Disciplinary Differences in the Use of Internet Discussion Groups: Differential Communication Needs or Trust Problems?

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Abstract

This paper tests empirically the claim that the successful application of information and communication technologies (ICTs) depends on the social context of its use. There are striking differences in the prevalence of ICT use between researchers in different academic disciplines. Nevertheless it is unclear whether and how they depend on disciplinary differences of the academic communication system. The paper presents several existing and new hypotheses that specify how disciplinary differences in communication systems influence whether researchers make use of so-called Internet Discussion Groups (IDGs). The hypotheses either argue that specific trust problems inhibit IDG subscription or that IDGs fulfill discipline-specific communication needs, which gives incentives for subscription. They are tested with data of a sample of university researchers in the natural and social sciences and the humanities. The trust hypotheses are not confirmed. The idea that IDGs have a distinct orientation function that diminishes deficiencies in the existing communication systems of some disciplines finds support. Scholars who work in research fields that are difficult to overview, that is fields with a high number of journals, have a special incentive to subscribe to IDGs.

Keywords: scholarly communication; information search, knowledge sharing, online community

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1. The problem: Social conditions for the successful use of new information technologies?

It is often stated that the successful use of information and communication technologies (ICTs) depends not only on the properties of the technology. ICT researchers claim that the technology has to fit in with the social environment in which it is intended to be used. If this is not taken into account, it is argued, then much money might be wasted [1]. There is a similar situation within university research. New tools of the Internet are loaded with high expectations for the whole research system without distinguishing between different disciplines [2-3]. Disciplinary differences in Internet use and appropriateness of tools have been little investigated [4]. Some even claim that in the long run, the same tools will be used in every discipline [5]. At the same time, other researchers argue that the distinct communication traditions of different disciplines have an impact on how researchers use the Internet [6] .

At the moment, there are clear differences in the use of ICTs by researchers of different fields [7-8]. The current development is characterized by a trial-and-error process in different disciplines involving several tools that costs time and money. If this trial-and-error process is not systematically evaluated through research, then the opportunities for other disciplines to learn from previous failures are missed and resources will be wasted. Research has to find out why a tool is often used under one set of conditions, but not under another. Such insights should be useful for the design and implementation of new ICTs. Designers can then anticipate which properties a new tool for a given social system should have, or which of a set of different tools promises to be most successful. The problem is that there is not yet much empirically grounded knowledge about which conditions of the research system might be relevant, nor theoretical knowledge about *why* they could be relevant. As will be shown below, existing theory is sparse and has not yet been tested appropriately [7-10].

The aim of this study is to contribute to filling this gap. Existing answers to the question 'which conditions of a discipline's communication system inhibit or stimulate the use of a specific Internet tool?' are reviewed, new answers are developed based on that prior research, and the hypotheses are systematically tested.

To test the hypotheses, this study analyzes the use of academic Internet Discussion Groups (IDGs), that is Internet mailing lists and newsgroups, by English and Dutch university researchers in eight different disciplines in the humanities and the social and natural sciences. Academic IDGs have shown to be useful tools for researchers to get information about their research field and to "network" with other researchers [11]. While in every discipline some researchers make use of IDGs, there exist clear differences in the prevalence of IDG use between different disciplines [8, 9, 11, 12]. Finally, an IDG is an Internet tool that has already been in existence for some time so that striking disciplinary differences in its use cannot easily be explained by its novelty. Accordingly, analyzing the use of IDGs in different disciplines provides ideal conditions for finding out more about which conditions stimulate or inhibit the use of a new ICT and why they do. The reader should note that in this paper 'use of IDGs' means being subscribed to/reading the messages of an academic IDG. However, for an IDG to be useful one needs not only passive readers, but additionally active message posters. While other research shows which conditions stimulate active discussion contributions in IDGs or continuation of membership, this paper contributes to finding out which conditions stimulate initial subscription to academic IDGs.

The next section gives an overview about existing hypotheses that could explain disciplinary differences in the use of IDGs, and develops additional arguments. Section 3 describes the design of this study and provides descriptive findings. In section 4 the hypotheses are systematically tested using questionnaire data about the use of IDGs. Section 5 summarizes the findings and draws conclusions.

2. Possible answers: Communication needs, trust problems, and different internet tools

The use of IDGs by researchers can depend, in principle, on many characteristics of the researcher. Additionally, some analysts claim that there are distinctive features in the communication systems of different disciplines that have an impact on whether researchers will make use of a specific Internet tool. These hypotheses

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primarily focus on the use of electronic publishing tools [10], email [9], or IDGs [13]. It is open whether they can be extended to other tools of the Internet. In this paper, the hypotheses are extended, if necessary, to the use of IDGs and then systematically tested. Additional factors are taken into account only to ensure that the hypotheses are tested properly. I will first briefly present arguments in the way they are given by the authors (section 2.1). Some arguments made by different authors are similar and others are contradictory if they are extended to IDGs. I assess the relation between the arguments and specify them in a number of testable hypotheses (section 2.2).

2.1. Theories of disciplinary differences in use of ICTs

Hypotheses about effects of the social conditions of a researcher's field on the decision to use an ICT can be distinguished in two groups. Some researchers argue that there are trust problems between researchers that inhibit use. According to this perspective the bases and amount of trust differ between fields or disciplines [10]. Additionally, there might be different communication needs for researchers of different fields, which could explain why there are disciplinary differences [9, 13].

Kling & McKim [10] distinguish between *two kinds of trust problems* that could have an impact on the use of ICTs in a research field. Firstly, a researcher who decides to use an Internet tool to receive informal information must trust the sender of information with respect to its reliability. Secondly, a researcher who decides to use an ICT to send information must be sure that this does not harm his own career advancement. Since he gives away information of potential value to competitors for status in the research system, this is not self-evident. The existence of either of these two trust problems can be a barrier for the use of new ICTs in a research field. In a next step, the authors relate different properties of the communication system of a research field to the magnitude of these trust problems. They propose that *four properties of a research field* affect the trust problems.

First, in research fields with a high degree of mutual *visibility* of ongoing research projects, the risk of sharing information with others in the field is comparatively low. The intensity of the trust problem might be lower because the field's transparency guarantees that the sent information does not have much value that is dependent on its secrecy. Second, the degree of *concentration of communication channels* (number of journals) might be important. If the results of ongoing research are published in a small number of journals, the research studies are much more visible than those in fields with a low degree of concentration. This visibility, in turn, lowers the risk of harming one's own career advancement through the sharing of information (see above). Third, a research field with a high *degree of industrial integration* tends to have a higher magnitude of trust problems. Researchers in such fields might harm themselves through sharing information that has a high commercial value. As the fourth condition, Kling & McKim [10] argue that the *high project costs* in some research fields have several effects. They can force researchers to collaborate more often because this increases the chance of obtaining funding. They tend to increase the visibility of the research project. They will also have the effect of putting pressure on the involved researchers to review their output more thoroughly internally. This latter effect will increase the trust problem for the sender and tends to make him more conservative with regard to information sharing.

