Introducing Mutual-Help Rules Based on the Idea of "Bi-Directional Debt" Into a Project Learning Activity: Enhancing the Formation of Social Capital In Classrooms

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Abstract: The present study aims to foster social capital among learners engaged in collaborative problem solving. For this purpose, the authors propose the norm of "bi-directional debts" and devise rules for mutual assistance based on this norm. These mutual assistance rules give a person who has been helped by someone an obligation to help another, while, at the same time, giving a person who has assisted someone an obligation to be assisted by someone else. The authors introduced these rules into a project-based cooperative learning setting to verify their effectiveness. This experimental study, which took place in a university's project-based learning classroom, has suggested that these rules are effective in facilitating the formation of social capital in a group of learners.

Keywords: mutual help activity, social capital, norm of exchange, bi-directional debt

Introduction

This paper discusses cooperative learning, in which learners tackle individual or group problem solving by helping each other, and examines a strategy to form social capital in a group of learners as the basis for such activities. Social capital is defined as the features of social mechanisms such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit (Putnam, 1995). It is also known as the characteristics of social mechanisms such as trust, norms, and networks that can improve the efficiency of society by facilitating cooperative behavior (Putnam, 1993). Lin (2001) defines social capital as the resources embedded in a social network that people access and use to perform some act.

Although there is no unitary definition of social capital, based on previous studies, the authors understand social capital as the social mechanism through which the members of a group can utilize the group's resources (capabilities and materials) through its embedded network of human relations. If this social mechanism is properly constructed, members can acquire necessary assistance from the group while performing certain activities. When such a mechanism is constructed within a group of learners, it is expected to facilitate their cooperative problem solving. Consequently, in this paper, the authors propose a method to form social capital in a group of learners and to confirm its effects through practice at a university.

Putnam highlights three important components of social capital—networks, norms, and trust—which are mutually reinforcing (Putnam, 1993). A network is a connection between people. This includes knowledge regarding what resources other accessible people possess. Without this knowledge, it is not possible to get help from the network efficiently. The existence of a network alone does not ensure the distribution of resources (i.e., assistance). It is a norm that drives the distribution of resources instead. Putnam thus emphasized the norm of general reciprocity. Reciprocity is an exchange of interests accompanied by a duty of reciprocation. Simply put, it means "Give back when you get help, inversely, if you help, it means you deserve to get help" (Gouldner, 1960). Also, here, the term "general" indicates an exchange relationship with the expectation that even if the balance is temporarily lost, the returns are to be given by someone belonging to the community in the future. The resources of the network are distributed by the learner acting in accordance with this norm of general reciprocity. Once this distribution cycle is established, learners understand that aid goes around in the group and that they can rely on it at any time. This is called trust.

To consider fostering social capital in the classroom, in this study, we focus on the norms, one of the three aforementioned factors. This is because we believe that the norms of exchange in classrooms may hinder the formation of social capital. For the general public, the exchange of assistance will eventually stop if someone does not repay the assistance, that is, if some of the members does not comply with the aforementioned reciprocity norms. As a result, the social capital of the community collapses and certain individuals, who do not repay, are excluded from the network. What about in the context of a classroom? Classrooms are designed for teachers to evaluate learners, as suggested by Mehan's study of I-R-E sequences (Mehan, 1979). In such a context, learners aim to be evaluated highly by the teacher. When collaborative learning is introduced into the classroom and

"mutual assistance" is recommended, the learner receives "praise" or a higher evaluation from the teacher as a return for their contribution to others. In this school setting, the reciprocity norm is transformed into the pseudo pure gift norm—implying that help may occur even without the promise of reward. In the classroom, the learner who is assisted by others is exempted from the obligation of repay. On the other hand, a learner who helps someone receives praise from the teacher as a substitute (In this sense, it is not a "pure" gift, but a quasi-pure gift).

A feature of this system is that even if the recipient of assistance cannot/ does not reciprocate the help they got, the chain of assistance does not end because the repaying is replaced by the teacher's praise. However, there is a big problem here. While learners who help someone continue to accumulate praise from teachers, learners who tend to be helped by someone continue to receive relatively low ratings. This relative subordination is in fact the unconscious debt paid by the recipient in this system. In such a situation, the support cycle and the subsequent confidence building will be challenging. The above situation occurs more likely when mutual cooperation is encouraged more eagerly by the teacher. This is because, as mentioned above, the school presupposes the peculiarity that the class activities are managed by teachers and evaluations are also given by them.

