

Quality of information in academic emailing lists^{*}

Uwe Matzat
Sociology Section
School of Innovation Science
Eindhoven University of Technology
P.O. Box 513, 5600 MB Eindhoven
The Netherlands

^{*} Correspondence address: Uwe Matzat (u.matzat@tue.nl, phone: +31402478392), Sociology Section, School of Innovation Science, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands.

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abstract

The paper analyzes how researchers evaluate the quality of information in internet emailing lists and whether the embeddedness of academic emailing lists in offline networks of a scientific community is related to it. The idea is that embeddedness gives researchers more opportunities to build up a reputation through contributing high quality information to the group. Survey and archive data are used to test hypotheses about the effects of offline networks in 47 academic emailing lists used by a random sample of university researchers. Results indicate that the information in embedded online groups is regarded as more valuable than in purely virtual groups.

key words: information quality, social networks, embeddedness, online community, disciplines, user satisfaction.

Introduction

The exchange of knowledge on the internet is regarded as important for business and research (Cothrel & Williams 1999; Verburg & De Ridder 2003; Wenger & Snyder 2000). In the academic system researchers often use so-called emailing lists for that purpose. Case studies report of researchers who regard their use as helpful (e.g., Harasim & Winkelmanns 1990; Rojo & Ragsdale 1997a; Rojo & Ragsdale 1997b; Tombaugh 1984) and large scale empirical research also points to some benefits (Cohen 1996; Matzat 2004a). Nevertheless some researchers have serious doubts about the use of such online groups for academic communication. They feel that the contributions of many users are of low value to them (e.g. Conner 1992; McCarty 1992). Sometimes prestigious researchers hesitate to use them (Lewenstein 1995), and their lack of contributions could weaken the quality of discussion. In addition, the use and maintenance of academic online groups costs resources. Conner (1992) mentions that he spends on average approximately 10 hours per week on the active moderation of a group within the humanities. Other listowners or moderators also are concerned about the time requirements (Berge & Collins 1993). Moreover, active mailing lists aggravate the problem of information overload for every user (McCarty 1992; Whittaker & Sidner 1997). Empirical research suggests that there might be differences between lists in their usefulness for the researcher to get material and up-to-date information (Rojo & Ragsdale 1997a). It is therefore of interest to find out how researchers assess the value of the information in academic emailing lists and what conditions influence its quality.

Research about communication on the internet often claims that relations offline would affect relations online (Garton, Haythornwaite & Wellman 1997). However, it is not clear how this happens, if at all. In online groups that are used by university researchers it can happen that some researchers interact with each other offline. They may regularly meet at conferences or work together in committees. In such cases the informal network in the offline world may be quite dense between some groups of researchers. The online group is then said

to have a high degree of embeddedness in offline social networks. Earlier research has revealed a complex interrelationship between social networks and cognitive developments in research areas (e.g., Lievrouw et al. 1987; Perry & Rice 1998). For emailing lists, findings indicate that a high degree of embeddedness stimulates the researchers' posting behavior resulting in more messages sent to the list (Matzat 2004b; 2009). However, it is not known whether and how this affects the content of the discussion contributions (messages). This paper contributes to answering the questions

- how researchers evaluate the quality of the information in academic emailing lists,
- whether there are *group differences* in the perceived quality of discussion contributions, and
- what group conditions might influence such differences.

The term 'group conditions' refers to characteristics of the emailing list in contrast to characteristics of its individual members. Knowledge about determinants of the information quality is one important input to the design and management of academic online communities. Related topics in this research area that also provide important inputs but are left out here include the analysis of the (passive) adoption of emailing lists within the academic system (e.g., Kling & McKim 2000; Markus 1987; Matzat forthcoming; Talja et al. 2007; Walsh & Bayma 1996; Walsh et al. 2000) and the quantitative stimulation of (active) contributing behavior to online communities (e.g., Cress, Kimmerle, & Hesse 2006; Matzat 2009; McLure Wasko & Faraj 2000; Rafaeli & LaRose 1993; Thorn & Connolly 1987).

The concept of 'information' is used here as describing environmental stimuli for the researcher (see Case 2007; Ruben 1992), namely the discussion contributions or messages sent to the emailing list. 'Quality' of information is related to the researchers' perceived usefulness of the messages (Rieh 2002) and explicated in more detail later.

The next section provides the theoretical background, resulting in a number of hypotheses about the users' satisfaction with the quality of information in academic emailing lists. The claim is that some emailing lists are embedded in a well-integrated academic

community, leading to dense informal networks between the researchers. In such emailing lists members can develop a reputation by contributing high quality messages to the online discussion so that members in general tend to be more satisfied with the quality of the emailing list. The design of the study and its main measurements are introduced. The study makes use of a large random sample of researchers in academic emailing lists used by a random sample of researchers in eight different disciplines. The findings are presented, followed by a summary and conclusions that are drawn for the setting up and maintenance of academic knowledge sharing communities on the internet.

Earlier research

Different types of emailing lists: Embedded versus purely virtual communities

The exchange of knowledge in academic communities of the internet became popular during the 1990s through the use of emailing lists (Harrison & Stephen 1996) although already in the 1970s forms of group exchange were used on the internet (Hiltz & Turoff 1978; Hiltz 1984). Research on these 'computer-conferencing systems' indicated that their continued use was feasible and led to stable communication structures (Rice 1982). In the meantime emailing lists are used more often than newsgroups and more researchers in the social sciences and humanities than in the natural and engineering sciences make use of emailing lists (Fry & Talja 2007; Matzat 2004a). There is evidence showing that –when aggregated over *all* emailing lists that researchers use- active emailing lists provide some useful information and, most of all, that they tend to bring researchers in touch with each other and expand their networks (Matzat 2004a) despite of all the contextual factors that affect collaboration (Traore & Landry 1997). However, even if there are overall benefits, they may be bought with a price of a high noise-to-information ratio. It is not known, how the *general quality* of the information in the '*average*' emailing list is regarded by researchers. Since the use and maintenance of emailing lists costs resources (Berge & Collins 1993; Conner 1992)

the benefits may be too small for the high price so that alternative ways of exchanging knowledge might be more useful. Moreover, it is unknown whether there are *differences between emailing lists* with respect to their usefulness for the researcher and on what conditions such differences could depend. We only know that for an academic emailing list it is crucial having enough active contributors generating a high enough volume of list communication (Matzat 2004a). Apart from that, existing research provides only limited evidence for qualitative differences in content between academic emailing lists (see Rojo & Ragsdale 1997a) and gives no guidance with respect to what conditions might affect them.

