Reward Contingencies and Student Interactions that Contribute to the Success of Cooperative Learning Groups

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Abstract

This study was conducted with students taking the EDPY 210 course in the Fall Semester of 2017 (total N = 142, range of ns in the six sections of the course = 16-30). The purpose of the study was two-fold: (a) examine changes in exam scores and earned bonus credit for exam performance under two cooperative reward contingencies (i.e., group only contingency versus individual plus group contingency) and (b) two different sequences of implementing these contingencies. Additionally, the research team examined the effects of the two independent variables on the nature and frequency of communication in cooperative study sessions. Participants used a free messaging tool (i.e., GroupMe) to interact with group members.

Several two-way mixed designs first determined the significance of differences in exam scores and extra credit earned under the two cooperative contingencies and the sequence in which those contingencies were presented. Results indicated significant interactions for both exam performance and extra credit under the two independent variables. The significant interaction ($p < 0.00$) and follow up simple effects showed that students who experienced the group only contingency after the individual plus group contingency scored significantly higher on both exams and extra credit than those who experienced the group only contingency before the individual plus group contingency. Furthermore, students under the individual plus group contingency did not differ significantly under the two treatment sequences.

The pattern of significance for the communication scores (i.e., planning. social, and on-ask communication) showed the interaction effects to be somewhat different from those obtained for exam scores and extra credit. Planning ($p = 0.001$) and social ($p = 0.013$) communication were greater when the individual plus group contingency came before the group only

contingency. Overall, the effects of the two contingencies depended on the sequence in which those contingencies were implemented.

Table of Contents

Chapter I Introduction and Literature Review……...1

The Nature and Effects of Cooperative Learning.....1

Theoretical Foundation.....1

Previous Research.....3

Technology and Cooperative Learning 7

Classical Communication 8

Micro-blogging 9

Mobile Devices.....10

Purpose of the Study.....11

Chapter II Methodology 13

Participants 13

Procedures.....13

Cooperative Groups 13

Reward Contingencies 14

GroupMe.....16

Record of Out-of-Class Group Meetings.....17

Chapter III Results of the Study 19

Analysis Plan 19

Preliminary Analysis 20

Primary Analyses.....20

ANOVAs 20

Correlations 22

Chapter IV Discussion 23

Implications of Findings 23

Limitations 25

Concluding Comments 26

List of References 28

Appendices 32

Vita 58

List of Tables

Table A1 Individual Credit Criteria……...……33

Table A2 Group Credit……...…….……..34

Table A3 Group Only Credit……..…….....35

Table B1 Question Communication Scoring Guidelines...…….….....38

Table B2 Response Communication Scoring Guidelines……..……39

Table B3 On-Task Scoring Guidelines……...……...39

Table B4 Planning Communication Scoring Guidelines…….…..39

Table B5 Social Communication Scoring Guidelines……...……40

Table B6 Overall Communication Scoring Guidelines……..…….....40

Table B7 Out-of-Class Self-Report Questionaire….....41

Table C1 Mean Critical Thinking Percentile Scores across Sections and Reward Contingency Treatment Sequences.……..……... ……..…42

Table C2 Cooperative Group Contingency Flow Chart.……...……...…….43

Table C3 Mean Exam Performance Scores across Course Sections and Reward Contingencies within Sections……..…….……...……44

Table C4 Mean Extra Credit across Course Sections and Reward Contingencies within Sections...……..…….45

Table C5 Mean Exam Performance Scores across Reward Contingency Treatment Sequences..46

Table C6 Mean Extra Credit Earned across Reward Contingency Treatment Sequences…...……...…… 46

Table C7 Mean Question Communication Scores across Course Sections..... 47

Table C8 Mean Response Communication Score across Course Sections.....47

Table C9 Mean Planning Communication Scores across Sections.....48

Table C10 Mean Social Communication Scores across Course Sections.....48

Table C11 Mean On-Task Communication Scores across Course Sections.....49

Table C12 Mean Overall Communication Scores across Course Sections.....49

Table C13 Mixed Design ANOVA comparing Exam Scores under each Reward Contingency.....50

Table C14 Exam Scores Main and Interaction Effects across Treatment Variables 50

Table C15 Mixed Design ANOVA comparing Extra Credit Earned under each Reward Contingency.....50

Table C16 Extra Credit Main and Interaction Effects across Treatment Variables 51

Table C17 Mixed Design ANOVA comparing Planning Communication Scores under each Reward Contingency.....51

Table C18 Planning Communication Main and Interaction Effects across Treatment Variables.....52

Table C19 Mixed Design ANOVA comparing Social Communication Scores under each Reward Contingency.....52

Table C20 Social Communication Main and Interaction Effects across Treatment Variables……..….53

Table C21 Mixed Design ANOVA comparing On-Task Communication Scores under each Reward Contingency...……...53

Table C22 On-Task Communication Main and Interaction Effects across Treatment Variables……...….54

Table C23 Correlations between On-Task, Planning, and Social Communication Scores across Mean Exam Scores and Extra Credit Earned under each Reward Contingency.……..54

Table C24 Correlations between Unit Exam Scores and Extra Credit Earned under the Individual plus Group Contingency…….……...55

Table C25 Correlations between Unit Exam Scores and Extra Credit Earned under the Group Only Contingency……..……...56

Chapter I

Introduction and Literature Review

Cooperative and collaborative learning are instructional strategies commonly used to promote social interdependence among students. Cooperative learning refers to a direct and systematic approach that encourages groups of students to work together to achieve a specific goal (Slavin, 1980). In contrast, collaborative learning is a student-directed approach that allows students to self-direct their learning process (Pantiz, 1999). Although there is debate regarding the nuance between cooperative and collaborative learning, these terms are often used interchangeably. For this research, cooperative learning is exclusively used in describing group activity. This notion is operationalized as a systematic method to promote interactions among students to achieve a mutual academic goal.

The Nature and Effects of Cooperative Learning

Theoretical Foundation

The effectiveness of cooperative learning as an instructional strategy is due to its solid theoretical, empirical, and contextual support in promoting academic achievement for low-, average-, and high-performing students (Johnson, Johnson, & Smith, 1998; 2014). This instructional strategy intersects with three theoretical perspectives on learning: (a) social interdependence, (b) cognitive-developmental theory or constructivism, and (c) behaviorism. Social interdependence theory describes learning as the process by which interaction with others obstructs or facilitates obtaining a mutual goal (Johnson et al., 1998). This interaction can either promote positive interdependence (i.e., students helping each other) or negative interdependence

(i.e., students working against one another). Cooperative learning evokes positive interdependence due to individuals' giving and receiving assistance to obtain a mutual reward.

Constructivist theorists perceive that peer interactions facilitate cognitive development (Johnson et al., 1998). Within the cooperative learning literature, theorists Piaget and Vygotsky both claim that learning is the by-product of students' social interactions and that learning is the product of challenging students' current beliefs (Schunk, 2012). Cooperative learning provides opportunities for students to learn social skills, problem solve, and deepen their understanding of learned material. As an example, a high-performing student would clarify a difficult concept for a lower-performing student. As a result, high-performing and low-performing students deepen their understanding of course concepts to obtains (e.g., extra credit points, team recognition).

Elements of behaviorism are also incorporated within the cooperative learning framework. Authority structure, task structure, and reward structure are essential elements in effective cooperative learning frameworks (Slavin, 1980). Authority structure refers to the amount of autonomy the cooperative group has in accomplishing a task. For college students, authority is established within groups to coordinate how to complete a task or how to utilize the group to achieve a common goal. As an example, individual groups may choose different communication methods (e.g., discussion boards, text messages) or logistical strategies in using their group (e.g., study groups, homework assistance).

Task structure refers to the specific activity (e.g., group paper, exam performance) addressed in cooperative learning. Researchers have established that task structure influences cooperative learning outcomes less than reward structure (Slavin, 1983; 1987; 1991). Reward structure is described as the possible incentives and reward contingencies that motivate students

to work toward a common goal. Behaviorists regard learning as resulting from environmental events that reinforce specific behaviors. Thus, students strive to achieve a mutual goal to obtain access to grades, praise, or tangible rewards (e.g., extra credit points).

Overall, the three basic elements of cooperative learning (positive interdependence, peer interactions, and incentives) are associated with specific theoretical philosophies of learning. The theoretical trends predominately focus on the notion of social interactions and the use of reinforcers. However, the theoretical notions of social interdependence and constructivism originated prior to the digital age. Thus, there is limited research addressing the differences that mobile learning (i.e., m-learning) has on promoting positive interdependence in cooperative learning. The current research examines the theoretical implications of cooperative learning in the digital age.

