DOCUMENT RESUME

ED 374 774 IR 016 814

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TITLE What Do Students Know about Computers and Where Did They Learn It? Results from an International Comparative Survey.
PUB DATE Apr 94
NOTE 15p.; Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA, April 4-8, 1994).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Computer Assisted Instruction; *Computer Attitudes; *Computer Literacy; Educational Technology; Elementary Secondary Education; Foreign Countries; Futures (of Society); Information Technology; Questionnaires; *Student Attitudes
IDENTIFIERS International Surveys; Netherlands (Enschede)

ABSTRACT

The purpose of this study was to determine if there are cross-national factors that account for students' computer know-how. The data used in the study were collected in the International Association for the Evaluation of Educational Achievement study on computers in education. In 1992, data were collected in seven different countries about the use of computers in elementary and secondary schools. A questionnaire was used to determine attitude scales, computer use at home, and scores on the Functional Information Technology Test (FITT) by students. Teachers were asked to indicate whether the subject matter covered in each item of the FITT was taught before the testing. The FITT consisted of 30 multiple choice items designed to measure the general practical knowledge and skills students will need to use information technology. Results showed that, in all countries, the average level of achievement differs across schools. Conclusions drawn from the analyses are that schools, student attitudes towards information technology, gender, and home background are meaningful factors in understanding differences in student achievement on functional information technology. (JLB)

What do students know about computers and where did they learn it? Results from an international comparative survey.

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New Orleans, 4 - 8 April, 1994.

INTRODUCTION

A major task for educational systems is to prepare students for the society they have to live in. Since the 1980s a rapid increase has taken place in the use of information technology. As a consequence of the world-wide technological influence, computers are also introduced in education systems. The idea that computers play an important role in the life of every citizen is no longer disputed. To prepare students for a society where it is necessary to be able to work effectively with information systems, computers are introduced more and more in education.

In describing computer use in education a distinction can be made between information technology as an 'object', as an 'aspect' and as a 'medium' (Dutch Ministry of Education, 1992).

Where information technology is an 'object' of education and learning, the focus is on technical functioning, its social implications and the possibility of employing particular applications in a useful way. The first principles of this approach are designated using the term 'computer literacy'.

Information technology as an 'aspect' refers to information technology as an integrated component of another subject. This is common in vocational education, where the corresponding careers at which the education is aimed would now often be unthinkable without this technology.

Information technology as a 'medium' relates to the use of the computer as a means of information transfer and organization. This approach covers computer-assisted instruction in all its forms, including computer managed instruction.

The knowledge of students about information technology is certainly not restricted to what they learn at school. In the 'information society' students also come in touch with information technology outside school.

PURPOSE

The major question in this paper is: What are - in international comparative perspective - the most important factors for differentiation between student scores on their knowledge about Functional Information Technology (FIT)? The central theme is to find out if there are cross national factors that account for students' know-how on computers.

Much research has been done on the effectiveness of schools and the explanation of student achievement. In early student achievement research, there was considerable emphasis on the ability and family background of the student in determining student achievement (Coleman et al., 1966; Jencks et al., 1972). In addition to the importance of the home background for student achievement, research studies in school effectiveness clearly show the importance of student attitudes towards their achievement (Scheerens, 1991; Keeves, ed., 1992).

In this study factors are included which proved to be powerful factors explaining student achievement (Keeves. ed., 1992). A description of the analysed variables is included in the next section.

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DESCRIPTION OF SAMPLE

The data are collected in the IEA (International Association for the Evaluation of Educational Achievement) study on Computers in Education (COMPED). In 1992 data were collected in 7 different countries about the use of computers in elementary and secondary schools. In each country, a national representative sample was drawn from computer using and non using schools. The design of this study has been more fully described in the international IEA report "Schools, Teachers, Students and Computers: a Cross-National Perspective" (Pelgrum, Janssen Reinen & Plomp, 1993).

In the context of this paper it is important to mention that the conceptual framework of the COMPED study reflects the hierarchical structure of educational systems. For that reason data have been collected at several levels.

