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THE SECOND INTERNATIONAL SCIENCE STUDY

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CONTENTS

CHAPTER 9

RESULTS OF THE SECOND INTERNATIONAL SCIENCE STUDY IN THE NETHERLANDS

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Abstract

This chapter describes how the Second International Science Study (SISS) was conducted in lower secondary education (population 2) in the Netherlands and summarizes results from the international part of SISS, as well as findings from six national options and secondary analyses.

The findings show that international comparative research can be tuned to the interest of quite different groups of educational researchers. The results show how Dutch students in different school types achieve in science subjects. The differences between the implemented curricula of the school types and the outcomes at student level are particularly clear. Moreover, the results show that even within school types large differences between schools exist. Even without performing international comparisons, these findings have, in particular, a mirror function within the Netherlands, as they show that achievement of particular groups of students is below expectation, despite differences in curricula that are meant to accommodate the learning abilities of students in different school types. The national options offered a large variety of interesting research findings and demonstrate the surplus value that can be gained by adding these options to the international core design.

Introduction

The Netherlands participated from 1970 onwards in the Six Subjects Survey conducted by the International Association for the Evaluation of Educational Achievement (IEA). In that study the content and outcomes of the curricula of six school subjects were investigated. Sandbergen (1974) reported the results for the science subjects biology, chemistry and physics; Comber and Keeves (1973) described the international results.

Although the Second International Science Study (SISS) formally started in 1980, Dutch participation in the study was not considered earlier than spring 1982, two years before the data collection. At that time the international preparations and decision making had proceeded to a stage that an active contribution to the construction of design and instruments was no longer possible. However, a committee of specialists in curriculum development, teacher training, educational test development and educational methodology in the Netherlands concluded that, considering the design and instruments developed for this study, the Dutch participation would be relevant. The Institute for

Educational Research (SVO) funded the study, which started in March 1983 and was conducted by the Department of Education (DoE) at the University of Twente (UT).

The Dutch participation in SISS was confined to population 2. Besides the international component of the study, six national options were included that addressed questions that were of specific relevance for researchers in the Netherlands. This chapter describes how the study was conducted in the Netherlands and summarizes results from the international part of SISS as well as findings of national options.

Organization of the Study

During the preparation and execution of SISS in the Netherlands, the project team was assisted by the following committees:

(1) *Advisory group*, an ad hoc committee, consisting of specialists in curriculum development, teacher training, educational test development and methodology was installed, who discussed the international design and instruments, and advised positively about a Dutch participation,

(2) *National specialists committee*, which acted during the study as an advisory committee to the researchers, and which consisted of experts from the same discipline as the advisory group, supplemented with representatives from the Inspectorate,

(3) *Internal UT committee*, consisting of the supervisor of the project, a methodologist, teacher trainers for physics and chemistry and a biologist from the Institute for Curriculum Development, with the task to serve as a daily sounding board for the researcher,

(4) *Working group of science teachers*, to provide on the basis of their practical experience much input to the study, such as judging the suitability of the test items, verifying the curriculum analysis, and judging the translations of instruments.

The Structure of the Dutch School System

At the time of the data collection for the SISS, the Dutch school system had the following characteristics.

Kindergarten started at age 4. Students followed at age 6 into the *elementary school* system which comprises 6 grades. After elementary education, students are streamed towards different types of schools in secondary education, which can be divided into two categories, namely general secondary or vocational education (special education is not taken into account in this study). *General secondary education* consists of a 6 year preuniversity school (called VWO), a 5 year higher general education school (HAVO), and a 4 year middle general education school (MAVO). *Vocational education* comprises lower vocational schools, such as technical (LTO), administrative (LEAO), domestic science (LHNO), nautical (LNO), and agricultural (LAO), as well as senior vocational schools, like technical (MTO), administrative (MEAO), social and nursery (MDGO), and a school type containing a mixture of vocational courses (KMBO). *Lower secondary education* consists of lower vocational education, MAVO, and the first part of HAVO (3 years) and VWO (4 years).

The population of students for SISS in the Netherlands was defined as "all students in grade 9 of secondary education in the school types HAVO–VWO, MAVO, LTO, LHNO–LEAO and LAO". It should be noted that LTO consists mainly of boys and in LHNO–LEAO the majority of students are girls. This population covers 95% of the total population of students and the fact that a small proportion of the population is excluded is assumed not to bias any national estimates of student achievement (Pelgrum & ten Bruggencate, 1986).