Previous Research

Cooperative learning research has demonstrated that reward structure is a stronger contributor to performance than is task structure (Slavin, 1980, 1983, 1987, and 1991). Reward contingencies are operationalized in terms of the criteria one must meet to access the specified reward. As an example, a student could earn extra credit points based on improving exam performance rather than on their specific exam score.

Although research indicates that cooperative learning can produce higher achievement, college students may not take full advantage of studying with members in their cooperative group. Students' excuses for their lack of participation in cooperative learning are based on scheduling conflicts with other students and personal factors such as a lack of interest in the subject matter or a preference for individual over group learning. To encourage students to take

full advantage of the cooperative learning experience, the instructor's provision of credit for individual and group improvement has been effective in promoting students' exam performance (Carroll & Williams, 2007; Carroll, Williams, & Hautau, 2006; Williams, Carroll, & Hautau, 2005).

Williams et al. (2005) examined the impact of three different reward contingences on exam performance for low-, average-, and high-performing students. Students were categorized as low-, average-, and high-performing based on their previous exam scores, and they could earn extra credit for improvement in subsequent exam performance. Researchers used a group-only contingency, a criterion-based individual contingency, and a differentiated group plus individual contingency. They found that the combination of a group and individual requirement produced greater group improvement than using a group-only contingency. However, Williams et al. reported that a higher percentage of students operating under a group-only contingency earned the maximum amount of extra credit compared to students operating under a differentiated group plus individual contingency. Nonetheless, a higher percentage of students earned some extra credit under the latter contingency.

Across all contingencies, low- and average-performing students improved their exam performance. In contrast, high-performing students' exam performance declined slightly in the group-only contingency, but not in the combined individual and group contingencies. It is evident that group-only contingencies distribute responsibility for improving exam performance within the group, such that high-performing students do not need to improve their exam scores to obtain extra credit. Thus, students under a group-only contingency are less helpful to one another compared to students in contingencies that rely on individual students to improve their

performance to access additional group credit. In fact, higher-performing students are more likely to explain concepts to their low-performing peers under contingencies that combine both individual and group performance.

In developing criteria for cooperative bonus points to improve students' exam performance, one must use a contingency that rewards both individual and group improvement. Carroll et al. (2006) examined the effects of independent (i.e., unrelated) and interdependent (i.e., related) group contingencies on undergraduate students' performance. Researchers investigated whether different bonus point ratios for individual versus group credit are more prevalent in an independent or dependent contingency. These credit ratios ranged from equal points distributed for individual and group improvement to unequal value that favors individual over group performance or vice versa. Dependent contingencies produced better performance for both individual and group performance. They found that independent ratios are only effective when the reward structure emphasized group improvement over individual improvement. When the group contingency is underemphasized within a course, students are more likely to under use group assistance.

College students may minimize the impact of cooperative learning based on their perceptions of unfairness in the reward contingencies. Carroll and Williams (2007) examined undergraduate students' exam performance under balanced extra credit contingencies. Credit was awarded for individual improvement, group improvement, or improvement split between individuals and the group. In the latter contingency, earning extra credit points was not dependent solely on group improvement. Students could earn either individual and/or group points depending on how well they performed individually. In the individual requirement,

students had to improve their grades by at least one point before they were eligible to earn both individual and group extra credit.

The group improvement requirement meant that students could only earn additional extra credit points if their group's average exam score improved by one point. Thus, if students improved their individual scores by one point but the group did not improve its average score, no group credit was awarded. On the other hand, if the group improved by one point but an individual within the group did not improve by one point, that individual would receive no individual or group credit. Results showed that this contingency produced the most individual improvement on exam scores compared to the independent individual requirement contingency. Although researchers found no significant difference in exam improvement across contingencies, they noted that some contingencies produced higher exam improvement in absolute terms.

In addition to examining the effect of differential reward contingency on performance improvement, educators need to evaluate the extent and nature of interaction within cooperative groups. In higher education, minimal time is allocated in class for students to work with one another in learning groups. Compared to primary and secondary students, college students are given more authority for coordinating and managing their groups on an out of class basis. However, college students may regard developing a positive interdependence relationship out of class as requiring excessive effort. To address this concern, researchers should systematically evaluate the nature of these group interactions and the differences found under different reward contingencies. It is unknown whether a group or a combination of group plus individual credit would increase or diminish communication between group members.

Technology and Cooperative Learning

Johnson et al. (1998) meta-analysis evaluating the differences between cooperative, individualistic, and competitive learning revealed that cooperative learning promotes higher achievement than individualistic and competitive learning. Although cooperative learning promoted higher achievement, college students were more inclined to engage in individualistic and competitive learning. There are barriers that compromise the effectiveness of using cooperative learning in higher education. College students are often uninformed on how to use cooperative groups and revert to individualistic or competitive learning within their assigned groups. Furthermore, college instructors lack training in organizing cooperative groups and mobilizing helpful behaviors within cooperative groups (Johnson et al., 1998). In addition to these impediments, difficulty in arranging times to meet with group members outside of class constitutes an additional impediment to group learning.

Most undergraduate students in the United States own or use electronic communication devices: 96% of students own cellphones, 88% laptop computers, 84% iPods, 9% e-readers (e.g., Kindle and Nook e-readers), and 5% tablets (Smith, Rainie, & Zickuhr, 2011). Aided by the rise in technology, educators are increasingly using technology to facilitate cooperative and collaborative learning. Educators use social software to facilitate cooperative learning for distance education and hybrid courses (i.e., blended learning), to increase active learning in lecture courses, and to mobilize more group work (Schaffert & Ebner, 2010). Social software enables collaborative development, creates a social presence, and facilitates communication among students. The integration of technology provides opportunities for students to engage in collaboration without requiring students to engage in face to face meetings (Eastman & Swift,

2002). Internet or software tools are essential for ameliorating barriers that college students encounter with respect to participating in cooperative learning. The literature has three main categories for technical communication tools: classical, micro-blogging, and mobile devices.

Classical Communication

In the research literature, discussion forums and online chat rooms are referred to as classical communication tools (Eastman & Swift, 2002; Kupxzynski, Mundy, & Maxwell, 2012; Schaffert & Ebner, 2010). These tools motivate students to become active learners, elicit feedback from the instructor and/or peers, and allow students to reflect on their peers' written responses pertaining to course concepts and/or questions. Discussion boards are accessible through educational technology (e.g., Blackboard, Canvas, Moodle) throughout universities. Discussion boards provide opportunities for students to exchange information, have a written record of their discussions, provide comments regarding lectured material, and receive assistance from peers (Eastman & Swift, 2002; Schaffert & Ebner, 2010). This tool is traditionally used for asynchronous communication among students.

In contrast, online chat tools are available to facilitate electronic communication. Although chat tools can be used asynchronously, they are frequently used to communicate simultaneously. The latter is unique because it provides students with an opportunity to express their emotions with symbols known as emoticons or emojis. Chat rooms provide the same benefits as discussion boards, but they allow learners to exchange information "instantly" (Schaffert & Ebner, 2010). Overall, chat rooms and discussion boards are commonly used in distance education and blended learning settings. However, instructors can also utilize these tools to facilitate cooperative learning in students' learning groups.

Micro-blogging

Micro-blogging refers to internet sites that allow individuals to post messages and update their thoughts, experiences, and activities instantaneously (Schaffert & Ebner, 2010). Examples of micro-blogging sites are Wiki tools and social media sites (e.g., Facebook, Twitter). Wiki Links or Wikis are supplementary software available on educational tools, such as Blackboard. Wiki Links are comparable to Google documents, because students are assigned links that allow them to collaborate on a mutual document simultaneously. As an example, a group of students may follow a Jigsaw cooperative framework by dividing and assigning specific parts of a study guide among members of their group. Therefore, all members have access to the study guide, but each person is only responsible for answering questions in a small component of the study guide.

Biasutti (2017) compared the differences between discussion forums and Wikis for collaborative learning. She noted that Wikis are more suited for collaboration that emphasizes permanent products (i.e., paper, project, presentation). This webtool is commonly used to generate ideas, develop plans, and combine students' texts into one document. In contrast, discussion boards are more likely used to deepen students' understanding of course content by reflecting on others' posts. Although both webtools are used for collaboration activities, college students are least likely to use webtools for these purposes. Students reported that these use of tools lacks any sense of connection with peers (Biasutti, 2017).

