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COMMUTER BRIDGE

A Braess Paradox Simulation to Teach Social Dilemmas

Abstract

COMMUTER BRIDGE is a n-person social dilemma game that allows participants to experience situations in which individual rationality leads to collective disaster. Participants are asked to imagine they are commuters who must every day reach a place in the shortest possible time. The game is divided in two phases: in the first phase, participants can choose between two routes whereas in the second phase they are given a third possibility by the construction of a bridge that, paradoxically, increases traffic. Participating in this activity will enhance understanding of social dilemmas, help discover the limitations of communications, and develop insights about personal fallacies in strategic reasoning.

Basic data

L*earning objectives*

- Examine the challenges of tacit negotiation
- Experience the difficulties of cooperation in social dilemmas
- Develop strategies to enforce non-binding agreements in social dilemmas

Simulation-game objectives: to gain a maximum number of points

Debriefing formats: open discussion supported by presentation

Target audience: students with a background in social science, management and economy, and anyone interested in social dilemmas.

Playing time: about 40 minutes

Debriefing time: 30 minutes

Number of players required: 4-30

Other materials/equipment required: whiteboards or blackboards to write instructions and report results, a set of answer cards, and worksheets to compute the payoff.

Introduction

COMMUTER BRIDGE is a game based on the Braess paradox (1968). COMMUTER BRIDGE allows the participation of large groups in which participants make their choices individually rather than in groups. For this reason, an activity based on the dynamics of the Braess paradox is particularly suitable to describe the collective damaging effects of social dilemmas (Kollock 1998), and the main constraints of situation of tacit negotiation (Thompson 2012). The Braess paradox is defined as the counter-intuitive phenomenon in which the introduction of a route in a traffic network leads to a traffic increase rather than a decrease (Braess, 1968). On Earth Day in 1990 New York's 42nd Street was closed for a parade (Kolata, 1990) and in 1999, due to maintenance, they shut down one of the three main traffic tunnels in South Korea's capital city (Vidal, 2006). Although both routes were heavily used for traffic, that traffic flows improved in both cases. For further details the reader may refer to Braess (1968), Rapoport, Kugler, Dugar and Gisches (2009), or Dal Forno and Merlone (2013).

In this activity, participants are asked to play the role of commuters who must each day choose among different routes to get from their home to their office. Each route has different travel times and the goal of the activity is to reach the OFFICE in the shortest possible time.

The activity is divided in two phases:

- in the first phase (*basic network*) participants can choose between two possible routes: *River road* and *Lake road*. Both routes are divided in two links: the route *Like road* consists of the links HOME-LAKE and LAKE-OFFICE while the *River road* consists of the links HOME-RIVER and RIVER-OFFICE. The links HOME-LAKE and RIVER-OFFICE depends on congestion whereas the links HOME-RIVER and LAKE-OFFICE have a constant travel time of 28 minutes (Figure 1).

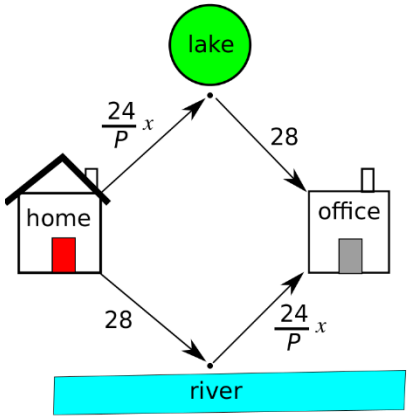

Figure 1. Basic network

- In the second phase (*augmented network*), participants are given a third possible choice provided by a bridge between the point LAKE and the RIVER. The travel time of this bridge is one minute and is not affected by congestion (Figure 2).

