Strategic, Metacognitive, and Social Aspects in Resource-oriented Knowledge Exchange

Dr. Ulrike Cress (u.cress@iwm-kmrc.de)
Department of Applied Cognitive Psychology and Media Psychology, University of Tuebingen
Konrad-Adenauer-Strasse 40, 72072 Tuebingen, Germany

Abstract

The increasing use of internet and intranet fosters the possibilities for resource-oriented knowledge exchange in large groups of people working in parallel. However, the individual decision to contribute information to a shared pool builds up a public-goods dilemma, and people are often discouraged from sharing knowledge because of strategic reasons. Additionally, the highly anonymous situation where resource-oriented knowledge exchange takes place could further amplify the tendency to withhold knowledge: this situation provides almost no metaknowledge about the importance of one's information for the others and almost no social cues. In two experiments the effects of metaknowledge and social standards are investigated. Results show that the former influences the quality of the exchanged information, whereas the latter influences the quantity.

Resource-Oriented Knowledge Exchange

One form of collaborative media use which is becoming more and more important in organizations is the use of shared databases as knowledge repositories. They provide an opportunity for sharing distributed knowledge[1] in groups or organizations. Databases collect information which normally is distributed over all members of an organization, save it permanently and thus make it accessible and searchable for all members of a group or organization (Beckmann, 1999; Nonaka & Takeuchi, 1995). Hence, shared databases can be used to establish some kind of organizational memory.

Such shared databases are especially useful in big organizations in which partly similar tasks are accomplished by different people or departments and subgroups (Cress, Barquero, Buder & Hesse, i.p.). Here all group members do not really work together, instead they work in parallel: the different persons or subgroups work on different or partly different tasks, and no common goal exists beyond the general goal that each person should perform the task as best s/he can. In those groups knowledge exchange is especially useful if the performances of the persons or subgroups are interdependent, and each person can benefit from each other's work. In such a situation, the knowledge exchange enhances the performance of all.

An example for such a parallel work situation is the following: In a consultancy each consultant's task is to attend to different companies. To decide which the best strategy is for one of his/her companies, a consultant should know about the efficacy of different possible strategies in other companies which are taken care of by one of her colleagues. To do his/her job in the best way s/he should be able to get information from those other projects. Therefore, knowledge exchange could enhance her/his performance.

But the question arises how knowledge can be effectively exchanged in such big organizations. Direct and *demand-oriented* knowledge exchange through asking each other isn't very efficient when group members do not know which persons are working on which tasks and who the experts are in which domain. Additionally, direct knowledge exchange through asking is not very efficient when similar questions arise for different people. In this case, answering each question separately is an ineffective method of knowledge exchange. Thus, in bigger groups, an effective kind of knowledge exchange seems to be one that is *resource oriented* instead of *demand oriented*. This kind of knowledge exchange is based on the idea that each member contributes that part of his/her knowledge which is possibly useful for other members of the organization.

But even if the resource-oriented knowledge exchange seems to an effective method for knowledge exchange in parallel working groups, it is reported in many knowledge management projects that implemented databases in organizations that people were reluctant from entering their knowledge into such a shared pool. From a psychological point of view this behavior can be described as a strategic one, resulting from the fact that the situation can be described as a social dilemma.

Strategic Aspect: Knowledge Exchange as Social Dilemma

From a psychological point of view the resource-oriented knowledge exchange has the formal structure of a *social dilemma* (Fulk, Flanagin, Kalman, Monge & Ryan, 1996; Hollingshead, Fulk & Monge, 2002; Thorn & Connolly, 1987): People are reluctant to enter their knowledge into a shared database because contributing is associated with individual *costs*. As knowledge in organizations is quite often seen as a kind of power, the contribution of knowledge to a shared pool is perceived as a loss of individual power

[1] In this article we do not distinguish between *knowledge* and *information*, even we are aware that from a cognitive point of view there are differences.

and reduced social influence. Other costs are related to the communication tool and the specific situation in which the communication takes place. It requires much time and effort to write down the information. And because the information should be useful for as many people as possible, the messages have to be worked out elaborately, so that the topics can be understood by people of different background and expertise. Thus, compared with direct verbal communication, a person must invest much more effort and work in preparing messages for knowledge repositories, and this extra effort competes with the daily work a person has to do.