Social media sites are commonly used by students in their personal lives to build communities, express their thoughts, and share information (Deng & Tavares, 2013). Educators have attempted to incorporate learning experiences into social media sites to build positive

interdependence, which is an important element in cooperative learning. Deng and Tavares compared use of Moodle discussion boards and Facebook for collaborative learning with university students. They found that students were more engaged with the latter digital tool than with discussion boards. Students posted more on social media sites and had more "depth" within their posts. Students reported that this avenue of communication was more interactive than using Moodle. Social media were more favorable to students due to the convenience and familiarity of this webtool, which they were already using to build relationships and to exchange ideas with others.

Mobile Devices

In the same vein as social media sites, mobile learning is being used in educational settings. Mobile learning is a new learning theory that claims learning can co-occur with accessible technology (El-Hussein & Cronje, 2010; Motiwalla, 2007; Tang & Hew, 2017). In the research literature, mobile learning is referred to as m-learning and "here and now" learning. The premise of this theory is that using wireless devices (i.e., cellphones, tablets, personal device assistants) provides flexibility of learning outside of the traditional education setting, easily accessible information, and avenues for social communication among peers (El-Hussein & Cronje, 2010; Martin & Ertzberger, 2013). It is hypothesized that using mobile learning may increase students' engagement (i.e., verbal interaction) in cooperative groups compared to face-to-face interactions within the university setting.

Approximately 92% of college students who own a cellphone use a smart-phone Pew Research, 2017). Smart-phone devices provide individuals with access to numerous applications that may be used for educational purposes. Researchers have investigated the utility of short

message services (SMS) or text messages in collaborative learning (Brett, 2011; Martin & Ertzberger, 2013; Zamani-Miandashti & Ataei, 2015). Brett (2011) found that college students offered mixed reviews as to the use of text messages for learning. Students found that the use of text messaging increased their engagement and their interaction with peers. In contrast, students were concerned about the monetary cost of using text messages and felt that using these devices constituted an invasion of privacy. Similar findings were observed in research conducted by Zamani-Miandashti and Ataei (2015). They found that students were more engaged and involved with the course material when using text messaging; however, students were concerned about the cost of sending text messages from their personal devices.

Purpose of the Study

As the utilization of modern technology increases in educational settings, it is imperative for traditional instructional strategies to adapt to these changes. Cooperative learning in higher education has unique barriers, even though college students experience positive outcomes in cooperative groups. Common barriers to cooperative group success include a lack of student knowledge of how to use cooperative groups and scheduling conflicts with group members (Johnson et al., 1998). Educators have incorporated discussion boards, Wikis, social media, and mobile devices to build social communication among peers as alternatives to face to face meetings (Biasutti, 2017; Deng & Tavares, 2013; Zamani-Miandashti & Ataei, 2015).

Although use of mobile devices in higher education increases positive interdependence between group members, students are concerned about the monetary expenditures associated with using these devices. Fortunately, applications are available that have the same benefits as text message communication, yet are free for students to use. The current study addressed

common barriers associated with cooperative learning by making electronic communication available for students to use for interacting with peers outside of class.

An overall purpose of this study was to examine the differences in academic performance and communication measures under two reward contingencies (group only and individual plus group contingency) and evaluate the utility of using a mobile device application (GroupMe) to facilitate on-task interaction within cooperative groups. This research study extended previous research on cooperative learning (Carroll et al., 2006; Carroll & Williams, 2007) by using a systematic electronic method in observing and noting the differences between students' interactions within cooperative groups operating under different reward contingencies (see Appendix A). This research identified the frequency and nature of communication among group members that could promote student improvement in academic performance measure.

Based on previous research, we hypothesized that students would show greater improvement in exam performance and earn more extra credit in the individual plus group reward contingency than in the group only reward contingency. Additionally, the former contingency was expected to promote more on-task communication within cooperative groups than the latter contingency. Across contingencies, level and type of group interaction within groups was expected to be associated with improvement in academic performance scores. (See Appendix B for a more detailed explanation of how the quantity and nature of the communication among group members were electronically tracked.) Communication and academic performance measures were correlated to determine if changes in the two sets of variables would be related with each other or if they would be more independently responsive to the reward variables.

Chapter II

Methodology

Participants

Participants included approximately 142 students, mainly undergraduate, enrolled in six sections of an educational psychology course at a large southeastern university. The majority of students were sophomores and juniors, but the sample also included freshmen, seniors, and graduate students. The course is required for entering the teacher education program and is also classified as a general education course for other majors at the university. All sections had 16-30 students who volunteered to participate in cooperative learning groups to earn extra credit. Students also completed the Watson Glaser Critical Thinking Appraisal to estimate course sections critical thinking levels (see Table C1). Historically, critical thinking has been one of the best predictors for exam performance in the course (Galyon, Blondin, & Williams, 2015).

This educational psychology course is divided into five units: cognitive development, social development, values development, psychological development, and physical development. Based on their exam performance in the initial unit, students were assigned to cooperative groups in the second unit (social development unit) when the course introduces the notion of cooperative learning. Students were able to earn up to 50 points on each unit exam. Students who volunteered to participate in cooperative groups for the entire semester were included in the study.

Procedures

Cooperative Groups

Prior to the end of the first course unit (Unit A Cognitive Development), instructors discussed and described the nature of cooperative learning groups in the upcoming units.

Students opted to earn extra credit by participating in a cooperative group for the duration of the semester. Opt-in procedures also included notifying their instructor about their participation. All cooperative group assignments were based on students' exam performance on the Unit A exam. This exam served as a baseline measure and differentiated students into three categories: low-, average-, and high- performing.

Cooperative group assignments were completed systematically. All groups included a combination of low, average, and high performing students based on their Unit A exam performance. Each group consisted of 4-5 members with a group average similar to the overall class average on the Unit A exam. Students were notified about their group average, group members, and the criteria they must meet to earn extra credit points (i.e., reward contingency) across the unit exams (see Table C2). Instructors formed each cooperative group and sent this information to the person conducting this study for her dissertation. The amount of extra credit earned and exam performance indicated which reward contingency produced greater improvement from the Unit A exam.

Reward Contingencies

Two reward contingencies were used in this study: group only and individual plus group reward. These reward contingencies alternated across unit exams and course sections. Participants potentially earned up to five extra credit points across both reward contingencies. Extra credit was prorated: every point that the student and/or group averages above the initial Unit A score/average determined the amount of extra points that the student or group would earn. Each unit B-E exam score/average was compared to Unit A exam measures, which constituted the baseline measure.

Under the group only contingency, students' credit was dependent on their group's average improvement on the unit exams. For example, if a cooperative group average improved by three points, then all students in the group earned three extra credit points (see Appendix A). A group could earn up to five extra points if the group average was five points above the baseline average. However, different criteria were used for cooperative groups whose Unit A score was 80% (40) or higher of the potential exam score. This provision was based on the assumption that it be would be challenging for groups that scored at the 80% level or above on the Unit A exam to average above that level on subsequent exams. Therefore, cooperative groups whose initial average was 80% or above earned some credit if they maintained at least 80% (40) on Unit B exam and subsequent exams. As an example, if a group's Unit A average was 42 (84%), an average of a 40 (80%) on subsequent unit exams would earn one extra credit point. In contrast, if a cooperative group's Unit A score average was 36 (72%), then students earned one extra credit point if they averaged a 37 (74%) on the next unit exam. On the other hand, if a group averaged 45 (90%) on Unit A, that group would earn one extra credit point for every average score 40 or above up to 5 extra credit points (the predetermined limit of the contingency) on subsequent exams. Under this contingency, an individual could earn extra credit points without scoring above his or her Unit A score.

For the individual plus group contingency, participants could earn up to three extra credit points for improvement above their individual Unit A exam score or score 40 or above on subsequent exams. Individuals could earn up to two extra credit points if their group average was higher than their Unit A average or were 40 or above on subsequent exams. If a student earned a score below 40 on the Unit A exam, then he/she could earn one extra credit point up to

three points for every point he/she scored above their individual Unit A exam. The same prorated arrangement applied to improvement in the group exam average. In this reward contingency, total credit was dependent on students' maximizing their individual credit (3 points) and the group's also maximizing its average credit (2 points). Participants' group extra credit points were not contingent on students earning individual extra credit. Thus, an individual could earn group credit without improving his or her exam performance.

GroupMe

An e-mail account was created for use by all course sections (e.g., edpy210.fall2017@gmail.com). This e-mail address served as the "creator" to all chat rooms for each cooperative group. The creator of these chat groups was responsible for adding and disabling group members from participating in the messaging group. This prevented participants from accidentally deleting or adding other members into their cooperative group chat room. Once students were assigned to groups, GroupMe sent notifications through a weblink for students to register for the phone application. Students had the option to add the GroupMe application onto their phone or add their personal number to receive short message services (SMS). Although the GroupMe application has a similar function as SMS, the former is free of charge for students who have limited text messaging services and have access to wireless internet.