National Design of the SISS

The advisory group concluded that in the Netherlands:

> Conducting the study in population 2 is intersting, provided that by the addition of national items the coverage of the test by the national curriculum will be improved and the data collection will take place in the third grade of secondary education. (Grant request, page 11.)

In addition, participation in population 1 and population 3 was considered less relevant. Besides that, there was concern about the willingness of schools to participate in the testing of population 3, as the testing date was just before the period of final examinations. Furthermore, it was also recommended to administer the biology subtests in the second grade of secondary education, because most students in the third grade do not attend biology classes. It was considered to be interesting to add other national options to the study. As the project team, due to the late start of the SISS in the Netherlands, did not have the time to elaborate these options, the members of the national specialist committee were asked to add options which were related to their own research. The result of this was that five national options were incorporated in the design of the study. This means that the Dutch participation in SISS contains the following six components (with their acronyms): (1) International part, including national test items (INT), (2) Administration of biology subtest in grade 2 (BIO), (3) Misconceptions of students in chemistry (CHE), (4) Attitudes of students towards biology and health education (HEA), (5) Student–teacher interactions in physics and comparison of experimental physics curriculum with the traditional curriculum (PLO), (6) Ability of students to interpret tables, figures and experimental designs in physics (TAB).

In the following description of the design and execution of the study, the different study-components will be distinguished,using the above listed acronyms.

Population

The target population in the Netherlands consisted of students in the third grade of secondary education. This population is comparable with populations in most other countries (see Table 1) as far as the number of years in school is concerned. However the age of the students may differ between countries due to legal regulations concerning compulsory education and entrance age.

For the national options, CHE, PLO and TAB, the target population is the same as for the international component. The target population for the options BIO and

Table 1
Grade Level of Population 2 in Participating Countries

Grade level of secondary education	Number of countries
2	4
3	17
4	3

Table 2
Grade Levels Included per School Type for Each Study Component

	School type					
Study component	HAVO–VWO	MAVO	LTO	LHNO–LEAO	LAO	PLON
INT	3	3	3	3	3	
BIO	2	2	—	—	—	
HEA	2	2	—	3	2	
CHE	3	3	3	—	—	
PLO+TAB	3	3	3	—	—	3

*PLON is an experimental physics curriculum.

HEA consists of students in the second grade of secondary education. For quantitative and qualitative reasons (for instance some school types are very small; the biology curriculum of lower vocational education is not of interest for the national opinion BIO) a further restriction of the definition of the target population was made for the national options. Table 2 gives a summary of school types which are involved in each study component. The part of the population 2, which was excluded from the international study component, consists of students in small school types (vocational) and students in integrated school types. The total percentage of excluded students is 20%. However, as the exclusions of students are restricted to just mixed school types and no strata were excluded, this will not affect national estimates, the only exclusion which is worthwhile considering is approx. 5%.

Instruments

A summary of all instruments which were used in this study is given in Table 3.

As some instruments contained too many questions, they were split up into different rotated forms. One of the most difficult problems to resolve in translating the instruments was how to deal with the word "science" in the questionnaires. In the Netherlands, science does not exist as a separate school subject, but is split up into the subjects biology, chemistry, physics and earth science, therefore it was decided to use different questionnaires for these subjects. A teacher answered the questionnaires for his/her subjects and the students got one of three rotated forms (there was no student and teacher

Table 3
Short Description of Instruments for Each Component of the Study

Study component*	Respondent	Instrument
INT		Cognitive science test
		Attitude towards science
	Student	Descriptions of science lessons
		Word knowledge test
		Background questionnaire
	Teacher	Opportunity to learn
		Background questionnaire
	School	School questionnaire
BIO		Biology subtest
	Student	Attitudes towards biology
		Description of biology lessons
	Teacher	Opportunity to learn
		Background questionnaire
	School	School questionnaire
HEA	Student	Biology subtest
		Attitude towards biology and health education
	Teacher	Opportunity to learn
		Opinions about biology and health education
		Background questionnaire
	School	School questionnaire
CHE	Student	Two questions about the concept of concentration
PLO	Student	Physics subtest
		Attitude questionnaire
		Questionnaire interaction student–teacher
		Background questionnaire
	Teacher	Opportunity to learn
		Questionnaire interaction teacher-student
		Background questionnaire
	School	School questionnaire
TAB	Student	Cognitive tests: physics, tables, figures, and designs
		Background questionnaire
	Teacher	Same as PLO
	School	Same as PLO

*The acronyms are explained in the design section.

background questionnaire for earth science because this subject in the Netherlands is much broader than in other countries).