In the field of internet research it is realized that online interaction is related to offline interaction (e.g., Wellman 2001). This is sometimes called the embeddedness of online interaction in social networks of the offline world. The degree of embeddedness of an online group is the higher, the higher the density of the members' social network outside the group (Matzat 2009). For different types of knowledge sharing groups a high degree of embeddedness can mean different things. In *academic groups* a high degree of embeddedness is given when a well-integrated scientific community is part of the online group. In such an emailing list many researchers meet at common conferences and are involved in the same editorial, administrative, or other academic activities. Empirical research on scholarly networks indicates that email communication between researchers is associated with other forms of communication including offline communication (Haythornthwaite & Wellman 1998; Koku, Nazer & Wellman 2001). Already the early use of computer-conferencing systems by researchers was characterized by a mixture of online interaction and offline meetings at conferences (Freeman 1984; Freeman & Freeman 1980). In a large scale study of academic emailing lists, it was found that they differed remarkable with regard to their social embeddedness. In some emailing lists members had a high frequency of interaction outside of the emailing list (Matzat 2009). In these highly embedded lists every member is confronted with an offline network of relations among (other) researchers with some density. This dense

network is a 'social fact' independent of the member's personal relationships that he has or does not have and it is independent of his personal identifiability. However, as indicated below, some desirable consequences of a high embeddedness require the identifiability of particular researchers.

Earlier research

The consequences of a high embeddedness

We know little about what happens with the online interaction if it takes place under a high degree of embeddedness. According to social network analysts this should affect relations online (Garton, Haythornwaite & Wellman 1997). Unfortunately, it is not often made clear *how* this happens. In the general literature on knowledge sharing groups the relevance of (offline) relationships between members and of face-to-face communication is often discussed. For example, Wenger (1998), and Brown and Duguid (1991) stress the importance of the relationships between the members of online communities of practice. However, they do not come up with ideas how characteristics of the *whole network* might affect online interaction. Other researchers speculate about whether face-to-face meetings between members might be necessary (e.g. Johnson 2001). In a similar vein, some researchers argue that the greatest potential of online communities of practice would consist of the opportunities that they would offer as a *supplement* to already existing local offline communities. Schlager and Fusco (2003) as well as Kling and Courtright (2003) propose to focus efforts on helping and supporting pre-existing local communities of practice for teachers. Barab et al. (2003) describe face-to-face interaction as an *essential* supplement to online interaction. I do agree with these authors that communities of practice have a very large potential for the support of pre-existing local communities. However, the authors do not invest much time in thinking about what effects face-to-face (or more general: offline) interaction has on the online interaction. Therefore they tend to overlook that offline

interaction of *some* members may change the situational constraints not only for those members who know each other already, but also for the *whole group*. Understood in this sense, the perspective that is presented here implies that face-to-face (or: offline) interaction is *not* an essential pre-condition for a member to change his behavior. It is 'enough' when some other members interact offline.

There is much research done on problems of group interaction *outside of the internet*. A remarkable finding in the results of experimental studies on problems of collaboration and cooperation is that consistently an effect of the communication between interaction partners was found (see Sally 1995). Individuals who verbally communicated with each other before they were faced with a problem of cooperation have significantly higher rates of cooperation than individuals who did not verbally communicate with each other. In the literature different mechanisms for this effect are mentioned. Face-to-face communication might increase the group identity, it might trigger cooperative norms of social conduct, and it might reduce the social distance between the communicating individuals (Riegelsberger, Sasse, & McCarthy 2003). All these mechanisms could stimulate cooperative behavior among individuals. It is less clear whether offline communication between members of groups does increase the cooperation rate during *online* interaction. *Experimental* research on *small* groups that use computer-mediated communication shows the following. Communication between group members increases trust. During free rider problems, which often prevent a high enough volume of communication within academic emailing lists (Rojo & Ragsdale 1997a), preceding communication between members increases the likelihood of contribution (Brosig, Weimann, & Ockenfels 2002; Riegelsberger, Sasse, & McCarthy 2003). In general the findings support the assumption that so called "richer" media of communication have larger effects. That is, the effects tend to be stronger for face-to-face communication than for video & audio communication. This resembles somewhat the well-known finding that for group support systems "richer" media are preferable for some tasks (Straus & McGrath 1994). Also,

preceding personal acquaintance among members has a cooperation-increasing effect (Brosig, Weimann, & Ockenfels 2002; Riegelsberger, Sasse, & McCarthy 2003). Much less *field* research is conducted on the effects of communication between members of *large* or *longer-lasting* online groups. The situation in *large* online groups is different from the interaction in small laboratory groups.

Field research on group support systems used for general -and not just academic- purposes suggests that additional verbal communication facilitates cooperation in groups (Fjermestad & Hiltz 2001). Existing field research on large *academic* internet groups indicates that a high embeddedness has two kinds of effects on the communication behavior of researchers in emailing lists. First, it provides incentives to gain reputation within one's scientific community by contributing actively to the online discussion. That is, researchers in embedded emailing lists are more willing to provide help and answers to known and unknown colleagues (Matzat 2009). Second, under a high degree of embeddedness group norms are more likely to emerge that prescribe researchers to help others (Matzat 2004b). So, embeddedness affects the quantity of the online discussion contributions because it provides opportunities to gain (or lose) reputation. However, it is not clear what embeddedness does to the satisfaction with the *quality* of the discussion contributions.