The primary researcher monitored students' interactions and scored the interactions on a 5-point scale (see Appendix B). Students' messages were read and monitored through computer access. This arrangement allowed the researcher to record the number of questions and answers that each participant contributed to their group message. For scoring purposes, a transcript of

each cooperative group's messages was printed from the GroupMe application, and a research team tallied each participant's communication scores. Participants' communication scores ranged from 0 to 5 points. The timeline for scoring group interactions ranged from the first day of the unit until the day of the unit exam. Group communication was monitored from the second unit to the last unit of the course. This measure determined the frequency and type of communication between group members. In addition to the primary researcher, a secondary researcher independently scored the communication transcripts to permit assessment of inter-rater agreement. Interrater agreement for participant's scaled communication scores was 100%.

Students' communication patterns were operationalized and categorized into on-task, planning, and social comments. On-task statements were defined as the combination of questions and response exchanges among students within the GroupMe application. Planning statements were defined as students initiating discussion about scheduling out of class meetings and exchanging communication outside of the GroupMe application. This category was developed to encompass students' exchanges that were indirectly related to the course material. Social statements were any statement that did not fit within the on-task or planning explanations. More detailed definitions of these categories and coding of communication exchanges are found in Appendix B.

Record of Out-of-Class Group Meetings

At the end of each unit, students answered a questionnaire indicating who attended the study session(s), how they communicated with other group members, and who took leadership roles in their cooperative groups (see Table B7 in Appendix B). This self-report measure assisted in determining consistency in interaction during out of class and online study sessions. This

measure was used to identify the common ways that students used their groups outside of the group messaging system.

Chapter III

Results of the Study

Analysis Plan

This study controlled for sequence effects and time of day effects by applying treatment conditions back to back across the six course sections. A coin toss was used to determine the order of the first treatment sequence. In three sections, the group only contingency preceded the individual plus group contingency, and the opposite order was used in the other three sections. In treatment sequence 1, the individual plus group contingency preceded the group only contingency. In treatment sequence 2, the group only contingency preceded the individual plus group contingency.

This study primarily used two-way mixed analysis of variance to determine whether there were significant treatment differences for (1) exam scores and (2) amount of extra credit earned for improvement in exam performance across reward contingencies and the sequence of reward contingencies. Additionally, two-way analysis of variance was used to identify the differences between communication scores across reward contingencies and the sequence of reward contingencies. Bivariate correlations were used to determine whether there were predictive relationships between on-task communication and extra credit points earned across reward contingencies. Prior to these analyses, preliminary analysis of variance was used to determine if there were significant differences in baseline means representing the units consistent with the two treatment sequences.

Preliminary Analysis

The exam means for each reward contingency are represented in Table C3. Prior to analysis, baseline scores (Unit A) means were compared across each section and treatment sequence. A one-way analysis of variance was used in this comparison. There was a significant mean difference between the 9:40 and 12:40 sections baseline exam scores (p = .034). Otherwise, the sectional baseline means (Unit A) were similar, ranging between 35 and 38 for the remaining sections. The composite baseline means for the sections representing the two treatment sequences did not differ significantly (Sequence 1 mean = 37.76, Sequence 2 mean = 37.15; t = .608, p = .554).

Primary Analyses

ANOVAs

A two-way mixed analysis of variance with exam performance as the dependent variable and reward contingency (individual plus group vs. group only) as the within independent variable and sequence of reward contingencies as the between independent variable yielded a significant interaction effect (F = 19.94, $p < 0.01$). Follow-up analysis of simple-effects revealed that students' average exam performance under the group only contingency was significantly greater than that under individual plus group contingency when the group only contingency came after the individual plus group contingency (t = -3.212, p = .002, d = .373). Also, the group only contingency produced higher exam scores when it came after the individual plus group contingency than before the latter contingency (t = 3.135, p = .002, d = -.527). Students' average exam performance under the individual plus group contingency was equivalent across intervention sequences (see Table C14).

A mixed analysis of variance with extra credit earnable under each reward contingency as the within variable and sequence of the reward contingencies as the between variable yielded a significant interaction effect for extra credit earned under reward contingency and reward sequence combinations ($F = 36.06$, $p < 0.01$). A simple-effects analysis revealed that students earned more extra credit in the group only contingency than under the individual plus group contingency when the former contingency was implemented second (sequence 1; $t = -2.456$, $p = 0.016$, $d = .285$). Also, the group only contingency produced more extra credit in the first than the second sequence ($t = 6.792$, $p < 0.01$, $d = .222$). These results are consistent with the findings for students' exam performance under the two treatment sequences (see Table C16).

Further analysis of variance investigated the relationships between series of communication scores under each independent-variable combination. A significant interaction effect ($F = 12.13$, $p = 0.001$) for planning communication scores was obtained under the reward contingencies. Simple effects indicated that each reward contingency produced greater planning communication when it came first in either sequence ($t = 4.246$, $p < 0.01$). Planning communication scores under the individual plus group contingency were equivalent under the two treatment sequences (see Table C18).

Social communication scores yielded a significant interaction effect ($F= 2.307$, $p < 0.013$) across the reward conditions. Follow up simple effects indicated that social communication under the reward contingencies was dependent on when these reward contingencies were implemented. Students engaged in more social communication when the individual plus group contingency was implemented before the group only contingency (sequence 1; $t = 5.589$, $p < .001$, $d =.333$). Social communication was greater under the group

only contingency when it came after the individual plus group contingency rather than before the latter contingency (see Table C20; $t = 3.256$, $p = .001$, $d = -.547$).

Results indicated a significant interaction ($F = 20.49$, $p < 0.01$) for on-task communication scores (combination of questions and responses) under the different reward and sequence conditions. The only two significant simple effects were (1) when the greater amount of on-task communication occurred when each contingency came first in a sequence and (2) when the group only contingency came after the individual plus group contingency ($t = 4.164$, $p < 0.01$, $d = .608$; see Table C22).

Correlations

All academic performance and communication variables were significantly affected by the treatment conditions. In addition, correlations were used to establish the predictive potential between planning, social, and on-task communication and the academic performance measures (see Table C23 in Appendix). There was a small negative relationship between planning communication and group only extra credit scores. Overall, the results indicated no strong relationship between communication scores and the academic performance measures. A step-wise regression was used to identify the best predictor of exam scores and extra credit scores. Results from this analysis indicated no predictive relationship between the variety of communication variables and students' exam improvement or the amount of extra credit earned. Thus, although both performance and communication measures were affected by the combination of reward contingencies and treatment sequences, the two sets of dependent measures were not significantly correlated with each other.

Chapter IV

Discussion

The primary goal of the study was to determine whether there would be differences in students' exam improvement under individual plus group or a group only reward contingency for the cooperative arrangements. It was expected that students would score higher on exams in an individual plus group reward contingency, and that students would earn more extra credit points under the group only reward contingency, given that they would have to do their best for their group to maximize its extra credit. Both interventions were effective in improving students' exam scores from their initial exam performance (Unit A). Students across treatment conditions improved their exam scores by a whole letter grade (C to B), which is a substantial increase in grades for students in this course.

Implications of Findings

The findings presented in the Results section do not show that any cooperative reward condition consistently produced higher exam performance and extra credit than any other condition. Both reward conditions have been used with considerable success in previous studies (Carroll et al., 2006; Carroll & Williams, 2007). The current findings show that both cooperative arrangements produced substantially higher exam scores than was the case in the non-cooperative baseline unit. Each cooperative arrangement in our study revealed some contextual advantages over the other. The group only contingency provides extra credit only if the group as a whole improved. There is no possibility of extra credit on a strictly individual basis under this contingency. Thus, group only is a truer cooperative contingency than the individual plus group contingency, in which case some extra credit can be earned on a strictly individual basis.

In comparing two potentially powerful treatment conditions, one needs to look closely at the contextual conditions to determine when each is more advisable. The significant interaction and simple effects provide those contextual cues for the exam scores and extra credit in this study. For example, the group only contingency condition produces greater effects when applied after the individual plus group contingency. Perhaps the latter contingency is boosted by students having had some experience working together under the individual plus group contingency. Past experience with this population indicates that college students generally are not accustomed to working in groups.