At student level a questionnaire was used for a Functional Information Technology Test (FITT) and student background information such as attitude scales, computer use at home, age, gender, SES, etc. Target grades are grade 5 (primary schools: mean age 10 years) and grade 8 (lower secondary schools: mean age 13 years). At school level a teacher was asked to indicate whether the subject matter covered in each item of the FIT-test was taught before the date of testing. The items concerned basic understanding of both hardware and software terminology as well as general applications such as word processors and spreadsheets. The percentage of items taught before the date of testing gives an Opportunity to Learn (OTL) index.

In most countries the data were collected in the period March-June 1992. Table 1 lists the countries and shows the sizes of the samples that were drawn in each of the educational systems considered in this paper.

Table 1

Sample sizes per educational system with data available at school and student level. Data are numbers of respondents in each category

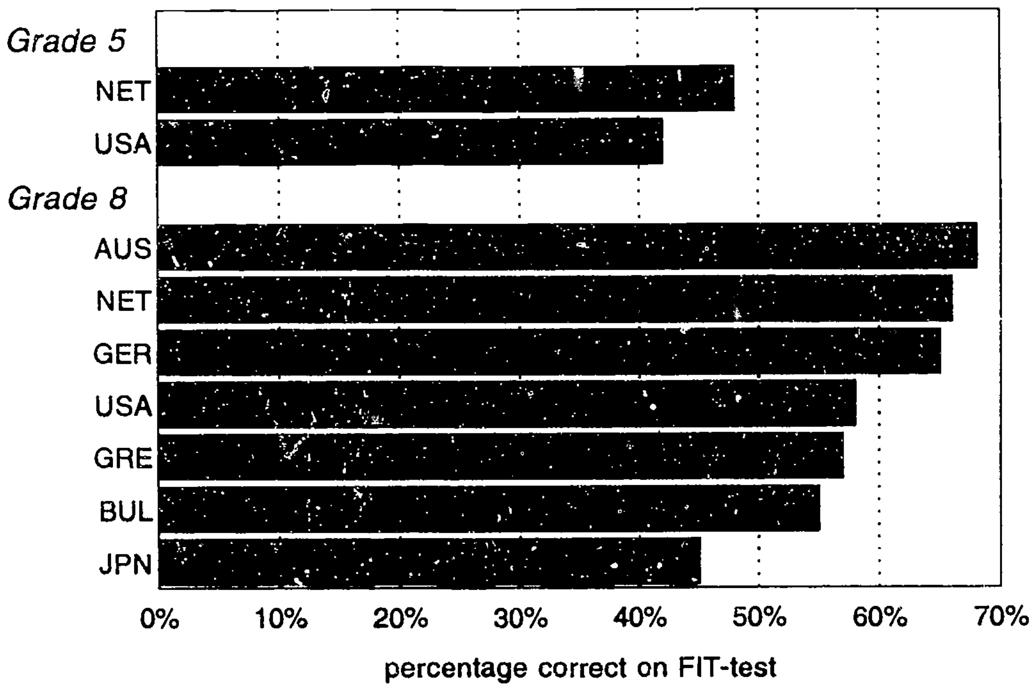
System	Schools	Students
Grade 5		
NET	151	3104
USA	185	3988
Grade 8		
AUT	237	4895
BUL	81	1154
GER	64	1328
GRE	132	3326
JPN	146	4802
NET	207	4298
USA	159	3299

VARIABLES

In this study the outcome measure is student achievement on Functional Information Technology (FIT). This measure consists of 30 multiple choice items. The test was designed to measure the general practical knowledge and skills students will need to be able to use information technology. The conceptual domain of the FIT-test is the continuum of those abilities necessary for handling computers and other information technology. These abilities range from low level keyboarding skills to higher level problem solving. Functional information technology skills, as defined in this study, do not include computer programming. Neither do they include formal knowledge about information technology that is not essential for using this technology. The test included about 10 items for each of the following three areas: (a) basic concepts; (b) user operations; (c) applications. The 5th grade test consisted of a 17 items subset of the 30 items test for grade 8. The test reliabilities (KR-20) in the 8th grade were good, varying between .73 and .85. The 5th grade reliabilities were low; in The Netherlands .55 and the USA .47. Figure 1 shows the average percentage correct on the FIT-test.

Figure 1

Average percentage correct on the FIT-test



Motivation and interest of students are important factors in learning and achievement. As explanatory variables three student attitude scales towards information technology have been included: Relevance, Enjoyment and Parental Support. Table 2 contains a short description of the content of these scales. The reliabilities of the scales are satisfactory in most countries (between .60 and .85). The scale parental support contains only two items and should therefore be interpreted with some caution.