How can a learner acquire knowledge about the network by engaging in the exchange of a wide range of knowledge and skill with many people without facing this problem and cultivate confidence within the network through aid circulation? In this paper, we propose a new norm which solves the above problem and facilitates the formation of social capital within a group of learners. We also propose a rule which enforces the norm within the group. Ostrom replaced norms in social capital with an institution that allows them to be actively designed (Ostrom et al., 2008). This study, based on Ostrom's idea, tries to form social capital in the learner group by introducing a new norm. This new norm is introduced by designing yet another rule of exchange.

The norm of bi-directional debts and rules of mutual assistance based on it

The norm of exchange proposed here is comprised of the body of the traditional norm, "if you are helped by someone, you should help someone in return," and an additional part, "if you help someone, you should be helped by someone." Traditionally, those who receive help are obligated to provide help in return. Here, those who provide help are obliged to receive help from someone. As those who provide and those who receive assistance are both obligated to reciprocate, we call this the "norm of bi-directional debts" (Suzuki et al., 2019). If people act in accordance with this norm, those who provide help are naturally led to actively seek help from someone else. This makes it less likely that help providers and receivers will be bound to fixed roles. In addition, since many people will receive assistance, they will accumulate experiences of being helped. Based on this norm, accepting help will settle a debt for people who previously offered help. The negative connotations of receiving help are expected to vanish for recipients and donors alike. Furthermore, both donors and recipients will look to the group for help in settling their own debts, consequently deepening their understanding of the resources available within the network. Thus, this expanded norm is expected to help the formulation of social capital among learners even if they are embedded in school settings.

The rules of skill exchange, based on the norm of bi-directional debts are summarized below:

A. Those who have received help are "obligated to help someone."
B. Those who have offered help are "obligated to be helped by someone."
C. Those who have fulfilled their obligations will receive credit (those who have received help will receive credit when they help someone; those who have offered help will earn credit when they receive help from someone).
D. The level of difficulty of the assistance and the time required to offer or receive it are irrelevant. These factors will be ignored when fulfilling obligations.

In the list above, Rule A is based on the traditional norm. To this has been added the new Rule B, stipulating that those who offer help are "obligated to be helped by someone." Those who have helped someone must thus seek help in return. Only when this obligation is fulfilled a credit is earned (C). Similarly, those who have received help from someone can only earn credit by helping someone in return (C). The level of difficulty and time involved in helping are irrelevant and thus ignored in this set of rules (D). The credit may take various forms, such as points, tokens, or grades.

To earn credit in accordance with these rules of skill exchange, learners must not only offer significant assistance, but must also find opportunities to rely on others, by paying attention to their surroundings. Naturally, those who have received a favor must think about what they can do for someone else. The more learners try to generate this credit, the more mutual contributions develop within the group. There is no bias attached to providing or receiving assistance. All learners—not just those with higher-level abilities—must offer help because no one can earn credit simply by receiving or providing assistance. Even if pairs of learners who provide and receive

assistance are rewarded with good grades, individuals striving to gain higher grades will expand their network of reciprocal assistance. By engaging in activities based on these rules, learners adopt the norm of bi-directional debts. As a result, they accumulate experiences of being helped on a broad scale. Social capital is thus expected to be created on a large scale within this group of learners.

The rules of mutual assistance proposed here can provide the infrastructure to design learning activities. Various types of cooperative learning can be designed, based on these underlying rules.

Experiment

Using the project type classroom of the university, the effect of mutual assistance based on the bidirectional debt norm was examined. The design of the experimental practice is described below.

Class/Activities

The experimental practice was conducted in the last four frames of the "information media theory" class for university students. 48 second year students were participants of the class. The activity was to make edutainment content (e.g., games, picture books, video works, etc.) which facilitates the transmission of knowledge regarding information theory and information systems that they studied in class to elementary and junior high school students. Although the production work was carried out individually, they were instructed to cooperate with each other over the course of production.