In this study 'quality of information' in emailing lists is related to the researchers' perceived usefulness of the information (Rieh 2002). A distinction can be made between the usefulness of the sent discussion contributions (email messages) and the usefulness of the whole discussion. The latter includes the interrelatedness of the single discussion contributions which may (or may not) be linked with each other so that the discursive combination of messages leads to new useful ideas and other outcomes. This study only focuses on the perceived usefulness of the messages, and not on the quality of the discussion as a whole. A number of studies indicate that emailing lists often are not well suited for the extensive discussion or solution of intellectual controversies among researchers (Hiltz 1984;

Harasim & Winkelmanns 1990; Lewenstein 1995; Tombaugh 1984), so that the study of the quality of the messages is more promising.

Development of new hypotheses

In the following a distinction is made between *four aspects* with regard to the qualitative evaluation of the discussion contributions. The first aspect is about the degree to which contributions reflect –from the subjective point of view of the reader- the progress of knowledge within the research field. Some researchers have the feeling that the content of the emailing list communication does not have much value for them and that prominent researchers with much knowledge on the field would avoid them (Lewenstein 1995; McCarty 1992). I would like to refer to this aspect as the subjective *content quality of the email messages* which are sent to the list.

The second aspect concerns the number of emails that are of no interest to the list members. Some users post emails as a way of advertising a new academic 'product'. This may sometimes be of interest to researchers within that particular field. However, questions that hardly have anything in common with the purpose of the list are sometimes asked, or discussions can develop about aspects that are relevant only for a very small minority (Talja, Savolainen, & Maula 2004). This problem of *off-topic contributions* is a problem for the whole group.

Alternatively, irrelevant messages create a problem only for single individuals who evaluate some emails as being uninteresting for themselves and thus as (individually) *professionally irrelevant*, although they cover topics of the field of research. This third aspect is partly dependent on the diversity of the academic community that uses the emailing list (see below).

The fourth aspect is related to the subjective problem of information overload (Eppler & Mengis 2004; Whittaker & Sidner 1997) or subjectively *perceived amount of communication*. While a too low volume of communication is a problem for the usefulness of

the list, some researchers withdraw when the amount of messages exceeds a certain threshold (Talja, Savolainen, & Maula 2004). The emergence of this problem depends to some extent on the absolute number of contributions. In addition, it may also depend on the number of subjectively perceived off-topic and professionally irrelevant emails. The larger the perceived proportion of off-topic and professionally irrelevant emails the earlier the threshold for information overload may be reached.

The claim of this section is the following. If the researchers' communication behavior is influenced by considerations about reputation in the academic community, then these considerations not only have consequences for the quantity of discussion contributions, but they also have effects on the nature and content of message contributions. More precisely, there is a positive relationship between the embeddedness of the emailing list and the satisfaction with the quality of the discussion contributions on the four dimensions. In emailing lists with a higher degree of embeddedness the informal network is denser. The denser the network, the more information (here: about one's reputation) is spread throughout the whole network (Raub & Weesie 1990). As a consequence, under a higher embeddedness there are more opportunities for gaining (or losing) reputation by posting high quality (or inadequate) discussion contributions. The claim is that researchers take these opportunities into account and adjust their communication behavior accordingly. Note that this assumes some degree of identifiability of actively posting researchers in embedded emailing lists.

In highly embedded emailing lists, more users will hesitate to contribute off-topic emails. They would damage their own reputations by doing so because in networks with a high density the reputation damaging information would spread very quickly (Raub & Weesie 1990). Consequently, in strongly embedded lists users suffer less from emails that are *off-topic* for the whole mailing list than in lists with a low degree of embeddedness.

Moreover, the embeddedness will have an additional effect. If the academic community in the background of the list is well-integrated, then its members will find it easier

to get something out of the discussion that is of professional interest to them. This is partly due to the reputation mechanism that prevents the sending of irrelevant emails. In addition, it can be due to a selection effect. Emailing lists with a well-integrated academic community in their background will attract a more selective audience of researchers. This audience, on average, will be more coherent with regard to its research interests than a less well-integrated research community. Both kinds of mechanisms – the reputation mechanism and the selection effect – have the consequence that the higher the embeddedness of the list, the more often the researcher will find the email contributions to be of *professional interest* for him- or herself.

Under a higher degree of embeddedness researchers are stimulated to send messages that reflect the up-to-date progress of knowledge in the field, because more reputation can be gained by sending high-quality contributions. As a result, the higher the embeddedness of the list, the better the researcher subjectively evaluates the *content quality* of the sent email messages in the list. Finally, since there are fewer problems with off-topic and professionally irrelevant emails and more emails with high quality content in a strongly embedded list, users in embedded lists will be better able to deal with the same number of messages they receive from the mailing list discussion. As a consequence, when controlling for the number of sent messages, the higher the degree of embeddedness of the researcher's list, the less likely it is that the researcher will regard the same *amount* of sent email messages as *too high* for himself. These claims can be summarized by the following four hypotheses.

Hypothesis 1: The higher the degree of embeddedness of the emailing list, the higher the number of sent email messages that are of professional interest to the researcher.

Hypothesis 2: The higher the degree of embeddedness of the emailing list, the lower the number of sent email messages that are regarded as off-topic to the list discussion.

Hypothesis 3: The higher the degree of embeddedness of the emailing list, the better the researcher evaluates the content quality of the sent list emails.

Hypothesis 4: The higher the degree of embeddedness of the emailing list, the less often the researcher considers a given number of sent email messages as being a too high amount.

The communication behavior of researchers is, of course, influenced by other factors as well that affect the four dimensions of the quality of the information. The hypotheses have to be tested under *ceteris paribus* conditions, taking into account a number of control variables, such as time restrictions, problems related to accessing the emailing list, gender differences (Herring 1999), the formal position, research experience, knowledge about the topic (Lewenstein 1995), being a native speaker of the relevant list language (mostly English), and the number of messages that have been sent in the past. The communication habits of some lists suggest that a public discussion of questions within the list is not always desired. In some lists the 'default reply-to' function is set in such a way that a public discussion is avoided. The tests of the hypotheses take this into account.

