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From the "analogue divide" to the "hybrid divide": no equalisation of information access in science through the Internet

1. Introduction

The OECD defines the catchword 'digital divide' as *"... the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities"* (OECD 5). This gap has been assessed for several socioeconomic groups, like people with disabilities, people on low incomes and from households of certain structures (e.g. single parent households), the unemployed, people with relatively low levels of skills and education attainment, people with literacy difficulties, people belonging to race and ethnic minority groups, people living in remote rural locations, and last but not least senior citizens (see e.g. NTIA and ESA 1-139; OECD 17-23; Work Research Centre 20-44).

In analogy to this concept we use the term 'analogue divide' to describe the disparate use of information sources and information access in pre-Internet times. This analogue divide was strong in science in pre-Internet times: scientists that were outside or at the fringe of an invisible college[1] did not receive as much information as its participants, and they obtained information with delays (Cole and Cole 161-190; Crane 117; Cronin 229-230; Mulkay 112). The system of information exchange discriminated against scientists that were younger, female, at lower positions in the hierarchy of their research organisation, of lower professional recognition, working at less renowned universities or in developing countries.

The spread of the Internet has raised hopes that information access for those disadvantaged groups would be improving and that the Internet would contribute to creating a more equal basis for communication in science. Most empirical analyses over the last decade have nurtured these hopes and shown a more intensive Internet use for the less established groups of scientists. The data analysed in this paper does not support this result: on the contrary, Internet use is consistently higher for established scientists. I argue that the Internet has become the dominant means of communication in science – to such an extent that any scientist, regardless of whether they are established or not, has to use the available Internet tools and applications in order to communicate effectively. A particular benefit of Internet use cannot be found for less established scientists.

[1] The invisible college has been defined as the *"power group of everybody who is really somebody in a field"* (Price and Beaver 1011). An invisible college controls research resources and decides on the research strategies in its field. It serves as a channel for the dissemination of research ideas and research results which it has evaluated positively. It also represents a regulator that matches the volume of information with the absorptive capacities of the researchers and it is a source of research ideas (Cronin 223).

2. Current state of knowledge

There are convincing arguments pro and against a positive contribution of the Internet to closing the information gap between established scientists and their less acknowledged colleagues (see on this issue Nentwich 250-255): on the one hand the Internet improved the access to information from scientific journals, databases, archives, and other information sources; scientists don't need to obtain one of the rare journal issues, they don't have to be on the mailing lists of eminent colleagues to receive their newest work results, and they need less of their own or of assistants' time for literature searches. Also e-mail provides a direct gateway to other scientists without the necessity to reveal ones identity and status (Dubrovsky, Kiesler and Sethna 122-124; Walsh and Roselle 61). On the other hand the access to electronic information sources is many times not gratuitous. It requires costly subscriptions and licences and may be restricted to a limited number of work stations. In regard to personal communication, overloaded scientists might have their e-mail screened and filtered. The filtering of on-line communication partners is facilitated by status cues such as addresses, biographies and photos which are increasingly inserted into Internet sites (Walsh and Roselle 61; Nentwich 253).

If the Internet contributed to lowering the analogue divide of information access and use of information sources in science, we would expect that groups which were formerly disadvantaged – like younger, female, less renowned, geographically peripheral scientists – use the Internet more or at least to the same extent as their more established peers.

Empirical analyses over the last decade have largely confirmed this assumption: Lazinger et al. (512) found lower Internet use for more senior scientists; correspondingly, Cohen (50-51) and Mitra et al. established that younger scientists used computer-mediated communication (CMC) applications more often. Kling and Callahan found that e-journal readers tended to be younger than non-readers. A 'lower' professorial status (assistant versus associate and full professors) also corresponded to a higher use of computer networks for communication (Cohen 50-51). Only the findings on gender differences between scientific CMC users were inconclusive: Whereas Cohen (50-51) reported higher CMC use by women, Mitra et al. and Walsh et al. (1301) did not find any gender-related differences in regard to e-mail use. However, these results are mostly based on data that was collected when the Internet was still in the early stages of its diffusion. More recent data is necessary.