Before performing the experiment, the subjects were randomly divided into two groups of 24 subjects (A and B). The initial state of each group's social network was confirmed through a questionnaire. Specifically, the subjects were asked to answer the following two items: (1) list a group of people you know, and (2) list a group of people that you have talked to. The results of this data's network analysis (Borgatti et al., 2013) are shown in Table 1. The two groups are found to be approximately homogeneous.

Table 1: Initial social network of group A and B

|	1. People you know		2. People you have talked to	
Group	A	B	A	B
Density	0.62	0.63	0.44	0.43
Dyad Reciprocity	0.63	0.68	0.62	0.61

In this experiment, group A was made to be the experimental group and group B was made to be the control group, and they worked in the difference but adjacent classrooms. In the experimental group, the mutual assistance activity was carried out based on the exchange rule inspired by bidirectional debt. In the control group, the mutual assistance activity was carried out based on the general rule that the credit (points) would be acquired when support is provided. Both groups were encouraged to collect as many points as possible.

Application program used in the experiment

In the experimental practice, AssociatingBoard (AB) (Suzuki et al., 2018) was utilized in order to visualize mutual-help activity (see Figure 1 left). AB is an application designed to be used on a smartphone, which records and visualizes support actions and credit acquisition situations. For example, when a learner is assisted by someone else, he or she registers who helped him or her. Then, a treasure box appears on the helper's screen. The key appears on the screen of the recipient of the assistance, i.e., the learner who registered the assistance that they got. When the helper eventually receives help from another person and registers it, a key appears on their screen. When a treasure box and key are paired, the lid of the box opens and a jewel comes out (see column three in Figure 1). In this experiment, group A utilized AB as described above. In group B, the interface was modified to display only a row of treasure boxes (See Figure 1 right). Group A regarded jewels as credit, while group B regarded treasure boxes as credit. Both groups were encouraged to collect as many points as possible.

Measurement of social capital

In this study, the "Acknowledgements for the work" were utilized in order to examine the situation of social capital in each group. In this acknowledgement, the name of the person who cooperated in the production and what they contributed were openly mentioned when the learners submitted their work. Figure 2 shows an example. This description shows the learners' recognition of those who supported their work and what kind of actions they considered as assistance. From this, it is possible to know the extent of the group's support network and better understand the network's resources.
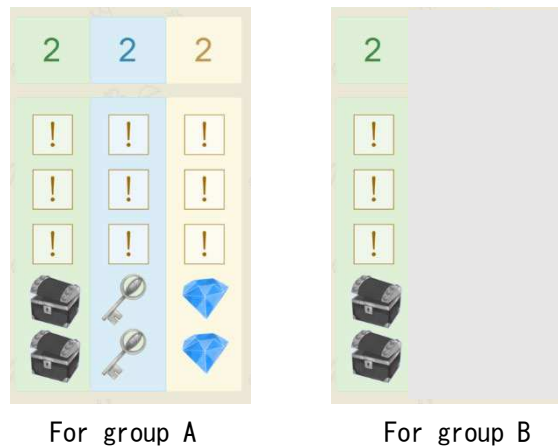
Figure 1. Screen image of AssociatingBoard.

作品クレジット
Acknowledgements

作品名： AI に なってみよう！
Name of the work

氏　名：
Name of the producer

Name of contributors
Content of Contributions

協　力： （助言・撮影） Advice
Thanks to Video Shooting

（作品体験） Test play

（作業援助） Manual aid

Figure 2. An example of the "Acknowledgements for the work".

Result

Analysis of the "Acknowledgements for the work"

Table 2 shows the average number of contributors and the number of contributions in each group. The number of contributors and the number of contributions does not match because more than one contribution may come for a single contributor. All students who did not submit the acknowledgements their work were excluded from the data. Therefore, the table shows the results of 23 students from group A and 22 from group B. The number of collaborators and the number of contributions is more in group A. The t-test showed that these differences were significant at the 1% level.