The fourth hypothesis is ambiguous. Whereas the increased social visibility of the research projects decreases the trust problem of the sender, the pressure for stronger internal output control has two sub-effects. It increases the trust problem for the sender, but it decreases the trust problem for the receiver. According to my point of view, the overall effect depends on the relative sizes of the contradictory effects and cannot be predicted a priori.

These hypotheses have not yet been tested explicitly. Kling & McKim [10] give a number of examples of research fields to illustrate their arguments. Since they used these examples to develop their arguments, as the authors frankly admit, they cannot (and do not) regard them as a test of the hypotheses. As a consequence, it is useful to test whether their arguments can be applied or extended to the explaining of disciplinary differences in the use of IDGs.

In another study, Walsh & Bayma [9] investigated the use of ICTs by a number of researchers in mathematics, physics, chemistry, and experimental biology. They identified a number of conditions which, according to their point of view, could influence whether a researcher will make use of a new ICT if access to it is given. As will be elaborated in section 2.2, the first two of these conditions relate to issues of trust, but the other two introduce a different perspective.

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According to these authors the strength of the *link to the (commercial) market* is important. If this link is strong, much of the information is too valuable for researchers to spread it informally, inhibiting the use of ICTs. As an additional condition, Walsh and Bayma [9] mention the *size of a research field*. They believe that in large research fields many researchers are unknown to each other, leading to complications in informal communication. This would discourage researchers from communicating informally with each other via ICTs.

Furthermore, a high degree of *interdependence between the projects of different researchers* within a research field will facilitate the use of ICTs. In such fields, these tools are especially useful in helping to co-ordinate and adjust research activities among researchers. Finally, the *compatibility of routine working traditions with the use of ICTs* is regarded as important. If it is too difficult for the researcher to integrate ICTs into the working routine, their usage would be avoided.

The arguments of all authors, in principle, might be valid for all kinds of ICTs, if access to them is available to the researcher. Since access to the great majority of IDGs is free, these hypotheses may also be able to explain disciplinary differences in the prevalence of IDG use. The findings of other empirical studies to be discussed below, however, cast doubt on the potential generality of the arguments for different types of ICT. They point to variation in ICT use within a discipline.

The common view is to regard researchers in the natural sciences, especially some physicists, as the most sophisticated users of new ICTs. For example, some studies note that at the beginning of the 1990s email use among some specific groups of physicists was very prevalent [9, 12]. A study of 26 US institutes found that the proportion of users of computer-mediated communication tools (CMC tools) among faculty in chemistry was higher than among faculty in the social sciences and humanities [14]. At the same time, Merz [12] mentions that only a few theoretical physicists use mailing lists or newsgroups. Fry and Talja [8] provide comparable qualitative evidence for high energy physicists. Although these studies cannot be used to evaluate the hypotheses systematically, they suggest an important insight. *Within the same discipline different ICTs can be used completely differently by the same researchers*. Although physicists may tend to be among the most frequent email and pre-print server users, they may tend to be infrequent IDG users.

I regard these findings as a hint to consider very carefully which *incentives* what groups of researchers have for using a *specific* ICT. The interdependence argument of Walsh & Bayma [9] suggests that some researchers use ICTs because they fulfill specific communication needs (e.g. a need for co-ordination and adjustment that may be related to the highly interdependent social organization of the field's research activities). However, this does not imply that all ICTs will be used in the same way. Different ICTs may fulfill different communication needs.

To control for any variation in ICT type, I propose to investigate the incentives that researchers may have to make use of a specific information and communication technology, namely IDGs. How are such incentives related to the social conditions of a discipline’s communication system?

IDGs are tools for informal communication between researchers. Although informal communication is important in every discipline [15] , there are strong disciplinary differences in informal communication practices [16]. In some disciplines the scope of problems is strictly limited (especially in high energy physics), leading to a highly efficient informal communication system, where most participants have few difficulties in identifying their required communication partners. Other disciplines have a very broad or vaguely defined range of problems, with many research niches, which are very difficult to overview. Becher [17] coined for this distinction the term "people-to-problem-ratio". Fields with a low "people-to-problem-ratio" are difficult to overview. "The scatter of problems characteristic of a loosely structured knowledge domain is reflected in the dispersion of literature across a wide range and variety of sources, whereas tightly structured knowledge tends toward concentration in relatively few journals" [17: 102]. This distinction is clearly related to what Kling & McKim [10] call the concentration of communication channels.

Social sciences are regarded as having a less strictly defined range of problems and therefore as having a lower concentration of communication channels than the hard sciences [17]. The range of problems, in turn, is related to the researcher's information needs [18, 19].

These findings provide a hint as to the benefits that some ICTs could have for disciplines with a low concentration of communication channels (journals). Since IDGs are intended for informal discussion, including announcements, questions, and answers about the research domain, one expectation of the researcher can be that

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IDG use provides information helpful for orientation in a research domain that is otherwise difficult to overview [13]. Orienting information includes information about significant findings, ideas, theories, methods, literature, unsolved problems as well as the most relevant conferences and names of researchers in a field. This type of information increases efficiency and effectiveness of research activities enormously, is usually necessary to know, and mostly, though not exclusively, needed in the early phases of a research project. In some research fields a part of such information is given in annual review articles and at summarizing presentations at the end of some conferences. Moreover, some IDGs in the social sciences and humanities also regularly provide a part of these benefits (see [11] for the details). If the *hope of obtaining orienting information* is one of the motivations for the initial use of IDGs, then it can be understood why, for instance, high energy physicists, who often do research in areas that are less difficult to overview, tend to have less strong a need for IDGs than, for example, historians.[2] The informal communication system of high energy physicists with its highly concentrated communication channels already fits well with this communication need. On the other hand, some social scientists and researchers in the humanities, many of whom may work in areas difficult to overview, tend to experience a need for more concentrated communication channels which can reduce existing deficiencies in their communication system. The reader should note that this argument rests on the researcher's subjective view of the number of communication channels that he has to overview.

The conclusion is contrary to what the extension of Kling & McKim's [10] analysis to IDGs implies. Whereas the "trust argument", expanded to include IDGs, supposes a negative association between the visibility of the research projects and the use of IDGs by researchers, the argument based on differential communication needs [13] implies a positive association.