Research design

The data are somewhat older (1999) and have been used somewhere else (Matzat 2004b; 2009). Nevertheless they are still valuable, have not yet been used for the present research question, and newer data of comparable extensiveness is unavailable. Since 1999 the emailing list technology did not change dramatically and emailing lists are still used.

There are two kinds of data used. Firstly, the communication behavior of members of 49 academic emailing lists was 'observed' by collecting in May and June 1999 all the emails that were publicly sent to these 49 emailing lists. This data includes the information about the communication behavior of researchers and is used for the measurement of two variables as indicated in the section on measurements. Secondly, a random sample of *all active and passive members* of the 49 mailing lists were sent an online questionnaire.¹ Both kinds of data were combined into one data set with the help of the email addresses of the respondents and

were then made anonymous. As a result, the combined data set contains information about the (non-)participation behavior of the respondent, the satisfaction with the discussion contributions, his social network, his academic community, etc. The 49 emailing lists were selected in the following way. In the first step, a 'traditional paper-and-pencil-questionnaire' was sent to a *random sample of English and Dutch university researchers in the following eight different disciplines in the humanities, the social sciences, and the natural sciences: physics, chemistry, mathematics, mechanical engineering, economics, management science, sociology, and history*. Every respondent to this questionnaire who was an emailing list user was asked to fill in the names and some additional information about the *five most important lists that he used for his research*. This resulted in a list of emailing lists used by a random sample of university researchers. From the list, a random sample of 49 un-moderated emailing lists was selected. Note that the members of the 49 emailing lists need not to come from one of the eight disciplines that were used to construct the 'list of emailing lists'.

The sample size of the used data set is 4562, which corresponds to a response rate of 35.1% of all 12996 randomly selected active and passive members who were subscribed in the middle of April 1999 to at least one of the 49 emailing lists. A total of 11.2% of the respondents sent at least one email message to their emailing list during the two months of email collection. The proportion of active participants among all 12996 selected members is 7.9%, which is slightly smaller. The sample thus has a slight bias in favor of active participants. This is reflected by the fact that those who filled in the questionnaire earlier (measured in months) have a slightly higher probability of having sent a message ($r=0.069$, $p<.01$, $n=4517$). The bias is disturbing, but additional data analyses (Matzat 2001) suggest that it does not influence the conclusions drawn from the data analysis.

The Measurements and the Method of Data Analysis

Dependent variable: The satisfaction with the quality of discussion contributions

Satisfaction with the four different qualitative aspects of the discussion contributions in the emailing list was measured with the help of four items that had to be assessed by every member on seven-point-Likert scales. “*Consider the amount of E-Mails that are sent to your Mailing List and which are of professional interest to you. Do you consider this amount to be: very small...very high*” (professional interest). “*Consider the general quality of the E-Mails sent to this Mailing List. Do you think the quality is: extremely poor...extremely high*” (content quality). “*Sometimes users of Mailing Lists receive E-Mails that may not be relevant to the List’s discussion topic. In your experience of this Mailing List is this number: very small...very high*” (off-topic messages). Because of its skewed distribution (see below) this variable was dichotomized for the multivariate analysis in such a way that it scored ‘one’ if the respondent had chosen one of the three highest answering options above the scale midpoint. The degree to which there is too high a number of messages had to be assessed using the following item. “*Consider the general number of E-Mails sent to this Mailing List. In your opinion is this number: too low...all right...too high*” (amount). This variable was dichotomized such that it scored ‘one’ if the respondent had chosen an answering option above the midpoint of “all right”.

Independent variables: Group embeddedness

Embeddedness consists of the frequency of the members’ social interaction with each other as a research community outside of the emailing list. It is measured in the same way as described in Matzat (2004b; 2009). Since the development of a comprehensive scale that directly measures the embeddedness of the emailing list was impossible, the measurement proceeds in two steps. First, it is measured to what extent the group of researchers constitutes an *integrated research community that shares many activities and interests in common*. Second, it is shown that this is associated with three separate indicators that measure dyadic interaction between members outside of the list. In step 1 embeddedness of the emailing list was measured

with the help of an unfolding scale analysis (Van Schuur and Post 1990) of five six-point Likert-scaled items, which resulted in a Mudfold scale. The following five items had to be answered (options ranging from '*disagree completely*' to '*agree completely*') by those mailing list members who had been a member for at least one year and who had been active researchers for at least two years in a field related to the mailing list.

To what extent do the following statements describe adequately the group of researchers in your Mailing List? 'a) It is more a group of unconnected individuals than a research community.' 'b) It is a set of groups and cliques with their own interests and activities, but not much in common as a research community.' 'c) It is a set of groups and cliques with their own interests and activities, but also some common interests as a research community.' 'd) It is a moderately integrated research community that shares some interests and some activities in common.' 'e) It is a well-integrated research community that shares many interests and activities in common.

Note that every respondent was selected for a specific emailing list that was explicitly mentioned in the email invitation so that it was clear which emailing list the respondent had to assess. The items uni-dimensionally cover a wide range of the degree to which the group of researchers in the list constitutes an integrated research community that shares many interests and activities in common. The scale analysis showed that the items form a good unfolding scale. The coefficient of scalability is $H=.65$; none of the five items has a scalability value of $H<.55$.

The assumption underlying the measurement procedure is that the more the group of researchers in the emailing list constitutes an integrated research community that shares many activities and interests in common, the higher is the degree of network embeddedness, which consists of the frequency of the members' social interaction outside of the online group. The following associations support this assumption. The same respondents were asked to what extent they agreed/disagreed with the following statements (six-point Likert scales). *'It is very likely that two arbitrarily selected researchers who (would) regularly send messages to this Mailing List, will ... a)...meet each other at least once every two years at a conference, a professional meeting or another academic gathering. b) ...publish an article in the same academic journal within the next*

two years. c) ...be members of the same academic committee within the next two years, such as an editorial board of the same academic journal, a board of an academic society, a review panel for grant applications, a dissertation defense panel etc.' The bivariate associations between the member's perceived degree of integration and their answers to the three statements ($r_1=.27$, $r_2=.22$, $r_3=.24$, all p-values $<.01$ [two-tailed], $n=1022$) provide some face validity for the assumption that there is more social interaction outside of the list for a higher degree of integration of the community.² The embeddedness of the emailing list is indicated by the mean scale value of the emailing list members' scores on the Mudfold scale.