Although we did obtain some significant interaction and simple effects for the various communication variables, the extent of that communication was quite limited. Students by no means took full advantage of an opportunity to study together to maximize their exam improvement and extra credit. In fact, students rarely participated in communicating with one another in GroupMe. A self-report survey administered after each exam revealed that some groups did not use our GroupMe arrangement at all. Instead, participants reported that they created google documents, exchanged email communication, created their own GroupMe chats, and met face-to-face.

These student changes created significant limitations in tracking students' digital communication. Thus, there may have been more nuanced differences in communication patterns within groups than was apparent to the researchers. Perhaps due to the limitations in tracking students' communication, no clear predictive relationship was obtained between the communication variables and students' exam performance. In fact, the communication scores were less than 3 points out of 5 across reward contingencies and different types of

communication (i.e., on-task, planning, and social).

Accessibility to students' google documents, email communication, and personal GroupMe chats would have provided more information as to how students interacted in their cooperative groups. Although the purpose of this study was to create an authentic cooperative learning experience, placing more requirements on students' communication with one another may provide more improvement in exam performance for low performing than high performing students, as has been the case in several other cooperative learning studies (Carroll et al., 2006; Galyon et al., 2015). Also, some participants may have been more hesitant to communicate within an assigned GroupMe, because they were aware that an outside researcher was monitoring their communication. Therefore, finding another popular method to systematically track student communication could have been more beneficial (e.g., google documents, email communication, chats available by the university).

Limitations

As previously mentioned, there were significant methodological limitations in measuring students' communication in their cooperative learning groups. For this sample, students failed to follow communication guidelines by not solely using their cooperative groups GroupMe. Back to back applications of treatments undermined clean comparison of treatment conditions, which may have caused carry over effects from one treatment phase to another. Failure to have a reversal between treatment conditions also limited comparisons between treatment and baseline conditions. The course was divided into five units; therefore, there were no opportunities for reversals between treatment conditions.

Perhaps, students experienced ceiling effects in exam performance due to low critical thinking scores. Compared to other undergraduate courses, this course challenges students to employ critical thinking in answering exam questions. Nonetheless, a majority of students in this course tend to make low scores on critical thinking, which has previously proven to be one of the strongest predictors of exam performance in the course (Galyon et al., 2015). Students who score at a low percentile on critical thinking typically have low performance on unit exams. For this sample, the mean critical thinking score was at the 20th percentile of a normative sample, which potentially produced a ceiling effect on these students' exam performance. Approximately 43% of the students in the sample were between the first and fifth percentiles on critical thinking. In fact, 17% of the population scored at the first percentile compared to a normative sample. Student improvement in exam performance may demonstrate higher improvement on exam scores in other courses that deemphasizes critical thinking. It is difficult to determine which students' characteristics or course predictors may significantly impact students' responsiveness to cooperative learning. Future studies should clearly differentiate between students who were most or least responsive to cooperative learning groups and treatment conditions.

Concluding Comments

At the end of the study, a social validity survey was administered to determine how students reacted to the cooperative contingencies and the communication options (see Appendix D). The purpose of this survey was to evaluate students' preferences regarding the reward contingencies and GroupMe communication. Furthermore, the questions within this survey were designed to determine students overall experience with cooperative learning and whether they would participate in cooperative learning groups in the future. Although the type of reward

contingency did not consistently differentiate student improvement on exams, an individual plus group reward contingency did require all students within a group to improve their individual exam scores to maximize both individual and group credit. However, they could earn individual extra credit without the group's earning extra credit or group extra credit without any specific individual's earning extra credit. Whatever the possibilities, 84% of participants who completed the survey preferred the individual plus group reward contingency over the group only reward contingency.

Although some participants were hesitant to participate in cooperative groups, 76% of participants who completed the social validity questionnaire reported that they had a positive experience, and 73% reported that they would participate again in cooperative learning. In the same survey, participants reported that they found GroupMe useful (86%) but also used other methods to work with their group. Other methods listed included google documents, quizlets, face-to-face meetings, and email exchanges.

Although results of this study demonstrated that type of reward contingency was not a singular factor in improving students' exam performance, most of the students did improve their exam performance under a cooperative learning arrangement and reported a positive experience in their cooperative groups. This investigation contributes to the literature regarding one method of systematically tracking students' communication patterns under cooperative learning groups and quantifying students' communication in cooperative learning. The incorporation of cellular devices in education (i.e., mobile learning) is an up-and-coming method for collaborative and cooperative learning; however, the exact benefits of such methods remain to be more extensively explored in future research.

List of References

Bisasutti, M. (2017). A comparative analysis of forums and wikis as tools for online collaborative learning. *Computers & Education, 111*, 158-171.

Brett, P. (2011). Students' experiences and engagement with SMS for learning in higher education. *Innovations in Education and Teaching International, 48*(2), 137-147.

Carroll, E., & Williams, R. L. (2007). Individual and group contingencies in cooperative learning at the collegiate level. *The Behavior Analyst Today, 8*, 298-306.

Carroll, E., Williams, R. L., & Hautau, B. (2006). Cooperative learning contingencies: Unrelated versus related individual and group contingencies. *Journal of Behavior Education, 15*, 191-202.

Deng, L., & Tavares, N. J. (2013). From moodle to facebook: Exploring students' motivation and experiences in online communities. *Computers & Education, 68*, 167-176.

Eastman, J. K., & Swift, C. O. (2002). Enhancing collaborative learning: Discussion boards and chat rooms as project communication tools. *Business Communication Quarterly*, *65*(3), 29-41.

El-Hussein, M. O. M., & Cronje, J. C. (2010). Defining mobile learning in the higher education landscape. *Educational Technology & Society*, *13*(3), 12-21.

Galyon, C. E., Blondin, C. A., & Williams, R. L. (2015). A historical analysis of the relationship between critical thinking and exam performance. *Inquiry: Critical Thinking Across the Disciplines*, *30*(1), 24-39. doi:10.5840/inquiryct20153015

Johnson, D. W., Johnson, R. T., & Smith, K. A. (1998). Cooperative learning returns to college what evidence is there that it works? *Change: The Magazine of Higher Learning*, *30*(5), 26-35.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014). Cooperative learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in College Teaching, 25*(3-4), 85-118.

Kupxzynski, L., Mundy, M., & Maxwell, G. (2012). Faculty perceptions of cooperative learning and traditional discussion strategies in online courses. *Turkish Online Journal of Distance Education, 13*(2), 84-95.

Martin, F., & Ertzberger, J. (2013). Here and now mobile learning: An experimental study on the use of mobile technology. *Computers & Education, 68*, 76-85.

"Mobile fact sheet." Pew Research Center, Washington, D.C. (January 12, 2017). http://www.pewinternet.org/fact-sheet/mobile/#. Retrieved July 14, 2017.

Motiwalla, L. F. (2007). Mobile learning: A framework and evaluation. *Computer & Education, 49*, 581-596.

Panitz, T. (1999). Collaborative versus cooperative learning: A comparison of the two concepts which will help us understand the underlying nature of interactive learning. Retrived on June 10, 2017 from http://ericae.net.k12assess/colcoo.htm.

Schaffert, S., & Ebner, M. (2010). New forms of and tools for cooperative learning with social software in higher education. *Computer-Assisted Teaching: New Development.* Nova Science Pub, 151-156.

Schunk, D. H. (2012). *Learning theories: An educational perspective* (6th ed.). Boston, MA: Person.

Slavin, R. E. (1980). Cooperative learning. *Review of Educational Research, 50*, 315-342.

Slavin, R. E. (1983). When does cooperative learning increase student achievement? *Psychology Bulletin, 94*(3). 429- 445.

Slavin, R. E. (1987). Developmental and motivational perspectives on cooperative learning: A reconciliation. *Child Development, 58,* 1161-1167.

Slavin, R. E. (1991). Synthesis of research on cooperative learning. *Educational Leadership, 48*(5), 71-81.

Smith, A., Rainie, L., Zickuhr, K. (2011). College students and technology. Retrieved from http://www.pewinternet.org/2011/07/19/college-students-and-technology/.

Tang, Y., & Hew, K. F. (2017). Is mobile instant messaging (MIM) useful in education? Examining its technological, pedagogical, and social affordances. *Educational Research Review, 21,* 85-104.

Williams, R. L., Carroll, E., & Hautau, B. (2005). Individual accountability in cooperative learning groups at the college level: Differential effects on high, average, and low exam performers. *Journal of Behavioral Education, 14,* 167-188.

Zamani-Miandashti, N., & Ataei, P. (2015). College students' perceptions of short message service-supported collaborative learning. *Innovations in Education and Teaching International, 52,* 426-436.

