieve, meer beschrijvende, methodes gebruikt, zoals tekeningen en interviews bij 10- tot 12-jarigen, opstellen bij 13- tot 15-jarigen en open vragen bij 16- tot 18-jarigen. Er zijn tien veronderstellingen geformuleerd en getoetst via t-tests en correlatie-analyses. De conclusies zijn:
1. jongens scoren significant positiever op de AB-schalen dan meisjes, met uitzondering van de schaal ROLE PATTERN. Ook scoren jongens significant hoger op de C-schalen. Meisjes kiezen vaker dan jongens voor de neutrale antwoordcategorie. Uit opstellen en interviews blijkt niet dat dit komt omdat meisjes 'genuanceerder' over techniek zouden denken dan jongens. De conclusie is dat jongens een positievere attitude ten aanzien van techniek hebben dan meisjes;
2. leerlingen met technische ambities scoren significant positiever op de AB-schalen en significant beter op de C-schalen dan leerlingen zonder technische ambities;
3. leerlingen met een positief technisch zelfbeeld scoren significant positiever op de AB-schalen, dan leerlingen zonder een positief technisch zelfbeeld;
4. leerlingen met een technische thuisomgeving scoren significant positiever op de AB-schalen INTEREST, SCHOOL en CAREER en significant beter op de C-schalen SOCIETY en PILLARS;
5. leerlingen van een technische school scoren significant positiever op de AB-schalen en significant beter op de C-schalen dan leerlingen van een niet-technische school. Tussen vwo-leerlingen en mavo-leerlingen bestaan geen significante verschillen in scores;
6. tussen leerlingen met een positieve en een negatieve schoolbeleving bestaan geen significante verschillen in scores;
7. er is een zwak positieve relatie tussen de attitude ten aanzien van techniek van de docent en de attitude ten aanzien van techniek van de klas;

8. er is een significant positieve relatie tussen de score op de C-schalen (beeld van techniek) en de score op de AB-schalen (houding ten aanzien van techniek). De richting van het verband loopt van de C-schalen naar de AB-schalen. Leerlingen met een goed beeld van techniek hebben een positievere houding ten aanzien van techniek dan leerlingen met een minder goed beeld van techniek;
9. oudere leerlingen scoren hoger op de C-schalen dan jongere leerlingen. De scores op de AB-schalen zijn voor oudere en jongere leerlingen vrijwel gelijk. De verschillen tussen jongens en meisjes op 10-12 jarige leeftijd zijn op 16-18 jarige leeftijd even groot. Dit toont het stabiele karakter van de attitude ten aanzien van techniek aan;
10. - uit interviews en tekeningen blijkt dat 10- tot 12-jarigen techniek beschouwen als iets van uitsluitend deze tijd, en daarbij vooral aan elektrische apparaten denken. De leerlingen zien hun eigen betrokkenheid bij techniek niet. Ze denken dat slechts een kleine groep mensen met techniek te maken heeft. Jongens hebben een breder beeld van techniek dan meisjes;
    - uit de opstellen van 13- tot 15-jarigen blijkt een sterke gerichtheid op technische produkten en een geringe gerichtheid op de proceskant van techniek. Dit geldt in sterkere mate voor meisjes dan voor jongens;
    - uit de definities van techniek van 16- tot 18-jarigen, komt een beperkt beeld van techniek naar voren als dit wordt afgezet tegenover de vijf techniekkenmerken. Alleen het techniekkenmerk 'vaardigheden' wordt regelmatig genoemd.

In *hoofdstuk 5* wordt beschreven hoe een instrument is ontwikkeld dat techniekdocenten kunnen gebruiken om in de eigen klas de attitude ten aanzien van techniek te meten.
Docenten bleken behoefte te hebben aan een korte vragenlijst, die eenvoudig en snel te verwerken zou zijn. De 'lerarenvragenlijst' moest korter worden dan de 'onderzoeksvragenlijst'. Het verkorten van de vragenlijst (alleen de AB-schalen) leidde niet tot een vermindering van de validiteit en betrouwbaarheid van de schalen. De korte vragenlijst wordt TAS (Technology Attitude Scale) genoemd.
Voor docenten is een handleiding geschreven waarin het gebruik van de TAS wordt uitgelegd. In de handleiding zijn normscores opgenomen, die afgeleid zijn van de resultaten van het hoofdonderzoek. De TAS is door tien docenten gebruikt en geëvalueerd. Op basis van de evaluatie is de handleiding verbeterd en is een computerprogramma voor de TAS ontwikkeld.

In *hoofdstuk 6* wordt ingegaan op de resultaten en relevantie van het internationale PATT-onderzoek.
PATT (Pupils' Attitude Towards Technology) is in 1986 gestart met een onderzoek naar de bruikbaarheid van de 78-item vragenlijst van De Vries in verschillende landen. In de periode 1986-1989 vonden er in Eindhoven vier conferenties plaats waar de resultaten van het onderzoek naar attitudes ten aanzien van techniek zijn besproken.
Er kunnen vier typen van PATT-onderzoek onderscheiden worden:
1. pilot studies: dit zijn studies waarbij de bruikbaarheid van de originele 78-item vragenlijst voor een land wordt onderzocht;
2. survey studies: dit zijn studies met het instrument dat is ontwikkeld op grond van de resultaten van de pilot studies. Het bestaat uit zes AB-schalen en vier C-schalen. Het doel van de survey studies is om per land of regio de attitude ten aanzien van techniek te beschrijven;
3. essay studies: dit zijn analyses van opstellen over techniek, vooral bedoeld om het beeld van techniek te onderzoeken en als aanvulling op de survey studies;

4. effect studies: dit zijn studies waarbij met behulp van de AB- en C-schalen wordt onderzocht wat de effecten van techniek onderwijs zijn op de attitude ten aanzien van techniek. Dit gebeurt via voor- en na-metingen. Deze studies zijn in 1989 van start gegaan.

Van vier landen worden de resultaten besproken: Australië (onderzoeksters L. Rennie en L. Parker), Frankrijk (onderzoekster C. Terlon), India (onderzoeker J.S. Rajput) en Polen (onderzoekers H. Szydlowski en G. Dudziak). Het overzicht van PATT-onderzoek in deze vier landen is representatief voor PATT-onderzoek in de meeste andere landen.
Over de resultaten van PATT kan het volgende geconcludeerd worden:

- de AB- en C-schalen zijn in Westerse landen betrouwbaarder en meer valide dan in het Oostblok en in Derde Wereld landen;
- cross-culturele vergelijkingen van schaalscores worden bemoeilijkt door problemen met vertalen, verschillende onderwijscontexten, en vooral door sterk verschillende onderzoekscondities;
- de scores van leerlingen op de AB-schalen liggen in de meeste landen aan de positieve kant, hetgeen duidt op positieve attitudes ten aanzien van techniek;
- de scores op AB- en C-schalen van leerlingen uit de Westerse landen komen sterk overeen, hetgeen duidt op overeenkomstige attitudes ten aanzien van techniek;
- de grootste verschillen in schaalscores bestaan tussen jongens en meisjes, in het nadeel van meisjes;
- uit de resultaten van de analyses van opstellen blijkt dat leerlingen in Australië, India, Nederland en Polen techniek (in meer of mindere mate) met drie dimensies associëren:
  -techniek als een verzameling produkten,
  -techniek als het geheel van kennis en vaardigheden,
  -evaluatieve aspecten van techniek.

Om de relevantie van PATT te bepalen is aan PATT-onderzoekers gevraagd om aan te geven of en zo ja op welke wijze de resultaten van hun onderzoek zijn gebruikt. Uit de reacties van de onderzoekers, afkomstig uit Australië, Engeland, India, Italië, Kenya, Mexico, Nigeria, Polen, USA, Zimbabwe en Zweden, blijkt dat de resultaten van PATT op twee niveaus van belang zijn:

1. politiek-beleidsmatig:
   het PATT-onderzoek blijkt een positief effect te hebben op de besluitvorming rondom de invoering (of uitbreiding/handhaving) van techniek als een zelfstandig schoolvak;
2. onderwijskundig:
   a. bij curriculum-ontwikkeling wordt meer dan voorheen het geval was rekening gehouden met wat leerlingen zelf van techniek vinden (leerling-gericht versus onderwerp-gericht), en
   b. techniekprogramma's kunnen geëvalueerd worden op affectieve resultaten.

In *hoofdstuk 7* worden de conclusies en aanbevelingen gepresenteerd.
In dit laatste hoofdstuk worden de antwoorden op de onderzoeksvragen geformuleerd. Resultaten van de studie, die momenteel in het techniek-onderwijs een toepassing vinden, worden kort beschreven. Tenslotte worden aanbevelingen gedaan over emancipatie, de TAS, PATT en vervolg-onderzoek.

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APPENDICES

1 Abbreviaton and translation of school types

2 Aspects of technology and corresponding test-items

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Appendix 1 Abbreviation and translation of school types

b.s.	basisschool groep 1-8	primary school group 1-8
avo	algemeen voortgezet onderwijs (avo=mavo/havo)	secondary general education
mavo	middelbaar algemeen voortgezet onderwijs	junior secondary schools
havo	hoger algemeen voortgezet onderwijs	senior secundary schools
vwo	voorbereidend wetenschappelijk onderwijs (vwo=atheneum/gymnasium)	pre university education
lbo	lager beroepsonderwijs (lbo=lto/lhno/leao....)	junior vocational training
lto	lager technisch onderwijs	junior technical training
lhno	lager huishoud- en nijverheids onderwijs	junior domestic training
leao	lager economisch en admistratief onderwijs	junior economic training
mbo	middelbaar beroepsonderwijs (mbo=mto/mdgo/mmo/meao...)	senior vocational training
mto	middelbaar technisch onderwijs	senior technical training
mdgo	middelbaar dienstverlenend en gezondheidsonderwijs	senior service and health care training
meao	middelbaar economisch en administratief onderwijs	senior economic training
mmo	middelbaar middenstandsonderwijs	senior training of the retail trade
hbo	hoger beroepsonderwijs (hbo=hto/heao/pabo...)	vocational colleges
hto	hoger technisch onderwijs	technical colleges
heao	hoger economisch en administratief onderwijs	economic colleges
pabo	pedagogische academie voor het basisonderwijs	primary school teacher training
wo	wetenschappelijk onderwijs	university education

Appendix 2 Aspects of technology and corresponding test-items

A. INTEREST in technology (15 items)

1. When something new is discovered, I want to know more about it immediately. (1,2,3,4)*
2. I positively do not want to have a job in technology.(1,2,3,4)
3. I have never used a screw driver. (1,2,3,4)
4. For pupils of my age technology is not interesting.(1,2,3,4)
5. In the newspapers you often read about technology.(1,2,3,4)
6. There should be more TV programmes about technology.(1,2,3,4)
7. Thoughts of technology are not often in my mind.(1,2,3,4)
8. If there was a hobby club about technology at school, I would certainly join it.(1,2,3,4)
9. I do not know what the word 'technology' means.(1,2,3,4)
10. I would like to work in technology later.(1,2,3,4)
11. I think technology is a bit scary.(1,2,3,4)
12. I am not interested in technology.(1,2,3,4)
13. I know what most appliances are for.(1,2,3,4)
14. I like to read technological magazines.(1,2,3,4)
15. I enjoy repairing things at home myself.(1,2,3,4)

B. ROLE PATTERN in technology (11 items)

1. Girls cannot do technology.(1,2,3,4)
2. A girl can have a technological profession just as well as a boy.(1,2,3,4)
3. Boys are able to repair things better than girls.(1,2,3,4)
4. Girls prefer not to go to a technical school.(1,2,3,4)
5. Boys know more about technology than girls do.(1,2,3,4)
6. More girls should go to a technical school.(1,2,3,4)
7. Technology is as difficult for girls as it is for boys.(1,2,3,4)
8. A girl had better not become a car mechanic.(1,2,3,4)
9. Mothers should be able to repair domestic appliances themselves.(1,2,3,4)
10. Girls should repair their own bicycle tyres.(1,2,3,4)
11. It is a good thing when girls learn to plug on a cord.(1,2,3,4)

C. CONSEQUENCES AND IMPORTANCE of technology (19 items)

1. Technology makes everything go better than before.(1,2,3,4)
2. Technology is good for the economy.(1,2,3,4)
3. Without technology there would be more poblems in the world.(1,2,3,4)
4. Technology gives people more leisure.(1,2,3,4)
5. Technology has brought more good things than bad things. (1,2,3,4)
6. Technology makes people ask for more and more comfort. (1,2,3,4)
7. Technology is the subject of the future.(1,2,3,4)
8. Technology gives more employment.(2,3,4)
9. Technology is bad for poor countries.(2,3,4)
10. Technology is mostly not dangerous. (1,2,3,4)
11. Technology gives people more money.(2,3,4)
12. Technology is always bad for the environment.(1,2,3,4)
13. Technology is very important in life.(1,2,3,4)
14. Developed countries can do much for developing countries by technology (1,2,3,4).
15. In every day life you do not have to much to do with technology (1,2,3,4).
16. In the newspapers there is always a lot about technology.(1,2,3,4)
17. Humans can not do without technology.(1,2,3,4)
18. Technology is good for the developing countries.(1,2,3,4)
19. It would be better if no technological inventions had ever been made.(1)

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*items from:
1=questionnaire 2 avo-vwo (De Vries)
2=test questionnaire groep 7 and 8 (basisschool) and 2 lbo
3=test questionnaire 4 avo-vwo
4=test questionnaire techn. schools (1 mts, 1 hts, 1 physics)

D. CREATIVITY and technology (10 items)

1. Working in technology is very creative.(1,2,3,4)
2. In technology you have many opportunities to use your imagination.(1,2,3,4)
3. In technology you design things by yourself.(1,2,3,4)
4. To work in technology you do not have to be creative.(1,2,3,4)
5. In technology there are not many inventions really new.(1,2,3,4)
6. Technology is working with your hands.(1,2,3,4)
7. Technology makes people more creative.(1,2,3,4)
8. Working in technology often means thinking up something new.(2,3,4)
9. Designing an appliance is not a part of technology.(1,2,3,4)
10. In technology there is not much opportunity to invent things by yourself.(1,2,3,4)

E. DIFFICULTY of technology (8 items)

1. Technology is too difficult for me.(1,2,3,4)
2. To understand something of technology you have to do a difficult training course.(1,2,3,4)
3. To know how a bike is constructed you don not have to study technology. (1,2,3,4)
4. I do not know what the word 'technology' includes.(1,2,3,4)
5. You must be very clever to be able to study technology.(1,2,3,4)
6. Technology is only for bright people.(1,2,3,4)
7. These sort of questions about technology are difficult for me. (1,2,3,4)
8. I think technology is a bit scary.(1,2,3,4)

F. TECHNICAL PROFESSIONS AND CAREERS (7 items)

1. I positively do not want to have a job in technology.(1,2,3,4)
2. All jobs have something to do with technology.(1,2,3,4)
3. It is difficult for me to say now whether or not I want a to choose a technological profession. (1,2,3)
4. I would like to work in technology later.(1,2,3,4)
5. When I choose a profession I do not consider whether or not it is technological. (1,2,3)
6. I cannot list many technical jobs.(1,2,3,4)
7. Technological professions are becoming more important in the future.(4)

G. SCHOOL and technology (8 items)

1. I would like to learn more about technology at school.(1,2,3,4)
2. At school I hear enough about technology to be able to make a choice about going or not going to a technical school.(1,2,3)
3. At school you do not hear a lot about technology.(1,2,3)
4. At school you should learn more about repairing things around the home.(1,2,3).
5. At school you never hear anything about technological jobs.(1,2,3)
6. I wish I should have learned more about technology at high school. (4)
7. At high school I heared enough about technology to be able to make a choice about going or not going to a technical school.(4)
8. A non-technical training gives you less opportunities than a technical training.(4)

H. DIVERSITY of technology (11 items)

1. Technology is only concerned with computers.(1,2,3,4)
2. A hundred years ago there was no technology.(1,2,3,4)
3. To know how a bike is constructed you do not have to study technology.(1,2,3,4)
4. In technology there are not many inventions that are really new.(1,2,3,4)
5. Between 'technics' and 'technology' is no difference.(4)
6. Designing an appliance is not a part of technology.(1,2,3,4)
7. With technology you learn to assemble appliances.(1,2,3,4)
8. Making a dress is a sort of technology.(1,2,3,4)
9. Technology is: working with your hands.(1,2,3,4)
10. Technology has always to do with electricity.(1,2,3,4)
11. In technology there is not much opportunity to invent things by yourself.(1,2,3,4)

I. KNOWLEDGE about technology (9 items)

1. I have never used a screw driver.(1,2,3,4)
2. I know very well how a coffee maker works. (1,2,3,4)
3. If you know nothing about technology, you are behind times.(1,2,3,4)
4. I do not know what the word 'technology' includes.(1,2,3,4)
5. I think technology is a bit scary.(1,2,3,4)
6. I know how most appliances are constructed.(1,2,3,4)
7. I know what most parts of a car are for.(1,2,3,4)
8. Sometimes I have taken things apart to see how they work.(1,2,3,4)
9. You can learn a lot about technology yourself.(1,2,3,4)

J. DEVELOPING COUNTRIES and technology (6 items)

1. Developed countries can do much for developing countries by technology.(1,2,3,4)
2. Developing countries should develop their own technology.(1,2,3,4)
3. Technology is good for developing countries.(1,2,3,4)
4. Technology is bad for developing countries.(2,3,4)
5. Poor countries have many benefits from the technology of rich countries.(2,3,4)
6. Modern technology should be adapted before being applied in developing countries.(1)

K. PHYSICS and technology (3 items)

1. Technology is nothing but applied physics.(1,3,4)
2. Technology is of no importance in physics.(3,4)
3. Technology can not develop without scientific knowledge.(3,4)

Appendix 3 Questionnaires

3.1 Questionnaire groep 7 and 8 basisschool
3.2 Questionnaire 2 lbo
3.3 Questionnaire 4 havo-vwo
3.4 Questionnaire 1 mbo
3.5 Questionnaire teachers primary school

In the main research five questionnaires have been used. For each questionnaire the scores on the general questions and items are given in percentages. The items of the AB-scales have a 5-point answering format. The meaning of the numbers are:
1= strongly agree
2= agree
3= not agree/not disagree
4= disagree
5= strongly disagree
The meaning of 'm'= mean and of 'sd'= standard deviation

The items of the C-scales have a 3-point answering format:
1= agree
2= disagree
3= don't know

Appendix 3.1 Questionnaire groep 7 and 8 basisschool

Techniek en Technologie

In de krant lees je vaak over techniek of met een moeilijk woord technologie. Ook op T.V. wordt er aandacht aan besteed. Techniek wordt steeds belangrijker. Er komen steeds meer technische beroepen.

Wij doen onderzoek naar wat leerlingen vinden van techniek. We willen bijvoorbeeld weten of je techniek leuk vindt.

Daarom vragen wij jou een vragenlijst in te vullen.

De vragen gaan niet over de voetbaltechniek van Ruud Gullit, of de pianotechniek van een pianist. Deze betekenis van techniek bedoelen we niet.

Het gaat bij elke vraag om wat JIJ vindt van techniek. Geef dus telkens JOUW mening. De vragenlijst is geen proefwerk of een test. Je krijgt geen cijfer, want er zijn geen goede of foute antwoorden.