3. Internet access and use for different status groups in science

The Statistical Indicators for Benchmarking the Information Society (SIBIS) survey contains data on more than 1,400 scientists from five academic disciplines (astronomy, chemistry, computer science, economics, and psychology) and seven European countries (Denmark, Germany, Ireland, Italy, the Netherlands, Switzerland and the UK). The data was collected through a mailed questionnaire in the period of April to July 2003 (response rate: 25%). It permits a comparison of scientists' Internet access and use along the lines of age, gender, position in regard to R&D, and academic recognition.

E-mail is used by 99.7 % and the World Wide Web by 98.9 % of all respondents. So, we can say that virtually everybody uses the Internet. Three aspects of information access and use of information sources for R&D could be analysed with the data set:

a) Internet access to the important information sources

b) Use of on-line and off-line information sources

c) Use of communication media in an average working week

The results are shown in the annexed tables 1-3 and discussed subsequently.

Ad a) *Internet access to the important information sources* (table 1)*:* Overall, Internet-based access to information sources which the respondents consider as important from their point of view is very

good. On average, only 3.5% of all respondents stated that they had access to only few or none of their important information sources. Access varies by academic discipline, country and between the different status groups. Higher percentages of female, younger and less renowned scientists could not access the important information sources via the Internet. The major reason in each case was that their organization has not enabled the access. This reason is above all important for the lower status groups, whereas insufficient technical infrastructure and the general absence of these sources from the web are less important.

Ad b) *Use of on-line and off-line information sources* (table 2): Male scientists are a little bit more often regular users of information sources than female scientists.[2] Scientists in higher positions (research managers and senior researchers) and with higher professional recognition[3] are also more often regular users of on-line sources than lower positioned (junior researcher) and less recognized colleagues. This is particularly notable for peer websites and web pages of other organisations, but it also applies to electronic journals.[4] Only the age differences are in line with the expectation that less established scientists use on-line sources more frequently than established scientists: Younger scientists are more often regular users of openly accessible information sources like Internet sites of libraries and electronic journals and databases than older scientists whereas they are less often regular users of their own collection of information items, off-line electronic sources, and conferences, workshops and seminars. These differences might be due to the main hypothesis of this paper. However, as the other status variables don't back the hypothesis, other explanations come to mind. It might not be their lower status, but other reasons that motivate younger scientists to use Internet-based information sources. For instance, we can assume that younger scientists show more affinity to new technologies and have higher incentives to learn how to use them, as they can expect higher cumulated returns in the future.

Ad c) *Use of communication media in an average working week*: Based on an assessment of the use of communication media during an average working week three clusters were identified in a hierarchical cluster analysis:[5]

- 'Silent researchers' use all the listed communication channels only to small extent.
- 'E-mail communicators' use mainly e-mail for their R&D communication.
- 'Communicators' use all the different communication media intensively.

How the different status groups are represented in these communication clusters is shown in table 3. For our purposes the second cluster of 'E-mail communicators' is the most interesting, as we would expect that the disadvantaged groups of scientists are overrepresented in this cluster. However, this is hardly the case. Only the youngest age group, scientists of 35 years and younger, is slightly overrepresented compared to scientists of 51 years and older. The other low status groups, i.e. female, little recognised and lower positioned scientists, are always clearly overrepresented in the 'Silent researchers' and underrepresented in the 'Communicators' cluster.

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[2] Multivariate analyses showed that some of the gender differences of Internet use are not primarily caused by gender, but they are rather a consequence of the lower recognition and position of female scientists.

[3] Professional recognition was assessed through assessing whether the respondent had won any scientific awards, served on a major professional committee, the editorial board of a scientific journal, or a national/international advisory committee.

[4] In multivariate analyses it could be corroborated that the differences of e-journal use between research managers, senior and junior researchers are significant.

[5] Intensity of usage was assessed for the following communication channels: e-mails sent and received, phone calls made and received, letters sent and received, formal face-to-face meetings, informal face-to-face meetings, and participation to chat room sessions and to video conferences.