If these individual costs for each contributor are lower than the group's total benefit from having access to the information, then the situations turns into an n-person Prisoner's Dilemma game: Individually, a person has no benefit from entering information into the database. Quite contrary, there are only private costs because time and effort must be invested. This means that every person would be better of if s/he does not enter any information and behaves uncooperatively in this way. Thus, in terms of decision theory, withholding information is the dominant strategy leading to Nash Equilibrium. But if all people behave in such a way, there is no knowledge exchange at all, and people can't benefit from each other. Then, the group has a lower benefit than if all had cooperated. Therefore, withholding is a *pareto-inferior* Nash Equilibrium. In this context contributing is the altruistic decision, whereas withholding means defection.

With respect to research about social dilemmas, entering information into a shared database defines a kind of public-goods dilemma. Public goods are characterized by *non-rivalry* (which is also called "jointness of supply", Barry & Hardin, 1982) and *non-excludability* (Head, 1972). Non-rivalry means that the amount and value of information in a database (as a kind of public good) is not reduced if a person uses the information. Non-excludability means that the whole content of the database is in principle accessible to all members. Thus, nobody can be prevented from using the database – even if s/he contributed nothing.

This means that a potential knowledge provider cannot have any founded expectation of a direct balance between costs and benefits. S/He cannot expect that if s/he gives away information, s/he will also obtain information from those people who could retrieve the provided information. Instead of this direct exchange, there is a kind of "generalized exchange" (Markus, 1990; Yamagishi & Cook, 1993). A knowledge provider can only have a slight hope that to possibly benefit from the knowledge of others as a whole. But it is a certainty that any other member can use provided knowledge, irrespective of that member's own contribution.

By considering the knowledge exchange as a social-dilemma situation the observed tendency for withholding knowledge can be interpreted as a strategic behavior of the group members. From the individual point of view withholding information is the most effective strategy, and therefore - individually seen - it is quite rational to do so.

But even if knowledge exchange is a dilemma situation the question arises which factors could influence a person's motivation to cooperate in this dilemma.

Metaknowledge: Knowledge about the Importance of one's own Knowledge

The communication via databases is an extremely anonymous communication situation. In demand-oriented knowledge exchange a person directly is asked to share knowledge. Therefore a knowledge provider knows that somebody is interested in his/her knowledge, and through the question of the person asking, one at least partly can anticipate the specific needs of the recipient. Additionally, through the verbal and non-verbal reactions during the dialog a provider continuously receives feedback on whether the recipient understood the messages. Thus one gets to know if the questioner is satisfied with the answer.

In resource-oriented knowledge exchange all these verbal and non-verbal cues are missing. Additionally, large groups of persons do not primarily work cooperatively. Instead they work in parallel which provides specific problems to develop an adequate transactive memory (Moreland, 1999; Wegner, 1987). A transactive memory relies on the idea that other group members can be a source of knowledge, thus leading to a distribution of relevant knowledge over the whole group. Consequently, metaknowledge about mutual expertise becomes important for efficient work. Transactive memories emerge through collaborative learning and working (Moreland, Argote, & Krishnan, 1996) where each person gets to know which expertise s/he and others have. Therefore persons get informed about what the others know and who the experts are on which domain.

Large groups with members working in parallel normally aren't able to develop a reliable transactive memory. When persons don't have to work together a person cannot know for certain which pieces of information others really need. In resource-oriented knowledge exchange this leads to a situation where a person has to decide to enter information into a shared pool without knowing if others already have this information, or if this information is irrelevant for their work. And in the context of the information sampling theory it was shown that metaknowledge about the distribution of expertise across the group members in fact increases the communication of non-shared knowledge (Stasser, Stewart & Wittenbaum, 1995). If people know about their own expertise and know that others need the information they own, they are more willing to communicate their knowledge to the group.

This prediction can also be deduced from decision theory and their formal analysis of payoffs. In the database situation a contributor's individual payoff doesn't differ if s/he contributes information that is more or less useful for the others. However, the payoff of the other group members in fact does: If a person contributes information that is

important for others, *their* payoff is higher than if s/he contributes information of less importance. Thus, if the decision to contribute or not contribute is not only based on maximizing one's own payoff, but also on maximizing the group's payoff (altruistic decision, Costa-Gomes, Crawford & Broseta, 2001), then the amount of contributions that are important for the others should increase.

In sum, we expect that the metaknowledge about one's own and about others' expertise effects the decision of persons to contribute information to a database or not. Metaknowledge about the importance of information for others should be used as criterion for the decision to enter information into a shared database or to withhold it.