Denk niet te lang na over een vraag.

DEEL 1: ALGEMENE VRAGEN (het goede antwoord aankruisen of invullen)

1. GESLACHT — jongen 50%; meisje 50%

2. LEEFTIJD — 11,2 jaar

3. DE NAAM VAN JE SCHOOL: ....

4. IK ZIT IN GROEP — 7: 46%; 8: 51%

5. NA DE BASISSCHOOL GA IK NAAR EEN:

	%
LBO	11
MAVO/LBO	4
MAVO	16
MAVO/HAVO/VWO	16
HAVO/VWO	18
weet nog niet	26
anders	6

6. LATER WIL IK NAAR EEN TECHNISCHE SCHOOL

ja	17
nee	35
weet niet	48

7. IK SPEEL(DE) MET TECHNISCH SPEELGOED (bouwdozen, lego)

ja, heel vaak	13
ja, vaak	18
ja, soms	54
nee, nooit	15

8. THUIS HEBBEN WE VEEL (83%) WEINIG (13%) GEEN (1%) GEREEDSCHAP

9. IK HEB BROERS DIE GOED ZIJN IN TECHNIEK

ja	29
nee	27
heb geen broers	43

10. IK HEB ZUSTERS DIE GOED ZIJN IN TECHNIEK

ja	10
nee	47
heb geen zusters	42

11. IK VIND DAT IK BEST VEEL VAN TECHNIEK WEET

	%
ja	26
nee	26
weet niet	48

12. WAT IK VAN TECHNIEK WEET, HEB IK: (je kunt hier meerdere antwoorden invullen)

ZELF GELEZEN	27
VAN DE T.V.	40
VAN M'N OUDERS	51
VAN BROERS/ZUSSEN	17
VAN VRIENDEN	14
VAN SCHOOL	27
WEET NIET WAARVAN	22

13. LATER WIL IK EEN TECHNISCH BEROEP:

ja	19
nee	33
weet niet	48

14. ALS JE VADER OF VERZORGER WERKT, KUN JE DAN OMSCHRIJVEN WAT HIJ DOET: (als je geen vader of verzorger hebt, of als hij niet werkt, zet dan een streepje)
31% technisch, 24% niet technisch, 26% niet duidelijk en 10% niet van toepassing

15. DOE HETZELFDE VOOR JE MOEDER OF VERZORGSTER:
0% technisch, 32% niet technisch, 4% niet duidelijk, 63% niet van toepassing (huisvrouw)

16. WAT DENK JIJ DAT TECHNIEK IS? PROBEER OP TE SCHRIJVEN WAAR JIJ AAN DENKT BIJ HET WOORD TECHNIEK.
(als je het echt niet weet, zet dan een streepje, en ga door naar de volgende bladzijde)

niets opgeschreven	19
techniek is iets kunnen in het algemeen	7
techniek is (opsomming van) apparaten	41
techniek is iets maken	25
techniek is kennis/vaardigheden	7
techniek is voor de mens	1

DEEL 2: MENING VRAGEN (het goede antwoord omcirkelen)

Wat moet je doen? Bij de volgende vragen moet je telkens omcirkelen of je het ermee eens bent of niet.

Een voorbeeld

PSV is de beste voetbalclub van Nederland 1 2 3 4 5

Als je het er helemaal mee eens bent, zet dan een rondje om het cijfer 1.
Als je het er mee eens bent, maar je aarzelt misschien wat, zet dan een rondje om het cijfer 2.
Als je het niet met een uitspraak eens bent, maar ook niet oneens, zet dan een rondje om het cijfer 3.
Als je het er niet mee eens bent, zet dan een rondje om 4.
Als je het er helemaal niet mee eens bent, zet dan een rondje om 5.

GEEF ZO GOED MOGELIJK JE EIGEN MENING.

DENK NIET TE LANG NA OVER EEN BEWERING.

ER ZIJN GEEN GOEDE OF FOUTE ANTWOORDEN

Om te oefenen enkele makkelijke vragen over school. Geef je mening door een rondje om het goede cijfertje te zetten.

NB: De scores worden in percentages weergegeven.

	1	2	3	4	5	m	sd
-Ik vind het leuk op school.	24	47	16	7	5	2.22	1.06
-Wij hebben een gezellige klas.	46	38	9	4	2	1.79	.93
-Ik verveel mij nooit op school.	19	28	20	26	8	2.87	1.24
-Ik heb een hekel aan school.	6	5	15	37	37	3.95	1.11

Kies uit vijf antwoordmogelijkheden:

	1	2	3	4	5	m	sd
1. Techniek interesseert mij niet.	6	9	29	29	27	3.63	1.15
2. Een meisje kan best een technisch beroep hebben.	70	25	3	0	2	1.39	.72
3. Techniek is erg belangrijk in het leven.	29	37	28	5	1	2.13	.93
4. Om iets van techniek te weten moet je eerst een moeilijke studie volgen.	10	18	39	23	9	3.04	1.10
5. Ik zou op school meer over techniek willen leren.	25	31	24	14	6	2.44	1.18
6. Jongens kunnen veel beter dingen repareren dan meisjes.	5	5	14	28	48	4.08	1.14
7. Ik zal later waarschijnlijk voor een technisch beroep kiezen.	10	7	50	17	15	3.20	1.11
8. Ik lees graag technische tijdschriften.	7	14	24	34	20	3.45	1.17
9. Door techniek gaat alles beter dan vroeger.	32	38	22	6	2	2.08	.99
10. Als er een hobby club over techniek was, werd ik zeker lid.	9	11	44	23	13	3.20	1.08
11. Je moet wel knap zijn om techniek te kunnen studeren.	5	15	27	35	18	3.46	1.11
12. De mensen hebben techniek beslist nodig.	20	33	30	13	3	2.47	1.05
13. Ik snap niet dat iemand voor een technisch beroep kiest.	2	5	25	34	33	3.92	.99
14. Een meisje kan beter geen automonteur worden.	4	3	10	30	53	4.27	1.01
15. De techniek heeft meer goede dan slechte dingen gebracht.	18	30	39	9	4	2.52	1.02
16. Er zouden minder T.V.-uitzendingen over techniek moeten zijn.	4	8	30	33	25	3.68	1.06
17. Ik zou later graag een baan in de techniek willen.	11	8	49	16	15	3.15	1.13
18. Door de techniek zijn er meer problemen in de wereld.	4	10	45	27	14	3.36	.98
19. Jongens weten meer van techniek dan meisjes.	4	7	15	31	42	4.00	1.11
20. Techniek is alleen weggelegd voor knappe mensen.	2	5	17	40	35	4.03	.94
21. Werken in de techniek lijkt me saai.	5	7	37	28	24	3.60	1.06
22. Ik zou op school liever geen lessen over techniek hebben.	5	9	23	34	29	3.73	1.13
23. Ik vind het leuk om thuis zelf iets te repareren.	41	34	14	7	4	1.99	1.09
24. Er zou meer onderwijs over techniek moeten komen.	18	25	39	13	5	2.63	1.08
25. De meeste beroepen in de techniek zijn leuk.	14	25	52	7	2	2.57	.88

Kies nu uit drie antwoordmogelijkheden:

	mee eens	niet mee eens	weet niet
26. Bij techniek denk ik vooral aan machines.	63	22	15
27. In de techniek kun je zelden je fantasie gebruiken.	21	44	35
28. Bij techniek denk je vooral aan het omgaan met apparaten.	76	11	13
29. Ik vind dat techniek alleen van deze tijd is.	14	50	36
30. In de techniek kun je nieuwe dingen bedenken.	82	3	15
31. De techniek is zo oud als de mensheid.	25	38	36
32. Techniek heeft grote invloed op de mensen.	54	6	40
33. Knutselen hoort bij techniek.	74	5	21
34. In het dagelijkse leven heb ik veel met techniek te maken.	34	27	39

	mee eens	niet mee eens	weet niet
35. In de techniek kun je weinig zelf bedenken.	8	59	32
36. De techniek staat ver van mijn dagelijkse leven.	15	47	38
37. In de techniek ga je met gereedschap om.	77	6	17
38. Techniek is bedoeld om ons leven prettiger te maken.	37	16	47

TOT SLOT: VOND JE HET LEUK OM VRAGEN OVER TECHNIEK TE BEANTWOORDEN?:

ja	91
nee	6
weet niet	2

VOND JE DE VRAGEN MOEILIJK?

ja	10
nee	83
weet niet	7

EINDE VAN DE VRAGENLIJST, HARTELIJK BEDANKT! ! !

Appendix 3.2 Questionnaire 2 lbo

Techniek en Technologie

In de krant lees je vaak over techniek en technologie. Ook op de TV wordt er aandacht aan besteed. Het woord techniek heeft een aantal betekenissen. Eén daarvan is:'de manier waarop je iets doet', bijvoorbeeld: 'de techniek van het pianospelen', of: 'een goede voetbaltechniek'. Die betekenis bedoelen we in de vragenlijst NIET.

Wij doen een onderzoek naar wat leerlingen vinden van techniek. Daarom vragen wij jou deze lijst in te vullen.
Het gaat bij elke vraag om wat JIJ vindt van techniek. Geef dus telkens JOUW mening als antwoord.

Een voorbeeld

PSV is de beste voetbalclub van Nederland 1 2 3 4 5

Als je het er helemaal mee eens bent, zet je een rondje om het cijfer 1.
Als je het er mee eens bent, maar je aarzelt misschien wat, zet dan een rondje om het cijfer 2.
Als je het niet met een uitspraak eens bent, maar ook niet oneens, zet dan een rondje om het cijfer 3.
Als je het er niet mee eens bent, zet dan een rondje om het cijfer 4.
Als je het er helemaal niet mee eens bent, zet dan een rondje om het cijfer 5.

GEEF ZO GOED MOGELIKJK JE EIGEN MENING

DENK NIET TE LANG NA OVER EEN BEWERING

DE RESULTATEN WORDEN ANONIEM VERWERKT.
JE HOEFT DAAROM JE NAAM NIET IN TE VULLEN

DE VRAGENLIJST IS GEEN TEST.
ER ZIJN GEEN GOEDE OF FOUTE ANTWOORDEN

Zou je vooraf de volgende vragen willen beantwoorden:

Geslacht: O jongen (58%) O meisje (42%)

Leeftijd: jaar (gemiddelde=13.6)

Gesteld dat je vader (of verzoger) werkt, kun je dan zo goed mogelijk omschrijven wat hij doet en waar hij werkt (in andere gevallen kun je een streepje zetten):

....
(technisch: 39%, niet-technisch: 18%, n.v.t./onduidelijk 43%)
....

....

Doe hetzelfde voor je moeder (of verzorgster):

....
(technisch: 1%, niet technisch 20%, n.v.t./onduidelijk 79%)
....

....

De naam van de school:...

Je klas aankruisen:

O 2 lts	O 2 lhno	O 2 leao	O verlengd brugjaar
51%	25%	5.6%	18%

O overig nl.:........

Als je naar de derde klas gaat kies je voor (of blijf je op):

O lts	O lhno	O leao	O overig nl.:........
55%	26%	6%	13%

DEEL 1 (vraag 1-40)

	1	2	3	4	5	m	sd
1. Techniek interesseert mij niet	7	8	22	29	33	3.73	1.21
2. Techniek is voor meisjes net zo moeilijk als voor jongens	34	40	13	8	4	2.07	1.07
3. Techniek is goed voor de toekomst van dit land	28	40	24	5	3	2.14	.98
4. Om iets van techniek te weten, moet je eerst een moeilijke studie volgen	7	15	25	32	21	3.45	1.12
5. Ik lees graag technische tijdschriften	7	13	22	28	30	3.61	1.23
6. Een meisje kan best een technisch beroep hebben	51	40	5	2	2	1.64	.83
7. Door techniek gaat alles beter	15	29	39	12	4	2.62	1.02
8. Je moet wel knap zijn om techniek te kunnen studeren	4	8	25	36	27	3.73	1.07
9. Als er een hobbyclub over techniek was, werd ik zeker lid	7	12	27	32	22	3.50	1.17
10. Jongens kunnen veel beter dingen repareren dan meisjes	8	11	19	28	34	3.69	1.26
11. Techniek is erg belangrijk in het leven	25	40	26	6	3	2.25	1.00
12. Techniek is alleen weggelegd voor knappe mensen	2	4	13	36	45	4.16	.95
13. Er zouden minder TV-uitzendingen over techniek moeten zijn	7	10	33	29	21	3.49	1.13
14. Een meisje kan beter geen automonteur worden	5	8	17	34	37	3.90	1.14
15. De mensen hebben techniek beslist nodig	25	33	28	9	4	2.34	1.09
16. Het is niet moeilijk om een computer te bedienen	14	21	30	23	11	2.95	1.20
17. Als er iets nieuws uitgevonden is, wil ik daar meer van weten	12	22	34	22	10	2.95	1.15
18. Jongens weten meer van techniek dan meisjes	6	10	21	30	33	3.73	1.20
19. De techniek heeft meer goede dan slechte dingen gebracht	15	30	38	11	6	2.63	1.06

	1	2	3	4	5	m	sd
20. Voor de meeste technische beroepen moet je sterk zijn	4	13	29	32	22	3.55	1.09
21. Ik vind het leuk om thuis zelf iets te repareren	43	30	15	8	4	2.00	1.13
22. Meisjes gaan liever niet naar een technische school	11	27	34	19	9	2.88	1.12
23. Zonder techniek zouden er minder problemen in de wereld zijn	6	9	28	29	28	3.64	1.14
24. Om techniek te studeren moet je talent hebben	4	9	26	37	25	3.70	1.05
25. Ik zou meer over computers willen weten	32	30	20	11	7	2.32	1.23
26. Meisjes vinden techniek saai	6	10	43	25	17	3.38	1.05
27. Techniek is slecht voor de welvaart van dit land	2	4	27	35	33	3.93	.96
28. Je kunt alleen techniek studeren als je goed bent in zowel wiskunde als natuurkunde	7	18	31	26	18	3.30	1.16
29. Het bezoeken van een fabriek lijkt me saai	8	11	19	33	28	3.63	1.23
30. Meisjes kunnen prima een computer bedienen	34	35	22	5	4	2.10	1.05
31. Omdat techniek vervuiling veroorzaakt moeten we het minder gebruiken	8	15	39	22	14	3.19	1.12
32. In de techniek heb je weinig wiskunde nodig	4	8	31	36	21	3.62	1.02
33. Oude machines vind ik saai	10	14	24	31	22	3.41	1.24
34. Jongens zijn meer geschikt om technische dingen te doen	10	16	24	24	25	3.36	1.30
35. Techniek veroorzaakt grote werkloosheid	17	17	29	20	17	3.03	1.31
36. Iedereen kan techniek studeren	44	35	11	6	4	1.91	1.06
37. Een technische hobby is saai	5	6	25	32	33	3.82	1.10
38. Er zouden meer meisjes in de techniek moeten werken	25	30	31	8	5	2.38	1.10

	1	2	3	4	5	m	sd
39. Techniek is het onderwerp van van de toekomst	23	31	34	7	5	2.39	1.06
40. Iedereen kan een technisch beroep hebben	35	35	18	8	4	2.09	1.08

DEEL 2: kiezen tussen drie antwoordmogelijkheden (vraag 1-28)

	mee eens	niet mee eens	weet niet
1. Bij techniek denk ik vooral aan machines	51	34	15
2. Natuurkunde en techniek hebben volgens mij met elkaar te maken	46	19	35
3. In de techniek kun je zelden je fantasie gebruiken	25	54	21
4. Ik vind dat techniek weinig te maken heeft met ons energie probleem	16	40	44
5. Bij techniek denk je vooral aan het omgaan met apparaten	70	21	8
6. Techniek en natuurkunde zijn voor mij hetzelfde	10	62	27
7. Ik vind dat techniek niet oud is	48	26	26
8. In de techniek kun je nieuwe dingen bedenken	85	5	10
9. Volgens mij hoort techniek eerder bij computers dan bij computerprogramma's	28	30	43
10. De techniek is zo oud als de mensheid	43	26	31
11. Je maakt in de techniek niet veel gebruik van natuurkunde	16	44	40
12. Je hoeft niet technisch te zijn om iets nieuws uit te vinden	45	38	16
13. Techniek heeft grote invloed op mensen	62	11	27
14. Ik denk dat je bij natuurkunde vaak de techniek gebruikt	46	18	36
15. Knutselen hoort bij techniek	79	9	11
16. In het dagelijkse leven heb ik veel met techniek te maken	59	22	19
18. De techniek staat ver van mijn dagelijkse leven	15	63	23
19. Biologie en techniek hebben niets met elkaar te maken	28	26	45
20. De regering kan invloed uitoefenen op de techniek	31	16	54
21. Het omzetten van energie hoort volgens mij ook bij techniek	59	8	33
22. In de techniek ga je met gereedschap om	83	9	8
23. Techniek is bedoeld om ons leven te veraangenamen	37	17	46
24. Ik denk bij techniek vooral aan computer-programma's	18	59	23
25. In de techniek hebben alleen technici het voor het zeggen	11	63	26
26. Tussen scheikunde en techniek is een relatie	27	12	61
27. In de techniek kun je weinig met je handen werken	8	83	9
28. Het bewerken van materialen is een belangrijk onderdeel van de techniek	73	6	20

EINDE VRAGENLIJST, BEDANKT VOOR HET INVULLEN

Appendix 3.3 Questionnaire 4 havo-vwo

Techniek en Technologie

In de krant lees je vaak over techniek en technologie. Ook op de TV wordt er aandacht aan besteed. Het woord techniek heeft een aantal betekenissen. Eén daarvan is:'de manier waarop je iets doet', bijvoorbeeld: 'de techniek van het pianospelen', of: 'een goede voetbaltechniek'. Die betekenis bedoelen we in de vragenlijst NIET.

Wij doen een onderzoek naar wat leerlingen vinden van techniek. Daarom vragen wij jou deze lijst in te vullen.
Het gaat bij elke vraag om wat JIJ vindt van techniek. Geef dus telkens JOUW mening als antwoord.

Een voorbeeld

PSV is de beste voetbalclub van Nederland 1 2 3 4 5

Als je het er helemaal mee eens bent, zet je een rondje om het cijfer 1.
Als je het er mee eens bent, maar je aarzelt misschien wat, zet dan een rondje om het cijfer 2.
Als je het niet met een uitspraak eens bent, maar ook niet oneens, zet dan een rondje om het cijfer 3.
Als je het er niet mee eens bent, zet dan een rondje om het cijfer 4.
Als je het er helemaal niet mee eens bent, zet dan een rondje om het cijfer 5.

GEEF ZO GOED MOGELIKJK JE EIGEN MENING

DENK NIET TE LANG NA OVER EEN BEWERING

DE RESULTATEN WORDEN ANONIEM VERWERKT.
JE HOEFT DAAROM JE NAAM NIET IN TE VULLEN

DE VRAGENLIJST IS GEEN TEST.
ER ZIJN GEEN GOEDE OF FOUTE ANTWOORDEN

DEEL 1: Algemene vragen: het 'goede' antwoord aankruisen/invullen

1. Geslacht O jongen (55%)
   O meisje (45%)

2. Leeftijd jaar (gemiddelde= 16.2)

3. De naam van je school:..

4. Je huidige klas (b.v. 4 havo of 1 mts):............................

5. Je vorige klas (b.v. 3 havo of 4 mavo):............................

6. Gesteld dat je vader (of verzorger) werkt, kun je dan zo goed mogelijk aangeven wat hij doet (in andere gevallen kun je een streepje zetten):

   ....
   (technisch: 33%, niet-technisch: 34%, onduidelijk: 23%, n.v.t.: 10%)
   ....