It is important to note that one of the major deviations from the international questionnaires occurs in the opportunity to learn questionnaire to the teachers: in the Netherlands the same form was used as in the Second International Mathematics Study, whereas the international form used in the SISS is the same as in the Six Subjects Survey:

Dutch version (abbreviated):

For each item in the tests answer the following questions:

(1) What percentage of students in the target class will answer this item correctly without guessing?

(2) When was the subject matter, which is necessary to answer this item, taught?
International version:
(1) What percentage of students had an opportunity to learn the concepts tested by this item?

Sample

The sampling procedure consists of three consecutive steps:
(1) Selection of a stratified random sample of schools with a probability proportional to the size of the school (see the section about population for the stratum definitions),
(2) Invitation of schools: request for a list of classes, class codes, number of students and names of science teachers,
(3) Selection of one intact class (third year of secondary education and, if appropriate, see Table 2: second year) per school with a chance proportional to the size of the class.

As it was not possible to combine the international and national components of the study which focussed on the same year level without exceeding the amount of three lessons testing time per student, it was decided to draw two independent samples for both components. Altogether 473 classes (with about 9000 students) from about 300 schools participated in the study.

Results

The results of the international and national components of the Dutch SISS study have been reported by several authors. In the following, some of these results will be summarized.

International Components (INT) and Biology Test in Grade 2 (BIO)

Pelgrum and Plomp (1986) described the data collected with the international instruments in grade 3 and the results obtained by administering the biology subtests in SISS to a sample of students in grade 2 of secondary education.

Table 4 shows some characteristics of the population of grade 3 students broken down by school type as estimated from the SISS results.

Table 4 shows that the school types in general education and also agricultural vocational education (HAVO–VWO, MAVO and LAO) are mixed with respect to gender, whereas technical vocational education (LTO) and domestic and administrative vocational education (LHNO–LEAO) are predominantly single-sex schools. It is also interesting to see that the socio-economical background of parents, here operationalized in father's education, differs between the school types.

Table 5 shows the descriptives from SISS about the amount of students that attend courses in science, while Table 6 gives estimated of the amount of science subject matter covered in the different school types (opportunity to learn).

Table 4
Characteristics of 3rd Grade Students as Estimated from SISS

Characteristics	HAVO–VWO $n=1209$	MAVO $n=1232$	LTO $n=1158$	LHNO–LEAO $n=938$	LAO $n=528$
	School type				
Age (months)					
mean	183	185	188	186	186
sd.	6.4	8.1	8.5	7.9	9.1
Gender (%)					
boys	49	44	94	4	74
girls	49	53	2	91	23
Father's education after sec.education					
none	32	42	50	51	49
1–2 years	17	18	15	18	17
3 and more	44	33	23	17	24
unknown	7	8	13	15	11
Language spoken at home					
Dutch	68	56	46	33	34
dialect	21	32	44	51	57
foreign	8	9	5	11	4
unknown	3	3	5	5	5

Table 5
Percentage of Students in Grade 3 Attending Classes in Science

Classes (%)	HAVO–VWO	MAVO	LTO	LHNO–LEAO	LAO
	School type				
Biology	14	83	10	92	91
Physics	96	60	91	10	78
Chemistry	96	91	9	7	86

Tables 5 and 6 show that the curriculum differences between the school types are rather large. For instance, Table 5 shows that almost none of the students in the vocational school types LTO and IHNO–LEAO attend classes in chemistry, whereas in the general secondary school types HAVO–WVO and MAVO almost all students attend classes in chemistry. These differences are also reflected in the opportunity to learn measures in Table 6, that are also low for the chemistry in the vocational school types. The achievement of students in science is one of the most central variables in SISS. Table 7 shows the means and standard deviations of the scores (in terms of percentage correct) on the science subtests for each of the different school types in grade 3 as well as the scores for the biology subtest in grade 2. Also included in Table 7 are the results on the vocabulary and mathematics subtest for each school type.