2.2. The hypotheses to be tested

Before specifying the hypotheses, I first would like to clarify the relation between the underlying arguments to make clear what the mechanisms are. Kling & McKim's [10] second argument concerning the number of journals in a field is an application of the first, more general argument about its visibility, since the second argument refers explicitly to the first one ("visibility") as the underlying mechanism. Walsh & Bayma [9] partly seem to indicate that some of their arguments rest on the same mechanisms specified by Kling & McKim [10], although they use a different terminology. The argument concerning the "link to the commercial market" is very similar to what Kling & McKim [10] term "the industrial integration" of a field. Accordingly, the underlying mechanism for both arguments is the (second kind of) trust problem of the sender. Since Walsh & Bayma [9] justify their "field size argument" with the insufficient degree of mutual awareness and the high anonymity among researchers in a large field, this argument is based on Kling & McKim's [10] "visibility" mechanism. Accordingly, it assumes that more awareness/visibility enhances the emergence of trust, which decreases communication problems and thereby stimulates the use of ICTs.

The other two arguments of Walsh & Bayma [9] concerning the interdependence and the compatibility between working traditions and ICT use do not rely on the idea that trust problems inhibit the use of ICTs. Rather, they introduce certain communication needs of researchers that result in ICTs with high benefits and low costs of use being favored. Researchers working in highly interdependent research fields can obtain extra benefits and researchers having working routines that make the use of ICTs difficult to integrate experience extra costs. As a result of this discussion, the hypothesized underlying mechanisms can be summarized as follows.

higher visibility	less trust problems [9, 10]
higher commercialization	more trust problems [9, 10]
higher project costs	either more or less trust problems [10]
higher interdependence	more communication benefits through informal communication via ICTs [9]

[2] This argument is in accordance with the findings of Talja, Savolainen, and Maula [30] who suggest that researchers in the humanities use emailing lists often because this corresponds to their information seeking habits including browsing guided by information accessed through social contacts.

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higher compatibility	less communication costs for informal communication via ICTs [9]
lower visibility	more communication benefits through informal communication via IDGs [13]

The first 'trust argument' and the last 'communication needs argument' imply contrary predictions with regard to the use of IDGs. The predictions implied by the third argument are unclear until one has more information concerning the differential sub-effects. Since such information was not available in this study, this hypothesis cannot be tested. To summarize, this study tests the following two 'trust hypotheses' and three 'communication needs hypotheses'.[3]

Hypothesis 1: The higher the visibility of the research in a field, the more likely the researcher will make use of IDGs.

Hypothesis 2: The higher the commercial relevance of a researcher's work, the less likely the researcher will make use of IDGs.

Hypothesis 3: The more interdependent the researcher's work is with other researchers' work, the more likely the researcher will make use of IDGs.

Hypothesis 4: The better the compatibility of routine work traditions with the use of ICTs, the more likely the researcher will make use of IDGs.

Hypothesis 5: The lower the visibility of the research in a field, the more likely the researcher will make use of IDGs.

The use of a new ICT depends, of course, on many other conditions. Social influences mediated through one's departmental colleagues' use of innovations have an impact on the use of new technologies [20, 21]; the researcher's information behavior may depend on his/her degree of research activity, prominence, the quality of the university department [22], or the disciplinary socialization processes [23]. Attitudes with respect to the use of computers might thus be of influence. Moreover, hypothesis 2 claims that commercial competition is a barrier for IDG use. Since other forms of competition for scholarly status also play a dominant role in the research system [24], one should control for non-commercial competition that may inhibit IDG use. Moreover, a researcher's international scholarly network affects his information seeking [25]. Since the theories claim a direct impact of the specified conditions, the hypotheses are tested while controlling for the other potential impact factors. These control variables include differences in the number of visited conferences and written papers, attitudes concerning PC use, perception of competition, indicators of the department's quality of research, differences in the researcher's departmental and international social networks, and other disciplinary heterogeneities.

3. The data

3.1. The Design of the Study and the Measurements

This study tests the five hypotheses using data obtained with the help of a postal questionnaire sent to a multi-stage random sample of English and Dutch university researchers in the following eight disciplines. These cover established disciplines in the humanities, the social, and the natural sciences and were expected to have sufficient variation in the theoretically interesting conditions that might affect IDG use.

History	Sociology	Management Science	Economics
Mathematics	Chemistry	Mechanical Engineering	Physics

[3] These hypotheses, of course, are not those that the two above-mentioned groups of authors had in mind when they formulated their ideas. Rather, they form the simplest specifications of their ideas if they are expanded to the realm of informal communication by IDGs.

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The study population consists of researchers, including Ph.D. students and postdoctoral researchers, who are doing research at a university department in the Netherlands or England within one of these eight disciplines. All 13 universities within the Netherlands were chosen. Within England 23 universities were randomly selected. Within every selected university all departments that belong to one of the 8 disciplines were chosen. Within every selected department a random sample of researchers was taken (see Appendix A).

The data were collected from September 1998 until March 1999. While they are somewhat older, in the meantime neither the basic characteristics of IDGs nor the basic disciplinary differences that are expected to affect IDG use did change dramatically. The author does not know of newer data of comparable quality. A total of 1063 out of 2688 researchers returned a usable questionnaire (~ 40%). For testing the hypotheses, however, a sub-sample of the respondents is adequate, as will be explained in the section on 'descriptive findings'.

The theoretical elaboration in section 2 showed that empirical tests of the different theories have to relate different "levels of analysis" to each other. The disciplinary differences can depend on features of other levels, namely the individual researcher, the university department, the research field, and, at least in principle, on other features at the level of the disciplines. The interesting theories focus especially on explanatory factors at the level of the research field. Existing preliminary empirical tests [7] suggest that the research field may exert its impact through the researcher's perceptions of the field's features. As a consequence, this study analyzes the impact of the social organization of research fields in the way this organization is perceived by the individual researcher.[4] Potential effects of departments are taken into account, although they are not of primary interest here.

Main Explanatory Variables:

To measure the *visibility* of the researcher's work in a field, this analysis makes use of the argument of Kling & McKim [10: 1314] which states that when a few journals in a field contain the majority of important studies, the research work of this field is more likely to be visible than when the research output of a field is usually published in numerous specialized journals. The questionnaire contained three questions that asked the respondent ...*"[w]hat is the total number of journals in which articles relevant for your research field are likely to appear?", "[h]ow many journals did you consider as potentially relevant to publish in one of them your last article in your research field?", and "[h]ow many journals do you consider as potentially relevant to publish in one of them your next article in your research field?"* The last two questions had to be answered only by researchers who had already published at least one article in their field or who had an ongoing project in the research field. The more journals a researcher considers as potentially relevant for his publication, the more journals tend to be relevant for similar publications of other researchers in the same field, which makes the research of the others less visible to him. The answer distributions for all questions were skewed with a number of extreme outliers. Moreover, approximately 40% of the answers to every question were clustered within two answer categories (10 and 20 journals for the first question, and 3 and 5 journals for the second and third questions), whereas the rest of the answers were either outside or between these values. Each of the three raw numbers was recoded into 5 categories (6 categories for the first variable that had a larger variance) in such a way that the middle categories included the modal answer to ensure that the univariate distributions of the three recoded variables are approximately normal. The recoded variables were then combined by using the scores of the first factor that emerged as the only factor with an eigenvalue larger than one in the factor analysis (51% explained variance of the items, KMO measure of sampling adequacy=.65, α=.73). Thus the higher the score, the more there is a dispersion (or low degree of concentration) of the communication channels. A high dispersion indicates a low degree of visibility.