Other independent variables:

Details about the measurement of the other independent variables, in addition to those about the measurement of the control variables, can be found in Matzat (2001). Here only the most crucial aspects of the measurements are dealt with.

Concept	Measurement
<i>Number of individually sent messages</i>	natural logarithm of counted number of email messages (plus one) within last 2 months
<i>Email experience</i>	natural logarithm of the months of use of email
<i>Knowledge</i>	Try and compare your knowledge about the topic of your Mailing List with the knowledge of other members of this List. What is your subjective assessment of your knowledge?' ['-3 below average' to '+3 above average']
<i>Prominence</i>	Consider the research field that is most closely related to the topic(s) of this Mailing List. How well known is your work by other researchers in this field?' ['1 (practically unknown)' to '7 (very well known)']
<i>Proportion prominent members</i>	proportion of members who scored five or higher on the scale
<i>Number of personal colleagues in the list</i>	With how many researchers of your Mailing List do you have a personal contact? With this we mean mutual acquaintance and at least some regular interaction with each other outside of any

	Mailing Lists.' [natural logarithm plus one]
Past group communication	natural logarithm of number of emails sent to the list during one month before the beginning of the study observation
Default-reply set as 'to group' (dichotomous)	It scores "one" if the setting of the mailing list implies that email answers sent via the 'reply-button' are posted to the whole list.
Group size	natural logarithm of number of email addresses subscribed at end of March
Self-efficacy (proxy)	'My own communication activity in this Mailing List is extremely helpful for others to conduct their research.' ['-3 (disagree completely)' to '+3 (agree completely)']
Filter for selection of researchers	'I am not involved in any research activity related to my emailing list'

The main analysis method consists of hierarchical linear modelling, namely two-level multiple linear and logistic regression analyses (Goldstein 1995). They take into account that there are violations of the assumptions of the standard regression model because of the clustering of the data consisting of variables describing individuals within groups (Snijders & Boskers 1999). The p-values presented in the multivariate analyses are one-sided p-values, unless otherwise stated.

Descriptive results

A total of 4562 respondents filled in the questionnaire (70.2% are male). A total of 68.8% reported that they had been a member of their emailing list for more than 12 months, while 37% had been a member of the same emailing list for at least three years. 34.7% had their main professional position in the USA, 22.3% in the UK, 5.2% in the Netherlands, 4.5% in Canada, 4.4% in Australia, 4.3% in Germany and 2.2% in France. The multivariate data analyses for testing the hypotheses of the reputation model include only the data of 47 lists. Two moderately small lists had to be excluded because of missing values. Most of the emailing lists were located on servers in England or the United States. For the hypothesis

testing only the answers of researchers (excluding librarians, students, consultants etc) without missing values are used, leading to a sample size of n=2588 for the multivariate analysis. The descriptive findings (Table 1) make clear that very different groups of researchers are included in the sample. In line with the findings of other empirical studies (Stegbauer & Rausch 2001; Zelman & Leydesdorff 1999), only a minority of the respondents were active participants in the list discussions during the two months of email collection, with 11.2% of them sending at least one email-message.

(Table 1 here)

How satisfied with the discussion contributions are all members including those who do not actively conduct research? A distinction was made between four aspects of user satisfaction: satisfaction with the amount of sent messages, satisfaction with the number of professionally interesting messages, dissatisfaction with the number of off-topic messages, and satisfaction with the quality of the content of the emails. As Table 2 shows, on average the general quality is regarded as slightly positive. The number of irrelevant messages is regarded as moderately low, the general amount of messages is on average regarded as acceptable and the number of professionally interesting messages is on average regarded as somewhat too low. At the same time, there is a considerable degree of heterogeneity of user satisfaction with regard to all four aspects.

(Table 2 here)

There are also clear group differences with respect to the user satisfaction. This is shown by the following numbers that describe group differences in the user satisfaction, that is, they show differences between the group means. The overall mean value of the group-mean values, naturally, need not be the same as the mean value of the individual scores, since the group means are not weighted by group size.

(Table 3 here)

The mean user satisfaction with an emailing list differs between the groups. On average the selected groups are positively evaluated by their members with regard to the perceived *content quality* of the sent messages. At the same time, 14.3% of the groups have a negative average score. In every group the users, on average, regard the number of *off-topic messages* to be more or less small. However, in a minority of groups, on average, the user is close to indifferent as to whether the number of irrelevant messages is small or large. Many groups are evaluated as having too low a number of *professionally interesting messages*. Nevertheless, 28.6% of the groups are regarded as having on average a more or less high number of professionally interesting messages (mean score >0). If we take the standard deviation of the mean values as an indicator for the heterogeneity between the groups then the mean satisfaction with the general *amount of sent messages* is the one aspect that differs most between the groups. Moreover, 73.5% of the groups evaluate their number of sent messages as being more or less too low. The next table shows the results of an analysis of variance of the four aspects of users' satisfaction. It indicates for every aspect how the variance is distributed over the two levels, emailing lists and members.

(Table 4 here)

The results also confirm the conclusion that there is some degree of variation between the groups. If we take the estimated intraclass correlation coefficient, that is, the proportion of the variance between groups with respect to the total variance, then the heterogeneity with regard to the *amount of sent messages* is highest between the groups.