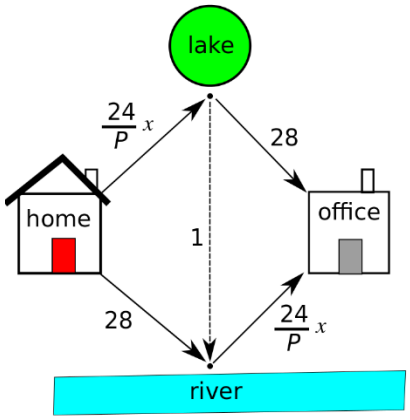

Figure 2. Augmented network

COMMUTER BRIDGE can be used in courses on social dilemmas and tacit negotiation. It can be interesting to use this simulation after participants have experienced a two-person prisoner's dilemma. In this way, participants can better understand the different dynamics and constraints underlined by large-group dilemmas.

Activities requiring two participants are the most common among negotiation courses. Among these types of exercises, we can find those based on two-person prisoner's dilemmas. Although for these activities it is possible to consider two groups rather than two persons, the dynamics remains related to the two-person interaction.

This ready-to-use simulation offers a social dilemma exercise that both works with several participants and is manageable enough to be used with little preparation. The Facilitator guide includes a completed example, not be shown to participants.

Facilitator's guide

The activity is played in 16 turns divided into two phases: eight turns in the *basic network* phase and eight turns in the *augmented network* phase. The simulation can be played by different sized groups. Required materials consist of a set of answer cards, a worksheet to compute the payoffs, and a whiteboard or blackboard to report results.

Materials

- Set of answer cards

The set of answer cards consists of 16 cards on which, at each turn, participants write the route they have selected (the cards are ready to be printed in Appendix B).

- Worksheet to compute payoffs (Appendix A)

A worksheet to compute payoff helps the facilitator manage the game

A spreadsheet program can be downloaded from: INSERT LINK. This will be added when the paper is published. FOR REVIEWERS SEE THE ATTACHED FILE.

- Whiteboard or blackboard

The basic network, the augmented network and the travel time of participants are written on a whiteboard or blackboard. An example of the payoff table is shown in Appendix A and in the completed example.

Operation instructions

- Distribute the participants instructions for Phase 1 (Appendix A), then draw the basic network on a whiteboard. Make sure that each participant has understood the instructions. Several examples can be provided for a better understanding of the game.
- Read aloud Phase 1 Participants' instructions
- Distribute the set of answer cards.
- Participants accumulate points by reducing the time taken to reach OFFICE. To provide some external motivation, points can either give participants extra class credits or be used to win a prize.
- Explain to the participants how their results will depend on both their decisions and those made by the other participants.

Phase 1: Basic network

Participants play the basic network phase for eight silent rounds: they cannot talk during the exercise. It can be useful to have a practice round or two to help the participants understand the game mechanics.

For each of eight turns, the participants simultaneously express their choice on separate cards.

At the end of each turn, the cards are collected by the Facilitator, and payoffs for each routes are announced and written on the whiteboard. To speed up the game management, ask one person to collect the cards, and another to enter the data into the worksheet. Do not erase the outcome matrix. It will be used to explain the dynamics of the game during Debriefing. Never answer questions asking advice on how to make decisions or choices during the game play.

Phase 2: Augmented network

The augmented network works like the basic network, with the addition of one route. Distribute the participants instructions for phase 2 (Appendix C).

A few practice rounds can again be run to help participants understand the game mechanics. No communication among participants is allowed. As a variant, participants may be given 10/20 minutes to discuss and negotiate a possible strategy. According to Susskind (2004), multiparty negotiations have several problems, such as the presence of subgroups, the discussion of multiple issues, and agreement on decision-making rules. If some participants ask questions that can affect the dynamics of the game, they should be postponed to the debriefing session. Although in this phase the interaction is supposed to be silent, often participants may comment and express their frustration. Unless these comments disrupt the interaction dynamics, they can be tolerated . Figures 3, 4 and 5 provide a completed example with 30 participants. Participants' choices for phases 1 and 2 are reported in Figures 3 and 4 respectively and allow computing travel times. These are summarized in the payoff tables reported in Figure 5.