Social Aspect: Information about the Social Standard

By considering a social aspect we assume that feedback about the amount of contributions made by others influences a person's contribution behavior.

In the situation where a person decides to contribute information or not, there exists no objective standard how to behave adequately. Is it adequate to provide as much knowledge as possible, even if this conflicts with the individual interests, or is it adequate to behave strategically and withhold or partly withhold one's own knowledge? It is assumed that persons being in such an unclear situation try to get information about others' behavior to get a social standard. If a person gets to know how many contributions the others made it is possible to adjust one's own cooperativeness to that of the others. Thus, information about others' contributions helps to establish norms which will influence the member's behavior.

The *SIDE-Model* (Social Identity and De-individuation Model) posits that in computer-mediated communication such group norms become very important (Lea & Spears, 1991; Postmes, Spears & Lea, 1998; Spears & Lea, 1992). This model assumes that in highly anonymous situations people tend to categorize others as group members and also perceive themselves more as a group member than in face-to-face situations. Thus, the model predicts that in computer mediated communication situations persons exhibit stronger group conformity than in less anonymous groups. Hence, we can expect that in the situation of resource-oriented knowledge exchange group norms affect the decisions to contribute information or not.

Experimental Environment

For an experimental investigation of the metaknowledge and social aspect within the knowledge exchange dilemma we developed an environment which maps those features that are typical for resource-oriented knowledge exchange via shared database:

- A knowledge provider does not communicate knowledge to people that are known personally, but to an anonymous group.
- The groups only possess an unreliable transactive memory: A potential knowledge provider does not know on which tasks the other database users are working. Thus, neither is knowledge of the others is known, nor can the relevance of one's knowledge be anticipated.
- Additionally, there could be high redundancy of information within the group. So, a potential provider can't be sure that the information s/he wants to enter is already known by many others, too.
- A provider has no direct benefit from making knowledge available. Instead, there are only costs associated with contribution.
- In the knowledge exchange there is only a low expectancy of reciprocity. A provider can't be sure that an equivalent amount of information will be obtained from others.
- The full database information is useful for any group member, independently of whether s/he entered some information into the database or not.
- Thus, the database content has the properties of a public good.

These situational characteristics were realized through an experimental setting where both costs due to database contributions, and benefits from using database information can be accounted for by a single scale. In the experimental setting each participant works in a team of 6 persons and calculates salaries of salesmen. Each salary is composed of two values: a base salary which is calculated in the first phase of a trial and the provision, which is calculated in the second phase. In the first phase a subject earns 0.25 Euro for each base salary s/he calculated. But after each calculation a person has to decide whether s/he wants to contribute this result to the shared database. The transfer to the database costs time (15 sec.) and, because the two phases are time-limited (9 and 12 minutes), the more one contributes the less base salaries one can calculate and - consequently - the less one earns.

In the second phase, each group member has to calculate the *total salary* of as many salesmen as possible. In this phase a participant gets 0.30 Euro for every total salary calculated. But for the calculation of a salesman's total salary the base salary is needed. If a participant did not calculate it in the first phase, and if this value was not contributed to the database by at least one of the other group members, s/he has to calculate it in the second phase and hence will lose time. Thus, being collaborative and contributing base salaries to the database in the first phase may facilitate the performance of the other group members in the second phase. But according to the individual payoff, a person has no benefit from contributing a base salary to the database because in the second phase a person has the base salaries s/he calculated in the first phase anyway. Concerning the benefit of the others, it is not sure if they really need a specific base salary because a person doesn't know which total salaries others will calculate in the second phase. Moreover, persons can't be sure that the information they contribute is really unique because other group members could have calculated the base salaries of the same

salesman, too. So it is possible that the database contribution of a base salary has no use for others. Therefore, the experiment reproduces a typical feature of knowledge exchange where the information a person has might be redundant or even unnecessary for others.

Experiment 1: Metaknowledge about the Importance of one's own Knowledge

In the first experiment we provided the participants with metaknowledge about the importance of their information. We varied this *importance* of information in a within-design. Therefore we introduced two different kinds of basic wages in the experiment: After each calculation of a basic salary, the result appeared (with a probability of 50%) as red. The red color indicates that a basic wage is high. Participants are informed that the total salaries of salesmen with high basic wages will have to be calculated first in the second phase. This denoted that the probability of needing a "red" basic salary in the second phase is higher than the probability of such a need for a non-red basic salary. So, on group level, the others' payoff is different if a person contributes important vs. less important information.