The group of researchers ($n_1=2588$), when compared to the other users ($n_2=1670$), regards the content quality of the messages as somewhat higher ($\bar{x}_1=.83$ vs. $\bar{x}_2=.69$, two-sided $p<.01$), the number of professionally interesting messages as higher ($\bar{x}_1=.06$ vs. $\bar{x}_2= -.16$, two-sided $p <.001$), the number of off-topic messages as somewhat smaller ($\bar{x}_1=-1.63$ vs. $\bar{x}_2 =-1.51$, two-sided $p =.02$), and the general amount of messages as somewhat more often as too high ($\bar{x}_1=.04$ vs. $\bar{x}_2=-.05$, two-sided $p =.02$). If we distinguish within the group of 2588

researchers between those within the social sciences and humanities ($n_1=1507$) versus those within the natural and engineering sciences ($n_2=689$) and leave out those smaller groups who claim themselves as multidisciplinary ($n_3=373$) or medical ($n_4=111$) researchers we find the following. The researchers within the social sciences and humanities regard the content quality as higher ($\bar{x}_1=.96$ vs. $\bar{x}_2=.61$, two-sided $p<.001$), the number of professionally interesting messages as higher ($\bar{x}_1=.14$ vs. $\bar{x}_2=-.13$, two-sided $p<.001$), and the number of off-topic messages as somewhat larger ($\bar{x}_1=-1.59$ vs. $\bar{x}_2=-1.78$, two-sided $p<.01$). Both groups do not differ significantly in their assessment of the amount of messages ($\bar{x}_1=.06$ vs. $\bar{x}_2=-.03$, two-sided $p>.05$). Briefly summarized, the researchers are a bit more satisfied by the emailing lists than the non-researchers, but they also are more likely to be disturbed by a too high amount of messages. Within the group of researchers, those within the social sciences and humanities tend to be satisfied somewhat more with their email lists than researchers within the natural and engineering sciences, although both groups tend to evaluate the content quality as rather positive.

There is some face evidence for the idea that reputation considerations motivate the sending of messages. Those researchers who had at least one year research experience in their field were asked to evaluate the item "individual members can develop a reputation for their regular provision of useful answers to questions in this mailing list" on a six-point Likert scale ranging from 'disagree completely' to 'agree completely'. Out of the 1646 researchers 20.5% rather disagreed while 79.5% rather agreed. Among researchers in emailing lists with a 'low' degree of embeddedness the median of the answer distribution corresponds to the option 'slightly agree', whereas the median answer in the emailing lists with a 'high' degree of embeddedness corresponds to the option 'agree' ($x_1=4.1$ vs. $x_2=4.5$, $t=5.7$, two-sided $p<.001$). So from the point of view of the researchers emailing lists provide opportunities for the obtainment of reputation and in highly embedded emailing lists they observe more opportunities.

Results of the hypothesis testing

This section tests the claim that a high embeddedness has some advantages for researchers with respect to their satisfaction with the perceived quality of the discussion contributions in the emailing lists. The four hypotheses concerning user satisfaction are tested, using only the survey data of active researchers without missing values ($n=2588$, $N=47$).

The bivariate associations between the degree of embeddedness and the four aspects of satisfaction of the member imply that the higher the degree of embeddedness of the member's emailing list, the more the member is satisfied with the number of *professionally interesting messages* ($r_1=0.16$, two-sided $p<0.001$), the more he is satisfied with the *content quality* of the messages ($r_2=0.27$, two-sided $p<0.001$), the less he is dissatisfied with the number of *off-topic messages* ($r_3=-0.16$, two-sided $p<0.001$) and the (slightly) more he is dissatisfied with the *amount of messages*, that is with a too high a number of messages ($r_4=0.04$, two-sided $p<0.05$). Whereas the first three bivariate associations have the expected sign, the fourth one does not. However, this may simply be due to the fact that a higher degree of embeddedness leads to more active participation of the members and therefore to a higher number of sent messages (Matzat 2009). The following multivariate analyses in the form of hierarchical linear models control for these and other possible factors of influence. The first two aspects are analyzed with the help of two-level multiple linear regressions and the other two aspects with two-level multiple logistic regression analyses.

(Table 5 about here)

The multivariate results presented in Table 5 make clear that user satisfaction is to some extent dependent on the personal situation of the individual researcher. For example, member satisfaction with different aspects of the discussion contributions depends on the researcher's knowledge, gender, whether there were interruptions in access to the list, and other influence factors. Those who regard themselves as more knowledgeable evaluate the

content quality as worse, they perceive a higher number of off-topic messages in their list, but they also claim to receive more professionally interesting messages as less knowledgeable members. Men regard the content quality as worse and they perceive a higher number of off-topic messages. Native speakers evaluate the content quality as better, perceive more off-topic messages, but are less likely to claim a too large amount of messages than non-native speakers. Those who visited more conferences during the last 12 months evaluate the content quality as worse and perceive a higher number of off-topic messages. Those who posted more messages are less likely to claim that the amount of messages is too high.

Group characteristics also influence the members' assessments of the quality of the exchanged information. An unsurprising but nevertheless notable finding is that the degree of list communication has a clear, significant effect on the assessment that there is too high a number of messages, and that a larger amount of messages also increases the likelihood that members perceive a high number of relevant messages. Interestingly, a larger amount of sent messages does not increase the likelihood that members receive a too high number of off-topic messages. Neither the size of the emailing list, when controlled for the communication volume, nor the proportion of prominent members influences the members' assessments of the quality. The important result is that all four *effects of the list embeddedness* have the expected signs. Most importantly, in three of the four cases the effects reach significance. The higher the degree of embeddedness, the more the member is satisfied with the *content quality* of the list messages, the higher he regards the number of *professionally interesting messages*, and the lower he regards the *number of off-topic messages*. The effect on dissatisfaction of too high a number of messages does not reach significance, although the model controls for the general number of messages sent over the past month. Briefly said, the analyses provide support for the first three hypotheses.

Additional analyses (tables available on request from the author) with regard to disciplinary differences in the effect of embeddedness show the following. The effect of

embeddedness does not differ between researchers in the social sciences and humanities versus researchers in the natural and engineering sciences with respect to the content quality, the amount of messages, and the number of off-topic messages. Only for the number of professionally interesting messages the effect of embeddedness differs between the disciplines. For researchers in the natural and engineering sciences the effect is positive ($t=3.8, p<0.001$), and for researchers in the social sciences and humanities ($t=3.0, p<0.01$) and researchers doing multidisciplinary or medical research the effect is even stronger ($t=2.02, p=0.02$). So a high embeddedness makes it for all groups of researchers likelier that they receive a high number of professionally interesting messages, and this effect is stronger for researchers in the social sciences and humanities than for engineers or natural scientists.