Interdependence was measured with the help of the following three questions (7-point Likert scales). "*How important in your research field is the ... [1] ...**early** reading of other researchers' pre-prints? [2] ...**regular** personal communication (face-to-face, letters, personal emails etc.) with other researchers? [3]… **regular** attendance of conferences?*" The more interdependent the researcher's work is with other researchers' work, the more important these methods of communication are for the researcher. The scores of the first and only factor with an eigenvalue larger than one resulting from a factor analysis of the three answers are used to measure

[4] This is in accordance with the approach that some of the authors [7] have used to test their hypotheses. It avoids the use of statistical multi-level models (see, e.g., [32]) that use a crossed classification of individuals, departments, research fields, and disciplines that would be difficult to handle in this case.

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interdependence between the work of researchers (43.2% explained variance of the items, KMO measure of sampling adequacy=.67, α=.69).

Commercialization was measured via the question "*[h]ow strongly does control over new information and findings in your research field have commercial consequences?*". The *compatibility* of routine working traditions with the use of CMC tools is only vaguely defined by Walsh & Bayma [9]. They mention technical limitations, such as difficulties in sending photos and drawings by email, which in the meantime have been overcome by the end of the 1990s. Additionally they argue that "[r]elated to this compatibility thesis is the idea that those who use CMC are those who use computers for other tasks" [9: 692]. Therefore the compatibility was measured with the help of two proxies that are cognitive and behavioral indicators for how easy/difficult it is for a researcher to integrate IDG use in his working routine. The first variable consists of answers to the question "*[w]hen you compare your knowledge about the use of computer software with the knowledge of other university researchers within and outside your own discipline, what is your subjective assessment of this knowledge?*". The answer categories varied between "*below average*" and "*above average*". A behavioral proxy for the difficulty of integrating IDG use in one's working routine is simply the use of other CMC tools. The more a researcher is familiar with the application of other CMC tools, the more easy the integration. The questionnaire contained the following questions. "*On how many days per week do you -on the average- use a computer / communicate by E-Mail / read a 'World-Wide-Web-page' / use the file transfer protocol (ftp) to copy data from another computer for professional reasons?*" The answers to these four separately asked questions were scaled on a seven point Likert scale using half-days as the unit of measurement. A principal component analysis resulted in one factor with an eigenvalue larger than one, which is taken as a behavioral proxy for the compatibility (56.2% explained variance of the items, KMO measure of sampling adequacy=.70, α=.74).[5] Additionally, the control variables mentioned in section 2.2 are used in the analyses to ensure that the associations between the explanatory variables on the one hand and IDG use on the other hand are not spurious (see Appendix B for their measurements).

Dependent Variable:

The respondent had to answer a question asking whether he or she is subscribed as a member to a mailing list or regularly reads the messages of at least one newsgroup for professional reasons. Moreover, those who were not members and did not use newsgroups had to indicate whether they had been mailing list members or had used newsgroups regularly in the past. The dependent variable consists of a dummy variable which indicates whether the respondent either is or has been an IDG user. The data showed that approximately 5% of the researchers had initially started to make use of an IDG, but had later left it. Since the leaving of an IDG is at least to some extent dependent on its quality and on the individual time restrictions of the researcher, it is more natural to test the hypotheses in this way. The hypotheses predict that some aspects of a research field influence the researcher's decision to start using IDGs. If in some fields more researchers start using IDGs then it is also possible that in these fields more researchers decide to stop using IDGs. The test of the hypotheses, however, should not confuse these two effects.[6]

To test the hypotheses adequately only a subgroup of the original sample need be used. According to the hypotheses the specified conditions should have an impact on the researcher's decision whether to make use of IDGs or not. As a consequence, the predictions are valid only for those researchers who have an email connection and have heard of the existence of IDGs so that they can decide whether to use them. This led to the exclusion of n_1=281 respondents. Additionally, the respondents must have a considerable amount of research experience to be

[5] Whereas the first association between the cognitive indicator and the use of IDGs can be interpreted only in one direction (good general software knowledge facilitates IDG use), the second association might also be interpreted as bi-directional. I decided that this disadvantage had to be tolerated in the empirical tests due to two reasons. 1. It ensures a stricter test of the other three mechanisms which are more directly related to properties of the research field and therefore of most interest. 2. It concerns only one of two indicators and no better alternative measure was available. Finally, as the most important point, the results with regard to the validity of the compatibility argument are unequivocal (see section 4). Therefore, this disadvantage does not restrict the interpretation of the results.

[6] At first glance, it appears somewhat awkward to test whether the current use of other CMC tools and current software knowledge have an effect on the present and past use of IDGs. Subsequently, this "compatibility hypothesis" is additionally tested by looking only at the effects on current IDG use.

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able to judge the concentration of journals in their field. This study fulfills this necessity by including only those researchers who had at least one publication in their research field and who were involved in an ongoing project in it. This leaves a sample size of n_2=533. Moreover, 77 of these respondents had to be removed because they filled in a shortened questionnaire version that did not include all relevant items. This excluded subgroup (n=77) does not differ from the used sample of 456 respondents with regard to the use of IDGs (p=0.23). For the multivariate tests of the hypotheses in section 4, an additional 37 respondents were excluded because of missing values in single control variables, leaving a sample size of n=409 for these empirical tests. The reported significance levels are based on one-tailed tests.

3.2. Disciplinary Differences: Descriptive Findings

Table 1A shows the proportion of researchers in the whole sample who had ever used an IDG, categorized by discipline.