   ....

7. Doe hetzelfde voor je mceder of verzorgster:

   ....
   (technisch: 2%, niet-technisch: 33%, onduidelijk: 5%, n.v.t.: 60%)
   ....

   ....

8. Vroeger speelde ik met 'technisch speelgoed' (bouwdozen, lego e.d.):

   O vaak (40%) O soms (49%) O nooit (11%)

9. Thuis hebben we O veel (71%) O weinig (23%) O geen gereedschap. (6%)

10. Ik heb broers en/of zusters die 'technische aanleg' hebben:
    O ja (39)
    O nee (54%)
    O heb geen broers/zuster (6%)

11. Ik heb ambitie om later voor een technisch beroep te kiezen:
    O ja (39%)
    O nee (57%)
    O weet niet (4%)

12. Omschrijf zo goed mogelijk wat jij onder techniek verstaat:

    ....

    ....

    ....

    ....

DEEL 2: kiezen tussen vijf antwoordmogelijkheden (vraag 1-58)

	1	2	3	4	5	m	sd
1. Techniek interesseert mij niet	5	11	27	31	26	3.62	1.14
2. Ik vind techniek een bedreiging voor de moderne samenleving	1	4	15	35	48	4.28	.82
3. Techniek is goed voor de toekomst van dit land	30	48	17	3	2	1.99	.88
4. Om iets van techniek te weten, moet je eerst een moeilijke studie volgen	5	21	33	30	11	3.31	1.04
5. Ik zou niet meer over techniek willen horen op school	4	10	20	40	25	3.73	1.08
6. Ik zal later waarschijnlijk voor een technisch beroep kiezen	12	18	20	23	27	3.36	1.35
7. Ik lees graag technische tijdschriften	7	16	21	22	34	3.60	1.28
8. Je moet wel knap zijn om techniek te kunnen studeren	2	16	36	33	12	3.36	1.00
9. Een meisje kan best een technisch beroep hebben	70	25	2	1	2	1.40	.75
10. Techniek lessen zijn belangrijk	11	39	40	8	2	2.51	.87
11. Ik peins er niet over om een technisch beroep te kiezen	16	15	18	22	29	3.32	1.44
12. Als er een hobbyclub over techniek was, werd ik zeker lid	2	4	23	37	34	3.98	.94
13. Jongens kunnen veel beter dingen repareren dan meisjes	4	12	24	29	30	3.69	1.15
14. Techniek is erg belangrijk in het leven	21	51	22	5	15	2.13	.84
15. Techniek is alleen weggelegd voor knappe mensen	11	7	30	42	21	2.25	.90
16. Ik zou op school liever geen lessen over techniek hebben	7	15	21	38	19	3.75	.90
17. Door techniek gaat alles beter	7	29	45	15	5	2.82	.93
18. Ik snap niet dat iemand voor een technisch beroep kiest	1	2	11	38	47	4.28	.84
19. Er zouden minder TV-uitzendingen over techniek moeten zijn	2	6	28	42	22	3.75	.93
20. Een meisje kan beter geen automonteur worden	2	5	10	37	46	3.20	.96
21. De mensen hebben techniek beslist nodig	21	49	22	6	2	2.19	.90
22. Ik vind dat computers zorgen voor een betere wereld	9	25	45	16	5	2.84	.97
23. Op school zou je meer moeten leren over huishoudelijke apparaten	4	21	34	30	11	3.21	1.0
24. Ik zou later graag een baan in de techniek hebben	12	20	23	26	19	3.22	1.30
25. Als er iets nieuws uitgevonden is, wil ik daar meer van weten	15	36	31	14	52	2.57	1.04
26. Jongens weten meer van techniek dan meisjes	4	23	25	27	21	3.40	1.17
27. De techniek heeft meer goede dan slechte dingen gebracht	11	34	33	17	5	2.70	1.04
28. Voor de meeste technische beroepen moet je sterk zijn	9	3	12	48	37	1.82	.80
29. Ik zou techniek als schoolvak moeten kunnen kiezen	11	35	28	17	9	2.78	1.11
30. Ik zou graag carrière maken in de techniek	10	19	23	26	22	3.29	1.28
31. Ik vind het leuk om thuis zelf iets te repareren	19	33	23	16	9	2.63	1.21
32. Meisjes gaan liever niet naar een technische school	4	23	39	22	12	3.15	1.03
33. Zonder techniek zouden er minder problemen in de wereld zijn	16	5	30	41	23	3.80	.90
34. Om techniek te studeren, moet je talent hebben	6	33	32	22	7	3.09	1.02
35. Er zou meer onderwijs in techniek moeten komen	6	28	44	18	4	2.86	.91
36. Werken in de techniek lijkt me saai	7	13	22	39	20	3.52	1.14
37. Ik zou meer over computers willen weten	20	40	19	12	8	2.41	1.17

	1	2	3	4	5	m	sd
38.Meisjes vinden techniek saai	31	8	40	31	19	3.55	.97
39.Techniek is slecht voor de welvaart van dit land	1	1	14	43	41	4.22	.80
40.Je kunt alleen techniek studeren als je goed bent in zowel wiskunde als in natuurkunde	8	44	30	14	4	2.62	.97
41.Techniek moet voor alle leerlingen een verplicht vak worden	0	4	14	41	41	4.18	.84
42.De meeste beroepen in de techniek zijn saai	19	6	29	47	17	3.71	.87
43.Het bezoeken van een fabriek lijkt me saai	20	45	20	11	4	2.34	1.04
44.Meisje kunnen prima een computer bedienen	49	41	7	1	1	1.66	.79
45.Omdat techniek vervuiling veroorzaakt, moeten we het minder gebruiken	3	11	41	32	13	3.51	.95
46.In de techniek heb je weinig wiskunde nodig	0	2	14	53	30	4.11	.75
47.Techniek lessen zijn belangrijk voor een goede baan	3	19	39	27	12	3.26	1.00
48.Werk in de techniek is interessant	13	34	35	14	5	2.64	1.03
49.Ik vind machines saai	7	17	27	37	13	3.33	1.11
50.Jongens zijn meer geschikt om technische dingen te doen dan meisjes	4	11	20	33	32	3.79	1.17
51.Techniek veroorzaakt grote werkloosheid	5	19	41	26	9	3.17	.99
52.Iedereen kan techniek studeren	11	27	25	31	7	2.96	1.13
53.Een technische hobby is saai	2	6	19	50	22	3.82	.92
54.Er zouden meer meisjes in de techniek moeten werken	17	39	36	6	2	2.98	.90
55.Techniek is het onderwerp van de toekomst	13	43	33	7	2	2.43	.90
56.Niet voor iedereen is het nodig om techniek lessen te volgen	2	8	20	48	22	3.79	.95
57.Iedereen kan 'n technisch beroep hebben	8	25	28	30	8	3.05	1.11
58.Ik vind dat we de wereld te snel laten veranderen door de techniek	5	11	41	32	11	3.33	.98

DEEL 3: kiezen tussen drie antwoordmogelijkheden (vraag 1-28)

	mee eens	niet mee eens	weet niet
1. Bij techniek denk ik vooral aan machines	58	34	8
2. Natuurkunde en techniek hebben volgens mij met elkaar te maken	93	3	4
3. In de techniek kun je zelden je fantasie gebruiken	12	72	16
4. Ik vind dat techniek weinig te maken heeft met ons energie probleem	6	70	24
5. Bij techniek denk je vooral aan het omgaan met apparaten	63	28	9
6. Techniek en natuurkunde zijn voor mij hetzelfde	12	75	13
7. Ik vind dat techniek niet oud is	30	45	25
8. In de techniek kun je nieuwe dingen bedenken	94	1	5
9. Volgens mij hoort techniek eerder bij computers dan bij computerprogramma's	34	37	29
10.De techniek is zo oud als de mensheid	67	15	18
11.Je maakt in de techniek niet veel gebruik van natuurkunde	4	83	12
12.Je hoeft niet technisch te zijn om iets nieuws uit te vinden	53	27	20
13.Techniek heeft grote invloed op mensen	84	4	13
14.Ik denk dat je bij natuurkunde vaak de techniek gebruikt	68	10	22
15.Knutselen hoort bij techniek	66	15	19
16.In het dagelijkse leven heb ik veel met techniek te maken	57	27	16
17.In de techniek kun je weinig zelf bedenken	8	74	18
18.De techniek staat ver van mijn dagelijkse leven	16	71	13
19.Biologie en techniek hebben niets met elkaar te maken	21	47	32
20.De regering kan invloed uitoefenen op de techniek	59	14	27

21. Het omzetten van energie hoort volgens mij ook bij techniek	80	3	17
22. In de techniek ga je met gereedschap om	79	11	10
23. Techniek is bedoeld om ons leven te veraangenamen	69	12	19
24. Ik denk bij techniek vooral aan computer-programma's	8	77	15
25. In de techniek hebben alleen technici het voor het zeggen	11	66	23
26. Tussen scheikunde en techniek is een relatie	73	7	19
27. In de techniek kun je weinig met je handen werken	4	87	9
28. Het bewerken van materialen is een belangrijk onderdeel van de techniek	64	8	28

EINDE VAN DE VRAGENLIJST, BEDANKT VOOR HET INVULLEN

Appendix 3.4 Questionnaire 1 mbo

Techniek en Technologie

In de krant lees je vaak over techniek en technologie. Ook op de TV wordt er aandacht aan besteed. Het woord techniek heeft een aantal betekenissen. Eén daarvan is:'de manier waarop je iets doet', bijvoorbeeld: 'de techniek van het pianospelen', of: 'een goede voetbaltechniek'. Die betekenis bedoelen we in de vragenlijst NIET.

Wij doen een onderzoek naar wat leerlingen vinden van techniek. Daarom vragen wij jou deze lijst in te vullen.
Het gaat bij elke vraag om wat JIJ vindt van techniek. Geef dus telkens JOUW mening als antwoord.

Een voorbeeld

PSV is de beste voetbalclub van Nederland 1 2 3 4 5

Als je het er helemaal mee eens bent, zet je een rondje om het cijfer 1.
Als je het er mee eens bent, maar je aarzelt misschien wat, zet dan een rondje om het cijfer 2.
Als je het niet met een uitspraak eens bent, maar ook niet oneens, zet dan een rondje om het cijfer 3.
Als je het er niet mee eens bent, zet dan een rondje om het cijfer 4.
Als je het er helemaal niet mee eens bent, zet dan een rondje om het cijfer 5.

GEEF ZO GOED MOGELIJK JE EIGEN MENING

DENK NIET TE LANG NA OVER EEN BEWERING

DE RESULTATEN WORDEN ANONIEM VERWERKT.
JE HOEFT DAAROM JE NAAM NIET IN TE VULLEN

DE VRAGENLIJST IS GEEN TEST.
ER ZIJN GEEN GOEDE OF FOUTE ANTWOORDEN

DEEL 1: Algmene vragen: het 'goede' antwoord aankruisen/invullen

1. Geslacht O jongen (55%)
O meisje (45%)

2. Leeftijd jaar (gemiddelde- 17.5)

3. De naam van je school:..

4. Je huidige klas (b.v. 4 havo of 1 mts):..............................

5. Je vorige klas (b.v. 3 havo of 4 mavo):..............................

6. Gesteld dat je vader (of verzorger) werkt, kun je dan zo goed mogelijk aangeven wat hij doet (in andere gevallen kun je een streepje zetten):

....
(technisch: 33%, niet-technisch: 26%, onduidelijk: 22%, n.v.t.: 19%)
....

....

7. Doe hetzelfde voor je moeder of verzorgster:

....
(technisch: 1%, niet-technisch: 24%, onduidelijk: 3%, n.v.t.: 72%)
....

....

8. Vroeger speelde ik met 'technisch speelgoed' (bouwdozen, lego e.d.):

O vaak (33%) O soms (53%) O nooit (14%)

9. Thuis hebben we O veel (75%) O weinig (21%) O geen gereedschap. (4%)

10. Ik heb broers en/of zusters die 'technische aanleg' hebben:
O ja (40)
O nee (51%)
O heb geen broers/zuster (8%)

11. Ik heb ambitie om later voor een technisch beroep te kiezen:
O ja (39%)
O nee (59%)
O weet niet (2%)

12. Omschrijf zo goed mogelijk wat jij onder techniek verstaat:

....

....

....

....

DEEL 2: kiezen tussen vijf antwoordmogelijkheden (vraag 1-58)

	1	2	3	4	5	m	sd
1. Techniek interesseert mij niet	7	10	25	30	27	3.61	1.19
2. Ik vind techniek een bedreiging voor de moderne samenleving	1	3	22	36	38	4.07	.90
3. Techniek is goed voor de toekomst van dit land	26	47	20	4	3	2.12	.95
4. Om iets van techniek te weten, moet je eerst een moeilijke studie volgen	5	20	31	32	12	3.25	1.07
5. Ik lees graag technische tijdschriften	6	16	18	23	38	3.17	1.27
6. Een meisje kan best een technisch beroep hebben	58	34	4	1	2	1.55	.83
7. Door techniek gaat alles beter	8	30	46	13	3	2.75	.90
8. Je moet wel knap zijn om techniek te kunnen studeren	3	9	31	37	20	3.63	.98
9. Als er een hobbyclub over techniek was, werd ik zeker lid	1	4	18	36	40	4.09	.93
10.Jongens kunnen veel beter dingen repareren dan meisjes	5	11	24	29	32	3.73	1.15
11.Techniek is erg belangrijk in het leven	20	46	26	5	2	2.24	.91
12.Techniek is alleen weggelegd voor knappe mensen	1	3	18	43	34	4.04	.88
13.Er zouden minder TV-uitzendingen over techniek moeten zijn	4	6	35	37	19	3.63	.97
14.Een meisje kan beter geen automonteur worden	2	4	12	36	45	4.17	.96
15.De mensen hebben techniek beslist nodig	22	48	21	7	2	2.21	.94
16.Ik vind dat computers zorgen voor een betere wereld	8	20	49	16	6	2.92	.97
17.Als er nieuws is uitgevonden wil ik daar meer van weten	14	32	31	18	5	2.69	1.08
18.Jongens weten meer van techniek dan meisjes	5	23	22	28	22	3.59	1.20

	1	2	3	4	5	m	sd
19.De techniek heeft meer goede dan slechte dingen gebracht	9	33	39	14	5	2.61	1.20
20.Voor de meeste technische beroepen moet je sterk zijn	1	5	19	44	31	3.98	.89
21.Ik vind het leuk om thuis zelf iets te repareren	27	32	17	14	9	2.46	1.28
22.Meisjes gaan liever niet naar een technische school	7	31	33	20	9	2.98	1.07
23.Zonder techniek zouder er minder problemen in de wereld zijn	19	41	33	6	2	3.68	.90
24.Om techniek te studeren, moet je talent hebben	5	23	28	32	12	3.22	1.09
25.Ik zou meer over computers willen weten	18	39	20	16	7	2.55	1.16
26.Meisjes vinden techniek saai	3	13	43	29	13	3.35	.95
27.Techniek is slecht voor de welvaart van dit land	1	2	21	44	32	1.98	.86
28.Je kunt alleen techniek studeren als je goed bent in zowel wiskunde als natuurkunde	8	29	31	24	9	2.98	1.08
29.Het bezoeken van een fabriek lijkt me saai	7	12	22	39	20	3.52	1.13
30.Meisjes kunnen prima een computer bedienen	45	40	11	2	2	1.75	.86
31.Omdat techniek vervuiling veroorzaakt moeten we het minder gebruiken	5	14	43	28	10	3.26	.98
32.In de techniek heb je weinig wiskunde nodig	2	3	22	46	27	3.94	.89
33.Ik vind machines saai	8	17	27	34	14	3.29	1.44
34.Jongens zijn meer geschikt om technische dingen te doen dan meisjes	5	17	24	31	23	3.04	1.15
35.Techniek veroorzaakt grote werkloosheid	10	26	37	21	7	2.90	1.06
36.Iedereen kan techniek studeren	19	36	23	16	5	2.52	1.13
37.Een technische hobbie is saai	3	5	22	42	27	3.84	1.00
38.Er zouden meer meisjes in de techniek moeten werken	22	40	31	5	2	2.24	.92

	1	2	3	4	5	m	sd
39. Techniek is het onderwerp van de toekomst	19	44	30	6	2	2.28	.88
40. Iedereen kan een technisch beroep hebben	15	34	26	20	5	2.67	1.11
41. Ik vind dat we de wereld te snel laten veranderen door de techniek	6	22	39	24	8	3.06	1.02

DEEL 3: kiezen tussen drie antwoordmogelijkheden (vraag 1-28)

	mee eens	niet mee eens	weet niet
1. Bij techniek denk ik vooral aan machines	59	35	6
2. Natuurkunde en techniek hebben volgens mij met elkaar te maken	77	9	14
3. In de techniek kun je zelden je fantasie gebruiken	13	70	16
4. Ik vind dat techniek weinig te maken heeft met ons energie probleem	9	58	32
5. Bij techniek denk je vooral aan het omgaan met apparaten	72	23	5
6. Techniek en natuurkunde zijn voor mij hetzelfde	9	74	17
7. Ik vind dat techniek niet oud is	34	39	26
8. In de techniek kun je nieuwe dingen bedenken	94	2	4
9. Volgens mij hoort techniek eerder bij computers dan bij computerprogramma's	31	38	31
10. De techniek is zo oud als de mensheid	66	12	22
11. Je maakt in de techniek niet veel gebruik van natuurkunde	7	66	28
12. Je hoeft niet technisch te zijn om iets nieuws uit te vinden	49	33	18
13. Techniek heeft grote invloed op mensen	83	48	13
14. Ik denk dat je bij natuurkunde vaak de techniek gebruikt	56	15	29
15. Knutselen hoort bij techniek	75	13	13
16. In het dagelijkse leven heb ik veel met techniek te maken	58	29	13
17. In de techniek kun je weinig zelf bedenken	8	73	18
18. De techniek staat ver van mijn dagelijkse leven	17	72	11
19. Biologie en techniek hebben niets met elkaar te maken	24	36	40
20. De regering kan invloed uitoefenen op de techniek	55	14	32
21. Het omzetten van energie hoort volgens mij ook bij techniek	79	3	18
22. In de techniek ga je met gereedschap om	85	8	7
23. Techniek is bedoeld om ons leven te veraangenamen	65	13	22
24. Ik denk bij techniek vooral aan computer-programma's	10	74	16
25. In de techniek hebben alleen technici het voor het zeggen	11	69	21
26. Tussen scheikunde en techniek is een relatie	56	8	36
27. In de techniek kun je weinig met je handen werken	5	86	9
28. Het bewerken van materialen is een belangrijk onderdeel van de techniek	76	6	18

EINDE VRAGENLIJST, BEDANKT VOOR HET INVULLEN

Appendix 3.5 Questionnaire teachers primary school

Voor de leraren en leraressen van groep 7 en 8.

Met deze vragenlijst gaan we na welke houding u tegenover techniek heeft. Daarbij gaat het niet om "voetbal"- of "piano"-techniek.