Table 2: The number of contributors and number of contributions

	Number of Contributors		Number of contributions	
Group	A	B	A	B
Average	3.82	2.00	4.91	2.26
SD	1.65	1.35	2.27	1.63

Next, a network analysis was carried out using the data of the acknowledgements since the data can be represented as a directed graph. Figure 3 illustrate the acknowledgement network of group A and B respectively.
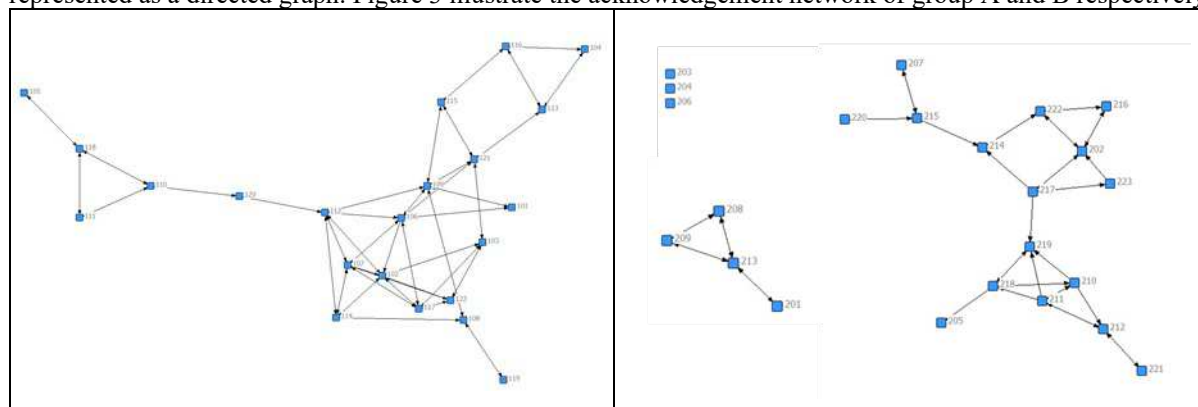

Figure 3. The acknowledgement network of group A(left) and B(right).

Table 3 summarizes several indicators of network status. As for the density (the ratio of the number of bonds actually present to the number of bonds theoretically possible), group A is larger than group B. This implies that the network of group A is more closely connected than that of group B. The reciprocity is also higher in group A. It shows that members of group A have a higher tendency to name each other as contributors. There is no large difference between both groups with respect to the centralization tendency. In this table, "outdegree" means naming others as contributors, and "indegree" means being named as contributors. The 7-10% centralization rate indicates that solely one learner was not a helper or a receiver. The components indicate network fragmentation. From a weak component viewpoint, i.e., considering a one-way connection as being "connected," all the students in group A comprise one network. However, group B is divided into five components.

Table 3: Network analysis of acknowledgements

Group	A	B
Density	0.25	0.10
Dyad Reciprocity	0.95	0.58
Average In/out degree	5.32	2.13
Centralization (Outdegree)	10.83	9.19
Centralization (Indegree)	7.09	6.82
Number of weak components	1	5

The two-step reachability was calculated for every student in order to examine the spread of the aid and aid receiving network. This is the number students that each student can reach within two steps in each group's network, divided by the total number of other students. Group A had a mean of 0.42, which was greater than group B's mean of 0.21. The t-test showed that the difference was significant at the 1% level.

Table 4: Types of contributions

Group	A		B	
Category	Number of counts	Per learner	Number of counts	Per learner
CONS	54	2.45	24	1.04
INF	12	0.55	0	0.00
SOCIO	2	0.09	0	0.00
TEST	30	1.36	6	0.26
MATOOL	5	0.23	7	0.30
WORK	14	0.64	12	0.52

The contributions were then categorized and counted. The results are shown in Table 4. "CONS" stands for consultation and the offering of ideas, and the "INF" category indicates information provision. Only group A mentioned contributions such as "they showed me their piece of work" or "they let me try the games they made." We thus categorize these contributions as a distinct category called INF. This is because these activities only provided only a small amount of information and were different from active consultation activities, such as those categorized as CONS. "SOCIO" stands for making the atmosphere of the field, "TEST" stands for testing the game or trial viewing the work, "MATOOL" stands for providing materials and tools, and "WORK" stands for assisting in manual work.

To summarize, CONS and TEST are predominant in group A. MATOOL was slightly more common in group B. INF and SOCIO appeared only in group A.