Table 1: Proportion of past or present IDG users in the 8 disciplines (3 samples)

	A: complete sample^{+}	**B: N=782**$^{++}$	**C: N=409**$^{+++}$
1 History	25.7% N=140	38.9% N = 90	37.2% N =43
2 Management Science	37.8% N=119	45.4% N = 97	55.6% N =45
3 Sociology	37.7% N=138	46.8% N = 109	52.6% N =57
4 Economics	31.4% N=140	38.9% N = 113	44.9% N =49
5 Mechanical Engineering	29.1% N=79	43.4% N= 53	46.2% N =26
6 Mathematics	36.2% N=127	44.9% N = 98	33.9% N =56
7 Chemistry	16.7% N=156	23.5% N = 102	25.0% N =60
8 Physics	15.4% N=149	20.0% N = 110	12.3% N =73
Total	28.2% N=1048	37.2% N = 772	36.2% N =409

+: all respondents, N=number of respondents with non-missing values, 15 respondents with missing values

++: only researchers with email connection and knowledge about the existence of IDGs, N=number of respondents with non-missing values; 10 respondents with missing values

+++: only active researchers with at least one publication, with email connection and knowledge about the existence of IDGs, N=number of respondents with non-missing values

Mathematics, sociology, and management science are the disciplines with the largest proportions of past or present IDG users. Historians, economists, and mechanical engineers are somewhere in the middle with regard to the prevalence of IDG use, whereas physicists and chemists used them rather infrequently. The use of IDGs does not differ between English or Dutch researchers (t=0.84, p=0.40), nor between men and women (t=0.03, p=0.97). Therefore these groups are merged in the multivariate analyses. IDG use does not depend on one's formal position in the university hierarchy (χ^2=2.53, df=4, p=0.67) nor on one's prominence (χ^2=9.23, df=6, p=0.16). The differences in IDG use are partly due to disciplinary differences in the distribution of email connections and information about the existence of IDGs, as Table 1 in Column B shows. It shows the proportion of IDG users by discipline for those researchers who have an email connection and have heard about the possibility of using IDGs. The ordinal ranking of the disciplines according to the prevalence of IDG use does not differ from the ranking of the whole sample, although both variables obviously have a significant effect on the use of IDGs (both p<0.01). Finally, Table 1 shows in Column C the proportion by discipline of IDG users in the sample that is adequate for testing the hypotheses (n=409). This is the subgroup of researchers who had at least one publication, who were actively carrying out research in their field at the time of the data collection, neglecting those respondents who had missing values.

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Although the disciplinary differences in this group are not the same as in the two larger groups shown in Column A and Column B of Table 1, the most remarkable differences did not change. Researchers in physics and chemistry make use of IDGs rather infrequently, whereas among researchers in sociology and management science IDG use is most prevalent. These disparities in IDG use between the 8 disciplines, as shown in Column C Table 1, are the phenomena that the 5 hypotheses claim to explain. Differences in these aspects of the communication system, that is disciplinary differences in the independent variables, are shown in the following table.

Table 2: Disciplinary Differences in the four independent variables (arithmetic means)

Discipline	Inter-dependency	dispersion of communication channels	degree of commerciali-zation	use of CMC tools	Knowledge about computer software	N
1 History	-.33	.25	.42	-.20	.07	43
2 Management Science	-.05	.43	2.27	.29	.42	45
3 Sociology	-.11	.03	1.28	.19	.49	57
4 Economics	.38	.38	1.27	.45	.82	49
5 Mechanical Engineering	.19	-.64	3.69	.11	.85	26
6 Mathematics	.36	.00	1.39	.18	.71	56
7 Chemistry	.00	-.04	3.11	-.19	.55	60
8 Physics	.45	-.47	2.14	.59	.85	73
Total	.13	-.01	1.89	.20	.60	409

The numbers in Table 2 confirm by and large what is known from other studies of the scholarly communication system. Thereby, they strengthen the trust in the validity of the used measures. The work of researchers in physics is the most interdependent and the work of historians the least. The concentration of communication channels is greatest in mechanical engineering and physics, whereas researchers in management science, economics and history face more dispersed communication channels. The commercial consequences of the research findings are regarded as largest within mechanical engineering, chemistry and management science and as smallest within history. The use of CMC tools is most prevalent in physics and economics and least prevalent in history and chemistry. Knowledge about computer software is most positively self-evaluated within physics, mechanical engineering, economics and mathematics. Historians evaluated their knowledge the least positively. The univariate distributions of these variables do not yet allow any conclusion about the validity of the hypotheses. In the following section multiple logistic regression analyses are used to distinguish between the different simultaneous effects.

4. The results

The first analysis of Table 3 shows the bivariate associations between IDG use on the one hand and the independent variables on the other hand. In this analysis only the degree of interdependence, commercialization, and dispersion of the communication channels have a statistically significant bivariate association ($p<0.05$) with the use of IDGs. Next, Table 3 examines to what extent the probability of IDG use is *simultaneously* dependent on the five variables that are specified by the five hypotheses to be tested. It shows the results of a multiple logistic regression analysis.

The results of this first multivariate test reveal the following. The past or present use of IDGs neither depends on the use of other CMC tools nor on knowledge about software. As a consequence, hypothesis 4 about communication needs does not find support. The degree of interdependence shows a statistically significant effect ($p<0.05$) when controlled for the effects of the other independent variables. The effect, however, is negative. That is, the more the researcher regards his activities in his research field as interdependent with the activities of other researchers, the less often he makes use of IDGs. This is contrary to hypothesis 3, which is rejected.

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Table 3: bivariate correlation (Pearson's r) between IDG use and the five independent variables and multiple logistic regression of IDG use (n=409)

Variable	r (bivariate)	B (multivariate)+	S.E.
Commercialization	-.10*	-.10*	.06
Interdependence	-.12**	-.34**	.14
Dispersion of communication channels	.16***	.37***	.12
CMC use	.07	.16	.12
Software knowledge	.06	.10	.08

*: p< 0.05 level (1-tailed). **: p< 0.01 level (1-tailed). ***: p<0.001 (1-tailed), +: Model-χ^2=22.911, df=5, p=.0004, n=409, Nagelkerke's R^2=0.075, constant not shown

Finally, degree of commercial relevance of the research findings and the dispersion of the communication channels show a statistically significant effect (p<0.05 resp. p<0.01). The more dispersed (or less concentrated) the communication channels of a field are, the more researchers make use of IDGs. This is in accordance with hypothesis 5 about communication needs and contradicts hypothesis 1 about problems of trust. Moreover, the higher the degree of commercial relevance, the less likely is IDG use. This is in accordance with hypothesis 2.

As a result of the first multivariate test, only hypotheses 5 and 2 find preliminary support, while hypothesis 1 and hypothesis 3 are contradicted. The evidence relating to hypothesis 4 is non-significant. Hypothesis 4 cannot explain the disciplinary differences in the use of IDGs. To find out whether the effects of the dispersion of communication channels and of commercialization are due to the mechanism specified by hypothesis 5 about differential communication needs and hypothesis 2 about problems of trust, the analyses include a number of additional control variables as mentioned in section 2.2. First, in Model 1 of Table 4 a number of individual control variables in included. Second, in Model 2, two network variables are added as controls. Two kinds of networks can be important for a researcher. Both, the researcher's colleagues in the university department [21], and his/her other national or international communication partners with whom (s)he regularly exchanges new information have an impact on his/her information behavior [25]. Consequently, the following analysis checks whether the hypothesized effect of the dispersion of communication channels goes beyond such network effects.[7] Third, in Model 3, other unknown differences between the disciplines might be important for differences in the prevalence of IDG use. Because hypothesis 5 supposes a direct effect of the dispersion of communication channels, this effect should continue to stimulate the use of IDGs when it is controlled for other unknown differences between the disciplines.

