FIVE ESSENTIAL ELEMENTS FOR COOPERATIVE LEARNING DESCRIBED IN THE MAA INSTRUCTIONAL PRACTICES GUIDE

James A. Mendoza Álvarez, Ph.D.
Department of Mathematics
The University of Texas at Arlington

MAA IP Guide

Effective teaching and deep learning require student engagement with content both inside and outside the classroom. This *Instructional Practices Guide* aims to share effective, evidence-based practices instructors can use to facilitate meaningful learning for students of mathematics.

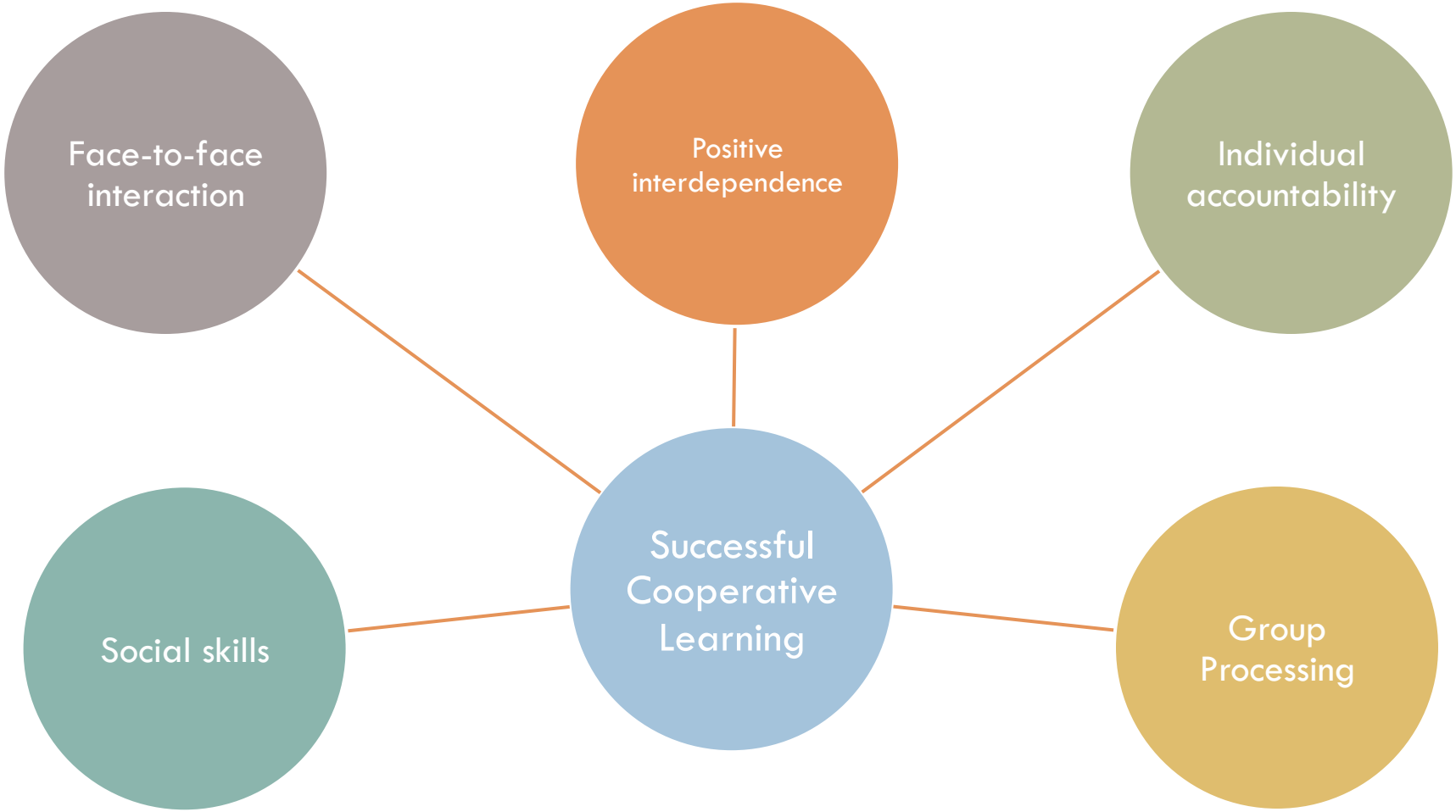
MAA IP Guide, p. 4

Cooperative or Collaborative Learning

- **Collaborative learning** typically refers to learning that takes place as small groups of students focus on open-ended, complex tasks.
- **Cooperative learning** typically refers to more structured, small-group learning that focuses on foundational or traditional knowledge with group roles (e.g., facilitator, summarizer, recorder, presenter) that may also serve to help students learn to work in group.

MAA IP Guide, p. 18

Five Essential Elements



Task: 80-minute class period

Exploration 3.1 Co-varying Quantities*

As shown in Figures 1a-3a, Secret Agent Cody walks counterclockwise along the (dashed) pathway shown beginning at Headquarters (Point H). Data on two variables, $d\downarrow 1$ and $d\downarrow 2$, are captured and graphed ($d\downarrow 1$ versus $d\downarrow 2$) by the dispatcher in corresponding Figures 1b-3b:

- $d\downarrow 1$ represents the agent's distance from the safety zone (represented by the y-axis); and
- $d\downarrow 2$ represents the actual distance along the pathway that the agent walks as measured by the agent's pedometer.

*From Álvarez, J.A.M., Jorgensen, T., & Rhoads, K. (2018). *Lesson 3: Qualitative Look at Graphical Representations*. Instructor Notes. Enhancing Explorations in Functions for Preservice Secondary Mathematics Teachers Project. The University of Texas at Arlington. Arlington, TX. This material is based upon work partially supported by the National Science Foundation Improving Undergraduate STEM Education (IUSE) program under Grant No. DUE #1612380. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the NSF.