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Table 2

Attitude items per scale

Relevance
Computer can help me to learn things
With computers possible to do practical things
Computer useful for future career
Knowing how to use computers worthwhile skill
All students should have an opportunity learn computers
Computers important for being informed citizen
With computer skills better jobs
Enjoyment
I like to talk to others about computers
Computer can be exciting
I like reading about computers
Computer job very interesting
Computer lessons favourite
Want to learn a lot about computers
Like to scan computer journals
Stop usually for computer shop
Computer interest me little
Parental Support
Parents encourage computer use
Parents want me to be good at working computers

Other student background variables included sex of the student, a material welfare index as indicator for SES, computer use at school and computer use at home. At the school level the OTL-measure was analysed. Table 3 includes a description and summary statistics for all variables.

Table 3

Description and summary statistics of variables

<<< INSERT TABLE 3 >>>

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DATA ANALYSES

In most schools pupils learn in classes and the classes are taught within schools. In these educational settings pupils are grouped or nested within schools and the pupils are subject to the influence of their grouping. The grouping of students, classes and schools occurs in a hierarchical order with each group influencing the members of the group in thought and behaviour. This means that students within a school will be more alike, on average, than students from different schools. Analyses which don't recognise the existence of clustering create serious problems because generally standard errors of regression coefficients will be underestimated (Goldstein, 1987) and will give rise to problems of aggregation bias and imprecision (Raudenbush, 1988). Multi-level modelling is an adequate technique to deal with hierarchical data. Multi-level modelling provides an integrated strategy for handling problems such as aggregation bias in standard errors and erroneous probability values in hypothesis testing of school effects. For this study multi-level modelling was chosen as the most appropriate procedure to study school and student effects. The extended version of the statistical package ML3 (Prosser, Rasbash & Goldstein, 1991) was selected for the analyses of the large amount of COMPED data. The present study examines the role of school and student effects by first decomposing variations in student outcomes into student and school components. As second step explanatory variables were analysed as fixed effects. For reasons of comparisons of the results between countries the possible significantly random-effects at school or student level are not included in the analyses. This means that it is assumed that the slopes for all explanatory variables are equal within each country.

RESULTS

The partitioning of variance in student knowledge about functional information technology into student and school level components was achieved by using the ML3E computer package. A comparison of the sizes of the student and school level variances is shown in table 4. The results show that in all countries the variance between the schools is much larger than the estimated standard error. This indicates that in all countries the average level of achievement differs across schools. The portion of variation in achievement attributable to differences between schools is indicated by the estimate of the intra-class correlation (icc). In the 5th grade about 20% of the differences in student achievement is related to differences between schools. This is the case in both The Netherlands and the USA. In the 8th grade there is more variation between countries. Relative low school effects are found in Japan (.13), Austria (.17) and Greece (.19). The highest influence at school level is found in Bulgaria (.53).

Table 4

Decomposition of the variance in achievement into student and school level components

	GRADE 5		GRADE 8						
	NET	USA	AUS	BUL	GER	GRE	JPN	NET	USA
School level	61.53	47.27	46.66	213.3	92.42	57.71	33.59	77.97	69.64
Student level	221.5	186.7	223.9	188.1	211.8	240.6	212.8	160.6	213.8
Intra-class correlation	0.21	0.20	0.17	0.53	0.30	0.19	0.14	0.33	0.25

For all countries the identical set of eight explanatory variables were analysed as fixed parameters. The estimates of the intercept (cons) and the slope associated with the explanatory variable are included in table 5. Standard errors are given between brackets and significant estimates ($p < .05$) are indicated with an asterisk.

Table 5

Fixed parameters

<<< INSERT TABLE >>>

The results in table 5 show that in most countries the three attitude scales, Relevance, Enjoyment and Parental Support, have a meaningful influence on student achievement in the area of functional information technology. The highest influence of relevance on student achievement is found in the USA (grade 8: .51). The Netherlands is the only country where relevance in grade 5 as well as grade 8 is negatively related to student achievement, although this effect is not significant for grade 8. The influence of enjoyment shows the contrary picture. In The Netherlands we find a rather high estimate for enjoyment (grade 5: .31; grade 8: .41) and in the USA the smallest of all countries (grade 5: .05 (not significant); grade 8: .12). Parental support has the highest influence in the USA (grade 8: .19) and Japan (grade 8: .15).