De vragenlijst bestaat uit uitspraken over techniek. Wilt u svp aangeven of u het met een uitspraak eens bent of niet. Dit doet u door een cirkel om het gewenste cijfer te zetten.
Het eerste deel van de vragenlijst bestaat uit 38 uitspraken met 5 antwoordmogelijkheden.
Het tweede deel van de vragenlijst bestaat uit 28 uitspraken met 3 antwoordmogelijkheden.

Wij vragen u deze lijst in te vullen als uw klas aan het onderzoek deelneemt.

Wilt u vooraf onderstaande vragen beantwoorden.

1. Naam en adres van de school:

2. Docent van groep
   - groep 6: 1 leraar
   - groep 7: 29 leraren
   - groep 7/8: 33 leraren
   - groep 8: 37 leraren

3. Geslacht m/v
   - 83 mannen
   - 7 vrouwen

4. Leeftijd 39,7 jaar

NB: De scores worden in percentage weergegeven.

Deel 1	1	2	3	4	5	m	sd
1. Voor mij is techniek niet interessant.	2	12	1	49	36	4.03	1.00
2. Een vrouw kan beter geen automonteur worden.	1	4	2	36	57	4.62	.83
3. Techniek is erg belangrijk in het leven.	40	44	3	7	6	1.93	1.10
4. Ik lees graag technische tijdschriften.	6	14	7	47	27	3.74	1.17
5. Om iets van techniek te weten moet je eerst een moeilijke studie volgen.	0	6	12	60	22	3.99	.76
6. Het is nuttig als er een apart vak techniek op de basisschool komt.	6	27	30	28	10	3.10	1.08
7. Een vrouw kan net zo goed een technisch beroep hebben als een man.	68	29	0	0	3	1.42	.81
8. Als er een hobbyclub over techniek was, werd ik zeker lid.	4	29	0	41	26	3.88	.85
9. Techniek is goed voor de economie.	28	54	12	3	2	1.98	.86
10. Je moet wel knap zijn om techniek te kunnen studeren.	1	12	14	50	22	3.80	.96
11. Jongens kunnen veel beter dingen repareren dan meisjes.	1	3	10	47	39	4.20	.83
12. Er zouden minder T.V.-uitzendingen over techniek moeten zijn.	0	0	34	50	16	3.82	.69
13. Op de basisschool moet meer aandacht aan techniek worden geschonken.	13	43	22	18	3	2.54	1.04

	1	2	3	4	5	m	sd
14. Techniek is goed voor ontwikkelingslanden.	22	61	10	3	3	2.04	.87
15. Jongens weten meer van techniek dan meisjes.	2	51	11	26	10	2.91	1.12
16. Techniek is alleen weggelegd voor knappe mensen.	0	3	2	71	24	4.15	.61
17. De mensen hebben techniek beslist nodig.	42	47	7	3	1	1.75	.81
18. Ik vind het leuk om thuis zelf iets te repareren.	44	40	1	11	3	1.90	1.10
19. Op scholen moet meer aandacht besteed worden aan techniek.	13	52	26	7	2	2.33	.88
20. Het zou beter zijn als er geen technische uitvindingen gedaan waren.	0	0	8	28	64	4.57	.64
21. Techniek is niets voor vrouwen.	1	0	1	28	70	4.70	.62
22. Ik denk weinig na over techniek.	6	35	5	42	12	3.21	1.21
23. Iedereen kan een technisch beroep hebben.	12	22	11	37	17	3.23	1.31
24. Door techniek gaat alles beter.	7	17	29	45	2	3.19	.97
25. Van de meeste onderdelen van een auto weet ik waarvoor ze dienen.	10	39	4	31	15	3.01	1.31
26. Het is niet terecht dat er een apart vak techniek komt in het basisonderwijs.	7	27	27	36	3	3.03	1.02
27. De techniek heeft meer goede dan slechte dingen gebracht.	15	42	24	18	2	2.52	1.02
28. Techniek is voor vrouwen net zo gemakkelijk/moeilijk als voor mannen.	27	46	13	4	0	1.92	.79

	1	2	3	4	5	m	sd
29. Iedereen kan techniek studeren.	13	31	12	41	2	2.87	1.16
30. Ik heb wel eens iets uit elkaar gehaald om te zien hoe het werkte.	30	53	3	12	1	2.01	.97
31. Zonder techniek zouden er minder problemen in de wereld zijn.	0	4	24	51	20	3.87	.78
32. Meisjes moeten op dezelfde manier met techniek in aanraking komen als jongens.	50	41	4	4	0	1.63	.77
33. Ik ben niet bekend met techniek.	6	23	7	46	19	3.49	1.20
34. Techniek veroorzaakt werkloosheid.	0	9	30	46	16	3.70	.85
35. Het is belangrijk dat leerlingen in het onderwijs in aanraking komen met techniek.	26	70	3	1	0	1.80	.55
36. Meisjes betrekken bij techniek in het onderwijs is ondoenlijk.	1	1	1	40	57	3.50	.69
37. Ik vind dat computers zorgen voor een betere wereld.	4	17	44	23	11	3.20	.99
38. Van de meeste apparaten weet ik hoe ze in elkaar zitten.	4	13	12	51	19	3.67	1.07

Deel 2

	mee eens	niet mee eens	weet niet
1. Bij techniek denk ik vooral aan machines.	53	46	1
2. Natuurkunde en techniek hebben volgens mij met elkaar te maken.	97	2	1
3. In de techniek kun je zelden je fantasie gebruiken.	3	89	8
4. Ik vind dat techniek weinig te maken heeft met ons energieprobleem.	7	89	4
5. Bij techniek denk je vooral aan het omgaan met apparaten.	52	43	6
6. Techniek en natuurkunde zijn voor mij hetzelfde.	12	78	10
7. Ik vind dat techniek niet oud is.	16	80	4
8. In de techniek kun je nieuwe dingen bedenken.	99	0	1
9. Volgens mij hoort techniek eerder bij computers dan bij computerprogramma's.	39	43	18
10. De techniek is zo oud als de mensheid.	96	3	1
11. Je maakt in de techniek niet veel gebruik van natuurkunde.	1	96	3
12. Je hoeft niet technisch te zijn om iets nieuws uit te vinden.	66	24	10
13. Techniek heeft grote invloed op de mensen.	97	1	2
14. Ik denk dat je bij natuurkunde vaak de techniek gebruikt.	75	10	15
15. Knutselen hoort bij techniek.	86	8	6
16. In het dagelijks leven heb ik veel met techniek te maken.	51	48	1
17. In de techniek kun je weinig zelf bedenken.	2	94	3
18. De techniek staat ver van mijn dagelijkse leven.	11	85	3
19. Biologie en techniek hebben niets met elkaar te maken.	11	74	15
20. De regering kan invloed uitoefenen op de techniek.	80	3	17
21. Het omzetten van energie hoort volgens mij ook bij techniek.	94	2	3
22. In de techniek ga je met gereedschap om.	88	6	7
23. Techniek is bedoeld om ons leven te veraangenamen.	74	16	10
24. In denk bij techniek vooral aan computer-programma's.	1	92	6
25. In de techniek hebben alleen technici het voor het zeggen.	4	81	16
26. Tussen scheikunde en techniek is een relatie.	88	3	9
27. In de techniek kun je weinig met je handen werken.	3	96	1
28. Het bewerken van materialen is een belangrijk onderdeel van techniek.	66	14	19

VRIENDELIJK BEDANKT VOOR UW MEDEWERKING!

Appendix 4 Handleiding tekeningen-onderzoek (Manual Drawing Research)

WAT VINDEN LEERLINGEN VAN GROEP 7 EN 8 VAN TECHNIEK?

Een handleiding bestemd voor 3e jaars PABO-studenten ter voorbereiding van een (voor)onderzoek naar het beeld van techniek bij leerlingen van groep 7 en 8 op basis van tekeningen.

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Inleiding

Techniek neemt in onze samenleving een steeds grotere plaats in. Ook in het onderwijs komt er meer aandacht voor techniek. Tot nu toe was techniek-onderwijs alleen voorbehouden aan leerlingen uit het beroepsonderwijs, met name de technische scholen. Met de invoering van de basisvorming in het voortgezet onderwijs krijgen straks alle leerlingen (van 12 tot 15 jaar) techniek in hun vakkenpakket. Hiermee hoopt men te bereiken dat grotere groepen leerlingen, en vooral meisjes, meer kennis en vaardigheden van techniek krijgen en daarbij ook een positievere attitude tegenover techniek.
Uiteraard spelen daarbij niet alleen emancipatorische motieven een rol maar ook (harde) economische motieven. Er is een groeiende behoefte aan technisch geschoolden.

Een van de redenen dat veel leerlingen en vooral meisjes niet kiezen voor een technische school- of beroepsloopbaan is gelegen in een negatieve houding of attitude tegenover techniek. Deze attitude wordt al op zeer jonge leeftijd gevormd. Uit onderzoek weten we dat op 10 jarige leeftijd veel attitudes een vaste vorm beginnen te krijgen en daarna niet eenvoudig meer zijn te veranderen. Zo ook met de attitude tegenover techniek. Deze wordt voor een belangrijk deel gevormd tijdens de basisschoolperiode. Door schoolse en buitenschoolse invloeden (de rol van de ouders en de lerares en de leraar zijn cruciaal) wordt er een attitude gevormd. Dat deze attitude bij meisjes anders is dan bij jongens, blijkt uit hun verschil in latere keuzen: jongens kiezen voor technische richtingen, de meisjes kiezen voor verzorgende richtingen.

Om hier wat aan te doen voert de overheid de bekende 'Kies Exact' voorlichtingscampagne. Ook bestaat er van de kant van de overheid belangstelling voor onderzoek naar deze problematiek. Het onderzoek naar de attitude tegenover techniek bij 10 tot 18 jarigen, waar het hier om gaat, is zo'n onderzoek.
In dit onderzoek gaan we na waaruit de attitude tegenover techniek bestaat. Uit welke elementen is deze attitude opgebouwd? Hoe verschilt deze attitude voor verschillende leeftijdsgroepen en hoe zou deze uiteindelijk verbeterd kunnen worden?

Het is belangrijk om meer over attitude tegenover techniek te weten te komen. Daarmee kunnen we uiteindelijk de attitude tegenover techniek effectiever (= positiever) beïnvloeden. We denken daarbij vooral aan het onderwijs. Hoe kun je in het onderwijs ervoor zorgen dat leerlingen een evenwichtiger beeld van techniek krijgen en een positievere attitude tegenover techniek?

De vakgroep Didactiek Natuurkunde van de Technische Universiteit Eindhoven is, onder leiding van prof.dr. J.H. Raat, al een paar jaar bezig met dit onderzoek naar de attitude tegenover techniek. Op allerlei manieren proberen we na te gaan welke attitude leerlingen van 10 tot 18 jaar tegenover techniek hebben. Naast gewone vragenlijsten hebben we opstellen en interviews gebruikt.
Een van de manieren, met name bij 10-12 jarigen, is het gebruikmaken van **tekeningen** over techniek. Dit is echter een vrij arbeidsintensiever methode. Daarom willen we graag een aantal (stage)studenten bij dit onderzoek betrekken.

In deze handleiding geven we aan wat je als stagestudent moet weten om aan dit onderzoek mee te werken. Het gaat daarbij globaal om drie dingen:

1. **wat is techniek? (hoofdstuk 1)**
2. **wat zijn attitudes en hoe meet je die? (hoofdstuk 2)**
3. **de opzet en uitvoering van het tekeningen-onderzoek (hoofdstuk 3)**

De stagestudenten laten leerlingen van groep 7 en 8 in de klas een tekening over techniek maken. Nadat de tekeningen door de student zijn onderzocht, worden met leerlingen afzonderlijk korte gesprekken gehouden over de inhoud van de tekeningen. De resultaten van beide activiteiten (analyse van tekeningen en het voeren van gesprekken) worden gerapporteerd. Om dit goed en zinvol te kunnen doen moet de student eerst zelf een goed beeld van techniek hebben (hoofdstuk 1) en moet iets weten over attitude-onderzoek, omdat het tekeningen-onderzoek daar deel van uitmaakt (hoofdstuk 2). Tot slot is er (in hoofdstuk 3) praktische informatie over de voorbereiding en de uitvoering van het onderzoek in de klas. De student voert dus geheel zelfstandig een wetenschappelijk onderzoek uit.

Hoofdstuk 1. WAT IS TECHNIEK?

De Technische Encyclopedie verstaat onder techniek:
"de verzameling creatieve manifestaties van de mens waardoor hij zich van middelen weet te voorzien waarmee hij zijn bestaan kan veraangenamen en zich kan verdedigen tegen al hetgeen dat bestaan bedreigt".
Dat is een hele mond vol. Je zou kunnen zeggen dat het bij techniek gaat om het ontwerpen en maken van iets, bijvoorbeeld een pan waarin je eten kunt koken, een kunstmaan of een elektriciteitscentrale.
Uit een omvangrijk literatuur-onderzoek van dr. Marc de Vries blijkt dat het vrij lastig is om een heldere en volledige definitie van techniek te geven. Beter is het om een aantal techniekkenmerken te onderscheiden.
Het zijn de volgende:
1. de relatie techniek-mens,
2. de drie pijlers van techniek: materie, energie en informatie,
3. de relatie techniek-natuurwetenschappen,
4. enkele bij techniek behorende vaardigheden,
5. de relatie techniek-samenleving.

We zullen deze vijf kenmerken van techniek toelichten.

De relatie techniek-mens

Techniek hoort wezenlijk bij de mens. Vragen naar het wezen van de techniek is vragen naar het wezen van de mens. In de techniek staat de mens centraal en niet de machine. Hieraan kunnen drie consequenties verbonden worden.
In de eerste plaats dat de visie van de mens op techniek wordt bepaald door zijn of haar visie op het leven. Zo ontwikkelt elke levensbeschouwing ook een eigen techniek-beschouwing.
In de tweede plaats dat techniek niet voorbehouden mag zijn aan alleen de man. In vele culturen verrichten vrouwen zeker niet minder technische handelingen dan mannen. Het feit dat in onze tijd de techniek eerder als een mannelijk werkterrein wordt gezien, zou gebaseerd kunnen zijn op een versmald beeld van de techniek als iets waarvoor lichaamskracht en uithoudingsvermogen noodzakelijk is. Een ander vertekend beeld van techniek is, dat hierin niet de mens, maar de machine bepalend is. Uit onderzoek is gebleken, dat meisjes en vrouwen zich meer interesseren voor de mens en het menselijk lichaam dan voor machines. Techniek is in dat beeld geen interessant onderwerp voor meisjes en komt dan ook niet in aanmerking als toekomstig werkterrein. Er is echter nog nooit aangetoond dat vrouwen en meisjes niet geschikt zijn voor techniek.
De derde consequentie is dat de techniek een ontwikkeling heeft doorgemaakt in de geschiedenis van de mensheid. Wanneer we spreken over onze eeuw als over de eeuw van de techniek kan het lijken of nu pas de techniek is ontstaan, Maar, zo lang de mens bestaan heeft, heeft zij en heeft hij zich aan de omgeving aangepast. De techniek is onderdeel van de cultuur en verandert met de cultuur mee. Wanneer we de techniek onderverdelen in materie-techniek, energie-techniek en informatie-techniek, kunnen we constateren dat de aandacht in de techniek in de loop van de geschiedenis van eerstgenoemde naar laatstgenoemde gaat. We komen daarmee bij het tweede kenmerk van techniek.

Materie, energie en informatie

Techniek heeft altijd te maken met materie, energie of informatie. Tegenwoordig bestaat er veel belangstelling voor de 'informatie-technologie'. Toch blijven ook in onze tijd de eerste twee techniek-richtingen van belang. Denk bijvoorbeeld maar eens aan het onderzoek naar supergeleidende materialen en aan het vele onderzoek om aan onze energiebehoefte te voldoen.

De relatie met de natuurwetenschappen

Veel mensen denken dat techniek toegepaste (natuur)wetenschap is. Dat is een éénzijdig beeld. Oorspronkelijk ontwikkelde de techniek zich zelfs helemaal los van de wetenschap (tot 1500). Nu vraagt de techniek juist om hulp uit de wetenschappen. Er is een wisselwerking tussen beide. Dit geldt zowel voor kennis als methoden. Een technicus gebruikt in zijn werk 'experimenten en modellen' die typisch uit de natuurwetenschappen komen.
Techniek hangt samen met natuurkunde, scheikunde en biologie (biotechnologie!), maar ook met wiskunde (computertechnologie) en zelfs de bedrijfskunde (ontwerpen van organisatie-strukturen).
Toch hebben de natuurwetenschappen en de techniek een eigen specifiek karakter. Bij de natuurwetenschappen gaat het principieel om het ontdekken van wetmatigheden die in de natuur

voorkomen. Bij de techniek gaat het niet om bestaande dingen, maar wordt juist iets nieuws gedacht en gemaakt.

Technische vaardigheden
In de techniek gaat het om drie vaardigheden:
1. praktisch-technische vaardigheden,
2. ontwerpvaardigheden,
3. vaardigheden in de omgang met technische produkten.

Praktisch-technische vaardigheden zijn de vaardigheden die direct nodig zijn om iets te kunnen maken. Het gaat daarbij niet alleen om 'handigheid', maar ook om kennis van gereedschappen en materialen.

Ontwerpen is een centrale activiteit in de techniek. Het gaat daarbij om het doorlopen van een zogenaamd ontwerpproces: vaststellen van een probleem, zoeken naar oplossingen, evalueren van oplossingen, uitwerken van oplossingen en tot slot het testen van een oplossing in de praktijk. Ontwerpen is meer dan alleen creativiteit, ook routine speelt een rol. Tegenwoordig is de rol van de computer bij het ontwerpen erg groot. (Computer Aided Design - CAD).

Bij **vaardigheden in de omgang met technische produkten** gaat het om het bedienen ervan, het gebruik kunnen maken van specifikaties, handleidingen, veiligheidsmaatregelen en onderhoudsvaardigheden. Dit zijn dus vaardigheden waar we allemaal dagelijks mee te maken hebben (de video, de pc, de auto).

Plaats van techniek in de samenleving
De techniek neemt in onze samenleving een belangrijke plaats in. Zij heeft gevolgen voor politiek en economie, ze verandert maatschappelijke verhoudingen tussen mensen. Het bepaalt de manier waarop we ons kleden, ons verplaatsen. Maar ook worden we geconfronteerd met energieproblemen en bewapening.
De techniek beïnvloedt niet alleen de samenleving, maar omgekeerd beïnvloedt ook de samenleving de techniek. Het wordt steeds belangrijker om vóór de toepassing van de techniek eerst na te gaan wat de mogelijke gevolgen zijn voor de economie of het milieu. Er is zelfs een aparte discipline die zich hiermee bezig houdt: technology assessment.
Sommige mensen vinden dat de invloed van de techniek bedreigend is. Men stelt dat het mensen reduceert tot 'technische dieren' of accepteert een bedreiging van menselijke waarden gelaten. Toch is de techniek zelf niet bedreigend. Techniek per se is niet positief of negatief, het is de mens die bepaalt wat ermee gebeurt. De mens is met zijn techniek een geïntegreerd deel van het milieu, waarmee hij wel rekening moet houden. Aardig is in dit verband de opmerking van Lucas Reijnders, de belangrijkste vertegenwoordiger van de Nederlandse milieubeweging: "ik kan meer genieten van een uitzicht op de Hoogovens in IJmuiden, dan een wandeling op de Veluwe" (NRC 14 mrt '88).