From Table 7 it may be concluded that the achievement differences between the students in the different school types are indeed very large. These differences are not only associated with the general abilities of students (due to the selection procedures at

Table 6
Means and Standard Deviations for Opportunity to Learn Measure (OTL) for all Science Subtests in Grade 3 and for the Biology Subtest in Grade 2

	School type									
	HAVO–VWO		MAVO		LTO		LHNO–LEAO		LAO	
Subtest (*n* items)	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd
Biology (33) grade 3	74	13	67	17	—	—	69	15	63	13
Biology (32) grade 2	65	16	50	19	—	—	—	—	—	—
Physics (32)	68	10	64	11	69	14	44	22	61	9
Chemistry (22)	79	8	71	15	25	24	28	19	61	13
Geography (16)	80	15	73	19	65	22	54	25	76	20

Table 7
Means and Standard Deviations for Test Scores (Percentages Correct) for all Science Subtests in Grade 3 and for the Biology Subtest in Grade 2

	School type									
	HAVO–VWO		MAVO		LTO		LHNO–LEAO		LAO	
Subtest	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd
(*n* items)	*n*=1209*		*n*=1232		*n*=1158		*n*=938		*n*=528	
Biology (33) grade 3	67	14	57	15	49	16	45	16	54	17
Biology (32) grade 2	61	16	51	16	—	—	—	—	—	—
Physics (32)	77	14	60	16	63	17	45	14	56	15
Chemistry (22)	75	16	54	20	42	18	33	16	44	18
Geography (16)	75	15	63	17	60	19	50	18	58	19
Vocabulary (25)	86	10	78	11	71	13	67	13	69	14
Mathematics (10)	80	18	64	21	58	24	46	21	52	24

*For grade 3 science, for vocabulary and mathematcs about half of the size. The *n*s for grade 2 HAVO-VWO and MAVO are respectively 1246 and 921.

the end of elementary education) but also with curricular arrangements as was already shown in Table 6. It is also interesting to note that the hypothesis of the National Specialist Committee that the results on the biology subtest in grade 3 might be deflated, is not confirmed.

The differences between the school types on the vocabulary subtest are relatively small, whereas the differences on the mathematics subtest correspond with those on the science subtests, which indicated that the major differences may be caused by the general learning abilities of students.

The attitude data collected by means of the international instruments were also of particular interest.

The international attitude questionnaire contained 40 statements which were analyzed with principal component analyses. Three scales could be identified which were labeled respectively as (1) *utility* of science (11 items), (2) *social* aspects of science (6 items) and (3) *liking* of school (3 items). Table 8 shows that there is a clear trend in the differences between the schooltypes; students in general secondary education have more positive attitudes than students in vocational education. Moreover, with the exception

Table 8
Means (Standard Deviations) of Percentage Agreement on Items in Attitude Scales

Scale	School type				
	HAVO–VWO	MAVO	LTO	LHNO-LEAO	LAO
Utility					
Boys	51(27)	40(25)	*	**	33(23)
Girls	34(24)	32(24)	*	**	35(23)
Total	43(27)	36(25)	34(22)	27(22)	34(23)
Social					
Boys	48(23)	40(23)	*	**	35(21)
Girls	42(23)	34(23)	*	**	34(21)
Total	45(23)	37(23)	35(21)	31(20)	35(21)
School					
Boys	44(39)	36(35)	*	**	34(36)
Girls	50(37)	44(38)	*	**	43(38)
Total	47(38)	41(37)	38(37)	40(38)	37(37)

*mostly boys; **mostly girls; see Table 4 for sample sizes.

of students in lower agricultural education, boys are far more positive about the utility and social aspects of science, whereas, it is also interesting to note that, girls tend to be more positive about attending school.

Misconceptions in Chemistry (CHE)

The results of the national option dealing with misconceptions of the concept of concentration in chemistry submitted to a sample of studens, have been summarized by De Jong (1985) as follows:

> The present study has been focussed on pupils' understanding of concentration as an "intensive" quantity. This characteristic of concentration means that the value of the quantity is not related to the extent of the amount of a mixture. Concentration is a standardized proportional quantity.
> Pupils at *MAVO/HAVO/VWO* were asked to solve some concentration problems concerning solutions which were poured off partly or were mixed with another solution. Their written and oral statements were collected and analyzed.
> The research results indicate that far too many pupils have no clear image of the "intensive" aspect of concentration. The major arguments of MAVO pupils involve only one of the components of concentration (no proportional reasoning). The major arguments of HAVO/VWO pupils involve concentration as an object-dependant quantity instead of a substance-dependant quantity".

De Jong (1985) gives specific suggestions for a more careful introduction of the concept of concentration.