The sex of the student is the only factor with a substantial influence on student achievement in all countries. The highest estimate for gender differences are in Germany (grade 8: 5.58) and Japan (grade: 4.89). The lowest (just significant) gender influence is found in the USA.

Remarkable is the effect of the education at school about information technology on the student achievement. For grade 8 in more than half of the countries the results show no influence of OTL on student achievement (Austria, Germany, Japan, The Netherlands). In the other countries the effect of OTL is very small. In line with these findings there is no effect (grade 8: Bulgaria and Japan) or even a negative effect (grade 5: USA and Netherlands; grade 8: Greece and The Netherlands) between the degree of computer use at school in different subjects and student achievement. The highest positive influence of computer use at school and student achievement is found in Austria. In order to explain variation between student results there is no influence of computer availab'lity in the USA and Bulgaria. In the case of the USA most students have a computer at home (see table 3: grade 5: 89% and grade 8: 91%) and in Bulgaria most families don't have a computer (14%). In both countries the variation between students is small. Computer availability at home has a relatively high influence in Germany, Greece and The Netherlands. In the USA the effect from SES on achievement is the highest. It seems that SES compensates for the lack in variance in the variable computer availability at home.

Finally table 6 shows the percentage explained variance at school and student level. The presented multilevel model accounts for more than 30% of the variance between schools in the USA in grades 5 and 8. About 20% of the variance at school level is explained by the set of explanatory variables in the The Netherlands (grade 5), Bulgaria (grade 8) and Germany (grade 8). At student level the highest proportion of variance is explained in Germany (22%). In general the restricted model with fixed parameters explains between 10-20% of the total variance in all countries.

Table 6

Percentage explained variance

	GRADE 5		GRADE 8						
	NET	USA	AUS	BUL	GER	GRE	JPN	NET	USA
School level	0.22	0.32	0.05	0.24	0.18	0.08	0.10	0.09	0.31
Student level	0.07	0.04	0.16	0.03	0.22	0.12	0.10	0.12	0.10
Total	0.10	0.09	0.14	0.14	0.21	0.11	0.10	0.11	0.15

DISCUSSION

The presented analyses show that school effects account for a substantial part of the variation in student achievement on functional information technology. Especially student attitudes towards information technology, gender and home background are meaningful factors in understanding differences in student achievement. Remarkable is the limited contribution of education to student achievement. It seems that many students learn a lot about information technology by living in the 'information society'. Students from affluent homes seem to be advantaged to come in touch with information technology, while students from poorer homes have less possibilities to learn about information technology in their environment. Except in the USA, in all countries substantial achievement differences are found between male and female students. In all countries male students know more about information technology than female students. Although the present study basically is preliminary, further analyses will provide useful information regarding the relationship between student achievement, attitudes toward information technology, gender, and school environment characteristics. One of the major questions for further analyses will be which conditions schools can provide in order to reduce the gender gap in information technology.

ACKNOWLEDGEMENTS

The data employed in this paper are derived from the IEA Computers in Education study. I wish to thank IEA and its International Coordinating Centre for making the data available.

I am grateful for advice about ML-analyses provided by Roel Bosker from the University of Twente.