PARTICIPANTS CHOOSING LAKE ROAD				
TURN		NUMBER		TOTAL TRAVEL TIME LAKE
1	$\frac{\text{ן}}{\text{ן}}$ × (	9	)+28=	35.2
2	$\frac{\text{ן}}{\text{ן}}$ × (	19	)+28=	43.2
3	$\frac{\text{ן}}{\text{ן}}$ × (	17	)+28=	41.6
4	$\frac{\text{ן}}{\text{ן}}$ × (	17	)+28=	41.6
5	$\frac{\text{ן}}{\text{ן}}$ × (	19	)+28=	43.2
6	$\frac{\text{ן}}{\text{ן}}$ × (	12	)+28=	37.6
7	$\frac{\text{ן}}{\text{ן}}$ × (	19	)+28=	43.2
8	$\frac{\text{ן}}{\text{ן}}$ × (	19	)+28=	43.2

PARTICIPANTS CHOOSING RIVER ROAD				
		NUMBER		TOTAL TRAVEL TIME RIVER
28+	$\frac{\text{ן}}{\text{ן}}$ × (	21	)=	44.8
28+	$\frac{\text{ן}}{\text{ן}}$ × (	11	)=	36.8
28+	$\frac{\text{ן}}{\text{ן}}$ × (	13	)=	38.4
28+	$\frac{\text{ן}}{\text{ן}}$ × (	13	)=	38.4
28+	$\frac{\text{ן}}{\text{ן}}$ × (	11	)=	36.8
28+	$\frac{\text{ן}}{\text{ן}}$ × (	18	)=	42.4
28+	$\frac{\text{ן}}{\text{ן}}$ × (	11	)=	36.8
28+	$\frac{\text{ן}}{\text{ן}}$ × (	11	)=	36.8

Figure 3. Worksheet tables for the worked example with 30 participants (phase 1).

PARTICIPANTS CHOOSING LAKE ROAD							
TURN		NUMBER OF PARTICIPANTS CHOOSING LAKE		NUMBER OF PARTICIPANTS CHOOSING BRIDGE		TOTAL TRAVEL TIME LAKE
9	$\frac{24}{30}$	× (5	+	21	)+28=	48.8
10	$\frac{24}{30}$	× (3	+	24	)+28=	49.6
11	$\frac{24}{30}$	× (2	+	25	)+28=	49.6
12	$\frac{24}{30}$	× (0	+	28	)+28=	50.4
13	$\frac{24}{30}$	× (0	+	30	)+28=	52
14	$\frac{24}{30}$	× (0	+	29	)+28=	51.2
15	$\frac{24}{30}$	× (1	+	29	)+28=	52
16	$\frac{24}{30}$	× (0	+	30	)+28=	52

PARTICIPANTS CHOOSING RIVER ROAD						
		NUMBER OF PARTICIPANTS CHOOSING RIVER		NUMBER OF PARTICIPANTS CHOOSING BRIDGE		TOTAL TRAVEL TIME RIVER
28+	$\frac{24}{30}$	× (4	+	21	)=	48
28+	$\frac{24}{30}$	× (3	+	24	)=	49.6
28+	$\frac{24}{30}$	× (3	+	25	)=	50.4
28+	$\frac{24}{30}$	× (2	+	28	)=	52
28+	$\frac{24}{30}$	× (0	+	30	)=	52
28+	$\frac{24}{30}$	× (1	+	29	)=	52
28+	$\frac{24}{30}$	× (0	+	29	)=	51.2
28+	$\frac{24}{30}$	× (0	+	30	)=	52