Hoofdstuk 2. HOE MEET JE ATTITUDES?
Een attitude is een gevoel tegenover een object (b.v. techniek), gebaseerd op kennis en kan een bepaald gedrag tot gevolg hebben. Een attitude bestaat zoals uit de omschrijving blijkt uit drie componenten:
1. kennis (cognitie),
2. gevoel (affectie),
3. gedrag (conatie).

Attitudes zijn een dankbaar onderwerp in psychologisch en onderwijskundig onderzoek. Dit komt omdat attitudes een zekere voorspellende waarde hebben en omdat ze, via de kenniscomponent, beïnvloedbaar zijn.
Zo zullen leerlingen met een negatieve attitude tegenover techniek later niet zo snel voor technische opleidingen kiezen. In het onderwijsonderzoek wordt veel met attitudes gewerkt: er is onderzoek gedaan naar attitudes tegenover school, tegenover de leraar, tegenover wiskunde. Er is tegenwoordig zelfs een trend waarneembaar waarbij men (o.a. het CITO) zich afvraagt hoe affectieve onderwijsdoelstellingen (zoals attitudes) gemeten zouden kunnen worden om ze een grotere betekenis te geven. Dit als tegenhanger van de dominerende cognitieve onderwijsdoelstellingen. Vooral bij stages spelen affectieve onderwijs-doelstellingen een steeds grotere rol.

Hoe meet je attitudes?
Dit kan op verschillende manieren. Het gebeurt vrijwel altijd schriftelijk, door middel van vragenlijsten. Deze vragenlijsten bestaan uit korte uitspraken over een onderwerp, in ons geval techniek. Als het goed is zijn twee van de drie attitude-componenten in een vragenlijst opgenomen: kennis en gevoel. In één vragenlijst wordt dan gevraagd naar de kennis van een object en naar het gevoel tegenover een object.

Langs deze weg doen wij ook onderzoek naar de attitude tegenover techniek.
We willen weten welk beeld (kennis) leerlingen van techniek hebben, maar we willen ook weten wat hun gevoel (houding) tegenover techniek is.

Dus: **attitude meten via:**

BEELD OF CONCEPT VAN TECHNIEK

EN

HOUDING TEGENOVER TECHNIEK.

Tot nu toe heeft ons onderzoek zich gericht op de leeftijdsgroepen 13-14 jaar (twee avo-vwo en twee lbo) en 16-17 jaar (vier havo-vwo en één mbo). Het beeld van techniek een attitude tegenover techniek zijn deze twee leeftijdsgroepen vragenlijsten gemeten. We weten van deze leeftijdsgroepen vrij goed welk beeld zij van techniek hebben en welke houding (vaak wordt voor het woord houding attitude genomen).
Het attitude-onderzoek richt zich dit jaar op de derde (misschien wel de belangrijkste) leeftijdsgroep: 10-12 jarigen.
Uit vooronderzoek dat we in 1986 onder 1000 leerlingen van 10 tot 18 jaar hielden, weten we uit welke aspecten of dimensies de houding tegenover techniek is opgebouwd:
1. **de interesse in techniek,**
2. **techniek op school,**
3. **techniek als beroep,**
4. **rolpatroon in de techniek,**
5. **moeilijkheid/toegankelijkheid van techniek als beroep/opleiding,**
6. **gevolgen en belang van techniek.**

Ook bij 10-12 jarigen wordt de houding tegenover techniek door deze zes dimensies bepaald. In een vragenlijst worden over elk van deze dimensies uitspraken gedaan waarop leerlingen antwoorden inhoeverre ze het er mee eens zijn (5 antwoordmogelijkheden: van helemaal mee eens tot helemaal niet mee eens). Het antwoord wordt in een score omgezet en zo kan voor elke dimensie en gemiddelde (positieve of negatieve) score worden berekend.
We hebben dus een middel of instrument om de houding tegenover techniek te meten, maar dan zijn we er nog niet omdat we immers ook het beeld van techniek willen meten.

Hoewel we hiervoor ook een vragenlijst hebben ontwikkeld, blijkt deze minder toepasbaar bij jonge kinderen. De vragen of uitspraken (28 in totaal) om het beeld van techniek te meten, zijn gebaseerd op de 5 techniekkenmerken die in hoofdstuk 1 zijn beschreven. Veel van deze uitspraken kenmerken zich door een zodanig abstractieniveau dat ze te moeilijk zijn voor leerlingen van groep 7 en 8 van de basisschool.

Om toch een idee te krijgen van het beeld van 10-12 jarigen van techniek hebben, kunnen door hen gemaakte tekeningen over techniek worden gebruikt. Het is zelfs mogelijk om na te gaan of elementen uit de 5 techniekkenmerken terug te vinden zijn in de tekeningen. Dit blijkt uit de resultaten van onderzoek door Dr. Jeff Moore uit Engeland, die nauw betrokken is bij het attitude-onderzoek in Nederland.
In het volgende hoofdstuk wordt beschreven hoe we met behulp van tekeningen kunnen na gaan welk beeld leerlingen van techniek hebben.

Hoofdstuk 3. HET TEKENINGEN-ONDERZOEK

We hebben gezien dat we om de attitude tegenover techniek te meten, de houding tegenover techniek en het beeld van techniek afzonderlijk moeten meten. Met het tekeningen-onderzoek willen we informatie verzamelen over het **beeld van techniek**.

Kinderen hebben al voordat er sprake is van echt formeel leren eigen ideeën en verklaringen voor technische en andere verschijnselen in hun omgeving. Als kinderen iets over techniek leren, dan betekent dat niet alleen het opnemen van nieuwe informatie, maar ook het veranderen van bestaande ideeën. Leraren (niet alleen op de middelbare school!) moeten zich bewust zijn van deze ideeën en impressies van techniek (en ook van de invloed die zij hierop kunnen hebben).

In dit hoofdstuk beschrijven we stapsgewijs hoe het techniek-tekeningen-onderzoek plaats moet vinden. Het klinkt misschien wat overdreven om dit stapsgewijs helemaal 'uit te kauwen', maar het is essentieel om uiteindelijk betrouwbare en vergelijkbare resultaten te hebben.

In het onderzoek kunnen we drie stappen onderscheiden:

1. **de tekenopdracht in de klas,**
2. **het analyseren van de tekeningen,**
3. **het gesprek over de inhoud van de tekening.**

We beschrijven elk van deze stappen:

Stap 1: Tekenopdracht in de klas

De leerlingen krijgen een tekenopdracht. Maar die tekenopdracht moet zo vrij mogelijk zijn. In principe moet een leerling kunnen tekenen wat er bij hem of haar opkomt als er aan techniek wordt gedacht, zonder dat hij of zij enige informatie heeft gehad. Voor veel kinderen is techniek toch een vrij vaag begrip.

Als we 10-12 jarige kinderen zonder enige voorinformatie vragen wat techniek is, dan zullen veel kinderen antwoorden 'iets dat je kunt, b.v. voetbal- of judotechniek'. Deze techniek bedoelen we natuurlijk niet! Daarom stellen we voor dat bij de tekenopdracht een klein stukje wordt uitgelegd:

UITLEG BIJ TEKENOPDRACHT (HET ONDERSTAANDE VOORLEZEN IN DE KLAS)

Vandaag hebben we het over techniek of met een moeilijk woord technologie. En dan bedoel ik ***niet*** *de techniek van een goede voetballer of de techniek van het pianospelen. Maar wat dan wel? Wat is dat eigenlijk, ... techniek? Dat is lang niet zo eenvoudig te zeggen. Er bestaan veel ideeën over wat techniek is. Zelfs volwassen mensen hebben verschillende ideeën over techniek.*

Techniek wordt steeds belangrijker, denk maar aan het toenemende gebruik van de computer voor alledaagse dingen. Je kunt ook aan het maken van een mooie fiets met vijf versnellingen denken. Voor steeds meer beroepen moet je een technische opleiding hebben gehad.

Vandaag vraag ik aan jullie om een tekening over techniek te maken. Dat mag van alles zijn. Je krijgt zo een papier waarop je de tekening mag maken. Als je niet precies weet wat je zult gaan tekenen, bedenk dan eerst wat volgens jou techniek is. Op de achterkant kun je een paar ideeën opschrijven, die je later tekent.

Met de tekeningen gebeurt iets speciaals. Je krijgt er geen cijfer of andere beoordeling voor, maar ze worden gebruikt voor een onderzoek. Een aantal onderzoekers willen namelijk weten waaraan jullie denken als het over techniek of technologie gaat. Daarom zeg ik van te voren niet precies wat techniek is, alleen dat het niet gaat om voetbaltechniek of pianotechniek.

Begin niet te snel met tekenen, denk eerst rustig na wat je zult gaan tekenen, je hebt alle tijd!!! (één lesuur).

Stap 2: Analyseren van de tekeningen: de inhoud

Wat is de inhoud van de tekening, wat wordt er mee bedoeld? Het eerste kun je met zekerheid antwoorden, het tweede niet. Om erachter te komen wat er met een tekening bedoeld wordt, worden achteraf nog enkele gesprekken gevoerd met leerlingen afzonderlijk (zie hieronder bij punt 3).

Hier gaat het erom zo goed mogelijk de inhoud van alle tekeningen in een overzichtstabel of matrix te zetten. Alle elementen die op een tekening aanwezig zijn, moeten geïnventariseerd worden. Dit gaat vrij snel.

We hebben al een aantal elementen onder elkaar gezet. Elke keer als een element voorkomt op een

tekening dan moet dat worden aangekruist. Als er nieuwe elementen zijn, dan moeten die eronder gezet worden en per leerling aangekruist.
Het resultaat is een overzicht van alle techniek-elementen die per leerling/tekening voorkomen.

Inventarisatielijst: een voorbeeld

PRODUKTEN
- radio/TV/video/CD
- huishoudelijke apparaten
- computer
- trein
- auto
- vliegtuig
- ruimtevaart
- niet electrische apparaten
- machines
- industriële machines
- bouwsels
- etc.

PROCESSEN
- een man is bezig
- een vrouw is bezig
- er wordt iets gemaakt
- er wordt iets ontdekt
- er wordt iets gerepareerd
- etc.

OORDELEN
- gevaarlijk
- ongevaarlijk
- moeilijk
- makkelijk
- belangrijk
- onbelangrijk
- leuk, interessant
- saai, niet interessant
- etc.

PLAATS AANDUIDING
- techniek op school
- techniek in een ziekenhuis
- techniek op een fabriek
- techniek thuis!!
- techniek op straat
- techniek in de ruimte
- etc.

FANTASIE OF EIGEN LEEFWERELD
- techniek in de toekomst (fantasie/futuristisch)
- techniek om ons heen (zelf gemaakt)
- etc.

'Beperkingen' van tekeningen:
Een nadeel van tekeningen-onderzoek is dat lang niet iedereen even goed en snel kan tekenen. Het is daarom goed mogelijk dat sommige techniekelementen niet aanwezig zijn op tekeningen omdat ze moeilijk te tekenen zijn. Dat is op zich niet erg. Het gaat er om dat associaties met techniek worden geïnventariseerd.
Tekeningen geven niet alleen informatie over het beeld van techniek, maar ook over de houding (bij oordelen). Ook dit is geen echte beperking, maar meer welkome extra informatie.

In het gesprek zal de aandacht zich vooral op het beeld van techniek richten.

Stap 3: Gesprek over de inhoud van een tekening
In het gesprek met een leerling wordt nagegaan of de kenmerken van techniek uit hoofdstuk 2 een rol hebben gespeeld bij het maken van de tekeningen.
Dit is geen eenvoudige opgave. Hoe ga je te werk?

1. Eerst moet je een aantal tekeningen uitkiezen waarover je wilt doorpraten. Als je 10 gesprekjes houdt, kies dan 10 tekeningen die zoveel mogelijk verschillen. Let erop dat je 5 jongens en 5 meisjes kiest en neem zowel goede als minder goede leerlingen.

2. Probeer iets te regelen waardoor je rustig met een aantal kinderen afzonderlijk kunt praten.

3. De resultaten van het gesprek moeten gerapporteerd worden. Het makkelijkste is om de gesprekjes op een recorder op te nemen en later te verwerken. Je kunt ook tijdens het gesprek korte aantekeningen maken en dit later verwerken.

4. Houd de gesprekjes kort, 10 tot 15 minuten is al genoeg.

5. Begin het gesprek met een compliment en zeg dat je de tekening interessant vond. Vraag hoe hij/zij erbij kwam om juist dit te tekenen. Hieruit kan al een bepaald beeld van techniek naar voren komen.

6. Probeer tijdens het gesprek in ieder geval aan de volgende aspecten aandacht te schenken:
   1. Vragen m.b.t. de relatie techniek-mens en techniek-maatschappij:
   1.1 Denk je bij techniek nou vooral aan allerlei apparaten of gaat het bij techniek om mensen?
   1.2 Heb je zelf veel met techniek te maken? Geef eens een voorbeeld.
   1.3 Heeft iedereen met techniek te maken?
   1.4 Is techniek iets moderns van deze tijd of bestaat techniek al heel lang?

   2. Vragen m.b.t. de relatie techniek-wetenschap:
   2.1 Er zijn veel technische beroepen. Kun je er een paar noemen?
   2.2 Waar zou je goed in moeten zijn (in welke vakken) om in de techniek te werken?

   3. Vragen m.b.t. de relatie techniek-vaardigheden:
   3.1 Hoort knutselen bij techniek? En iets uitvinden? En iets repareren?
   3.2 Is het repareren van een lekke band van een fiets net zo 'technisch' als werken met een computer?

   N.B. Geen antwoord of iets niet weten is ook een antwoord.

   Als je nog tijd over hebt kun je wat houdingsvragen stellen:

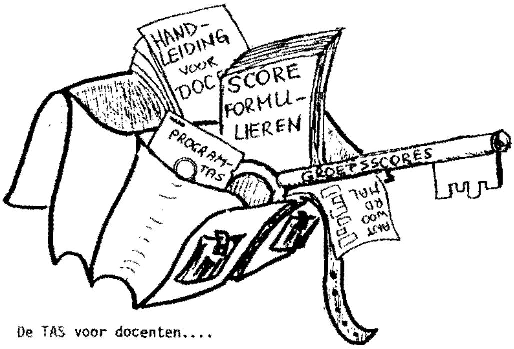
   1. Vind je techniek leuk (Interesse)?
   2. Zou een meisje automonteur kunnen worden (Rolpatroon)?
   3. Vind je techniek belangrijk (Gevolgen)?
   4. Is techniek goed of slecht (Gevolgen)?
   5. Is techniek moeilijk of makkelijk (Toegankelijkheid)?
   6. Moet er op school meer techniek komen (Techniek)?
   7. Zou je later in de techniek willen werken (Beroep)?

7. Rapportage van het leerlingengesprek:
   - Probeer je rapportage kort en zakelijk te houden.
   - Probeer zoveel mogelijk te refereren aan de techniekkenmerken uit hoofdstuk 2.
   - Ga na welke verschillen en overeenkomsten er tussen leerlingen zijn.

VEEL SUCCES!!

Appendix 5 Handleiding TAS (Manual TAS)

HANDLEIDING TECHNIEK ATTITUDE SCHAAL



De TAS voor docenten....

Falco de Klerk Wolters
Rosy Coenen - van den Bergh
Project MENT - Attitude
TU Eindhoven
Januari 1989

MENT

1. DOEL VAN DE TAS

De Techniek Attitude Schaal, afgekort TAS, is een vragenlijst die informatie verschaft over hoe leerlingen over techniek denken. Zeker voor een leraar of lerares Techniek in het LBO en straks in het AVO en VWO is het van belang te weten wat de leerlingen van zijn of haar klas vinden van techniek.

Het woord 'techniek' zal bij verschillende mensen verschillende betekenissen oproepen. Voor de één is techniek iets dat met apparaten te maken heeft, vooral met computers en andere moderne electronica. Voor de ander is techniek het kunnen repareren van een kapotte auto of wasmachine. Een derde denkt bij techniek aan de moderne wetenschap en aan knappe geleerden.

Dat leerlingen verschillend over techniek denken is reeds aangetoond in diverse onderzoeken. Voor een leraar/lerares is het nuttig te weten of de leerlingen van zijn/haar klas andere ideeën over techniek hebben dan hij/zij heeft. Hij/zij zal hiermee in zijn/haar onderwijs rekening kunnen houden.
De TAS levert informatie over een groep leerlingen; bijvoorbeeld over een klas of over de jongens of meisjes van een klas.
We weten dat jongens in het algemeen meer in techniek geïnteresseerd zijn dan meisjes. De TAS geeft aan waarop meisjes en jongens precies verschillen in hun beeld van techniek, zodat de leraar/lerares precies weet aan welke aspecten 'extra' aandacht kan worden besteed.

De TAS is ook geschikt om na te gaan of en zo ja hoe het beeld van, en de houding tegenover techniek verandert na verloop van een cursus 'techniek'.

De TAS is niet geschikt voor gebruik op individueel niveau en zeker niet voor het beoordelen van individuele leerlingen.

In deze handleiding geven we aan hoe een leraar/lerares de TAS in de klas kan gebruiken. Het komt erop neer dat voor een groep leerlingen gemiddelde antwoordscores worden berekend en deze worden geïnterpreteerd aan de hand van beschikbare normen. Deze berekeningen kunnen op twee manieren worden uitgevoerd: met de hand of met een computer. Als de leraar/lerares een PC ter beschikking heeft is deze laatste manier van verwerken de meest eenvoudige. Voor degenen die niet over een PC beschikken is het mogelijk de scores te berekenen met behulp van de aanwijzingen in deze handleiding en een simpele zakrekenmachine.

2. BESCHRIJVING VAN DE TAS

De TAS bestaat uit twee delen.
Het eerste deel bestaat uit 26 uitspraken of items verdeeld over 6 subschalen en het tweede gedeelte bestaat uit 28 uitspraken of items verdeeld over 4 subschalen.
Het eerste gedeelte van de TAS meet de houding tegenover techniek van leerlingen, het tweede gedeelte meet het beeld van techniek dat leerlingen hebben. We zullen beide delen van de TAS achtereenvolgens beschrijven.

HOUDING TEGENOVER TECHNIEK

De houding tegenover techniek wordt gemeten met 6 subschalen die elk uit 3 tot 5 items bestaan. Deze subschalen hebben betrekking op belangrijke aspecten van de houding tegenover techniek. Dit is vastgesteld aan de hand van onderzoek.

> Deze houdingsaspecten onderscheiden zich van de beeldaspecten doordat ze betrekking hebben op het affectieve deel van de attitude tegenover techniek. Met andere woorden, de houdingsaspecten hebben betrekking op gevoelens en emoties, terwijl de beeldaspecten het cognitieve (kennis) deel van de attitude tegenover techniek meten.

De subschalen van de houding tegenover techniek kunnen als volgt worden omschreven:

1. INTERESSE (5 uitspraken)
   Deze schaal geeft aan de mate waarin leerlingen buiten school in techniek geïnteresseerd zijn. Aan de hand van de uitspraken van deze schaal geven leerlingen bijvoorbeeld aan of ze het leuk vinden om een technisch tijdschrift te lezen, of om thuis zelf iets te repareren. Bijvoorbeeld: als er een hobbyclub over techniek was, werd ik zeker lid.