In Model 1 only one of the control variables shows a significant effect on the use of IDGs. Researchers who are more concerned about being anticipated use IDGs less often (p< 0.05). More importantly, researchers with a lower degree of interdependence and those who are involved in a field with more dispersed communication channels use IDGs more often. These two effects are not due to influences of the other control variables; rather, they keep their significance (both p<0.01). The effect of commercialization, however, loses its significance. This can be explained as follows. A higher degree of commercialization comes along with a slightly larger concern for being anticipated in one's research findings (r=.19) which, in turn, reduces the likelihood of IDG use. When we control for the concern about being anticipated, the degree of commercialization does no longer show an independent effect. That is, hypothesis 2 does no longer find support. The only hypothesis that finds evidence when we control for other factors of influence, is hypothesis 5 about differential communication needs.

7 Since the proportion of colleagues who are IDG users might also be dependent on properties of the research field, for example the dispersion/concentration of communication channels, this is a strong test of the original hypothesis 5.

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Table 4: multiple logistic regression of IDG use with control variables relevant for the researcher's information behavior (n=409)

Variable	Model 1		Model 2		Model 3	
	B	S.E.	B	S.E.	B	S.E.
Commercialization	-.09	.06	-.03	0.07	-.06	.08
Interdependence	-.38**	.15	-.52***	0.16	-.44**	.17
Dispersion of communication channels	.34**	.13	.36**	0.14	.30*	.15
CMC use	.12	.13	.07	0.14	.08	.15
Software knowledge	.03	.10	.04	0.11	.07	.11
Control variables						
PC attitude	.24	.15	.23	0.16	.21	.16
Conferences	.06	.05	.07	0.05	.08	.05
Competition	-.20*	.12	-.19	0.13	-.10	.14
Papers	.02	.04	.02	0.04	.03	.04
Department Rank+	-.27	.24	-.28	0.27	-.37	.28
Network control variables						
Number of departmental colleagues using IDGs			.17***	.05	.16***	.05
Proportion of IDG users among one's external communication partners			2.45***	.50	2.26***	.51
Other disciplinary heterogeneities++						
Management Science					1.82***	.57
Chemistry					.96	.59
Economics					1.63**	.56
History					1.01	.62
Mathematics					1.07*	.57
Mechanical Engineering					2.24**	.65
Sociology					1.85**	.55
Adequacy of complete model	Model 1: χ^2= 32.415 df=10, p=.0003 Nagelkerke R^2=0.104		Model2 : χ^2= 101.284 df=12, p=.0000 Nagelkerke R^2=0.301		Model 3: χ^2= 125.872 df=19, p=.0000 Nagelkerke R^2=0.363	

n=409, , , constant not shown, *: p< 0.05 level (1-tailed), **: p< 0.01 level (1-tailed). ***: p<0.001 (1-tailed), +: department rank is a property of the whole department, not the individual respondent; its standard error is underestimated in this analysis; conclusions, however, are not influenced by this (see e.g., Goldstein [32]), ++: +:Physics as the baseline category

Model 2 of Table 4 shows the results when the number of colleagues within the respondent's department who use IDGs, as well as the proportion of IDG users among the respondent's five most important discussion partners outside the department, are introduced as additional control variables.[8] It shows three results that are most notable. Firstly, the effects of the dispersion of communication channels and of the interdependence are still significant (p<0.05). The more dispersed the communication channels or the lower the degree of interdependence, the more likely that the researcher starts using IDGs. The effects are independent of those that any of the other control variables have. These findings support the claim of hypothesis 5. At the same time, the negative association between the degree of interdependence and the use of IDGs remains unexpected.[9] Secondly, the social influence mechanisms play an important role. The effects of the proportion of external and the number of departmental colleagues who use IDGs are statistically significant (at p<0.001). For instance, the higher the

[8] The straightforward inclusion of both network variables might lead to violations of some assumptions of the statistical model. Matzat [33] makes use of a more elaborated way of controlling for other factors of influence by applying multilevel techniques. However, since the conclusions do not change, I only present the easier to understand method of analysis here.

[9] The negative association does not disappear when the group of researchers who work most interdependently and most frequently use pre-print servers, namely physicists, is removed from the sample.

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proportion of IDG users among one's communication partners, the higher the probability of one's own IDG use. This might be an effect of social influences via networks [20, 26] or it might be that researchers' IDG use is stimulated by a 'critical mass' of large enough numbers of colleagues who use it [27]. Whatever the causal direction and the exact mechanism, to some extent the use of IDGs is mediated through the researcher's social networks. As a third point, the effects of the other theoretically interesting variables, namely CMC use, software knowledge, and commercialization are not significant. Moreover, none of the other control variables including the concern for being anticipated has a significant effect.

To assess whether the found effects might be due to unobserved disciplinary heterogeneities the analysis additionally includes dummy-variables for the disciplines, as shown in Model 3. Two results are most important. Firstly, the results with respect to the variables included in Model 2 hardly change. Secondly, the explanatory and control variables leave a large amount of disciplinary differences in the prevalence of IDG use unexplained. Five of the seven dummy variables that indicate the difference in the prevalence of IDG use, compared to IDG use in physics, are still significant. Researchers in management science, economics, mechanical engineering, mathematics, and sociology use IDGs more often than researchers in physics, even when disciplinary differences with regard to the concentration of communication channels, to the degree of interdependence and to social network influences in addition to other individual differences are controlled.

The evidence for the hypothesis about differential communication needs supports the idea that an incentive for the use of IDGs is the hope of receiving information that facilitates obtaining an overview of research areas that are otherwise difficult to oversee. However, the hypothesis and the data leave open the question of whether such information is really given to the researchers in a satisfactory manner. Rather, it underlines the communication deficiencies that exist in some research areas.

It would be interesting to find out whether the hypothesis can not only explain whether researchers ever started to use an IDG, as the analyses of Table 4 showed, but also whether they continue to use them. Table 5 shows the results of a multiple logistic regression on the probability of being a *current* IDG user. Current IDG users are a sub-group of those who ever started to use an IDG.

Two results are most notable. Firstly, the dispersion of communication channels does not have a statistically significant effect ($p>0.10$) on the probability of being a current IDG user when controlled for a number of other influencing factors. Secondly, the degree of interdependence is negatively associated with being a current IDG user ($p<0.01$).

The results presented in tables 3-5 make the following clear. The predictions with regard to the effects of commercial relevance, interdependence, and the compatibility between working routines and CMC use are not supported by the data. That is, hypothesis 2 on problems of trust and hypotheses 3 and 4 about differential communication needs are not supported. Moreover, it is not true that researchers in fields with a larger dispersion of communication channels tend to avoid using IDGs. As a consequence, hypothesis 1 on problems of trust does not find support either.