We expected that people select their contributions accordant with their metaknowledge. Thus, people should contribute more important basic wages than less important ones.

Method

Subjects: Subjects of this study were 20 students of the University of Tuebingen (Germany). The participants were on average 24.5 years old and 50% were women.

Procedure: The participants worked in groups of 4 to 6 persons in one room with 6 computer workstations. The group members couldn't see each other's displays and couldn't communicate because the working places were separated through dividing walls. The groups where told that they had access to one shared database. But in fact they worked totally independent from each other and the other's actions were faked. The task (containing phase 1 and phase 2) was repeated three times. After the experiment each participant was paid according to the number of basic salaries and total salaries calculated during the three trials. On average each participant earned about 20 Euro. None of the participants noticed that the groups were faked.

Design: A 2x3 analysis of variance (ANOVA) was calculated with the within-factors importance of information and trial. Because the participants became faster from trial to trial, we did not use the absolute number of contributions as dependent variable. Instead we used the contribution rate, describing the ratio of contributed basic wages to the number of calculated basic wages.

Results and Discussion

The ANOVA yielded two significant main effects, $F(1, 19)=12.96$, $p<0.001$, $\eta^2=0.41$, for importance, and $F(2, 38)=3.56$, $p<0.05$, $\eta^2=0.16$ for trials. The mean contribution rate of important values was 0.58 (SD=0.07), and for less important values 0.31 (SD=0.08). Across the trials contribution rate decreased from 0.54 (SD=0.07) in the first trial, to 0.44 (SD=0.08) in the second, and 0.37 (SD=0.08) in the third trial.

There was no significant interaction.

The results confirmed the metaknowledge hypothesis. In all trials more important than non-important basic salaries were contributed. This main effect was very strong and could explain 41% of the variance.

We replicated this effect size in other studies in our laboratory where we used different costs for contribution and diverse bonus systems (Cress, Barquero, Buder, Schwan & Hesse, 2003). These studies show that the effect of metaknowledge is quite stable: in situations where contribution costs for more and less important information are equal, people select their database contributions according to their metaknowledge. This reflects that a person's decision to contribute is not only based on considering individual payoff but also on considering the payoff of the others. By primarily contributing highly useful information the contributors individually have no more costs, but they enable higher benefits for others. With respect to the individual payoff, withholding important information is still dominant. But if one decided to provide information at all, it is more effective to provide important than non-important information. Thus, providing more important information than less important is a strategic behavior, too.

Experiment 2: Information about the Social Standard

The second experiment deals with the effect of information about the amount of contributions made by "co-workers". It is proposed that people in the situation of knowledge exchange via databases use their knowledge about the others' contributing behavior as a kind of social standard. It is assumed that they compare their own behavior with that of the others and conform to the others (Smith & Bell, 1994). The sucker-effect (Orbell & Dawes, 1981) proposes that those persons who feel exploited and perceive that they contributed much more than the others should be motivated to behave more egoistic, too. Thus, they should reduce their amount of contributions. On the other hand, persons who perceive that they contributed less than the others should contribute more, even if this is against their individual interest.

Thus, we expect that persons receiving feedback that their co-workers made many contributions will enter more information into a shared database than persons knowing that their co-workers only made very few contributions.

Method

Subjects: 55 students of the university of Tuebingen took part in this study (mean age 25 years, 70.4% were women). They were randomly assigned to the two conditions with low-cooperation group members (26 persons) and high-cooperation group members (29 persons).

Procedure: The experimental task was the same as in the first study, except for one feature: After the second phase of each trial each subject got a feedback about the number of contributions s/he made and a (faked) feedback on the mean number of contributions the other group members made. A bar diagram visualized these two values for direct comparison. Ss in the high-cooperation group received feedback that other group members on average contributed 8 (1st trial), 8.4 (2nd trial) and 6.4 items (3rd trial). Persons in the low-cooperation condition got the information that the others contribute on average only 3, 2 and 1 items, respectively. To make sure that these feedback values were credible, values were chosen based on study 1, representing the first and third quartile of the number of actual contributions in each of the three trials.

According to this feedback the number of database entries a person was able to use in the second phases in each trial had to differ between both conditions. Therefore the task was constructed in a way that the persons in the low-cooperation group could use about 5 basic wages from the database, whereas those in the high-cooperation group could use about 12.