Appendices

Appendix A

Reward Contingencies Credit Breakdown

Individual accountability and Group Reward (I = 1-3 extra-credit points G = 1- 2 extra credit points)

Individual credit

There are one of two ways a participant can earn up to three extra credit points on their next unit exam. (1) If participants scored below 40 on the Unit A exam, they can earn one extra credit point up to three points for every point they score above their Unit A score on the next unit exam. (2) If participants scored above 40 on the Unit A exam, they can earn one point for every point scored 40 or above on the next unit exam.

Table A1

Individual Credit Criteria

Unit A (A) Individual Score	**Subsequent Unit Exam Score:**		
	1 Extra Credit Point	*2 Extra Credit Points*	*3 Extra Credit Points*
0-39	**A score +1**	**A score +2**	**A score +3**
Example: 35	36	37	38
40-50	**40**	**41**	**42 or more**
Example: 43	40	41	44

Group Credit

Cooperative groups can earn up to two extra credit points for their group in the same way individual participants earned individual extra credit points. (1) If cooperative groups' average was below 40 on the Unit A exam, groups earn one extra-credit point up to two points for every point the group averaged above its Unit A average on the following unit exam. (2) If cooperative groups averaged 40 or above on the Unit A exam, groups can earn one additional point up to two extra-credit points for every point 40 or above.

Table A2

Group Credit

Unit A (A) average	**Group Average Unit Exam score:**	
	1 Extra Credit Point	*2 Extra Credit Points*
0-39	**Unit A score +1**	**Unit A score +2**
Example: 37	38	39
40-50	**40**	**41 or more**
Example: 44	40	44

Group Only Reward Contingency (1-5 extra-credit points)

Participants can only earn credit based on their group's average. If a cooperative group's average on the Unit A exam was below 40, groups can earn one additional extra-credit point up to five points for every point above the groups' Unit A average.

Table A3

Group Only Credit

Unit A (A)average	**Group Average Unit Exam score:**				
	1 Extra Credit Point	*2 Extra Credit Points*	*3 Extra Credit Points*	*4 Extra Credit Points*	*5 Extra Credit Points*
0-39	**A+1**	**A+2**	**A+3**	**A+4**	**A+5**
Example: 36	37	38	39	40	41
40-50	**40**	**41**	**42**	**43**	**44 or more**
Example: 45	40	41	42	43	44

Appendix B

Coding of GroupMe Communication

Operational Definitions

Electronic communication – defined as responding and/or sending questions or statements through the GroupMe application.

Questions- defined as sending questions and/or pictures regarding the course content (e.g., discussion questions, review materials, practice exam questions, and/or clarifying questions about specific concepts in class). Traditionally, these comments are denoted with question marks. Questions are classified as using who, what, when, where, why, and how.

Responses- defined as responding to questions and/or sending pictures to answer a student's inquiry about course materials (e.g., discussion questions, practice exam questions, clarifying concepts from class, and/or answering review questions). Statements are denoted by periods and/or exclamation marks. Pictures (e.g., emojis, screenshots) may be used to answer a question made by a peer or to begin a discussion about the course content for review.

Planning Statements- defined as sending a message that indicates a proactive intention to answer a student's question later and/or a proactive response that pertains to meeting or communicating outside the GroupMe application (e.g. exchanging emails, sending a link to a google document, promising to answer a question later, and/or setting a time/place for a group meeting). Planning statements are denoted by temporal words indicating a future intention (e.g. will, later, should, afterwards, tonight, tomorrow, and so on).

Social Statements- defined as statements that do not fit within the question, response, and planning category (e.g., emojis, pictures).

Electronic Exchange –is a full communication exchange between group members on a topic. Exchanges begin with a question and ends with a series of statements that answer the question.

Multifunctional Statement – any GroupMe comment that could be coded as two or more of the coding classifications (questions, responses, planning, and social).

Chained Comment – two or more comments that function as one question, response, planning, or social coding category (i.e., if a participant answered their own question, then it is coded as one question).

Coding Procedures

1. For multifunctional statements, questions and response comments supersede planning and social comments.
2. For multifunctional statements, planning comments supersede social comments.
3. For a multifunctional statement that is both a response and question comment, code that comment as both a question and comment.
4. Code chained comments as only one codable comment.
5. Comments that correct spelling, grammar, or clarify the previous comment should be counted as chained comments.
6. Comments consisting of providing group members with email addresses should be coded as planning.
7. Comments consisting of expressions of gratitude should be coded as social.
8. Comments consisting of communication about exam scores should be coded as social.
9. Comments that agree with a previous question should also be counted as a question.

10. Incoherent comments that do not contain any meaningful or understandable comment should be coded as social.

Scoring Guidelines

Each participant will receive a communication score for asking questions, responding within the chat, and an overall communication score. A transcript of for each groups message board will be printed and scored in the tables below. Messaging transcripts starts on the first day of the unit (12 am midnight) and communication ends at 5 pm on the day of the unit exam.

Table B1

Question Communication Scoring Guidelines

Score	Criteria
0	No questions were exchanged
1	1x-2x questions asked for entire unit
2	3x-4x questions asked for entire unit
3	5x-6x questions asked for entire unit
4	7x-8x questions asked for entire unit
5	9x or more questions asked for entire unit

Table B2

Response Communication Scoring Guidelines

Score	Criteria
0	No responses were exchanged
1	Responded to questions 1x-2x for entire unit
2	Responded to questions 3x-4x for entire unit
3	Responded to questions 5x-6x for entire unit
4	Responded to questions7x-8x for entire unit
5	Responded to questions 9x or more for entire unit

Table B3

On-Task Scoring Guidelines

Score	Criteria
0	No questions and/or responses were exchanged
1	Combination of questions and answers 1x-2x for entire unit
2	Combination of questions and answers 3x-4x for entire unit
3	Combination of questions and answers 5x-6x for entire unit
4	Combination of questions and answers 7x-8x for entire unit
5	Combination of questions and answers 9x or more for entire unit

Table B4

Planning Communication Scoring Guidelines

Score	Criteria
0	No planning responses were exchanged
1	Planning responses exchanged 1x-2x for entire unit
2	Planning responses exchanged 3x-4x for entire unit
3	Planning responses exchanged 5x-6x for entire unit
4	Planning responses exchanged 7x-8x for entire unit
5	Planning responses exchanged 9x or more for entire unit

Table B5

Social Communication Scoring Guidelines

Score	Criteria
0	No social communication was exchanged
1	Social communication exchanged 1x-2x for entire unit
2	Social communication exchanged 3x-4x for entire unit
3	Social communication exchanged 5x-6x for entire unit
4	Social communication exchanged 7x-8x for entire unit
5	Social communication exchanged 9x or more for entire unit

Table B6

Overall Communication Scoring Guidelines

Score	Criteria
0	No exchange of communication
1	Exchange communication 1x-2x for entire unit
2	Exchange communication 3x-4x for entire unit
3	Exchange communication 5x-6x for entire unit
4	Exchange communication 7x-8x for entire unit
5	Exchange communication 9x or more for entire unit

Table B7

Out-of-Class Self-Report Questionnaire

Measure	Question	Answer Options
General Communication	How did your group communicate with each other outside of class?	E-mail; Group Message; Before/After Class; Google Docs, N/A
Frequency of Communication	How often did you communicate with group members?	Every day; Twice a week; Once a week; Never; N/A
Contacting Group Members	Did you contact your group members when you had questions about the material?	Yes; No
Out-of-Class Meeting	Did you meet with your group members outside of class?	Yes; No
Cooperative Group Use	If you met outside of class, how did you use your cooperative group?	Sharing notes; Instructor notes questions; Practice exams; Studying for the exam
Frequency of Meeting	How often did you meet with your cooperative group outside of class?	Every day; Twice a week; Once a week; Never; N/A

Appendix C

Results Tables

Table C1

Mean Critical Thinking Percentile Scores across Sections and Reward Contingency Treatment Sequences

	Section	N	Critical Thinking Percentile
Sequence 1	8:10	23	22.83
	11:10	24	18.13
	2:10	25	18.64
		72	20.43
Sequence 2	9:40	25	22.16
	12:40	29	20.41
	3:40	11	25.55
		64	21.58