However, researchers in fields with a low degree of visibility, that is a high dispersion of communication channels (journals), have incentives to start using an IDG because they hope to obtain orienting information, as predicted by hypothesis 5. The positive association between the dispersion of communication channels and initial IDG use remains significant in all uni- and multivariate analyses, which strongly supports hypothesis 5 about differential communication needs.

At the same time, these researchers do not necessarily continue with their use of IDGs. It may either be the case that the information benefits are not large enough or that the costs of use are too high for some of the researchers who were initially motivated to start using IDGs. This interpretation is in accordance with other findings that show that the most prevalent benefits of IDGs are contact benefits, although some information benefits also are received [11]. Moreover, the data reveal a negative association between the degree of interdependence and IDG use, contrary to what is expected in the literature. For this unexpected finding I offer the

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following potential explanation.[10] IDGs often include many members and it is likely that in academic IDGs researchers communicate with a large number of people to whom they are only weakly related. Even researchers whose work is highly interdependent may experience the interdependence only with a limited number of other researchers so that IDGs might not offer much of the coordination benefits that hypothesis 3 supposes. Furthermore, a higher degree of interdependence tends to increase coordination difficulties [28]. Also, it tends to come along with a larger number of group meetings [29], resulting in more work interruptions and a higher burden of communication and coordination efforts. It might be that under such conditions any additional informal email communication via IDGs is too much. The findings of Talja, Savolainen, and Maula [30] suggest that researchers can experience communication in emailing lists in some phases of their research as disturbing. Future research has to test this potential explanation in detail.

Table 5: multiple logistic regression of being a current IDG user (n=409)

Variable	B	S.E.
Commercialization	-.04	.09
Interdependence	-.52**	.19
Dispersion of communication channels	.17	.16
CMC use	.20	.17
Software knowledge	.01	.12
Control variables		
PC attitude	.23	.18
Department Rank	-.25	.30
Conferences	.08	.06
Competition	.01	.15
Papers	-.01	.05
Network control variables		
Proportion of IDG users among one's external communication partners	2.49***	.51
Number of departmental colleagues using IDGs	.19***	.05
Other disciplinary heterogeneities[+]		
Management Science	2.97***	.80
Chemistry	1.77*	.84
Economics	2.92***	.81
History	2.11**	.84
Mathematics	1.92**	.81
Mechanical Engineering	2.80***	.87
Sociology	2.81***	.79

Model-χ^2=144.096, df=19, p=.0000, n=409, , Nagelkerke's R^2=0.42, Constant not shown, +:Physics as the baseline category

*: p< 0.05 level (1-tailed). **: p< 0.01 level (1-tailed). ***: p<0.001 (1-tailed)

10 Fry & Talja [8] suggest that researchers in fields with low interdependency would use IDGs to overcome their intellectual and social isolation. This is not completely supported by the data. The presented tables show that Fry & Talja [8] are right in claiming that lower interdependence comes along with a higher likelihood of using IDGs. However, this cannot be explained by higher isolation. Additional analyses of the data show that less interdependent researchers are less integrated (r=0.15, p<0.01), but it is not true that less integrated researchers use IDGs more often (B=+0.07, p>0.4 in a bivariate logistic regression). Moreover, adding indicators of integration to Model 3 of Table 4 does not remove the significance of the negative effect of interdependency (tables available on request from the author).

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5. Summary and conclusions

This paper tests empirically the often-stated claim that the successful use of a new information and communication technology (ICT) is dependent on the social context of its use. Different hypotheses argue that the use of specific ICTs by researchers is dependent on aspects of the social organization of the communication systems within disciplines. As a consequence, such hypotheses might be able to explain disciplinary differences in the use of Internet Discussion Groups (IDGs), if they are broadened appropriately.

The hypotheses, when expanded to include the realm of IDGs, can be contrasted according to the mechanisms that they specify by which disciplinary differences in the communication systems affect the decision of a researcher whether to make use of IDGs. On the one hand, some hypotheses developed here argue that trust problems inhibit the use of IDGs by researchers. The degree of trust problems, in turn, depends on different conditions within the scholarly communication system [10]. On the other hand, it is argued that disciplinary differences in the communication systems lead to different communication needs. The existence of specific communication needs, in turn, gives incentives to start using IDGs (see [9] for email use; [13] for IDG use).

Data on the use of Internet Discussion Groups (IDGs) by English and Dutch university researchers show that more researchers in the social sciences and humanities, on average, make use of IDGs than researchers in the natural sciences. The proportion of IDG users is lowest among researchers in physics and chemistry. It is highest among researchers in management science and sociology.

The testing of the hypotheses using multivariate data analyses yielded five notable results. Firstly, the examined hypotheses about problems of trust claiming that higher commercial relevance of research findings and less visibility of research would inhibit the use of IDGs did not find support in the data. Secondly, one of the tested hypotheses about diferential communication needs found support. Researchers who work in fields where research projects have a low visibility, i.e., researchers in fields with a high dispersion of communication channels (journals), have a higher likelihood of starting to use IDGs. The underlying argument is that they have a special incentive to start using IDGs because they hope to obtain some orienting information through the use of IDGs. This effect found strong support in all analyses. Thirdly, the degree of interdependency is negatively associated with the initial use of IDGs. Since a positive association was expected in the literature, the stability and relative strength of this unexpected effect is remarkable. Fourth, a large number of disciplinary differences in the prevalence of IDG use are still unexplained. After controlling for differences in the theoretically interesting variables, many of the disciplinary differences were still statistically significant. Fifth, although researchers who work in research fields with a low degree of visibility have special incentives to start using IDGs, this does not mean that they have a higher likelihood of continuing to use IDGs. The hypothesis about differential communication needs can explain why researchers start using IDGs. This, however, does not imply that they continue to use them.

Where do these results leave us with respect to the claim that the use of ICTs in the scholarly communication system is dependent on the social context of its use? How should we evaluate the idea that trust problems or differential communication needs have an impact on disciplinary differences in the use of ICTs? For the case of Internet Discussion Groups, the results make clear that the impact of the social context is, at best, only partly understood. More theory is needed about how disciplinary differences in the communication systems may have an impact on the use of IDGs.[11]

Moreover, the data demonstrate that a *general* claim that trust problems inhibit the use of all kinds of information and communication technologies would not be supported. It may be true that the use of *other* ICTs is more inhibited by trust problems. Future empirical research on other ICTs is needed to show whether this is the case.

Independently of the relevance of trust problems, the results underline the importance of another idea about *how* the social organization of a disciplinary communication system affects the use of ICTs. The *dispersion of communication channels (journals) in a research field gives incentives to make use of IDGs.* The underlying

[11] For instance, Talja [34] suggests that some researchers in the humanities avoid IDGs because they work in projects so unique that there is nobody to share information with.