4. Discussion and conclusions

The SIBIS survey data doesn't back the hypothesis that differences of information access between lower and higher status groups are equalised by means of the Internet. On the contrary, higher status groups with the exception of older scientists have consistently better access to Internet-based information sources. They are more often regular users of on-line information sources and they are more intensive users of e-mail as well as most other communication channels. Hence the analogue divide of information access between established and not established groups in science has been carried over to the Internet age. The Internet does not convey a particular advantage for the previously discriminated groups. It seems that the mechanisms that caused the analogue divide, like disparate financial resources for journal subscriptions, other published information and conference attendances, differing resources (above all personal assistance) for searching for and filtering information and unequal participation at academic in-groups are still valid. To some extent even on-line equivalents to these access barriers exist. It looks like the old analogue divide has become a new 'hybrid divide' including analogue and digital information and communication.

How does this combine with the results of older analyses? The latter mostly date back to the early diffusion phase of the Internet in science. When the Internet was only one among several communication media, established scientists could still rely on other media and ways of communicating. At this time, discriminated groups may have had an advantage by using the Internet to get hold of material that they could not obtain off-line. Nowadays, at the advanced stage of Internet diffusion, it has become a dominant means of information retrieval and communication. Established scientists have to use it in order to work effectively. Partially, they also have the means to regulate and control Internet access and the use of on-line information sources of less established scientists. So it is like before: the hierarchy and power distribution in science determines information access and not the technology.

Some qualifications are, however, necessary. First of all, the dataset was limited to scientists from seven developed European countries. The Internet might have had more notable effects on information access for scientists from developing countries. Also, the reputation, research orientation and location of the organisation could not be included among the discriminatory variables. Second, the data covers the mere use of Internet-based information sources and communication channels. It does not measure the significance and value of the information obtained from on-line sources. However, this information might have a higher value for the less established scientists, as they could not obtain it by other means and don't have any substitutes. Third, younger scientists are more often regular users of Internet-based information sources than older scientists. Though other causes might contribute to this result, we cannot negate that the Internet might have solved some of younger scientists' problems of getting information; also younger scientists are slightly overrepresented, and junior researchers are equally represented in the cluster of 'E-mail communicators'. Therefore, we may conclude that the Internet has not closed the information divide in science entirely, but it might have reduced it at least a little bit.

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Tables

Table 1: Percentage of scientists with insufficient Internet access to the important information sources and reasons given for this insufficient access by status group, academic discipline and country

		Insufficient Internet access to the important information sources	Reasons given for this insufficient access (only for respondents that state insufficient access)		
			Information source is not available on the Internet	Technical infrastructure is insufficient	Organization has not enabled access
Gender	Male	3.3	34.3	11.8	51.4
	Female	4.4	16.7	16.7	61.1
Age	35 and younger	4.0	30.0	5.0	71.4
	36 to 50	3.7	25.0	15.8	57.9
	51 and older	2.8	30.8	23.1	23.1
Level of recognition	Low	3.8	27.0	11.1	64.9
	Medium	3.7	36.4	18.2	18.2
	High	2.3	.[a]	.[a]	.[a]
Position	Research Manager	3.6	30.0	10.0	50.0
	Senior Researcher	3.2	34.8	18.2	36.4
	Junior Researcher	3.3	20.0	6.7	81.3
Academic discipline	Astronomy	1.1	.[a]	.[a]	.[a]
	Chemistry	2.9	.[a]	.[a]	.[a]
	Computer Science	3.5	0.0	30.0	50.0
	Psychology	5.2	46.7	7.1	35.7
	Economics	3.3	.[a]	.[a]	.[a]
Country	Switzerland	1.3	.[a]	.[a]	.[a]
	Germany	2.2	.[a]	.[a]	.[a]
	Denmark	5.6	.[a]	.[a]	.[a]
	Italy	4.0	25.0	33.3	41.7
	Ireland	7.2	9.1	18.2	81.8
	The Netherlands	3.5	.[a]	.[a]	.[a]
	United Kingdom	2.9	.[a]	.[a]	.[a]
All respondents		3.5	28.3	13.5	54.7

a Less than 10 observations and therefore excluded from the table.

Source: SIBIS survey on the Internet in R&D.