Analysis of system log

Based on the system log, the mutual assistance activity in each group is analyzed. Table 5 presents an analysis of the aided and aided networks that appeared in the log. The density shows that the networks of the actual assisted and assisted activities in group A are more tightly connected than those in group B. The interconnectedness suggests that group A performed more mutually supportive activities. There is no difference in the centralization tendency between both groups in the entry order, and group A rises in the exit order.

Table 5: Network analysis of system log

Group	A	B
Density	0.29	0.16
Dyad Reciprocity	0.87	0.63
Average In/Out degree	6.75	3.63
Centralization (Outdegree)	6.58	3.83
Centralization (Indegree)	9.30	9.50
Number of weak components	2	4

The density shows that the network of actual helping activities of group A are more tightly connected than that of group B. The reciprocity suggests that members of group A were more mutually supportive in their activities. There is no difference in the indegree centralization tendency between both groups, while in outdegree centralization, group A was higher than that of group B. It can thus be said that there was a relative bias in receiving help from people. An analysis of the weak components shows that there are two components in group A and four in group B.

Discussion

From the analysis of the students acknowledgements for their work, it was proven that the students of group A recorded more cooperators and contributions. In the network analysis, it was shown that the network density of group A was high. The density depicts the speed and extent of information transmission, and it is regarded as one of the indexes of social capital. From the above, it can be inferred that a larger cooperation network was recognized in group A. The acknowledgements describe contributors to the work, which generally overlap with the aid networks available to learners in the future. Thus, it can be said that the introduction of the bi-directional debt norm was effective in terms of expanding the network, which is a component of social capital.

The results of the category analysis of the content of the contributions show that INF and SOCIO appeared only in group A. This indicates that the students in group A are cognizant of more types of aid in their activity. It illustrates the effectiveness of the network in providing help. These results suggest that the introduction of the bi-directional debt norm improved the effectiveness of the network.

Most of the assistance categorized as INF were cases of students "showing their work" to another. The tendency to consider that kind of effortless behavior as "assistance" may be the result of a scheme to easily obtain points under the bi-directional debt rules. However, even if that is the case, acknowledging this light assistance implies that the learner believed it contributed toward the completion of their work. That is to say, even if the acknowledgement was forced by the rule, the action actually contributed to the work, and the student who showed their work was recognized as a contributor. It can thus be said that the introduction of the bi-directional debt norm led the learners to positively recognize each other's contributions.

From the result of network analysis, it is proven that more aid-oriented relationships were constructed in group A. This means that the learners in group A may have obtained a stronger sense of aid circulation, which is the feeling of being able to rely on someone anytime. This is the basis of the trust that Putnam has listed as a component of social capital. With respect to networks and trust, it can be said that the bi-directional debt norm worked effectively.

The log analysis of the system shows that more exchanges of aid occurred in group A and that they were reciprocal. The high degree of reciprocity is thought to have been created by aiming to obtain more points as per the bi-directional debt rules. The positive mutual assistance that was promoted in compliance with the bi-directional debt norm is considered to be the cause of the development of Group A's social capital.

As described above, by conducting assistance activities in accordance with the bi-directional debt rules, a large number of mutual assistance exchanges inevitably occurred, which led to the formation of a wide and highly effective network and the fostering of trust. These are components of social capital.

Here, the problem concerning this system will be discussed. First, a problem to give the point to the aiding action is going to be considered. This problem can be divided into the aspect on the continuity of learning effect and psychological discomfort. The problem on the continuity of learning effect can be pointed out from the behaviorist viewpoint. If the "point" is considered as a reinforcement stimulus, what we carried out in the experiment can be regarded as a continuous reinforcement of assistance behavior. Some studies of behaviorism have shown that continuous reinforcement has weak resistance to extinction. That is to say, it can be predicted that the frequency of the target action decreases as soon as the point is not obtained.One answer to such criticism is that even if it is a outcome of point-based reinforcement, it is certain that learners' networks and knowledge about resources on the network is formed and accumulated through mutual assistance activities based on the bidirectional debt rule. If this is the case, the likelihood of mutual helping actions being taken will be higher in comparison to the control group when point-based reinforcement is stopped.However, in this study, the long-term effect has not been examined, and it is a future problem. Especially, it is necessary to examine in detail the change of the assistance action of the learner when the point system was stopped.