One must take into account that the four indicators of user satisfaction with the quality are quite simple. Restrictions in the length of the online questionnaire did not allow the construction of more elaborate scales of the four aspects of member satisfaction, and the indicators thus contain measurement errors to some extent. Nevertheless, three of the four hypotheses are confirmed by the data. The signs of all four effects and the general pattern of findings strengthen the trust in the validity of the four indicators. Emailing lists with a higher degree of embeddedness have more satisfying discussion contributions for the member with regard to the number of professionally interesting messages, the lower number of off-topic messages, and the perception of the general content quality of the messages. The findings show that there are differences in the perceived quality of emailing lists and they point to an important group condition that might influence the differences in quality.

Summary, discussion, and conclusion

This paper contributes to answering the question how researchers evaluate the quality of the information in academic emailing lists on the internet and what group conditions might determine differences in satisfaction with their quality. Earlier findings suggest that emailing

lists differ in quality (Rojo & Ragsdale 1997a), but leave open on what conditions differences might depend.

Social network analysts claim that relations offline would affect online interaction, but leave open what network characteristics are important and how they might affect online interaction. This study argues that emailing lists that are embedded in a well-integrated academic community provide information that is regarded as being of a higher quality. In embedded emailing lists the researchers' informal network is higher, giving the researcher more opportunities to develop a reputation for sending highly valuable information to the online group. The study uses a combination of archived information on the communication behavior in 47 academic emailing lists and information obtained by a survey of a random sample of the same list members. The emailing lists were sampled in a two-stage random selection. These are a random sample of emailing lists used by a random sample of Dutch and English university researchers in eight disciplines in the natural, engineering, and social sciences as well as the humanities.

The results show the following. The content quality, on the average, is evaluated as moderately positive and the number of off-topic messages as rather low. The number of professionally interesting messages is regarded as somewhat too low. The amount of sent messages was, on the average, regarded as neither too large nor too small. There was also a large amount of variation in the four dimensions of quality between the lists found. The results of the testing of the hypotheses provide evidence for three of the four hypotheses. Emailing lists with a higher degree of embeddedness tend to be evaluated as having a higher content quality, as providing a higher number of professionally interesting messages and a lower number of off-topic messages. Moreover, in highly embedded emailing lists researchers observe more opportunities for the development of reputation than in emailing lists with a low degree of embeddedness. There were also some, although limited, disciplinary differences found. By and large, the results support the claim that there exist differences in the quality of

the information exchange between different emailing lists and they point to the high density of the researchers' offline social network in highly embedded emailing lists as one important group condition that might affect the differences.

The findings also shed some light on the mechanism by which offline networks affect online interaction. They strengthen the claim that researchers take into account the effects of their online activity on their reputation in the academic community and that they are aware of the opportunity to gain reputation under a high degree of embeddedness. Researchers in stronger embedded emailing lists with denser networks expend more effort in maintaining the quality of the sent messages and hesitate more in sending messages to the list that may not fit in with the discussion topic. The findings are additional evidence for the claim that a concern for reputation influences online interaction (Matzat 2009).

Nevertheless there are some limitations of this study. Although there is no reason to assume that the found relationships are no longer valid, a replication of the findings with newer data would be useful. Furthermore, the used indicators of the information quality are based on subjective evaluations and are prone to measurement errors. Further research would profit from the use of harder indicators.

As a general conclusion, the findings do not provide reasons for casting a doubt on the quality of the information in academic emailing lists *in general*. The average user does not seem to be unsatisfied. However, one should take into account that, at least at the end of the 1990s, on the average only one out of four researchers used emailing lists (Matzat 2004a), and in physics and chemistry the proportion was even lower. It might be that some other researchers who were rather unsatisfied stopped using emailing lists.

The results have implications for the design and management of academic online communities. First of all, the results show that not all emailing lists are of equal value to the researcher. Some lists were having a rather limited value. This speaks for the necessity to plan and design academic online communities rather carefully to avoid problems. The findings

indicate that there are various individual differences in the degree of satisfaction with the emailing list messages. For instance, managers could take into account that the many inactive members are much more likely to feel disturbed by a given number of messages than the few actively posting members. This also holds for the most active researchers who are busy writing many papers. Most of all, if one is interested in the maintenance of a satisfying quality of the discussion contributions, it makes sense to build academic online communities in such a way that they have a high degree of embeddedness. This can be taken into account during the initial phase of building up the online community. The community manager can choose the discussion topics in such a way that they are linked to an existing academic community or give rise to a new and well-integrated academic community that is interested in common meetings. Moreover, in later phases of the existence of the online community, the list manager or other interested members can point the members' attention to common meetings and other events that increase the embeddedness and that make other members aware of the existing amount of embeddedness. Such efforts are likely to result in increasing satisfaction with the quality of the information in academic online communities.

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Table 1: Descriptives of the most important independent variables

Variable	Arithmetic mean	Standard deviation	Minimum	Maximum
<i>Continuous variables (n=2588)</i>				
Raw number of individually sent messages	0.29	1.9	0	70
Prominence	1.8	1.7	0	6
Papers	3.2	2.9	0	30
Conferences	2.2	2.2	0	43
Knowledge	-0.1	1.5	-3	3
Years of research experience	7.6	7.8	0	50
<i>Group variables (N=47)</i>				
Group size (raw number)	439	445	16	2100
Embeddedness	24.7	3.3	16.5	30.9
Proportion prominent members	.19	.11	.03	.67
Past group emails (raw number)	53	109	0	600
<i>Dichotomous variables (N=2588)</i>				
		Proportion		
Male		.71		
Native speaker		.60		
Full Professor		.14		
Sent at least one message		.11		

n: number of individuals, N: number of groups

Table 2: Individual satisfaction with quality aspects of the mailing list

	AMOUNT	PROF. INTEREST	OFF-TOPIC	CONTENT QUALITY
Mean	.00	-.03	-1.58	.78
Median	.00	.00	-2.00	1.00
Std. Deviation	1.14	1.56	1.52	1.31
Minimum	-3.00	-3.00	-3.00	-3.00
Maximum	3.00	3.00	3.00	3.00

n=4258

Table 3: Group satisfaction with quality aspects of the mailing list

	AMOUNT	PROF. INTEREST	OFF-TOPIC	CONTENT QUALITY
Mean	-.35	-.28	-1.51	.53
Median	-.28	-.30	-1.59	.56
Std. Deviation	.75	.50	.57	.58
Minimum	-3.00	-1.50	-3.00	-1.75
Percentiles: 25%	-.77	-.64	-1.92	.23
Percentiles: 50%	-.27	-.29	-1.59	.56
Percentiles: 75%	.03	.07	-1.14	.89
Maximum	1.06	.78	-.09	1.89