PARTICIPANTS CHOOSING BRIDGE												
	NUMBER OF PARTICIPANTS CHOOSING LAKE		NUMBER OF PARTICIPANTS CHOOSING BRIDGE					NUMBER OF PARTICIPANTS CHOOSING RIVER		NUMBER OF PARTICIPANTS CHOOSING BRIDGE	TOTAL TRAVEL TIME LAKE-RIVER
$\frac{\text{И}'}{\text{Т}'}$ × (	5	+	4)	+	1	+	$\frac{\text{И}'}{\text{Т}'}$ × (	4	+	21) =	41.8
$\frac{\text{И}'}{\text{Т}'}$ × (	3	+	3)	+	1	+	$\frac{\text{И}'}{\text{Т}'}$ × (	3	+	24) =	44.2
$\frac{\text{И}'}{\text{Т}'}$ × (	2	+	3)	+	1	+	$\frac{\text{И}'}{\text{Т}'}$ × (	3	+	25) =	45
$\frac{\text{И}'}{\text{Т}'}$ × (	0	+	2)	+	1	+	$\frac{\text{И}'}{\text{Т}'}$ × (	2	+	28) =	47.4
$\frac{\text{И}'}{\text{Т}'}$ × (	0	+	0)	+	1	+	$\frac{\text{И}'}{\text{Т}'}$ × (	0	+	30) =	49
$\frac{\text{И}'}{\text{Т}'}$ × (	0	+	1)	+	1	+	$\frac{\text{И}'}{\text{Т}'}$ × (	1	+	29) =	48.2
$\frac{\text{И}'}{\text{Т}'}$ × (	1	+	0)	+	1	+	$\frac{\text{И}'}{\text{Т}'}$ × (	0	+	29) =	48.2
$\frac{\text{И}'}{\text{Т}'}$ × (	0	+	0)	+	1	+	$\frac{\text{И}'}{\text{Т}'}$ × (	0	+	30) =	49

Figure 4. Worksheet tables for the worked example with 30 participants (phase 2).

[Sim... ...for each column, you need c... ...n

	Lake	River
Day 1	35.2	44.8
Day 2	43.2	36.8
Day 3	41.6	38.4
Day 4	41.6	38.4
Day 5	43.2	36.8
Day 6	37.6	42.4
Day 7	43.2	36.8
Day 8	43.2	36.8

	Lake	Bridge	River
Day 9	44.8	41.8	48
Day 10	49.6	44.2	49.6
Day 11	49.6	45	50.4
Day 12	50.4	47.4	52
Day 13	52	49	52
Day 14	51.2	48.2	52
Day 15	52	48.2	51.2
Day 16	52	49	52

9

Figure 5. Payoff tables for the completed example with 30 participants.

Debriefing section

Begin the debriefing with questions on personal sensations, emotions and thoughts experienced during the game. Possible questions include:

Did the participants notice the degrading collective performance?

Did they understand the payoffs structure?

Did someone think that the goal of the game was to earn more than others?
Did anyone feel frustrated during the negotiations?
Did anyone see collective trap of the game?

Always give the participants the opportunity to express feelings or raise questions. The Facilitator can underline the point that the poor performance of the collectivity is typical of negotiation games, and it does not reflect on their talents or competence.

Once the Debriefing is over, it is possible to explain tacit negotiation, to present the main features of social dilemmas, and to show the applications to real world negotiations. The meaning of the Braess paradox can now be discussed, and clarified, using the game experience.

Conclusion

In our experience, participants reaction has always been positive, as this game allows the experience of the complex dynamics of large group negotiation. In our experience, this activity, especially when run with large groups may be an occasion to simulate the main dynamics of social dilemmas and difficulties of managing group interactions (Susskind 2004). The capacity to make possible an interaction among several participants, the short time required and the focus on constraints of social dilemmas are the main strong points of this ready-to-use-game. This tool can increase