In this experiment there was no distinction between more and less important basic wages as it was in the first experiment.

Results and Discussion

A mixed two-factorial ANOVA with group as between factor (high- vs. low-cooperation group) and trial (3 trials) as within factor yielded a significant main effect for group, $F(1, 53)=4.48$, $p<.05$. Persons receiving feedback about highly cooperative co-workers showed a higher cooperation rate (M=0.54, SD=0.31) than persons with a feedback about less cooperative co-workers (M=0.45; SD=0.34). A post-hoc analysis shows that this main effect is caused only by the second and third trial, where both groups significantly differ (second trial $t=2.15$, $df=53$; $p<0.05$, third trial=2.33, $df=53$; $p<0.05$). In the first trial both groups didn't differ in their contribution rate. This is in line with our hypotheses because before the first trial groups didn't receive feedback about the others' behavior. In the first trial participants on average contributed 4.95 (SD=3.29) basic wages which gives a contribution rate of 0.5 (SD=0.34). Thus, every second calculated basic wage was contributed. In the second and third trial both groups adjust to their faked group members. The participants with a feedback about highly cooperative co-workers contributed 6.67 values (SD=3.81) in the second trial and 6.31 (SD=4.36) basic wages in the third trial. This is equivalent to contribution rates of 56% (SD=0.33) and 51% (SD=0.04). Those with a feedback about less cooperative co-workers contributed 3.73 (SD=0.03) and 2.85 (SD=0.04) values, which is equivalent to basic rates of 35% (SD=0.04) and 27% (SD=0.04). The absolute number of contributions show that the two groups assimilate to their co-workers' behavior. Indeed, persons with highly cooperative co-workers don't fully assimilate to their co-workers' cooperativeness. With 6.67 and 6.31 contributions in the second and third trial they still contribute significantly less than the faked group members whose contributions were 8 and 8.4 in the preceding trials 1 and 2 – $t=1,9$, $df=28$, $p<0.10$ and $t=2,58$, $df=28$, $p<0.05$. In contrast, the groups with low-cooperation group members assimilate to their faked co-workers' number of contributions. In this group there was no significant difference to their co-workers' number of contributions.

These results of this second experiment show that people in the database situation in fact adapt to the behavior of their co-workers. If they perceive them as highly cooperative, people over time become more cooperative as well. If they perceive them as very uncooperative, people become more egoistic, too. But the results show that this adaptation to the cooperativeness of the others' isn't equally strong in both conditions. The assimilation to a low social norm of cooperativeness seems to be stronger than the assimilation to a higher level. It could be interpreted in a way that the sucker effect seems to be stronger than the effect of social facilitation. This difference in the degree of assimilation between both effects of social norms could perhaps be explained by the specific features of knowledge exchange via shared databases. In this highly anonymous situation where the behavior of each group members can't be identified by the others, the group members can't detect the free riders. Therefore, the social pressure for behaving as cooperatively as the others is reduced through anonymity. In contrast, in situations, where the group behaves very uncooperatively, people assimilate to the group norm not because of a feeling of social pressure, but because of a feeling of exploitation. But this feeling isn't reduced through the high anonymity of database communication.

General Discussion

The two studies show that aspects of metaknowledge and social standards in fact play important roles in knowledge exchange via shared databases. The first experiment revealed that people primarily contribute information which they assume to be important for the others. This effect is quite strong. However, comparisons between the mean contribution rates in the first and second experiment show that metaknowledge is only useful as a criterion for the decision on which information to contribute, but is does not increase the contribution rate in general. In both experiments contribution rates didn't differ, they were about 50%. Thus, in general, providing metaknowledge about the usefulness of the information a person has, does not itself increase the number of contributions. Therefore providing

this kind of metaknowledge does not solve the problem of withholding information. But this kind of metaknowledge could enhance the quality of information in a database, because persons will contribute the information they expect as being useful for others. Therefore the database will contain more information that can be of interest for many users. In sum, this kind of metaknowledge influences the quality of shared pool, not the quantity.

The second experiment shows that quantity of database contributions can be influenced by a different kind of meta-information: Providing information about the group's behavior can increase database contributions, - but only when people perceive themselves as free-riders. On the other hand, if they feel themselves exploited, they will reduce their cooperativeness. Thus, providing metadata about the behavior of the co-workers can have desired and undesired effects - dependent on the group's standard contributing behavior.

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