2. ROLPATROON (4 uitspraken)
   Leerlingen geven op deze schaal aan in hoeverre zij meisjes en jongens geschikt vinden voor de techniek. Bijvoorbeeld: een meisje kan best automonteur worden.

3. GEVOLGEN (5 uitspraken)
   De schaal Belang geeft aan hoe belangrijk in het algemeen techniek voor de wereld wordt gevonden (of techniek voor vooruitgang zorgt). Bijvoorbeeld: door techniek gaat alles beter dan vroeger.

4. MOEILIJKHEID (3 uitspraken)
   De schaal Moeilijkheid geeft de moeilijkheid en toegankelijkheid van techniek op school aan, zoals dat door leerlingen wordt ervaren. Bijvoorbeeld: techniek is alleen voor geleerden.

5. CURRICULUM (4 uitspraken)
   De schaal Curriculum geeft aan of leerlingen (meer) techniek op school zouden willen hebben. Bijvoorbeeld: ik zou techniek als schoolvak moeten kunnen kiezen.

6. CARRIERE (5 uitspraken)
   De Carrière-schaal geeft aan of leerlingen later een technisch beroep willen hebben. Bijvoorbeeld: de meeste beroepen in de techniek zijn saai.

De leerlingen vullen het eerste deel van de TAS in door aan te geven in hoeverre zij het met elke uitspraak eens zijn. Zij hebben daartoe de keuze uit vijf antwoordalternatieven:
1. helemaal mee eens,
2. mee eens,
3. niet mee eens, maar ook niet mee oneens,
4. niet mee eens,
5. helemaal niet mee eens.

BEELD VAN TECHNIEK

Het tweede deel van de TAS is gebaseerd op 5 algemeen aanvaarde kenmerken van het begrip techniek:
1. de relatie techniek - mens,
2. de relatie techniek - samenleving,
3. de relatie techniek - wetenschap,
4. ontwerpen, praktische vaardigheden, omgang met technische

apparaten als vaardigheid in de techniek,
5. materie, energie en informatie als de pijlers van de techniek.

Deze beeldaspecten van techniek worden via uitspraken in 4 subschalen (de kenmerken 1. en 2. in één subschaal) gemeten:

1. TECHNIEK EN MAATSCHAPPIJ (10 uitspraken)
   Deze schaal meet in hoeverre leerlingen vinden dat techniek wordt bepaald en gecontroleerd door de mens en alle aspecten van de samenleving beïnvloedt. In het ene uiterste (een hoge score) zijn ze het met deze stelling eens, in het andere uiterste (een lage score) vinden ze dat techniek alleen te maken heeft met (moderne) apparaten, en dat techniek niet beïnvloed kan worden (techniek is ongrijpbaar en ontwikkelt zich zelfstandig).

2. TECHNIEK EN WETENSCHAP (6 uitspraken)
   Tussen de techniek en de wetenschap, met name de natuurwetenschappen, bestaat een wederzijdse relatie. Natuurwetenschappen beïnvloeden de techniek, maar ook andersom beïnvloedt de techniek de natuurwetenschappen. De schaal Techniek en Wetenschap meet in hoeverre leerlingen deze wederzijdse relatie zien.

3. TECHNIEK EN VAARDIGHEDEN (7 uitspraken)
   Techniek heeft een proceszijde, het gaat niet alleen om de producten, maar ook om het proces om de producten te vervaardigen en ermee om kunnen gaan. Ontwerpen, praktische vaardigheden (timmeren) en het kunnen omgaan met apparaten (b.v. een videorecorder) zijn allemaal technische vaardigheden. De schaal meet of leerlingen de relatie tussen Techniek en Vaardigheden zien. Een hoge score betekent dat ze dit inderdaad zien.

4. TECHNIEK EN PIJLERS (5 uitspraken)
   Het informatie-tijdperk, zo noemen we de tijd waarin we nu leven. Informatie vormt inderdaad een voorname pijler in de techniek. Maar de andere pijlers, materie en energie, zijn minstens zo belangrijk voor de huidige techniek. Als leerlingen vinden dat materie, energie en informatie de pijlers van techniek zijn, zullen ze een hoge score op deze schaal halen.

De vragen uit het tweede deel van de TAS meten op een zeker abstract niveau kennis en beeld van techniek. Er is bewust gekozen voor een benadering waarin geen feiten worden gevraagd, omdat er anders sprake zou zijn van een cognitieve test. Wel is het zo dat bij de beeldvragen de antwoorden goed of fout worden gescoord, terwijl er bij de houdingsvragen sprake is van een positieve of een negatieve houding.

De leerlingen vullen het tweede deel van de TAS in door te kiezen uit drie antwoordalternatieven:
1. mee eens,
2. niet mee eens,
3. weet niet.

UITSLAG

De uitslag van de TAS bestaat uit 10 klassescores of groepsscores die ieder betrekking hebben op één van de 10 subschalen.
Deze uitslag kan op twee manieren verkregen worden. De makkelijkste manier is door de gegevens met behulp van een computer te verwerken. Hierdoor krijgt men automatisch de klassescores of groepsscores per schaal en de overeenkomst met/afwijking van de normgroep aangeleverd.
Docenten die (nog) geen computer tot hun beschikking hebben kunnen de verwerking handmatig uitvoeren met behulp van een zakrekenmachine. Om het rekenwerk voor de docent te beperken zijn voor elke subschaal antwoordmallen gemaakt. De scores worden vermeld op een scoreformulier. Aan de hand van normtabellen zal vastgesteld kunnen worden hoe gebruikelijk de behaalde klassescores zijn voor de Nederlandse onderwijssituatie.

TAS-MATERIAAL

Het materiaal van de TAS omvat:

- deze handleiding,
- de TAS-vragen (achtergrondvragen + attitudevragen),
- sheets met antwoordmallen,
- de scoreformulieren, waarop de resultaten van een klas of een groep leerlingen worden vermeld (dubbelzijdig bedrukt),
- de 'sleutel' voor het omscoren en berekenen van de groepsscores.
- een diskette met het verwerkingsprogramma (op aanvraag verkrijgbaar voor degenen die beschikken over een PC).

3. AFNAME VAN DE TAS

Doelgroep:
De TAS is geschikt voor klassikale afname in tweede klassen van LBO, MAVO, HAVO en VWO. De normgegevens uit Nederland zijn gebaseerd op deze doelgroepen.

Tijdsduur:
Voor de afname van de TAS moet ongeveer een half uur worden uitgetrokken: tien minuten voor het uitdelen en het geven van instructie, terwijl zo'n twintig minuten nodig zijn voor het invullen.

Instructie:
De afname begint met het uitdelen van de vragenlijst.

Dan volgt een korte introductie voor de leerlingen waarin de docent bijvoorbeeld vertelt dat hij graag wil weten hoe de klas denkt over techniek en dat daarom een gedeelte van de lestijd wordt besteed om de leerlingen in de gelegenheid te stellen hun mening daarover te geven.

De docent legt uit dat het niet gaat om een test of proefwerk en dat er geen goede of foute antwoorden bestaan en dat de vragenlijst anoniem wordt ingevuld.

Tot slot legt de docent uit dat het erom gaat wat de leerlingen van techniek vinden. Hij/zij zal daarom niet vertellen wat techniek volgens hem/haar is, ook zal niet worden ingegaan op vragen over de interpretatie van de uitspraken.

ANTWOORDMAL DEEL 1

Geslacht: jongen meisje
Leeftijd: jaar

SCHAAL INTERESSE

Deel 1 (vraag 1-26)

1. Als er een hobbyclub over techniek was, werd ik zeker lid.	1 1	(2)2	3 3	4 4	5 5
2. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxx	x	x	x	x	x
3. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxxxxxxx	x	x	x	x	x
4. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxx	x	x	x	x	x
5. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxx	x	x	x	x	x
6. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxxx	x	x	x	x	x
7. Ik lees graag technische tijdschriften.	1 1	2 2	(3)3	4 4	5 5
8. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	x	x	x	x	x
9. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxx	x	x	x	x	x
10. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxx	x	x	x	x	x
11. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxx	x	x	x	x	x
12. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxx	x	x	x	x	x
13. Er zouden minder TV-uitzendingen over techniek moeten zijn.	(1)5	2 4	3 3	4 2	5 1
14. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxx	x	x	x	x	x
15. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxx	x	x	x	x	x
16. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	x	x	x	x	x
17. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	x	x	x	x	x
18. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxx	x	x	x	x	x
19. Ik vind het leuk om zelf thuis iets te repareren.	(1)1	2 2	3 3	4 4	5 5
20. xxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	x	x	x	x	x
21. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxx	x	x	x	x	x
22. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxx	x	x	x	x	x
23. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxx	x	x	x	x	x
24. Techniek interesseert mij niet.	1 5	2 4	3 3	4 2	(5)1
25. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	x	x	x	x	x
26. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxx	x	x	x	x	x

Figuur 1. Uitrekenen individuele score.
Voor deze leerling worden voor de interesseschaal de scores 2+3+5+1+1 genoteerd. De gemiddelde score van deze leerling op deze schaal is nu het totaal van de scores per vraag (=12) gedeeld door het aantal items uit deze schaal (=5), vermenigvuldigd met 10. Deze gemiddelde score is hier dus 12 : 5 x 10 = 24.

4. HET BEPALEN VAN KLASSESCORES OF GROEPSSCORES

De scores voor het eerste deel van de TAS (houding tegenover techniek) worden op een andere manier berekend dan de scores voor het tweede gedeelte (beeld van techniek). In beide gevallen gaat het om gemiddelde scores op een subschaal. We zullen eerst de handmatige scoreberekening voor beide delen bespreken. Daarna volgt een beschrijving van de verwerking per computer.
Voor beide manieren van verwerken geldt: als een leerling een vraag niet heeft ingevuld, of als 2 antwoorden ingevuld zijn, moet U zowel voor de houding- als voor de beeldschalen bij die vraag antwoordmogelijkheid 3 (de meest neutrale) nemen.
Verder kunt U doordat de leerlingen hun geslacht invullen de resultaten van jongens en meisjes apart berekenen en deze vergelijken met de normgroep (mits de groepen jongens of meisjes uit minimaal 5 leerlingen bestaat).

HANDMATIGE SCOREBEREKENING DEEL 1 TAS

Bij de houdingsitems zijn vijf antwoordmogelijkheden, en ook vijf mogelijke antwoordscores, namelijk 1,2,3,4 of 5. Welke score in de berekening wordt meegenomen hangt af van het feit of een item positief, dan wel negatief geformuleerd is. Het houdingsgedeelte bestaat uit 13 positief geformuleerde uitspraken en 13 negatief geformuleerde uitspraken. We gaan ervan uit dat een score van 1 de meest positieve houding en een score van 5 de meest negatieve houding is. Dit betekent dat bij de negatief geformuleerde uitspraken de scores van de leerlingen omgedraaid moeten worden: 5=1, 4=2, 2=4 en 1=5. Door de antwoordmallen op de antwoorden van de leerlingen te leggen, worden meteen de goede scores voor één subschaal gegeven (zie figuur 1 op pag. 122: voor deze leerling worden voor de interesseschaal de scores 2+3+5+1+1 genoteerd, de cijfers rechts naast de door de leerling omcirkelde cijfers).
De scores die in de berekening worden meegenomen kunnen dus door de leraar/lerares direct van de antwoordmallen gelezen worden. Vervolgens worden deze scores van de items uit een subschaal opgeteld en gedeeld door het aantal items uit deze schaal.
De gemiddelde individuele score verkrijgt men vervolgens door het

SCOREFORMULIER

		SCHALEN									
		INT	ROL	GEV	MOE	CUR	CAR	TEM	TEW	TEV	TEP
L	1	24	30	20	23,3	20	10	3	6,6	7,1	4
	2	34	42,5	16	33,3	27,5	18	6	6,6	7,1	6
E	3	30	30	18	43,3	30	22	7	1,6	5,7	4
	4	24	10	30	16,6	25	18	6	6,6	7,1	10
E	5	10	32,5	28	33,3	22,5	26	4	1,6	7,1	8
	6	22	10	24	26,6	30	24	4	1,6	7,4	4
R	7	22	17,5	26	26,6	30	24	6	5	5,7	2
	8	18	25	26	16,6	25	10	1	1,6	7,1	0
L	9	20	17,5	30	20	20	18	5	8,3	7,4	8
	10	16	20	30	26,6	25	18	6	6,6	8,6	8
I	11	16	15	22	23,3	15	42	3	1,6	7,1	4
	12	22	25	28	36,6	20	32	4	8,3	8,6	6
N	13	26	20	26	43,3	40	12,5	7	5	7,4	10
	14	18	15	26	20	15	12	7	6,6	7,1	6
G	15	30	17,5	26	33,3	30	22	1	6,6	0	8
	16	26	30	28	30	27,5	24	2	0	8,6	4
E	17	16	10	20	20	10	10	8	5	10	8
	18	24	15	18	16,6	20	24	6	6,6	8,6	10
N	19	26	15	24	16,6	25	10	6	3,3	8,6	4
	20	28	25	35	26,6	17,5	20	7	1,6	8,6	2
	21										
	22										
	23										
	24										
	25										
	26										
	27										
	28										
	29										
	30										
groeps-score		23,1	21,1	25,1	27,2	24,3	18,7	5,0	4,6	7,2	5,8
		INT	ROL	GEV	MOE	CUR	CAR	TEM	TEW	TEV	TEP

Figuur 2. Scores invullen op het scoreformulier.

laatste getal telkens met 10 te vermenigvuldigen. De scores liggen tussen minimaal 10 en maximaal 50.

Een score van 10 is de meest positieve houding en een score van 50 is de meest negatieve houding.

De gemiddelde klassescores of groepsscores ontstaan door het gemiddelde van de leerlingscores te berekenen.

Zowel de leerlingscores als de gemiddelde groepsscores kunnen op het scoreformulier worden ingevuld (zie figuur 2 op pag. 124). Het is de bedoeling de groepsscores te vergelijken met de normgegevens om tot een interpretatie te komen (zie hoofdstuk 5).

We geven de berekening nogmaals in stappen weer:

1. <u>Individuele score berekenen:</u>
   - optellen van de scores van de items uit een schaal, met behulp van de antwoordmal,
   - delen door het aantal items uit een schaal,
   - vermenigvuldigen met tien.

   Bijvoorbeeld voor Interesse (Int):

$$\frac{(\text{Score}(1) + \text{Score}(7) + \text{Score}(13) + \text{Score}(19) + \text{Score}(24))}{5} \cdot 10$$

2. <u>Groepsscores berekenen:</u>
   - optellen individuele scores,
   - delen door het aantal leerlingen.

<u>HANDMATIGE SCOREBEREKENING DEEL 2 TAS</u>

Bij de beelditems zijn drie antwoordmogelijkheden, maar er zijn 2 antwoordscores, namelijk 0 of 1. De "foute" en de "weet niet" antwoorden krijgen de score 0 en de "juiste" antwoorden de score 1. Deze scores verkrijgt men door de antwoordmallen te gebruiken. De berekening vindt verder op dezelfde wijze plaats als bij de houdingsitems:

1. <u>Individuele scores berekenen:</u>
   - de scores van de items uit één schaal worden opgeteld, met behulp van de antwoordmal,
   - vervolgens gedeeld door het aantal items en weer met 10 vermenigvuldigd.

   Bijvoorbeeld voor TEW (Techniek en Wetenschap):

```
Techniek Attitude Schaal

                              HOOFDMENU

          -0-  einde programma

          -1-  invoeren   leerlingengegevens
          -2-  wijzigen   leerlingengegevens
          -3-  verwerken  leerlingengegevens


          -8-  default schooltype en groepsnummer
                              (Geen)
          -9-  uitvegen   leerlingengegevens

          maak uw keuze (0 .. 3, 8, 9) :
```

Scherm 1. Hoofdmenu.

```
Techniek Attitude Schaal : invoeren leerlinggegevens.

  schooltype     :              A = avo/vwo, L = lbo
  groepsnummer   :              jongen/meisje  :
  leerlingnummer :              leeftijd       :

leerlingen antwoorden deel 1 : mogelijke antwoorden 1, 2, 3, 4 of 5.
      1 :       6 :      11 :      16 :      21 :      26 :
      2 :       7 :      12 :      17 :      22 :
      3 :       8 :      13 :      18 :      23 :
      4 :       9 :      14 :      19 :      24 :
      5 :      10 :      15 :      20 :      25 :

leerlingen antwoorden deel 2 : mogelijke antwoorden 1, 2 of 3.
      1 :       6 :      11 :      16 :      21 :      26 :
      2 :       7 :      12 :      17 :      22 :      27 :
      3 :       8 :      13 :      18 :      23 :      28 :
      4 :       9 :      14 :      19 :      24 :
      5 :      10 :      15 :      20 :      25 :


‹ESC› is beeindigen invoeren
```

Scherm 2. Invoeren leerlinggegevens.

$$\frac{(Score(2)+Score(6)+Score(11)+Score(14)+Score(19)+Score(26))}{6}.10$$

2. Groepsscore berekenen:
   - optellen individuele scores,
   - delen door het aantal leerlingen.

De individuele scores en de groepsscores kunnen op het scoreformulier ingevuld worden. Ook deze scores dienen vergeleken te worden met de normgegevens om tot een interpretatie te komen.

VERWERKING LEERLINGGEGEVENS PER COMPUTER

Een vereiste om het TAS-verwerkingsprogramma te kunnen gebruiken is dat de PC waarop de verwerking dient te gebeuren voorzien is van een MS-DOS besturingsprogramma. Verder hoeft men alleen in staat te zijn de PC op te starten en over te schakelen naar de programma-diskette (bij één diskette-station in hetzelfde station, bij twee stations in het station dat niet door de MS-DOS-diskette wordt gebruikt).
Nadat de PC opgestart is verschijnt de DOS-prompt (A:›) op het scherm. Bij een PC met twee diskette-stations wordt nu de TAS programma-diskette in het tweede station geplaatst en ‹b:› getypt, gevolgd door een [return].
Om het TAS-programma te starten typt U ‹TAS›, gevolgd door een [return].
Op het scherm verschijnt nu het Hoofdmenu (zie scherm 1 op bladzijde 126). U kunt nu de leerlinggegevens gaan invoeren.