N=49

Table 4: Analysis of Variance of the four original indicators of satisfaction

	σ^2 (SE)	τ_0^2 (SE)	Intra-class correlation
Amount	1.04 (0.02)	0.43 (0.09)	0.29
Professional interest	2.30 (0.05)	0.16 (0.04)	0.07
Off-topic	2.06 (0.05)	0.25 (0.06)	0.11
Content quality	1.40 (0.03)	0.25 (0.08)	0.15

n=4258 N=49

n: level 1 sample size (number of individuals); N: level 2 sample size (number of groups); τ_0^2 : level 2 variance of the intercept; σ^2 : level 1 error variance

**Table 5: Embeddedness and qualitative aspects of the discussion contributions:
Results of 2-level multiple logistic and linear regression analyses**

Variable	Professionally interesting messages	Content quality of messages	Off-topic messages (1=high)	Amount of messages (1=too high)
	Estimated value (standard error)	Estimated value (standard error)	Estimated value (standard error)	Estimated value (standard error)
Group level effect:				
Embeddedness	0.06**(0.02)	0.08**(0.02)	-0.10**(0.04)	-0.02(0.04)
Control Variables:				
Group level effects:				
Default reply to group	-0.26* (0.13)	-0.12 (0.13)	0.11 (0.24)	0.18 (0.23)
Proportion of prominent members	0.25 (0.72)	-0.11 (0.75)	-0.02 (1.44)	-0.94 (1.33)
Past group communication	0.12* (0.05)	0.08 (0.06)	0.01 (0.11)	0.59** (0.10)
Group size	0.01(0.09)	-0.03(0.10)	0.08(0.20)	-0.08(0.17)
individual level effects:				
Knowledge	0.08** (0.02)	-0.09** (0.02)	0.09* (0.05)	0.04 (0.04)
email experience	-0.04 (0.06)	-0.08* (0.05)	-0.36** (0.12)	-0.06 (0.10)
Prominence	0.01 (0.02)	0.01 (0.02)	0.07 (0.05)	0.07* (0.04)
Years of research experience	-0.01 (0.01)	-0.00 (0.00)	-0.02 (0.01)	-0.00 (0.01)
Number of individually sent messages	0.02 (0.08)	0.06 (0.07)	-0.37 (0.24)	-0.34** (0.14)
Interruption in Access to list	-0.14** (0.06)	-0.14** (0.05)	0.40**(0.13)	0.18* (0.10)
Male	-0.11 (0.07)	-0.13* (0.05)	0.31* (0.15)	-0.18 (0.12)
Non-university researcher	-0.01 (0.10)	-0.04 (0.08)	0.17 (0.22)	0.00 (0.18)
Other university researcher	0.12 (0.11)	0.11 (0.09)	-0.29 (0.25)	0.19(0.18)
Full Professor	-0.07 (0.10)	-0.09 (0.08)	-0.13 (0.21)	0.36* (0.17)
Native speaker	-0.05 (0.06)	0.17** (0.05)	0.29* (0.14)	-0.39** (0.11)
Number of written papers	0.00 (0.01)	0.00 (0.01)	0.02 (0.02)	0.03* (0.02)
Number of visited conferences	0.02 (0.02)	-0.03* (0.01)	0.05* (0.03)	-0.01 (0.03)
Self efficacy	0.28** (0.03)	0.18** (0.02)	-0.18** (0.06)	-0.01 (0.05)
*: $p \leq 0.05$				
**: $p \leq .01$ (one-sided)				
n=2588 N=47	$\tau_0^2=0.09$ (0.03) $\sigma^2=2.11$ (0.06)	$\tau_0^2=0.13$ (0.04) $\sigma^2=1.35$ (0.04)	$\tau_0^2=0.32$ (0.12)	$\tau_0^2=0.23$ (0.9)
Variances of the 'empty' model	$\tau_0^2=0.18$ (0.05) $\sigma^2=2.27$ (0.06)	$\tau_0^2=0.25$ (0.06) $\sigma^2=1.41$ (0.04)	-----	-----

n : level 1 sample size (number of individuals); N : level 2 sample size (number of groups); τ_0^2 : level 2 variance of the intercept; σ^2 : level 1 error variance

Footnotes

¹ Dependent on the size of the mailing list and on the privacy concerns of the list owner either a random sample of the members' email addresses or all email addresses have been selected. An email version of the questionnaire was sent to those mailing list members who had no access to the world-wide-web during the time of the data collection.

² The reader can find more details of the Mudfold scale analysis in Matzat (2001). In addition, the three items on interaction outside of the group are highly correlated with each other (all r 's between 0.53 and 0.65). Nevertheless, they do not form a good scale for the measurement of embeddedness. The first principal component that resulted from a principal component analysis of the three items leads to a score that is highly dispersed within the same group. The intra-class correlation is 0.055, meaning that only 5.5% of the variance of the score is between the groups. The low intra-class correlation indicates a low degree of reliability of the principal component scores as a measurement for the groups' embeddedness. As a consequence, these items are not used as a direct measurement for the degree of embeddedness. The intra-class correlation for the Mudfold scale scores is 0.12, which indicates a higher degree of reliability of this index for the measurement of the groups' embeddedness. So the used indicator of the degree of embeddedness is a proxy for the density of the informal network.