Table C2

Cooperative Group Contingency Flow Chart

Sections	Unit B	Unit C	Unit D	Unit E
8:10	I= 1-3 G= 1-2	G= 1-5	I =1-3 G= 1-2	G= 1-5
9:40	G= 1-5	I= 1-3 G=1-2	G= 1-5	I= 1-3 G= 1-2
11:10	I= 1-3 G= 1-2	G= 1-5	I =1-3 G= 1-2	G= 1-5
12:40	G= 1-5	I= 1-3 G=1-2	G= 1-5	I= 1-3 G= 1-2
2:10	I= 1-3 G= 1-2	G= 1-5	I =1-3 G= 1-2	G= 1-5
3:40	G= 1-5	I= 1-3 G=1-2	G= 1-5	I= 1-3 G= 1-2

Note: G = Group Credit; I= Individual

Table C3

Mean Exam Performance Scores across Course Sections and Reward Contingencies within Sections

	Unit A	Unit B	Unit C	Unit D	Unit E	Row *M*
8:10	**Baseline** 38.8 (6.18)	**IG** 40.7 (3.61) [1]	**G** 44.7 (3.73)	**IG** 43.0 (4.68)	**G** 41.5 (6.21)	**IG** 41.8 (3.93) **G** 43.1 (4.47)
9:40	**Baseline** 40.2 (5.19)	**G** 39.0 (3.71)	**IG** 43.6 (4.60)	**G** 42.2 (5.40)	**IG** 41.6 (4.93)	**IG** 42.6 (4.06) **G** 40.6 (4.18)
11:10	**Baseline** 38.5 (5.84)	**IG** 41.7 (5.31)	**G** 44.6 (3.44)	**IG** 42.5 (4.95)	**G** 44.2 (4.35)	**IG** 42.1 (4.40) **G** 44.4 (3.66)
12:40	**Baseline** 35.4 (5.17)	**G** 42.0 (4.63)	**IG** 42.6 (4.53)	**G** 39.0 (4.67)	**IG** 39.9 (4.79)	**IG** 41.2 (4.23) **G** 40.5 (3.78)
2:10	**Baseline** 36.2 (5.54)	**IG** 41.9 (3.67)	**G** 39.4 (3.95)	**IG** 39.4 (3.95)	**G** 41.7 (4.15)	**IG** 40.6 (3.31) **G** 40.5 (3.20)
3:40	**Baseline** 35.3 (7.19)	**G** 41.3 (4.25)	**IG** 41.2 (6.37)	**G** 38.7 (6.55)	**IG** 39.1 (5.55)	**IG** 40.1 (5.58) **G** 40.0 (4.90)
Column *M*	**Baseline** 37.5 (5.95)	**IG** 41.4 (4.23) **G** 40.7 (4.38)	**IG** 42.6 (5.02) **G** 42.7 (4.48)	**IG** 41.5 (4.75) **G** 40.1 (5.55)	**IG** 40.3 (5.04) **G** 42.4 (5.02)	**IG** 41.5 (4.19) **G** 41.5 (4.23)

Note. IG = Individual plus Group Contingency; G = Group Contingency
[1]Numbers in parentheses represent standard deviations within cells.

Table C4

Mean Extra Credit across Course Sections and Reward Contingencies within Sections

	Unit B	Unit C	Unit D	Unit E	Row *M*
8:10	**IG** 4.04 (1.64) [1]	**G** 4.78 (0.42)	**IG** 4.78 (0.74)	**G** 2.91(1.98)	**IG** 4.41 (1.02) **G** 3.85 (1.06)
9:40	**G** 0.20 (0.41)	**IG** 4.84 (0.62)	**G** 2.60 (1.53)	**IG** 3.64 (1.63)	**IG** 4.24 (0.84) **G** 1.40 (0.68)
11:10	**IG** 4.38 (1.17)	**G** 5.00 (0.00)	**IG** 3.67 (1.90)	**G** 4.96 (0.20)	**IG** 4.02 (0.97) **G** 4.96 (0.20)
12:40	**G** 4.86 (0.36)	**IG** 4.68 (1.09)	**G** 3.68 (1.16)	**IG** 3.89 (1.73)	**IG** 4.29 (1.10) **G** 4.27 (0.65)
2:10	**IG** 4.70 (0.72)	**G** 5.00 (0.00)	**IG** 4.00 (1.39)	**G** 4.81 (0.40)	**IG** 4.35 (0.89) **G** 4.91 (0.20)
3:40	**G** 4.60 (0.83)	**IG** 4.53 (1.06)	**G** 4.00 (0.76)	**IG** 4.47 (1.13)	**IG** 4.50 (0.89) **G** 4.30 (0.56)
Column *M*	**IG** 4.14 (1.47) **G** 3.01 (2.36)	**IG** 3.40 (1.28) **G** 4.70 (1.02)	**IG** 4.05 (1.50) **G** 3.20 (1.54)	**IG** 3.41 (1.95) **G** 4.26 (1.52)	**IG** 4.00 (1.18) **G** 3.85 (1.52)

Note. IG = Individual plus Group Contingency; G = Group Contingency
[1]Numbers in parentheses represent standard deviations within cells.

Table C5

Mean Exam Performance Scores across Reward Contingency Treatment Sequences

	Unit A	Unit B	Unit C	Unit D	Unit E
Sequence 1	37.76 (5.88)[1]	41.45 (4.23)	42.73 (4.48)	41.51(4.75)	42.43(5.02)
Sequence 2	37.15 (6.06)	40.70 (4.38)	42.65 (5.02)	40.13 (5.55)	40.34(5.04)
Mean Difference	0.61	0.75	0.08	1.38	2.09

[1]Numbers in parentheses represent standard deviations within cells

Table C6

Mean Extra Credit Earned across Reward Contingency Treatment Sequences

	Unit B	Unit C	Unit D	Unit E
Sequence 1	4.39 (1.23)[1]	4.93 (0.25)	4.14 (1.48)	4.27 (1.45)
Sequence 2	3.09 (2.28)	4.71 (0.93)	3.35 (1.36)	3.93 (1.59)
Mean Difference	1.30	0.22	0.79	0.34

[1]Numbers in parentheses represent standard deviations within cells

Table C7

Mean Question Communication Score across Course Sections

Section	Unit B	Unit C	Unit D	Unit E
8:10	0.43 (0.59)[1]	0.09 (0.29)	0.38 (0.50)	0.17 (0.39)
9:40	0.52 (0.59)	0.12 (0.33)	0.16 (0.37)	0.04 (0.20)
11:10	0.71 (.075)	0.46 (0.51)	0.42 (0.50)	0.58 (0.72)
12:40	0.34 (0.55)	0.00 (0.00)	0.03 (0.19)	0.07 (0.26)
2:10	0.22 (0.51)	0.37 (0.49)	0.04 (0.19)	0.15 (0.60)
3:40	0.50 (0.63)	0.69 (0.60)	0.25 (0.58)	0.60 (0.50)

[1]Numbers in parentheses represent standard deviations within cells

Table C8

Mean Response Communication Score across Course Sections

Section	Unit B	Unit C	Unit D	Unit E
8:10	0.57 (0.66)[1]	0.26 (0.45)	0.43 (0.59)	0.17 (0.39)
9:40	0.68 (0.75)	0.20 (0.41)	0.08 (0.28)	0.04 (0.20)
11:10	0.58 (0.72)	0.29 (0.55)	0.33 (0.64)	0.33 (0.56)
12:40	0.79 (1.11)	0.17 (0.38)	0.14 (0.35)	0.10 (0.31)
2:10	0.19 (0.40)	0.26 (0.53)	0.11 (0.32)	0.33 (1.20)
3:40	0.63 (0.50)	0.38 (0.89)	0.19 (0.40)	0.06 (0.25)

[1]Numbers in parentheses represent standard deviations within cells

Table C9

Mean Planning Communication Score across Sections

Section	Unit B	Unit C	Unit D	Unit E
8:10	0.57 (0.84)1	0.48 (0.59)	0.22 (0.42)	0.00 (0.00)
9:40	1.00 (1.26)	1.84 (1.25)	1.32 (1.55)	0.64 (0.99)
11:10	1.21 (0.88)	0.67 (0.70)	0.63 (0.65)	0.04 (0.20)
12:40	0.76 (0.83)	0.17 (0.38)	0.10 (0.31)	0.07 (0.26)
2:10	1.41 (1.21)	0.89 (1.08)	0.48 (0.70)	0.19 (0.48)
3:40	1.25 (1.57)	1.13 (1.41)	0.44 (0.96)	0.56 (0.96)