Invoeren leerlinggegevens
Om over te gaan tot het invoeren van de leerlinggegevens typt U ‹1› van invoeren leerlinggegevens. Op Uw scherm verschijnt nu een pagina waarin U bovenaan de achtergrondgegevens van de leerling kunt aangeven, daaronder de antwoorden van de leerling op deel 1 van de TAS-vragenlijst, en onderaan de antwoorden van de leerling op deel 2 van de TAS-vragenlijst.
Een afdruk van deze pagina ziet U bij scherm 2 op bladzijde 126.
U kunt nu het schooltype (A = AVO/VWO, L = LBO), groepsnummer (U

```
Techniek Attitude Schaal : invoeren defaultgegevens


  schooltype     : Geen          A = avo/vwo, L = lbo , G = geen
  groepsnummer   : 00




‹ESC›    is afbreken invoeren.          ‹PGDN›   is bewaren defaultgegevens.
```

Scherm 3. Default schooltype en groepsnummer.

kunt de klassen nummeren met 01, 02, enz. U dient dan wel zelf bij te houden welke klas hoort bij welk nummer), leerlingnummer (per klas kunt U nummeren van 01 tot en met 99), geslacht van de leerling(e) (U kunt volstaan met j of m) en leeftijd van de leerling(e) intikken (steeds gevolgd door een [return]). De cursor blijft in dit blok rondgaan voor het geval U nog iets aan deze gegevens wilt wijzigen.
Zo gauw U wilt doorgaan naar het invoeren van deel 1 van de vragenlijst drukt U op ‹PgDn› waarna de cursor achter 1: komt te staan. U kunt nu de antwoorden op de 26 vragen van deel 1 intikken zonder regelomhalen, nadat een antwoord gegeven is gaat de cursor vanzelf naar de volgende vraag. Ook hier blijft de cursor weer in dit vlak rondgaan voor eventuele wijzigingen.
Om door te gaan naar deel 2 van de vragenlijst drukt U op ‹PgDn›. Het invullen van de antwoorden gebeurt op dezelfde manier als bij deel 1.
Als U klaar bent met deel 2 kunt met ‹PgUp› terug naar deel 1, bijvoorbeeld om fout ingevoerde antwoorden uit deel 1 te corrigeren, of verder terug om leerlinggegevens te wijzigen.
Alleen vanuit deel 2 kunt U met de toets ‹PgDn› de ingevoerde gegevens opslaan! Nadat U de gegevens van een leerling hebt opgeslagen komt U automatisch weer terug bij een lege pagina met deel 1 waarna U de gegevens van een volgende leerling kunt invoeren.
Nadat U de gegevens van de hele groep leerlingen hebt ingevoerd kunt U stoppen met invoeren door op de lege pagina de ‹Esc›-toets in te drukken. Als U de ‹Esc›-toets gebruikt komt U automatisch terug in het Hoofdmenu. U kunt trouwens op elk gewenst moment het invoeren van gegevens afbreken door op deze toets te drukken! De zojuist ingevoerde gegevens worden dan niet opgeslagen!

Default schooltype en groepsnummer

Met de laatste optie van het hoofdmenu, ‹8›, kunt U een default schooltype en groepsnummer instellen (scherm 3, pag. 128). Als U bijvoorbeeld enkel gegevens van een AVO/VWO-school invoert, kunt U dit als default instellen. Het programma zal dan automatisch bij elke nieuwe leerling die U wilt invoeren het schooltype AVO/VWO invullen.
Hetzelfde geldt voor het groepsnummer. Als U een aantal

```
Techniek Attitude Schaal : wijzigen leerlinggegevens.

  schooltype      :                A = avo/vwo, L = lbo
  groepsnummer    :
  leerlingnummer  :


leerlingen antwoorden deel 1 : mogelijke antwoorden 1, 2, 3, 4 of 5.



leerlingen antwoorden deel 2 : mogelijke antwoorden 1, 2 of 3.




‹ESC› is beeindigen wijzigen
```

Scherm 4. Wijzigen leerlinggegevens.

```
Techniek Attitude Schaal : selecteren.

  schooltype      :                   A = avo/vwo. L = lbo.
  groepsnummer    : 00                00 voor alle groepen.

  jongen/meisje   : Beiden            J = jongen, M = meisje, B = beiden
  leeftijd        : 00                00 voor alle leeftijden.





                                      ‹PGUP›   is verwerken selectie.
‹ESC›    is afbreken selecteren.      ‹PGDN›   is lijsten selectie.
```

Scherm 5. Verwerken leerlinggegevens.

leerlingen van dezelfde groep gaat invoeren en U wilt niet steeds het groepsnummer zelf invullen, dan kunt U dit instellen met behulp van optie ‹8›. Het programma zal dan zelf bij elke nieuwe leerling het door U opgegeven groepsnummer invullen. Om de ingevoerde defaultgegevens op te slaan drukt U ‹PgDn› in.
Ook bij deze optie geldt: met ‹Esc› kunt U terug naar het Hoofdmenu zonder de ingevoerde defaultwaardes op te slaan.

Het wijzigen van leerlinggegevens
Als U nog iets wilt wijzigen in de door U ingevoerde gegevens typt U ‹2›. Op Uw scherm verschijnt dan de pagina "wijzigen" (zie scherm 4 op pagina 130). U kunt hierin aangeven het schooltype, groepsnummer en leerlingnummer om de leerling van wie U de gegevens wilt wijzigen te selecteren.
Door op ‹PgDn› te drukken krijgt U de gewenste gegevens op het scherm, waarna U deze kunt wijzigen. De procedure hiervoor is gelijk aan die voor het invoeren van gegevens.
Ook bij het wijzigen geldt dat U met de ‹Esc›-toets op een lege pagina de procedure kunt stoppen en terugkeren naar het Hoofdmenu, terwijl ‹Esc› op elke andere plaats de gemaakte wijzigingen voor deze leerling negeert.

Het verwerken van leerlinggegevens
Het eigenlijke verwerken van de gegevens gebeurt in optie ‹3› van het Hoofdmenu. Als U deze kiest verschijnt er een pagina op Uw scherm (zie scherm 5 op bladzijde 130) waarin U kunt aangeven van welke leerlingen U de resultaten wilt weten, c.q. vergelijken met de normgegevens.
Als U op ‹PgDn› drukt verschijnt er op Uw scherm een lijst van alle door U geselecteerde leerlingen (zie voorbeeld pag. 132). De gegevens zijn achtereenvolgens: schooltype, groepsnummer, leerlingnummer, geslacht leerling, leeftijd leerling, antwoorden deel 1, en antwoorden deel 2. Dit is een controlemogelijkheid om te kijken of alle door U gewenste leerlingen geselecteerd zijn, maar bovendien een extra controlemiddel om nogmaals alle ingevoerde gegevens te controleren.
Als het aantal geselecteerde leerlingen meerdere pagina's beslaat gaat U met [return] steeds naar de volgende pagina. Op de laatste pagina staat onderaan "einde selectie, type ‹RET› om verder te

```
Techniek Attitude Schaal : geselecteerde leerlingen.
--------------------------------------------------------------------------------
L 01 01 J 16 : 34141521115344142411334512 1112111133212111221211121122
L 01 02 J 14 : 31124452124241242221132121 1312132121311321321121323122
L 01 03 J 15 : 31141141114541143313444415 2222331111211111222132122121
L 01 04 J 15 : 55153451553351133151533343 1333131132321313313311112321
L 01 05 J 14 : 31232252244441145222423523 3211221321323323213233322113
L 01 06 J 14 : 35241441324353235511421533 3211223121221331232322123331
L 01 07 J 13 : 14111331115555155311515515 2122111131211111221311123321
L 01 08 J 14 : 43143252123453243222125434 1312131212323112233221322121
L 01 09 J 14 : 31131345114351225312535424 2122211132211111222331122321
L 01 10 J 13 : 21132222224431133222443313 2112211122111111122211122111
L 01 11 J 13 : 25211354125452255211435535 3131113122211311223311323321
L 01 12 J 14 : 43243452224245234422444424 2332312323311111213331323321
L 02 01 J 15 : 211531312555511155111535515 2112122132222111211231333221
L 02 02 J 15 : 42232253143521132325524415 2112123132211111223111332321
L 02 03 J 15 : 32214242243422123322524414 1333123131111311223111132321
L 02 04 J 14 : 35143241114543544211334414 1122123123211211221112122121
L 02 05 J 15 : 21121342324453224213343413 2132113123321311333321123221
L 02 06 J 13 : 35233431233545144211344423 2332223133321211223213231223
L 02 07 J 13 : 33233431133545344212344423 2332223133231213221123212123
L 02 08 J 15 : 41235122525555234112525515 1313223133313312223331233323

type ‹ESC› om te stoppen, ‹RET›,‹PGDN› voor volgende pagina
```

Scherm 6. Geselecteerde leerlingen.

```
Techniek Attitude Schaal : verwerking geselecteerde lijsten.
--------------------------------------------------------------------------------



aantal lijsten : 60


   interesse  rolpatroon    gevolgen  moeilijkheid   curriculum     carriere
        25.8        22.5        24.4          25.8         24.1         22.6

         TEM         TEW         TEV         TEP
         5.1         4.3         6.7         5.7




‹ESC› terug naar selecteren, ‹PGDN› vergelijking met norm.
```

Scherm 7. Verwerking geselecteerde leerlingen.

gaan". Met een [return] gaat U dan terug naar het scherm "verwerken".

Als U de gegevens van de geselecteerde leerlingen wilt verwerken drukt u op ‹PgUp›. U krijgt dan op Uw scherm het aantal door U geselecteerde leerlingen en de scores van deze groep op de diverse schalen van de TAS (zie scherm 7, pag. 132). Mocht U graag de resultaten van een groep op papier hebben, en er is een printer aangesloten op Uw PC, dan kunt U ten allen tijde een afdruk maken van de gegevens op het scherm door op ‹Print Screen› te drukken.

Als U alleen geïnteresseerd bent in de resultaten van een groep kunt U nu met ‹Esc› terug naar het scherm "verwerken" en een nieuwe selectie maken, of met nogmaals ‹Esc› terug naar het Hoofdmenu en stoppen.

U kunt echter ook de resultaten van de groep vergelijken met de ingeprogrammeerde normgegevens. Dit is verder uitgewerkt in Hoofdstuk 5.

Het uitvegen van leerlinggegevens

Als U gegevens van leerlingen wilt uitvegen, omdat deze niet meer nodig zijn, of omdat de diskette vol is, dan kan dit door in het hoofdmenu de optie ‹9› te kiezen. Daarna is de procedure gelijk aan die van het wijzigen van leerlinggegevens, met dien verstande dat de gegevens nu niet gewijzigd maar uitgeveegd worden.

5. INTERPRETATIE AAN DE HAND VAN NORMGEGEVENS

HANDMATIGE VERWERKING

Een groepsscore op een schaal zegt op zich niet zoveel. Scores kunnen alleen geïnterpreteerd worden als we de betekenis van de scores weten en deze kunnen vergelijken met scores van andere groepen. Deze "andere" groepen zijn dan de norm. Uiteraard wordt de norm betrouwbaarder naarmate deze representatiever is. Daarom wordt bij alle normgegevens vermeld om hoeveel leerlingen het gaat en welk type onderwijs. Alle normgegevens hebben betrekking op 13-14 jarigen.

Voor de interpretatie van de subschalen van de TAS staan 2 typen normtabellen ter beschikking.

> Het eerste type (type a) is vrij grof en gaat ervan uit dat een score 'gemiddeld' is indien deze binnen één standaarddeviatie vanaf het gemiddelde valt. Omdat deze normering vrij grof is vallen veel groepsscores binnen de 'gemiddelde' norm en blijft de informatie beperkt.
> Het tweede type (type b) levert meer informatie omdat een afwijking ten opzichte van de norm van betekenis wordt geacht als deze meer dan een aantal eenheden van de mediaan afwijkt. (De mediaan is de middelste score, ofwel de score bij het 50% punt.)
> Vuistregel: bij de houdingsschalen 5 eenheden, bij de beeldschalen 1 eenheid.

In de bijlage 1 en 2 zijn de normgegevens opgenomen. We beschrijven hoe deze normtabellen geïnterpreteerd kunnen worden aan de hand van de normtabellen voor de subschalen Interesse en Techniek en Maatschappij.

VOORBEELD 1: DE INTERESSESCHAAL

Normtabel (a) voor de Interesseschaal

score	normscore	% normgroep	betekenis normscore
10-14,5	1	10%	ver onder gemiddelde
14,6-18,3	2	9%	onder gemiddelde
18,9-37,8	3	64%	gemiddelde
37,9-43,0	4	9%	boven gemiddelde
43,1-50	5	8%	ver boven gemiddelde

Opmerkingen:
1. de houding is positiever naarmate de score lager wordt,
2. normgegevens afkomstig van 2667 2 AVO-VWO leerlingen in Nederland.

Normtabel (b) van Interesse

% leerlingen dat lager scoort dan de gegeven leerlingscores	leerlingscores 2 AVO-VWO
0	0
10	15
20	19
30	22
40	25
50	27
60	30
70	32
80	35
90	40
100	50

Opmerkingen:
1. de houding is positiever naarmate de score lager wordt,
2. normgegevens afkomstig van 2667 2 AVO-VWO leerlingen in Nederland.

Stel dat een groep leerlingen een gemiddelde score van 22,0 op de Interesseschaal heeft, wat betekent dit dan?
Uit normtabel (a) blijkt dat aan 22,0 de normscore 3 moet worden toegekend. Het resultaat is vergelijkbaar met dat van 64% van alle leerlingen in 2 AVO-VWO. De score van de groep is 'gemiddeld'. Voor de onderzoeksgroep, evenals trouwens voor de normgroep, blijkt dat de interesse voor techniek positief is.
Als men preciezer wil nagaan wat de betekenis is van een groepsscore, dan kan men tabel (b) gebruiken. In tabel (b) valt af te lezen dat 70% van de 2 AVO-VWO leerlingen hoger scoort, dus minder in techniek geïnteresseerd is. Om nu te bepalen in hoeverre de score van 22,0 afwijkend is en dus betekenisvol, hanteren we de vuistregel dat de groepsscore 5 eenheden of meer moet afwijken van de 50% score van de normgroep (hier 27). Deze score wordt in de beschrijvende statistiek 'mediaan' genoemd.
We kunnen concluderen dat een score van 22,0 geen abnormale score is omdat het valt binnen de gemiddelde groep (zie tabel a), maar er is ten opzichte van de normgroep duidelijk sprake van een sterke interesse (dus een positieve houding) voor techniek (tabel b).

VOORBEELD 2: TECHNIEK EN MAATSCHAPPIJ

Ook voor de subschaal Techniek en Maatschappij (TEM) staan 2 tabellen ter beschikking. De normgroep is hier 2 LBO.

Normtabel (a) voor TEM

score	normscore	% normgroep	betekenis normscore
0-1,0	1	5%	ver onder gemiddelde
1,1-2,3	2	11%	onder gemiddelde
2,4-6,3	3	64%	gemiddelde
6,4-7,8	4	15%	boven gemiddelde
7,9-10	5	5%	ver boven gemiddelde

Opmerkingen:
1. een hoge score betekent een 'goed' beeld,
2. normgegevens afkomstig van 2349 2 LBO leerlingen in Nederland.

Normtabel (b) van TEM

% leerlingen dat lager scoort dan de gegeven leerlingscores | leerlingscores 2 LBO

% leerlingen	leerlingscores 2 LBO
0	0
10	1,8
20	2,7
30	3,3
40	3,8
50	4,3
60	4,8
70	5,0
80	6,3
90	7,2
100	10

Opmerkingen:
1. een hoge score betekent een goed beeld,
2. normgegevens afkomstig van 2349 2 LBO leerlingen in Nederland.

We veronderstellen dat de groepsscore op de TEM-schaal 6,2 is. Dit betekent dat 62% van de vragen 'goed' beantwoord is, zodat een kleine meerderheid van de groep vindt dat er een relatie tussen techniek en de maatschappij bestaat en dat techniek meer is dan alleen apparaten.
Een score van 6,2 is een normale score, in die zin dat deze score valt in de grote gemiddelde groep 64% van de 2 LBO-ers.
Het 50% punt (de mediaan) bij de norm geeft echter als score 4,3 aan, hetgeen beduidend lager ligt dan 6,2.
Als vuistregel voor de beeldsubschalen hanteren we één eenheid verschil met het 50% punt als betekenisvol. Omdat 6,2 › (4,3 + 1) concluderen we dat de groepsscore duidelijk hoger is dan de norm in 2 LBO.

Concluderend kunnen we zeggen dat we bij het interpreteren van een groepsscore op 2 aspecten kunnen letten.
In de eerste plaats: <u>Wat betekent de score in zijn algemeenheid</u>; is er sprake van een positieve houding, is er sprake van een goed beeld? Of meer specifiek voor een schaal: hebben leerlingen interesse in techniek buiten schooltijd om en/of associëren

Techniek Attitude Schaal : vergelijking met norm LBO.

---

score	%
10 - 13.0	5
- 19.6	14
- 35.6	66
- 39.9	9
- 50	5

normtabel (a)

De score van deze groep voor interesse is 25.8. Uit normtabel (a) blijkt dat deze score vergelijkbaar is met de score van 66 % van alle leerlingen in 2 LBO. De score van de groep is gemiddeld. De interesse van de groep voor techniek is positief.

Volgens normtabel (b) scoort 56% van de leerlingen in 2 LBO hoger, en is dus minder in techniek geinteresseerd dan deze groep. De score van deze groep wijkt niet betekenisvol af van de score van de normgroep. Dat wil zeggen dat hun interesse voor techniek niet betekenisvol positiever is dan die van alle leerlingen in 2 LBO.

% (cum)	leerling scores
0	0
10	16
20	20
30	23
40	25
50	27
60	29
70	31
80	33
90	37
100	48

normtabel (b)

‹ESC› afbreken, ‹RET›,‹PGDN› volgende scherm

Scherm 8. Voorbeeld interpretatie houdingsschaal Interesse.

Techniek Attitude Schaal : vergelijking met norm LBO.

---

score	%
0 - 1.0	5.0
- 2.3	11.0
- 6.3	64.0
- 7.8	15.0
- 10	5.0

normtabel (a)

De score van deze groep voor Techniek en Maatschappij is 5.1. Dit betekent dat 51% van de vragen "goed" beantwoord is, zodat een kleine meerderheid van de groep vindt dat er een relatie bestaat tussen techniek en maatschappij. Volgens normtabel (a) is een score van 5.1 een gemiddelde score, die vergelijkbaar is met 64% van alle leerlingen in 2 LBO.

Volgens normtabel (b) scoort 50% van alle leerlingen in 2 LBO 4.3.
Dit is lager dan 5.1.

De score van deze groep is dus niet betekenisvol hoger dan de score van de norm in 2 LBO.

% (cum)	leerling scores
0	0.0
10	1.8
20	2.7
30	3.3
40	3.8
50	4.3
60	4.8
70	5.0
80	6.3
90	7.2
100	10.0

normtabel (b)

‹ESC› afbreken, ‹RET›,‹PGDN› volgende, ‹PGUP› vorige scherm

Scherm 9. Voorbeeld beeldschaal Techniek en Maatschappij.

leerlingen techniek meer met apparaten dan met mensen?
In de tweede plaats moeten we de scores relateren aan normgroepen, waarbij de vraag centraal staat hoever de groepsscore afwijkt van een norm en of die afwijking betekenisvol is.

VERWERKING PER COMPUTER

Voor de verwerking per computer wordt eerst in het hoofdmenu optie ‹3› gekozen. In het scherm "selecteren" wordt de gewenste groep geselecteerd. Met ‹PgUp› gaat U door naar het verwerken van de gegevens. De groepsscores verschijnen op het scherm (dit is uitgebreid beschreven in het vorige hoofdstuk).
Met ‹PgDn› kunt U deze scores vergelijken met de scores van de normgroep.
Op het scherm verschijnt dan voor elke schaal afzonderlijk de score van de groep op die schaal. Dit wordt gevolgd door een vergelijking met normtabel (a), dat wil zeggen dat U een melding krijgt of de score van de door U geselecteerde groep (ver) onder het gemiddelde, binnen het gemiddelde, of (ver) boven het gemiddelde van de normgroep ligt, en ook of de score duidt op een positieve of negatieve houding tegenover techniek, of een goed/minder goed beeld van techniek van de leerlingen.
Vervolgens kunt U lezen of de score van Uw groep betekenisvol afwijkt van de normgroep, dat wil zeggen of de houding van Uw groep significant positiever/negatiever, of het beeld van Uw groep significant beter/minder goed is dan die/dat van de normgroep (volgens normtabel (b)).