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Table 3

Description and summary statistics of variables

		GRADE 5		GRADE 8						
		NET	USA	AUS	BUL	GER	GRE	JPN	NET	USA
Theoretical variable	scale	mean (sd)	mean (sd)	mean (sd)	mean (sd)	mean (sd)	mean (sd)	mean (sd)	mean (sd)	mean (sd)
FITT-score	0-100	48.31 (16.93)	41.94 (15.24)	67.88 (16.45)	55.15 (20.2)	65.42 (17.26)	57.19 (17.19)	44.92 (15.67)	66.41 15.23)	58.38 (16.8)
Relevance	0-50	28.02 (3.93)	28.62 (5.27)	29.78 (4.16)	32.00 (5.19)	28.72 (4.98)	31.45 (4.68)	25.61 (5.36)	27.13 (3.95)	30.4 (4.4)
Enjoyment	0-50	24.89 (5.25)	25.19 (5.51)	25.16 (6.05)	28.25 (6.28)	23.85 (6.67)	27.02 (5.93)	20.74 (6.1)	22.86 (5.41)	24.2 (5.83)
Parental Support	0-50	19.1 (7.4)	23.67 (11.32)	21.17 (8.51)	24.91 (11.24)	21.64 (9.36)	25.92 (8.95)	20.32 (9.25)	20.59 (7.53)	28.26 (9.41)
Gender	1-2	1.47 (0.49)	1.48 (0.49)	1.49 (0.5)	1.48 (0.49)	1.53 (0.49)	1.47 (0.49)	1.52 (0.49)	1.48 (0.499)	1.47 (0.49)
OTL	0-100	17.45 (23.68)	22.24 (30.14)	85.01 (21.29)	22.61 (29.74)	69.61 (30.18)	79.85 (18.64)	16.64 (24)	56.18 (30.35)	28.15 (34.59)
Computer home	0-1	0.77 (0.41)	0.89 (0.3)	0.65 (0.47)	0.14 (0.35)	0.60 (0.48)	0.55 (0.49)	n.a (n.a)	0.77 (0.42)	0.91 (0.28)
Computer School	0-27	3.19 (4.58)	4.64 (3.81)	5.23 (3.4)	1.33 (2.65)	3.25 (3.82)	4.24 (4.22)	1.36 (2.17)	3.06 (3.93)	3.37 (3.1)
SES	0-25	13.06 (3.17)	12.83 (3.7)	14.06 (3.6)	10.55 (3.24)	11.85 (2.74)	10.31 (3.42)	n.a (n.a)	13.68 (2.97)	14.08 (3.36)

Table 5

Fixed parameters

	GRADE 5		GRADE 8						
	NET	USA	AUS	BUL	GER	GRE	JPN	NET	USA
Theoretical variable	est. (se)	est. (se)	est. (se)	est. (se)	est. (se)	est. (se)	est. (se)	est. (se)	est. (se)
Cons	27.94 (2.28)*	22.79 (1.63)*	36.37 (2.62)*	26.52 (3.65) *	29.74 (3.75) *	27.22 (3.58) *	22.22 (1.29) *	44.97 (2.04) *	22.32 (2.225) *
Relevance	-0.18 (0.08)*	0.18 (0.05)*	0.35 (0.06)*	0.3 (0.1) *	0.3 (0.09) *	0.16 (0.07) *	0.12 (0.05) *	-0.02 (0.05)	0.51 (0.07) *
Enjoyment	0.31 (0.06)*	0.05 (0.05)	0.42 (0.04)*	0.15 (0.09)	0.37 (0.08) *	0.39 (0.05) *	0.39 (0.04) *	0.41 (0.04) *	0.12 (0.06) *
Parental Support	0.10 (0.04)*	0.04 (0.02)*	0.12 (0.02)*	0.01 (0.04)	0.08 (0.04) *	0.12 (0.03) *	0.15 (0.02) *	0.11 (0.02) *	0.19 (0.03) *
Gender	3.19 (0.57)*	2.28 (0.43)*	2.51 (0.46)*	3.75 (0.89) *	5.58 (0.86) *	3.78 (0.54) *	4.89 (0.41) *	3.51 (0.44) *	1.08 (0.51) *
OTL	0.15 (0.02)*	0.09 (0.01)*	-0.04 (0.02)	0.21 (0.04) *	-0.01 (0.03)	0.06 (0.03) *	0.02 (0.02)	0.03 (0.02)	0.08 (0.01) *
Computer home	2.76 (0.71)*	-0.05 (0.79)	2.36 (0.5)*	-1.04 (1.3)	3.85 (0.88) *	4.19 (0.61) *	n.a. (n.a.)	4.43 (0.5) *	0.86 (0.95)
Computer School	-0.16 (0.06)*	-0.09 (0.06)	0.68 (0.07)*	-0.3 (0.17)	0.29 (0.1) *	-0.43 (0.06) *	0.18 (0.13)	-0.18 (0.05) *	0.29 (0.09) *
SES	0.50 (0.09)*	0.59 (0.06)*	0.22 (0.06)*	0.38 (0.15) *	0.41 (0.15) *	-0.05 (0.08)	n.a. (n.a.)	0.01 (0.07)	0.44 (0.08) *