Attitudes of Students Towards Biology and Health Education (HEA)

This national option constituted part of a study about health education as an innovation that addresses questions about the content and context of health education and the role that inservice education of biology teachers can play in the innovation process. Waarlo (1989) describes the results of the SISS national option that included measures of attitudes towards health education and biology in a sample of students in grade 2 secondary education as well as measures collected from teachers.

The instruments for students consisted of the following questions:

(A) Two open-answer questions:

(1) Nowadays what in the Netherlands, in your opinion, are the two main threats to the health of people (try to mention four threats).

(2) What can you do yourself to keep or improve your health? (try to mention four ways).

(B) Statements related to health to be answered on a three-point scale.

The majority of students mention health threats related to environmental problems, while 1/3 mentions eating and smoking and 1/4 alcohol and/or drugs. Environmental problems are more often mentioned by students in general education as compared to students in vocational education. Girls more often mention health threats like eating, smoking and alcohol and/or drugs. The comparisons of perceived health threats and perceptions of students own behavior to keep healthy are interesting: what students mention as preventions are not a direct mapping of what they see as important threats. For instance, environmental problems are mentioned very often as threats, whereas almost none of the students suggested preventions in this area. Eating is mentioned by 3/4 of the students as important element of healthy behavior, whereas 1/3 mentions health threats in this direction.

The attitude scales showed the following results:

(1) Almost half of the students perceive their own influence on health and disease as modest and 1/4 even as very small.

(2) More than half of the students see health as an important value of life, while 3/4 state that their way of life is healthy.

(3) About 40% of the students find it difficult to find out what is good or bad for their health.

(4) A majority of the students have a moderate to great interest in health education, girls indicating a higher interest than boys.

Waarlo (1989) summarizes the results of the student measures as follows:

> HEALTH is very strongly associated with environmental health threats, viz. the negative aspects of our (chemical–)technological culture. Pupils perceive health behaviour, ranked consecutively, as good diet, sufficient physical exercise, no smoking, little or no use of alcohol and drugs, sufficient rest, fresh air and hygiene. Strong emphasis is on the physical dimension of health. Three quarters of the pupils believe they hold a healthy way of living. There are some indications that pupils only have superficial knowledge about the relationship between behaviour on the one hand and health and disease on the other (Waarlo, 1989, p. 176).

Teachers were also asked to express their opinions about health education. Many teachers do not have clear opinions on issues related to health education. It could be that teachers were, at that time, not too well informed about recent developments with respect to health education. Waarlo uses the findings for providing advice on further elaboration of health education as a relatively new subject domain in secondary education.

Student–teachers Interaction in Physics and a Comparison of an Experimental Physics Curriculum with the Traditional Curriculum (PLO)

The major goal of this national option, reported by Brekelmans (1989) was:

(1) to compare the achievement of students attending an experimental physics cur-

riculum (called PLON) with the achievement of students in a traditional physics curriculum,

(2) to collect measures of student–teacher interactions in a representative sample of students for studying how these measures relate to measures of student achievement in both types of curricula. The measures of student achievement used in this option consisted of a selection of 23 items from 32 physics items from the SISS-test (including Dutch physics items added as a national option to the international SISS physics subtest). The selection was made by PLON experts and based upon the criterion that the items should fit the PLON curriculum. For measuring student–teacher interactions students as well as teachers reacted to statements about the occurrence of certain teacher behaviors that refer to so called sectors in a model for interpersonal teacher behavior: Leading, Helping/Friendly, Understanding, Tolerant, Uncertain, Unsatisfied, Correcting, Severe.

The comparisons do not show real differences on the physics tests between the PLON curriculum and the traditional curriculum. If one expresses the test score on a scale between 0 and 10, the means (and standard deviations) for the students for PLON (n=513) and traditional curriculum (n=562) are respectively 7.5(1.4) and 7.7(1.2).

By means of regression analyses, the contribution of the measures of interpersonal teacher behavior in explaining the variance in achievement scores between classes was found to be only 3.5% after compensating for the variable school types. Further analyses showed that teacher behavior qualified as authoritarian, tolerant, directive/authoritarian was associated with higher student achievement than teacher behaviors qualified as laboriously dominating. On the other hand, students of teachers who are tolerant and authoritarian, uncertain/tolerant or uncertain/agressive show lower achievement scores than students of teachers of the laboriously dominating type.