participants' skill, awareness, and competence against the negative consequences of competition. Finally, it shows how failing to find an enforceable agreement among the parties means leaving money on the table. COMMUTER BRIDGE is a negotiation exercise for large groups, and provides an activity suitable when the class size is large and few teaching assistants are available (Patton 1995). In the future, we plan to create more social dilemma games which can be run with groups of different sizes.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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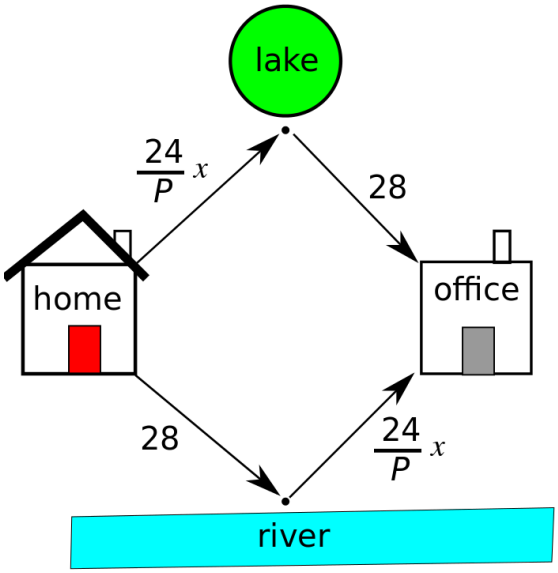
Appendix A