[1]Numbers in parentheses represent standard deviations within cells

Table C10

Mean Social Communication Score across Course Sections

Section	Unit B	Unit C	Unit D	Unit E
8:10	1.57 (1.20)[1]	0.70 (0.97)	0.61 (0.66)	0.43 (0.59)
9:40	0.36 (0.49)	0.44 (0.51)	0.20 (0.41)	0.32 (0.56)
11:10	0.58 (0.65)	0.71 (0.81)	0.29 (0.46)	0.46 (0.59)
12:40	0.31 (0.54)	0.10 (0.31)	0.03 (0.19)	0.10 (0.31)
2:10	0.63 (0.74)	0.48 (0.58)	0.59 (0.75)	0.26 (0.53)
3:40	0.38 (0.50)	0.38 (0.50)	0.31 (0 .48)	0.06 (0.25)

[1]Numbers in parentheses represent standard deviations within cell

Table C11

Mean On-Task Communication Score across Course Sections

Section	Unit B	Unit C	Unit D	Unit E
8:10	0.96 (0.63)[1]	0.35 (0.49)	0.78 (0.80)	0.35 (0.49)
9:40	1.04 (1.10)	0.24 (0.44)	0.24 (0.44)	0.80 (0.28)
11:10	1.29 (1.16)	0.58 (0.65)	0.71 (0.81)	0.88 (1.03)
12:40	1.10 (1.29)	0.17 (0.38)	0.17 (0.38)	0.17 (0.38)
2:10	0.37 (0.56)	0.52 (0.70)	0.11 (0.32)	0.37 (1.33)
3:40	0.88 (0.62)	0.60 (1.06)	0.38 (0.62)	0.38 (0.62)

[1]Numbers in parentheses represent standard deviations within cells

Table C12

Mean Overall Communication Score across Course Sections

Section	Unit B	Unit C	Unit D	Unit E
8:10	2.35 (1.56)[1]	1.43 (1.24)	1.17 (1.19)	0.61 (0.66)
9:40	2.12 (1.69)	2.20 (1.32)	1.60 (1.50)	0.88 (1.27)
11:10	2.63 (1.64)	1.75 (0.90)	1.42 (1.28)	1.25 (1.36)
12:40	1.79 (1.70)	0.41 (0.50)	0.24 (0.44)	0.31 (0.54)
2:10	2.00 (1.69)	1.67 (1.47)	1.11 (1.25)	0.73 (1.41)
3:40	2.19 (1.52)	2.13 (1.78)	1.06 (0.99)	0.75 (1.00)

[1]Numbers in parentheses represent standard deviations within cells

Table C13

Mixed Design ANOVA comparing Exam Scores under each Reward Contingency

	F	Sig.
Exam Sores IG-G	0.003	0.955
Exam Scores IG-G * Sequence	19.94	0.000

Table C14

Exam Scores Main Effects and Interaction Effects across Intervention Sequences

Reward Contingency	Sequence 1		Sequence 2	Mean
Individual plus group	41.48^{1}	=	41.49^{2}	41.48
Group only	42.58^{2}	>	40.42^{1}	41.54
Mean	42.03	>	40.95	

Note. Superscripts represent the order of the reward contingencies in each treatment sequence.

Table C15

Mixed Design ANOVA compare Extra Credit Earned under each Reward Contingency

	F	Sig.
Extra Credit Earned IG-G	10.08	0.002
Extra Credit Earned* Sequence	36.06	0.000

Table C16

Extra Credit Main Effects and Interaction Effects across Treatment Variables

Reward Contingency	Sequence 1		Sequence 2	Mean
Individual plus group	0.76[1]	=	0.71[2]	0.73
	∨			∨
Group only	0.38[2]	<	0.78[1]	0.57
Mean	0.57	<	0.75	

Note. Superscripts represent the order of the reward contingencies in each treatment sequence.

Table C17

Mixed Design ANOVA comparing Planning Communication Scores under each Reward Contingency

	F	Sig.
Planning IG-G	5.52	0.020
Planning* Sequence	12.13	0.001

Table C18

Planning Communication Score Main Effects and Interaction Effects across Treatment Variables

Reward Contingency	Sequence 1		Sequence 2	Mean
Individual plus group	0.76^{1}	=	0.71^{2}	0.73
	∨			∨
Group only	0.38^{2}	<	0.78^{1}	0.57
Mean	0.57	<	0.75	

Note. Superscripts represent the order of the reward contingencies in each treatment sequence.

Table C19

Mixed Design ANOVA comparing Social Communication Scores under each Reward Contingency

	F	Sig.
Social IG-G	4.68	0.032
Social* Sequence	2.31	0.013

Table C20

Social Communication Score Main Effects and Interaction Effects across Treatment Variables

Reward Contingency	Sequence 1	Sequence 2	Mean
Individual plus group	0.70 >	0.23	0.47 >
Group only	0.50 >	0.25	0.38
Mean	0.60 >	0.24	

Note. Superscripts represent the order of the reward contingencies in each treatment sequence.

Table C21

Mixed Design ANOVA comparing On-Task Communication Scores under each Reward Contingency

	F	Sig.
Purposeful IG-G	2.050	0.154
Purposeful* Sequence	20.49	0.000

Table C22

On-Task Communication Score Main Effects and Interaction Effects across Treatment Variables

Reward Contingency	Sequence 1		Sequence 2	Mean
Individual plus group	0.68^{1}	>	0.27^{2}	0.48
			∧	
Group only	0.50^{2}	=	0.61^{1}	0.55
Mean	0.59	>	0.44	

Note. Superscripts represent the order of the reward contingencies in each treatment sequence.

Table C23

Correlations between Purposeful, Planning, and Social Communication Scores across Mean Exam Scores and Extra Credit Earned under each Reward Contingency

Correlations	Communication Scores			
	IG Exam Scores	G Exam Scores	IG Extra Credit	G Extra Credit
	ΔR^2	ΔR^2	ΔR^2	ΔR^2
Purposeful (IG)	0.055	0.272**	0.097	0.208*
Purposeful (G)	0.095	0.151	-0.034	-0.004
Planning (IG)	0.077	-0.014	0.139	-0.118
Planning (G)	0.031	-0.086	0.102	-0.225**
Social (IG)	-0.020	0.041	0.056	-0.004
Social (G)	-0.008	0.091	-0.005	0.043

**$p < 0.01$
*$p < 0.05$

Table C24

Correlations between Unit Exam Scores and Extra Credit Earned under the Individual plus Group Contingency

	Unit B Exam	Unit C Exam	Unit D Exam	Unit E Exam	Mean Exam
Unit B Extra Credit	.542**	-	0.057	-	.330**
Unit C Extra Credit	-	.425**	-	.308*	.406**
Unit D Extra Credit	-.016	-	.380**	-	.224
Unit E Extra Credit	-	.229	-	.539**	.427**
Mean Extra Credit	.334**	.396**	.330**	.596**	4.69**

**$p < 0.01$
*$p < 0.05$

Table C25

Correlations between Unit Exam Scores and Extra Credit Earned under the Group Only Contingency

	Unit B Exam	Unit C Exam	Unit D Exam	Unit E Exam	Mean Exam
Unit B Extra Credit	.311**	-	-.289*	-	-.029
Unit C Extra Credit	-	-.129	-	-.013	-.083
Unit D Extra Credit	.113	-	.113	-	.135
Unit E Extra Credit	-	-.109	-	.327**	.141
Mean Extra Credit	.280*	-.119	-.165	.294*	.180*

**$p < 0.01$

*$p < 0.05$

Appendix D

Social Validity Survey

Name: _____ Section: _____ Group #: _____

GroupMembers:_____

Cooperative Learning Groups Feedback:

Please complete the following questions to reflect on your experience with participating in a cooperative group in the EDPY 210 course. Thank you for your participation!

1. How was your overall experience in participating in a cooperative group?

   _____

   _____

   _____

2. To what extent did you find using GroupMe a useful tool in staying connected and exchanging information with others in your group?

   _____

   _____

   _____

3. What additional methods did you use in working with your cooperative group?

   _____

   _____

4. Which reward contingency (individual plus group or group only) did you prefer?

   _____

5. Would you want to participate in a cooperative learning group in your other college courses?

   _____

6. If you should become a teacher, to what extent would you likely use cooperative learning your teaching?

   _____

Vita

Kendall Bree Hauck was born in Jacksonville, North Carolina. She spent her childhood and adolescence in Columbia, South Carolina. She obtained her B.A. in Psychology at North Carolina State University in the spring of 2014. Starting in the fall of 2014, Kendall attended the University of Tennessee's School Psychology Ph.D. Program. In May of 2017, she received a M.S. in Applied Educational Psychology. Kendall will receive her Ph.D. in August 2019 upon completion of a year-long pre-doctoral internship with the Tennessee Internship Consortium in Knoxville, Tennessee.