Ability of Students to Interpret Tables, Figures and Experimental Designs in Physics (TAB)

This option was designed and reported by De Bruyn (1986), who summarizes the content and results of this national option as follows:

> A test of science process skills was administered to 14 year old students. The abilities included reading graphs, reading tables and judgement of experimental designs. Some additional tests (extracted from the SISS item pool) were given to assess the knowledge of biology, chemistry and physics. The analysis revealed no interpretable clustering of items, indicating that a scale for the abilities can not be distinguished. Furthermore the achievement of students in separate disciplines does not influence the response on process skill items. The whole test showed a close relationship to a physics test, i.e. comparable sex-bias and dependence on mathematical ability were found. However, on the level of school type a difference with physics test performance was found. The students who followed an experimental curriculum in physics (PLON) showed a significantly higher level of science process skills (De Bruyn, 1986, p. 107).

Secondary Analyses on the Dutch SISS Data

Besides the primary reports of the international and national components in the Dutch participation in SISS, steps were taken for performing secondary analyses on the collected data. One of these analyses concerns gender differences in science.

Alting and Pelgrum (1989) used a model developed by Eccles (1987) to investigate gender differences in science. They found that girls in comparison to boys: Expect to leave school earlier; are less inclined to attend future education that includes science subjects; tend to perceive science as difficult and not to like it. The finding that there is a high correlation (r=0.53) between the expectation of attending future education with science and the interest in science is relevant for explaining why a minority of girls in the Netherlands choose to incorporate science subjects in their final years of upper secondary education. Other secondary analyses, that will not be reported here, are in the field of psychometrics. Further secondary analyses that are planned to be conducted in the near future are in the field of school effectiveness research.

Concluding Remarks

The summary of findings from the Dutch participation in SISS, as given above, shows that international comparative research can be tuned to the interest of quite different groups of educational researchers. The results show how Dutch students in different schools types achieve in science subjects. The differences between the implemented curricula of the school types and the outcomes at student level are made particular clear. Moreover, the results showed that even within school types large differences between schools exist. Even without performing international comparisons these findings have in particular a mirror function within the Netherlands, as they show that achievement of particular groups of students is below expectation, despite differences in curricula that are meant to accommodate the learning abilities of students in different school types. The national options offered a large variety of interesting research findings and demonstrate the surplus value that can be gained by adding these options to the international core design.

References

Alting, A., & Pelgrum, W. J. (1989). *Siss-ters in science: Een aanvullende studie naar sekseverschillen in prestaties in en houding tegenover natuurwetenschappen bij leerlingen in derde klassen havo–vwo en mavo* [A secondary analysis of gender differences in achievement and attitudes towards science of students in third grade havo–wvo and mavo]. Paper gepresenteerd op de Onderwijsresearchdagen 1989.

Brekelmans, M. (1989). *Interpersoonlijk gedrag van docenten in de klas* [Interpersonal behaviour of teachers in classes]. Utrecht: thesis.

Comber, L. C., & Keeves, J. P. (1973). Science education in nineteen countries. *International Studies in Evaluation* I. Stockholm: Almqvist & Wiksell.

De Bruijn, I. (1986). Toetsing van procesvaardigheden bij natuurwetenschappen [Testing process skills in science]. *Tijdschrift Didactiek b-wetenschappen*, 107–117.

De Jong, O. (1985). Concentratie als 'intensive' grootheid [Concentration as 'intensive' quantity]. *Tijdschrift Didactiek b-wetenschappen*, 219–233.

Eccles, J. S. (1987). Gender roles and women's achievement related. *Psychology of Women Quarterly*, II, 135–172.

Pelgrum, W. J. & ten Bruggencate, G. C. (1986). *Second International Science Study: Technical Report*. Enschede: T. H. Twente, Toegepaste Onderwijskunde.

Pelgrum, W. J., & Plomp, Tj. (1986). *Second International Science Study: Beschrijving van uitkomsten en analyse* [Description of results and analysis]. Enschede: University of Twente, Department of Education.

Sandbergen, S. (1974). *Nederlandse resultaten in tekstbegrip en natuurwetenschappen. Een empirisch vergelijkende studie.* [Dutch results in text comprehension and science. An empirical comparative study]. Amsterdam: Stichting Research Instituut voor Toegepaste Sociologie.

Waarlo, A. (1989). *Biologie en gezondheidseducatie* [Biology and health education]. Utrecht: thesis.