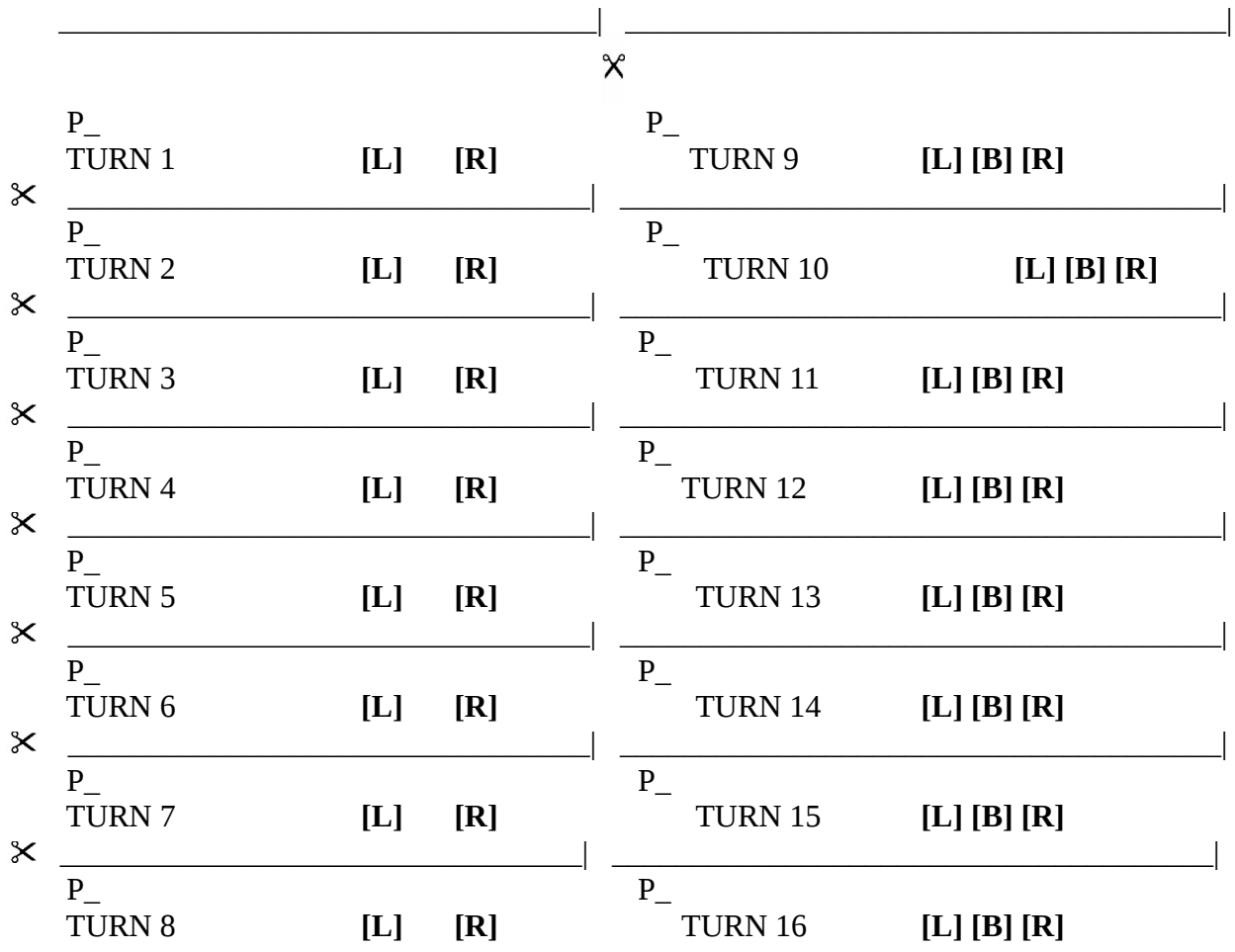
Phase 1: participants' instructions



- Imagine you are a commuter who must travel every day from your HOME to your OFFICE. You can choose two possible routes: one is the LAKE ROAD and the other one is the RIVER ROAD.
- Your goal is to reach your OFFICE in the shortest possible time.

- RIVER ROAD and LAKE ROAD consist both of two segments: for the first one travel time is always 28 minutes, and the other one it depends on the traffic congestion in the route.
- Let P be the number of commuters who will be on the route at the same time. If you choose the LAKE ROAD route, the section from HOME to LAKE ROAD has a travel cost of 24/P minutes times every commuters in that section; the section from LAKE ROAD to OFFICE has a constant travel time of 28 minutes.
- If you choose the RIVER ROAD route, the section from HOME to RIVER ROAD takes a constant travel cost of 28 minutes and the section from RIVER ROAD to OFFICE takes a travel time of 24/P multiplied by every commuter in that section.
- You will accumulate points depending on how much time you have saved
- You cannot communicate with other participants

Appendix B: ***Set of answer slips to be given to the participants***



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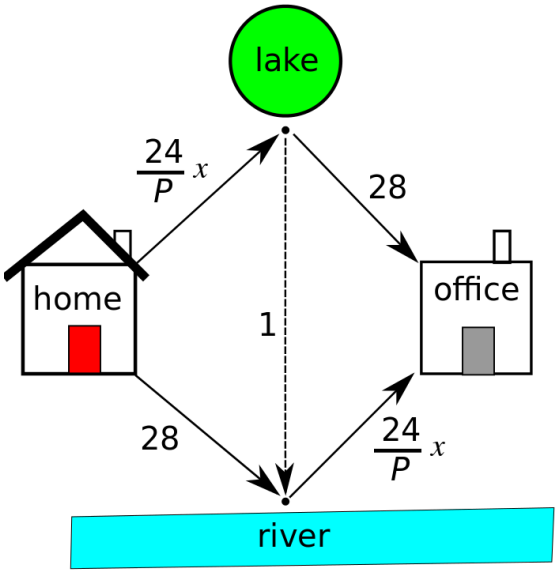
Appendix C

Phase 2: participants' instructions



- A bridge with a constant travel time of 1 minute has been built from LAKE ROAD to RIVER ROAD. You have now another way to reach your OFFICE from your HOME. The new choice (RIVER-LAKE ROAD) consists of three parts, the first segment of the route HOME to LAKE

ROAD, the BRIDGE, and the second segment of RIVER to OFFICE route. The travel costs of other choices, LAKE ROAD and RIVER ROAD, remain the same as in the Basic Phase

- You goal is to reach your OFFICE in the shortest possible time.