The psychological discomfort is based on the feeling that the learner is forced to help someone by the point system. This may deprive learners of the sense of voluntary participation and give them feeling that they are carrying out assistance activities without necessity for the sake of points. Such psychological discomfort produced by to the point system has been pointed out in the previous experiment (Suzuki et al. 2019). It was equally observed in both groups. However, only the learners in the control group expressed their feelings of distrust toward the exchange system. The followings are the comments from students from group B.

The one offering help is positioned as the superior. If the positions were equal, it would be much better.

I kind of felt that the benefit for the person giving away "Thank You card" (note: the supported learner) obtained lower evaluation than the other (note: the supporting learner).

The above descriptions can be regarded as an expression of the psychological discomfort of establishing the superiority of "the person who helped me" through receiving help and as a result placing oneself in a relatively inferior position. In the control group, a simple reward system was introduced in which points are earned by helping others. Here, the more one helps people, the more points one is able to get. If you think that getting points is valuable, the learners who tend to receive help are placed in a relatively low position. Thus, learners who realize this could have had become reluctant to ask for help. In comparison, the situation where points are earned based on bi-directional debt rules is "peaceful". In other words, it prevents people from gaining points by unilaterally helping someone, and it also prevents people from exploiting resources of others by unilaterally relying on others without giving them. Although both groups have the same problem in terms of the sense of discomfort due to the point system, the bi-directional debt rule can prevent the learners who have competence to help others from monopolizing points, that is, evaluation.

The second problem is the grain size of assistance. In this practice, the size of the aid which should be input to the AssociatingBoard system was not controlled. It is the same in the experimental group as in the control group. The students were instructed to input assistance information into the system when they simply thought "Thank you for your help.". They were instructed that there was no need to worry about the balance of the time it took to help and the level of skills needed to help. This meant that several minutes of consulting and simple assistance in cutting paper would both be treated as the same weight. There would be possibility that this may causes some sense of unfairness among learners. Therefore, it is necessary to examine the effect of the size of assistance on learning in detail in future. However, the authors consider forming learning association, in which

learners provide what they can offer and obtains the assistance they need, as the ideal of mutual assistance in the classroom, and in that sense, we would say that it might be better to avoid the unification of the size of assistance.

Creating the learning association, that is to say non-capitalist foundation of mutual aid) is one direction of school reform. In general, schools are places where teachers evaluate students' behavior and performance. If teachers value and award learners who help others, competent and sociable learners will be frantic to try to stay on the "helper" side. Therefore, learners who fail to do so will be placed in subordinate position relatively. It may be fair to say that when the act of "help others", which is naturally good deed, is entangled in the school evaluation, it becomes violence. The point system of the control group simulates this reality of school. Since such a structure is incorporated in school, it is difficult to overcome it while staying in school. No matter how artfully the design of the activity is devised, when it is introduced into the classroom, that is to be incorporated into the system of the school-like evaluation, as a result , the competition of point acquisition occurs, and then the learners are divided into "who have" and "who do not have". The concept of mutual assistance based bi-directional debt suggests one direction for resisting the transformation of mutual assistance activities into violence against others. This is because this rule inevitably leads learners to change role in the mutual assistance activity. Consequently, it can be said that the concept of bi-directional debt has the potential to reform schools from the direction of exchange systems.

Conclusion

In this study, we proposed the concept of bi-directional debt and a mutual assistance rule based on it, aiming to form social capital within a group of learners. The mutual assistance rules under the bi-directional debt norm gives a person who is aided by someone an "obligation to help someone," while giving the person who aides someone an "obligation to receive help from someone." The introduction of this rule into the project type cooperative learning and the verification of its effects indicated that this rule was effective for social capital formation in the classroom. Future studies should be conducted along the following research avenues. First, the problem of the domain specificity and transferability of the social capital formed through a particular activity should be explored. Second, studies should undertake long-term effect verification. Third, a review on the social capital measurement technique should be undertaken. Finally, the visualization system should be evaluated and improved.

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