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argument is that researchers hope to gain orienting information about the field that would otherwise be difficult to obtain. A low degree of visibility in research fields thus creates a special communication need. Other research supports the idea that IDGs provide some orienting information benefits to researchers in the social sciences who tend to conduct research in fields with low visibility. Such benefits include information about important conferences and the names of the most important researchers in the field (see [11]).

Additionally, the paper shows that it is important to make a *distinction between different kinds of ICTs*. Physicists, especially within high energy, theoretical, or solid state physics, may be among the most frequent users of pre-print servers. At the same time, they are among the least frequent users of Internet Discussion Groups.

If we believe that trust problems are of importance for understanding disciplinary differences in the use of ICTs, then the question emerges as to how the findings of this paper can be brought in accordance with the idea that trust problems do matter. It might be a good strategy for future research to realize that *different ICTs have different potentials for trust problems*. The usual information transfer in Internet Discussion Groups is characterized by answers and questions that may be helpful. The large majority of information items have no secrecy value. Accordingly, Internet Discussion Groups have a low trust problem potential. Pre-print servers are tools for the exchange of written information that is new and that has a preliminary, informal status. Since the information transfer conducted by this tool is based on items consisting of new papers (not emails about topics already known to the academic community), the trust problem potential of pre-print servers should be higher than for Internet Discussion Groups. Moreover, electronic journals, used as a tool for information transfer and communication in the research community, should have a higher trust problem potential than pre-print servers. The information transfer of this tool is based on official publications that have a formal status. Their value depends directly on the trustworthiness of the editorial committee and the reviewers. The higher the trust problem potential of an ICT, the stronger might be the inhibiting effects of those conditions that strengthen the trust problem (see section 2). Future research is needed to show whether it is useful to make a distinction between different trust problem potentials of ICTs in order to integrate research findings on the use of different kinds of ICTs.

A limitation of this study is that data collection took place in 1999. However, at this time IDGs in its current form were already established so that there is no reason to believe that researchers' attitudes towards them changed much. Nevertheless it would be useful to replicate the findings with newer data. Additionally, future research is required to find out whether the negative association between interdependence and use of IDGs can be replicated. It should be tested whether the proposed explanation of this finding as an effect of a high burden of coordination efforts that increase the disturbing consequences of additional email communication via IDGs is valid.

As a final point, the findings, should they be confirmed by further research, have implications for our understanding of the nature of information search in the different disciplines, science policy, and technology development in the research system. The data confirms the well-known insight [31] that the visibility of research in the social sciences and humanities is, on average, lower than in the hard sciences. As a new insight, the analyses reveal how the search for information depends on the degree of visibility. The persistence of differential visibility and its relationship with the academics' digital information search suggest that researchers in the humanities and social sciences have their reasons to prefer specific forms of information sharing and that convergence between disciplines is "not just a matter of time" [10]. Science policy could devote more attention and resources to the development of technologies that are especially adjusted to the difficulties in the communication system of the humanities and social sciences. The system would profit from technology that incorporates social forms of information sharing. The findings also have implications for general ICT development. ICTs that fulfill the researchers' special communication need of orientation in the humanities and social science could lessen important deficiencies of the scholarly communication system. Orienting functions, however, need not be restricted to Internet Discussion Groups. Professional scholarly web-sites and multifunctional research portals that are designed with an eye on a specific group of researchers as a target group can also include such functions. By doing so, designers take into account that their products have to fit in with the social environment of their users. This insight might not only make the conduct of research as a common undertaking more pleasant, but may also improve the efficiency of the scholarly communication system.

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Appendix

Appendix A: The Sampling Design

Within every randomly selected university the following departments belonging to one of the eight disciplines were deliberately selected. Within economics the departments that include micro- or macro-economics were selected, within management science those for Human Relation Studies/ Organizational Behavior were chosen. The chosen departments within chemistry are related to organic or inorganic chemistry. Physics departments

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include research within theoretical or solid state physics. The mechanical engineering departments cover research on topics like material science, production or design management or mechanics. Within sociology, mathematics and history no selection was made. Selection of the departments was done in such a way that the chosen research areas are represented by a large number of university departments. Within a selected department a random sample of university researchers, including Ph.D. students and postdoctoral researchers, was taken – with one exception. A small number of departments had a very high proportion of Ph.D. students. In such departments I sampled researchers with a permanent position disproportionately often to ensure that the sample included a large enough number of them. I detected only one minor bias mentioned below in the sample. The immediacy of response is not related to whether the respondent has an email connection, whether he makes use of IDGs, or how intensively he makes use of email. I interpret this as a hint that the use of email and IDGs is something 'ordinary' for those who use email/IDGs and hence does not give extra motivation for survey participation. As a consequence, there is no indication of a bias in the response rate in favor of IDG users. The response rate does not differ between Dutch and English respondents ($p>0.9$). It does not differ between respondents of different disciplines, with the single exception of mechanical engineers who answered significantly less often. Just 30.4% of them returned a completed questionnaire ($Chi\text{-}Square=15.1, df=7, p<0.05$ for all 8 disciplines and $Chi\text{-}Square=5.2, df=6, p>0.45$ for the remaining 7 disciplines). Filling in the questions took 45-60 minutes.

Appendix B: The measurement of the control variables:

Conference participation: "How often did you attend conferences and official scientific meetings during the last 12 months?", Written research output (papers): "*How many research papers did you write (published and unpublished papers including those articles already mentioned) during the last 12 months*?", Prominence: "*How well known is your work within your most important field of research?*" (seven point Likert scale), Competition: *"Researchers are sometimes anticipated by others in the presentation of research findings. That is, after they have started to work on a problem, another researcher publishes its solution. ... How concerned are you that you might be anticipated in your current research?"* The respondent could choose between 5 answer categories. PC attitudes: The first factor measuring "computer liking" of the Computer Anxiety Scale (CAS) developed by Loyd and Gressard [35] was used, since this measure has proven to be useful in different samples (see Bandalos & Benson [36] for the details). The factor analysis resulted in one factor with an eigenvalue larger than one which can explain 44.5% of the variance of the seven used items (KMO measure of sampling adequacy=.81), Department ranking: Every respondent was ranked within his discipline according to the number of manuscripts reviewed for a journal during the previous 12 months, the number of conferences visited, the number of research papers written, and his prominence. These four discipline-specific ranking variables were combined in a factor analysis leading to one factor score for every respondent. For every department the arithmetic mean of the factor scores of its researchers was taken. Network variables: Number of IDG users among the respondent's department: *"From how many researchers in your university department do you know that they use such Internet Discussion Groups?"*, Proportion of IDG users among the 5 most important discussion partners: *"If you discuss any parts of your research sometimes with national or international colleagues outside of your own department, please write down the number of such colleagues who strongly influence your own research through these questions." ... "Do some of these colleagues use Internet Discussion Groups? Think about at most 5 external colleagues who are most influential on your research through these discussions."*

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