Appendix D

Worksheets phase 1

PARTICIPANTS CHOOSING LAKE ROAD				
TURN		NUMBER		TOTAL TRAVEL TIME LAKE
1	' И — × (		)+28=	
2	' И — × (		)+28=	
3	' И — × (		)+28=	
4	' И — × (		)+28=	
5	' И — × (		)+28=	
6	' И — × (		)+28=	
7	' И — × (		)+28=	
8	' И — × (		)+28=	

PARTICIPANTS CHOOSING RIVER ROAD				
		NUMBER		TOTAL TRAVEL TIME RIVER
28+	' И — × (		)=	
28+	' И — × (		)=	
28+	' И — × (		)=	
28+	' И — × (		)=	
28+	' И — × (		)=	
28+	' И — × (		)=	
28+	' И — × (		)=	
28+	' И — × (		)=	

Worksheets phase 2

PARTICIPANTS CHOOSING LAKE ROAD							PARTICIPANTS CHOOSING RIVER ROAD						
TURN		NUMBER OF PARTICIPANTS CHOOSING LAKE		NUMBER OF PARTICIPANTS CHOOSING BRIDGE		TOTAL TRAVEL TIME LAKE			NUMBER OF PARTICIPANTS CHOOSING RIVER		NUMBER OF PARTICIPANTS CHOOSING BRIDGE	TOTAL TRAVEL TIME RIVER
9	$\frac{24}{--}$	× (		+		)+28=		28+ $\frac{24}{--}$ × (		+	)=	
10	$\frac{24}{--}$	× (		+		)+28=		28+ $\frac{24}{--}$ × (		+	)=	
11	$\frac{24}{--}$	× (		+		)+28=		28+ $\frac{24}{--}$ × (		+	)=	
12	$\frac{24}{--}$	× (		+		)+28=		28+ $\frac{24}{--}$ × (		+	)=	
13	$\frac{24}{--}$	× (		+		)+28=		28+ $\frac{24}{--}$ × (		+	)=	
14	$\frac{24}{--}$	× (		+		)+28=		28+ $\frac{24}{--}$ × (		+	)=	
15	$\frac{24}{--}$	× (		+		)+28=		28+ $\frac{24}{--}$ × (		+	)=	
16	$\frac{24}{-}$	× (		+		)+28=		28+ $\frac{24}{-}$ × (		+	)=	

PARTICIPANTS CHOOSING BRIDGE												
	NUMBER OF PARTICIPANTS CHOOSING LAKE		NUMBER OF PARTICIPANTS CHOOSING BRIDGE						NUMBER OF PARTICIPANTS CHOOSING RIVER		NUMBER OF PARTICIPANTS CHOOSING BRIDGE	TOTAL TRAVEL TIME LAKE-RIVER
' И / [illegible] × (		+	)	+	1	+	' И / [illegible]	× (		+	)=	
' И / [illegible] × (		+	)	+	1	+	' И / [illegible]	× (		+	)=	
' И / [illegible] × (		+	)	+	1	+	' И / [illegible]	× (		+	)=	
' И / [illegible] × (		+	)	+	1	+	' И / [illegible]	× (		+	)=	
' И / [illegible] × (		+	)	+	1	+	' И / [illegible]	× (		+	)=	
' И / [illegible] × (		+	)	+	1	+	' И / [illegible]	× (		+	)=	
' И / [illegible] × (		+	)	+	1	+	' И / [illegible]	× (		+	)=	
' И / [illegible] × (		+	)	+	1	+	' И / [illegible]	× (		+	)=	

Appendix E

Example of tables for the instructor to display collective scores in the phase 1 (basic network), and in the phase 2 (augmented network).

	Lake	River
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		
Day 6		
Day 7		
Day 8		

	Lake	Bridge	River
Day 9			
Day 10			
Day 11			
Day 12			
Day 13			
Day 14			
Day 15			
Day 16			