Table 2: Percentage of regular users (once a week and more) of an information source by status group, academic discipline and country

		Internet sites of libraries and archives	Electronic journals, working paper and article databases	Peers' web pages	Websites of other institutions	Your own collection of information items	Off-line electronic sources	Libraries	Colleagues, assistants, superiors	Conferences, workshops, seminars
Gender	Male	68.3	76.5	45.0	65.5	82.9	42.1	43.2	64.4	18.1
	Female	67.6	76.6	31.8	52.9	79.5	33.1	39.2	57.6	13.9
Age	35 and younger	71.6	83.2	39.9	54.0	79.7	34.6	40.1	65.5	14.7
	36 to 50	67.6	75.3	45.7	67.7	82.1	38.9	36.3	61.3	15.5
	51 and older	64.4	70.2	39.7	66.0	85.4	47.9	52.2	61.2	21.8
Level of recognition	Low	67.1	76.0	39.1	59.9	80.9	37.4	42.2	60.8	14.4
	Medium	68.8	81.5	45.0	68.4	81.6	39.1	41.3	66.5	21.0
	High	71.7	73.6	51.4	68.1	88.8	52.6	44.7	67.6	24.2
Position	Research Manager	65.5	75.2	50.4	70.6	84.2	45.1	41.4	63.8	23.0
	Senior Researcher	69.4	78.8	44.1	66.3	84.4	40.6	43.9	61.5	17.8
	Junior Researcher	69.5	77.3	35.8	54.0	79.5	37.7	41.5	65.3	13.9
Academic discipline	Astronomy	73.2	89.5	36.6	79.5	80.6	45.7	42.0	76.9	23.0
	Chemistry	77.0	88.9	34.8	46.5	82.7	42.3	52.7	59.1	15.4
	Computer Science	54.7	60.3	64.8	73.2	82.4	33.2	27.3	65.8	17.8
	Psychology	70.8	67.0	30.7	49.4	82.8	40.7	45.1	57.7	9.4
	Economics	70.3	83.5	47.8	70.7	83.3	39.7	42.9	59.7	22.5
Country	Switzerland	66.7	78.7	46.9	71.6	81.1	43.6	40.6	70.7	20.4
	Germany	67.6	70.8	46.3	69.2	82.8	41.3	50.9	63.0	19.8
	Denmark	66.5	75.0	41.0	61.2	86.8	46.7	42.6	66.3	16.0
	Italy	74.0	82.1	43.7	66.2	78.1	47.1	44.3	58.7	18.8
	Ireland	64.2	73.5	34.7	50.0	85.1	30.8	40.9	51.7	8.1
	The Netherlands	71.3	81.0	33.6	50.7	81.2	35.2	35.5	70.9	15.1
	United Kingdom	63.6	73.9	39.5	55.4	82.4	26.2	35.4	57.0	16.7
All respondents		68.1	76.6	42.0	62.6	82.1	40.0	42.4	62.7	17.1

Source: SIBIS survey on the Internet in R&D.

Table 3: Percentage of respondents in clusters of communication channel usage by status group, academic discipline and country

		Silent researchers	E-mail communicators	Communicators	Total
Gender	Male	39.1	28.2	32.7	100.0
	Female	49.3	27.7	23.0	100.0
Age	35 and younger	52.9	29.3	17.8	100.0
	36 to 50	34.2	31.0	34.8	100.0
	51 and older	37.5	22.8	39.7	100.0
Level of recognition	Low	51.6	26.6	21.7	100.0
	Medium	23.9	32.1	44.0	100.0
	High	15.1	31.2	53.7	100.0
Position	Research Manager	21.4	25.5	53.1	100.0
	Senior Researcher	32.5	32.5	34.9	100.0
	Junior Researcher	62.3	25.3	12.4	100.0
Academic discipline	Astronomy	32.4	33.0	34.6	100.0
	Chemistry	54.6	15.5	29.9	100.0
	Computer Science	36.2	37.8	26.0	100.0
	Psychology	36.2	30.6	33.2	100.0
	Economics	44.4	27.3	28.3	100.0
Country	Switzerland	43.9	34.1	22.0	100.0
	Germany	40.9	19.2	39.9	100.0
	Denmark	41.1	35.0	23.9	100.0
	Italy	32.4	23.4	44.1	100.0
	Ireland	56.8	23.3	19.9	100.0
	The Netherlands	45.7	28.6	25.7	100.0
	United Kingdom	37.9	39.1	23.0	100.0
All respondents		41.5	28.2	30.4	100.0

Source: SIBIS survey on the Internet in R&D.