NOTA BENE (DIT GELDT ZOWEL VOOR DE HANDMATIGE VERWERKING ALS VOOR DE VERWERKING PER COMPUTER):

- voor AVO/VWO kunt U alleen de houdingsschalen vergelijken met de norm. Voor de beeldschalen zijn nog geen normgegevens beschikbaar.
- voor LBO zijn geen normgegevens beschikbaar voor de houdingsschalen Curriculum en Carrière omdat deze groep leerlingen al voor een min of meer technische carrière gekozen heeft. Het was dus niet relevant om deze schalen in de LBO-groep te onderzoeken.

Appendix 6 Statistics

6.1 Score frequencies of boys and girls
6.2 Scale scores of boys and girls
6.3 Correlations between variables
6.4 Results interviews

Appendix 6.1 Score frequencies of boys and girls

1. Score frequencies boys and girls basisschool (A), 4 havo-vwo (B) and 1 mbo (C) on AB-scales (in %)

AB-scales			answering categories				
			1	2	3	4	5*
INTEREST							
	A.	boys	32.7	26.3	22.3	11.6	6.7
		girls	10.9	22.6	33.5	20.8	12.0
	B.	boys	22.6	36.3	22.7	11.6	6.8
		girls	8.8	30.0	25.2	20.0	16.1
	C.	boys	24.5	20.9	34.9	11.8	8.0
		girls	8.7	26.7	25.2	20.5	18.8
ROLE PATTERN							
	A.	boys	44.2	30.2	15.3	5.1	4.9
		girls	62.2	26.7	5.9	2.6	2.4
	B.	boys	25.8	37.8	18.2	13.9	4.3
		girls	50.9	32.7	6.6	8.0	1.8
	C.	boys	23.2	25.6	32.0	14.5	4.7
		girls	38.1	19.4	31.7	8.5	2.4
CONSEQUENCES							
	A.	boys	26.8	33.9	26.0	9.2	3.9
		girls	18.0	31.9	39.7	7.9	2.2
	B.	boys	25.3	37.8	25.3	8.2	3.3
		girls	12.8	34.4	37.2	10.0	2.5
	C.	boys	23.7	27.3	36.4	8.9	3.6
		girls	9.5	39.5	34.5	12.7	4.0
DIFFICULTY							
	A.	boys	26.9	32.2	24.2	11.4	5.0
		girls	21.3	33.9	29.7	10.6	4.4
	B.	boys	12.0	26.7	27.1	26.5	7.6
		girls	12.6	27.5	26.0	26.3	7.6
	C.	boys	16.0	26.0	29.1	20.3	8.5
		girls	18.5	24.8	34.5	17.7	4.6
SCHOOL							
	A.	boys	36.9	32.6	19.0	6.8	4.4
		girls	11.2	27.0	38.7	16.5	6.6
	B.	boys	12.2	28.7	27.4	20.5	11.1
		girls	5.4	22.2	30.9	27.6	13.9
CAREER							
	A.	boys	23.5	22.3	39.1	7.8	7.1
		girls	6.2	12.4	54.1	15.8	11.2
	B.	boys	25.3	34.6	22.6	10.8	6.6
		girls	13.1	23.4	22.6	21.3	19.6

*1=strongly agree : very positive attitude
2=agree : positive attitude
3=not agree/not disagree : neutral attitude
4=disagree : negative attitude
5=strongly disagree : very negative attitude

2. Score frequencies boys and girls 4 havo-vwo (B) and 1 mbo (C) on the C-scales (in %)

C-scales			answering categories		
			1	2	3*
SOCIETY					
	B.	boys	62.0	23.3	14.7
		girls	52.9	27.3	19.7
	C.	boys	62.3	23.9	13.8
		girls	49.2	29.8	21.0
SCIENCE					
	B.	boys	75.2	10.4	14.4
		girls	70.8	8.6	20.6
	C.	boys	64.8	14.0	21.3
		girls	56.2	9.4	34.4
SKILLS					
	B.	boys	71.0	14.4	14.5
		girls	71.5	15.3	13.2
	C.	boys	76.2	14.0	9.8
		girls	71.1	13.7	15.2
PILLARS					
	B.	boys	69.5	12.5	18.0
		girls	60.6	11.3	28.0
	C.	boys	71.8	11.5	16.7
		girls	56.6	12.3	30.9

*1= right answer
2= wrong answer
3= don't know

Apendix 6.2 Scale scores of boys and girls

school	b/g	n	age	INT	ROL	CON	DIF	AFF*
basisschool	b	1.021	10-12	233	196	229	235	223
	g	1.089		300	156	244	243	236
2 lhno	b	31	13-15	305	213	265	227	252
	g	565		323	186	257	220	247
2 leao	b	50	13-15	298	235	268	189	248
	g	82		342	210	251	202	251
1 lts	b	1.169	13-15	236	223	229	225	228
	g	26		279	221	262	226	247
2 mavo	b	678	13-15	227	239	202	219	227
	g	834		322	177	224	225	237
2 avo-vwo	b	263	13-15	248	213	213	215	222
	g	273		339	175	229	226	240
2 havo	b	138	13-15	223	229	198	220	217
	g	119		333	192	213	331	242
2 vwo	b	183	13-15	239	232	215	217	226
	g	177		330	164	222	218	234
1 mts	b	391	16-18	229	231	227	249	233
	g	8		243	234	218	233	231
1 mdgo	b	52	16-18	284	217	244	252	250
	g	273		344	172	269	217	250
1 meao/mmo	b	202	16-18	317	226	240	230	253
	g	245		358	186	252	236	258
4 havo	b	263	16-18	277	231	241	248	249
	g	253		360	189	252	251	260
4 vwo	b	432	16-18	257	223	230	264	244
	g	307		320	169	247	253	247

*INT=INTEREST, ROL=ROLE PATTERN, CON=CONSEQUENCES, DIF=DIFFICULTY, AFF=(INT+ROL+CON+DIF)/4

Appendix 6.3 Correlations between variables for pupils basisschool

earson correlation coefficients between scale scores

	INT.	ROL.	CON.	DIF.	SCH.	CAR.	SOC.*	SKIL.*	AB.	C.*
T.	1.0	-.12	.21	.20	.63	.63	-.25	-.19	.70	-.27
L.		1.0	n.s	.21	n.s	-.08	-.09	.26	.26	-.08
N.			1.0	n.s	.26	.26	-.22	-.15	.43	-.22
F.				1.0	.17	.13	-.22	-.22	.43	-.27
H.					1.0	.68	-.32	-.27	.83	-.36
R.						1.0	-.30	-.26	.78	-.30
C.							1.0	.31	-.39	.75
IL.								1.0	.31	.86
.									1.0	-.43
										1.0

Kruskal's coefficient Gamma between scales scores and variables

	INT.	ROL.	CON.	DIF.	SCH.	CAR.	SOC.*	SKIL.*
NDER	.52	-.34	.18	.08	.49	.47	-.32	-.21
IBITION	.88	-.24	.28	.16	.87	.98	-.43	-.28
OWLEDGE	.84	-.11	.41	.14	.75	.73	-.67	-.44
ME ENVIR.	.39	-.06	.24	.07	.39	.31	-.17	-.30
HOOL TYPE	.08	-.06	.07	.07	.09	.10	-.10	-.02
HOOLEXPER	.05	-.03	.03	.02	.04	.03	-.02	-.02

cales with low reliability
INT=INTEREST, ROL=ROLE PATTERN, CON=CONSEQUENCES, DIF=DIFFICULTY, SCH=SCHOOL, AR=CAREER, SOC=SOCIETY, SKIL=SKILLS, AB=AB-scales, C=C-scales, HOME ENVIR=HOME NVIRONMENT, SCHOOLEXPER=SCHOOL EXPERIENCE

Appendix 6.4 Results interviews pupils basisschool

Fifteen students of 3 pabo's held interviews with 60 boys and 60 girls of group 7 and 8 of the basisschool. The students recorded the interviews on tape. The aim of the interviews was to test the assumption that pupils have a narrow view on technology. The interviews started with questions about the drawings the pupils made of technology. Next they asked questions about technology that are refering to the description of technology in five features. The results of the interviews are presented in tables according the features of technolgy. With chi-square tests we have indicated the significance of differences between the answers of boys and girls.

1. Relation 'technology-human being' and 'technology and society'

1.1 With reference to technology do you mainly think of all kinds of equipment or is technology mainly concerned with people? (see table 1)
1.2 Do you have a lot to do with technology yourself? Could you give an example? (see table 2)
1.3 Does everybody have to do with technology? (see table 3)
1.4 Is technology something modern, from this time or has technology existed for a long time? (see table 4)

2. Relation 'technology-science'

2.1 There are many technical professions. Could you mention some of them? (see table 5 and 6)
2.2 What things (subjects) should you be good at to work in technology? (see table 7 and 8)

3. Relation 'technology-skills'

3.1 Is 'doing things with your hands' part of technology? And inventing something? And repairing something? (see table 9)
3.2 Is repairing the flat tyre of your bike as 'technical' as working with a computer? (see table 10)

4. Attitude towards technology (see table 11)

4.1 Do you like technology?
4.2 Can a girl become a car mechanic?
4.3 Do you think technology is important?
4.4 Is technology good or bad?
4.5 Is technology difficult or easy?
4.6 Should there be more technology at school?
4.7 Would you like to work in technology later on?

Table 1: Technology= equipment or human beings

	boys abs	%	girls abs.	%
humans	5	8.3	10	16.7
equipment	39	65.0	32	53.3
both	16	26.6	18	30.0
total	60	100	60	100

χ^2 = 2.48 df=2 (no sign. difference)

Table 2: Personal involvement in technology

	boys abs.	%	girls abs.	%
yes, involved	32	53.3	17	28.3
no, not involved	23	38.3	30	50.0
not much involved	5	8.3	13	21.7
total	60	100	60	100

χ^2 = 8.92 df=2 (sign. difference)

Table 3: Who is/are involved in technology?

	boys abs.	%	girls abs.	%
everybody	30	50	17	28.3
not everybody	22	36.7	36	60.0
don't know	8	13.3	7	11.7
total	60	100	60	100

χ^2 = 6.06 df=2 (sign. difference)

Table 4: Modern and old technology

	boys abs.	%	girls abs.	%
techn. is modern	14	23.3	27	45
techn. is old	45	75.0	28	46.6
don't know	1	1.6	5	8.3
total	60	100	60	100

χ^2 = 10.78 df=2 (sign. difference)

Table 5: Knowlegde of technical professions

	boys abs.	%	girls abs.	%
yes	57	95.0	36	60.0
no	3	5.0	24	40.0
total	60	100	60	100

χ^2 = 21.30 df=1 (sign. difference)

Table 6: Frequencies technical professions mentionned

	boys	girls	total
car mechanic	25	15	40
computerexpert	18	19	37
electricien	8	5	13
radio-,tv assembler	5	7	12
pilot	9	1	10
carpenter	5	4	9
plumber	3	5	8
repairer cycles	3	5	8
welder	3	2	5
bricklayer	3	2	5
designer	3	1	4
dentist/doctor	3	1	4
tv-programmaker	-	4	4
technician	1	3	4
engineer (motor)	3	1	4
car driver	3	-	3
telephonist	-	3	3
typist	-	3	3
labor worker	1	2	3
architect	2	1	3
watch maker	-	3	3
engineer	2	-	2
astronaut	1	-	1
shipbuilder	1	-	1
construction worker	1	-	1
thief	1	-	1
total	107	86	193

Table 7: Schoolsubject and technology

	boys abs.	%	girls abs.	%
know subjects	55	91.7	37	61.7
don't know subjects	5	8.3	23	38.3
total	60	100	60	100

χ^2 = 15.08 df=1 (sign. difference)

Table 8: Frequencies of subjects mentioned

	boys	girls	total
Arithmatics	25	10	35
Maths	12	8	20
Manual dexterity	14	4	18
(Dutch) Language	8	6	14
English language	3	2	5
Geography	2	3	5
Physics	4	1	5
Chemistry	5	-	5
Computer science	2	3	5
Economics	2	2	4
Biology	-	2	2
Architecture	-	1	1
total	86	47	133

Table 9: Manual Dexterity, inventing and repairing and technology

	boys abs.	%	girls abs.	%
dexterity				
yes	49	81.7	43	71.6
no	2	3.3	3	5.0
depends	8	13.3	7	11.7
don't know	1	1.7	7	11.7
total	60	100	60	100
inventing				
yes	53	88.3	50	83.3
no	6	10.0	4	6.7
depends	1	1.7	6	10.0
total	60	100	60	100
repairing				
yes	45	75.0	42	70.0
no	5	8.3	5	8.3
depends	9	15.0	5	8.3
don't know	1	1.7	8	13.3
total	60	100	60	100

Table 10: Working with a compter versus repairing a bike

	boys abs.	%	girls abs.	%
both technical	17	28.3	14	23.3
computer more techn.	43	71.7	40	66.7
don't know	--	----	6	10.0
total	60	100	60	100

$\chi^2 < 1$

Table 11: Results of attitude questions

	boys abs.	%	girls abs.	%
like technology				
yes	53	88.3	33	55.0
no	2	3.3	15	25.0
depends	2	3.3	8	13.3
don't know	3	5.0	4	6.7
girl as car mechanic				
yes	60	100	60	100
technology is important				
yes	58	96.6	52	86.7
no	--	----	--	----
depends	1	1.7	5	8.3
don't know	1	1.7	3	5.0
technology is good				
techn. is good	35	58.3	46	76.6
techn. is bad	--	----	--	----
depends	21	35.0	11	18.3
don't know	4	6.7	3	5.0
technology is difficult				
difficult	27	45.0	46	76.6
easy	5	8.3	1	1.7
depends	25	41.7	10	16.6
don't know	3	5.0	3	5.0
technology at school				
yes, more	43	71.7	22	36.7
no, not at al	14	23.3	33	55.0
don't know	3	5.0	5	8.3
work in technology				
yes	40	66.7	19	34.7
no	10	16.7	23	38.3
depends	4	6.6	8	13.3
don't know	6	10.0	10	16.7

CURRICULUM VITAE

Falco de Klerk Wolters werd op 30 juni 1960 te Leiden geboren. In 1978 behaalde hij het diploma Atheneum β aan het Revius Lyceum te Doorn. Hierna studeerde hij Sociale Geografie aan de Rijksuniversiteit Utrecht. Het doktoraaldiploma werd in 1984 gehaald. In 1983 en 1984 werkte hij als onderzoeker-beleidsmedewerker bij de gemeente Zeist. Na het vervullen van zijn militaire dienst is hij vanaf 1986 werkzaam als onderzoeker bij de vakgroep Didaktiek Natuurkunde van de Technische Universiteit Eindhoven. In 1989 is hij benoemd als docent onderzoek bij de studierichting Toegepaste Vrijetijdswetenschappen aan de Christelijke Hogeschool Noord-Nederland in Leeuwarden.

Falco de Klerk Wolters was born on June 30th. 1960 in Leiden. In 1978 he passed his A-levels at the Revius Lyceum in Doorn. Afterwards he studied Human Geography at the State University of Utrecht. He graduated in 1984. In 1983 and 1984 he was policy-worker and researcher in the city of Zeist. After serving in the army he has been working as researcher at the Eindhoven University of Technology, Department of Physics Education. In 1989 he was appointed lecturer in research methods at the Department of Leisure studies at the Christelijke Hogeschool Noord-Nederland in Leeuwarden.

STELLINGEN

1. Naarmate leerlingen een breder beeld van techniek hebben, wordt hun houding tegenover techniek positiever.

   Dit proefschrift, hoofdstuk 4.

2. 'Onbekend maakt onbemind' geldt, voor techniek, in het bijzonder voor meisjes.

   Dit proefschrift, hoofdstuk 4.

3. Omdat attitude-vorming ten aanzien van techniek reeds op 10 jarige leeftijd heeft plaatsgevonden, is het van belang om op de basisschool aandacht aan techniek te schenken.

   Dit proefschrift, hoofdstuk 4.

4. Terecht merken Knulst en Van Beek op: "Omdat mensen bij technologie voornamelijk denken aan computer-toepassingen, reageren zij op dit beperkte idee van technologie vrij positief".

   Zie: W. Knulst en P. van Beek, 'Publiek en Techniek', Uitgave van het Sociaal Cultureel Planbureau, 1988, p. 21.

5. De stelling van Grant en Harding dat meisjes genuanceerder over techniek denken dan jongens wordt in dit onderzoek niet bevestigd.

   Zie: M. Grant en J. Harding, Changing the Polarity, International journal of technology education, 9, 3, p. 335-342.

6. Factoren die de status van het vak techniek verhogen zijn: de invoering van techniek als eindexamenvak, een initiële lerarenopleiding, curriculum-ontwikkeling welke niet voornamelijk gebaseerd is op een lbo-AT-verleden en tenslotte de ontwikkeling van een internationaal 'school-techniek' paradigma.

7. De negatieve zijde van een positieve attitude ten aanzien van techniek blijkt uit de argumentatie van de voorstanders van het Strategisch Defensie Initiatief (SDI), welke is gebaseerd op een groot vertrouwen in technologie (Manhattan project, Apollo project) en de daarmee samenhangende verwachting dat het technisch-wetenschappelijk potentieel zal groeien.

   Zie: W. Ruiter en B. van der Sijde, De Nucleaire Erfenis, 1985, p. 518.

8. Het is verbazingwekkend dat, ondanks diverse onderzoeks-aanbevelingen (Page en Nash 1980, Harvey en Stables 1986, De Leeuw 1986), er in Nederland op middelbare scholen niet geëxperimenteerd wordt met aparte jongens- en meisjesgroepen tijdens lessen in de vakken natuurkunde, wiskunde en techniek (en andere vakken).

9. Het is van belang dat docenten worden getraind in het evalueren van affectieve onderwijsdoelstellingen.

10. Omdat docenten geïnteresseerd zijn in de attitude van hun leerlingen, maar met de resultaten van een attitude-vragenlijst vaak niet uit de voeten kunnen, dient er meer aandacht aan 'gebruikersvriendelijkheid' van attitude-instrumenten te worden besteed.

Zie: M. Martinot, Studiedag CITO-PATT 'Het meten van attituden: theorie-instrument- toepassing', 17 februari 1987.

11. Gelet op de macro-economische betekenis van sport in Nederland is professionalisering van sport-management hard nodig.

12. Het is onjuist dat in het Waddengebied ten aanzien van activiteiten die een relatief beperkte invloed hebben op natuur en milieu (recreatie en toerisme) een hard beleid wordt gevoerd, terwijl activiteiten die een veel grotere schade aanrichten (militaire oefeningen, Rijnwatervervuling, off-shore), worden gedoogd en soms geïntensiveerd.

Zie: A.H. Staas, symposium Toerist (V)aardig Noorden, 21 september 1989.

13. Het gebruik van tele-fax, electronic mailing en tekstverwerken doet een nieuw tijdsbesef onstaan.

Stellingen behorend bij het proefschrift 'The attitude of pupils towards technology'.
Falco de Klerk Wolters, Eindhoven, 3 november 1989.