Task: Exploration 3.1

1. Using qualitative reasoning (i.e. do not write down an algebraic expression), sketch what the dispatcher sees on her screen (Figure 1b) as Secret Agent Cody completes one mission (leaves and returns to Headquarters) along the indicated path in Figure 1a.

Discuss the appropriateness of your sketch, including important points and curvature.

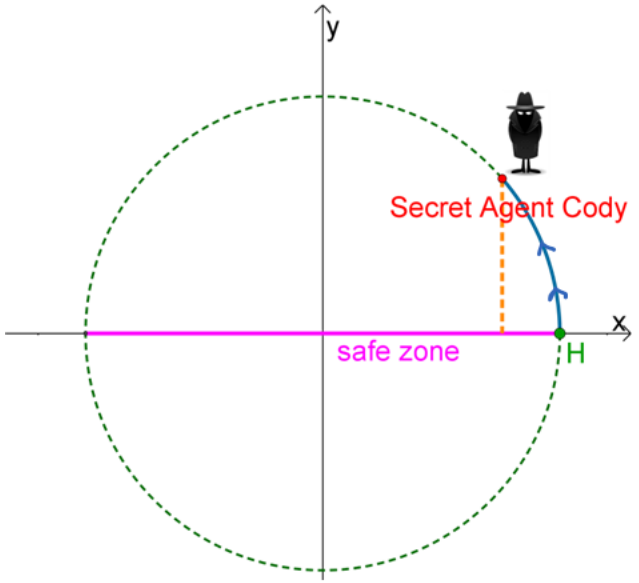


Figure 1a: Secret Agent Cody, Safe Zone, & Headquarters

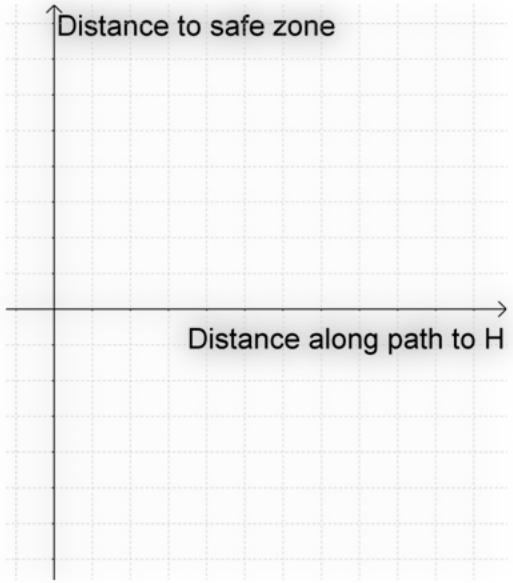


Figure 1b: Dispatcher's Screen

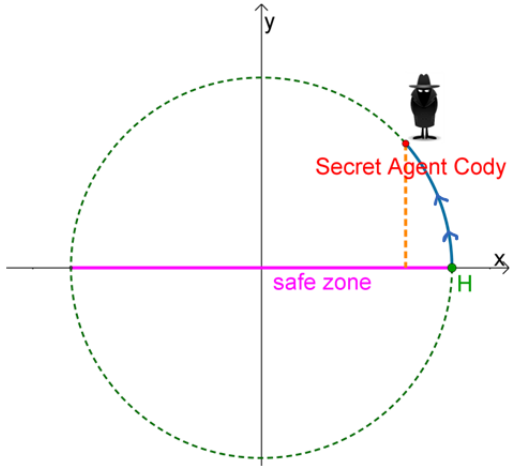


Figure 1a: Secret Agent Cody, Safe Zone, & Headquarters

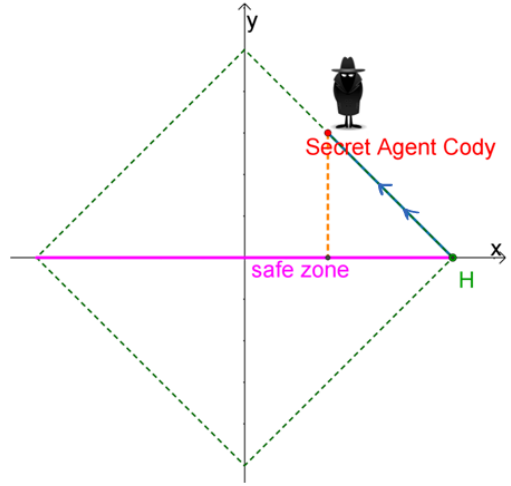


Figure 2a: Secret Agent Cody, Safe Zone, & Headquarters

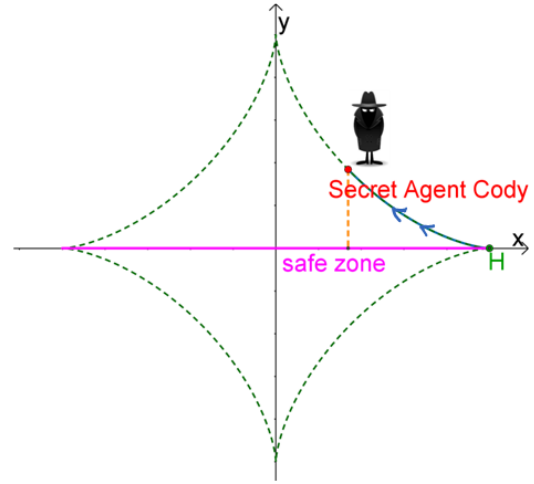
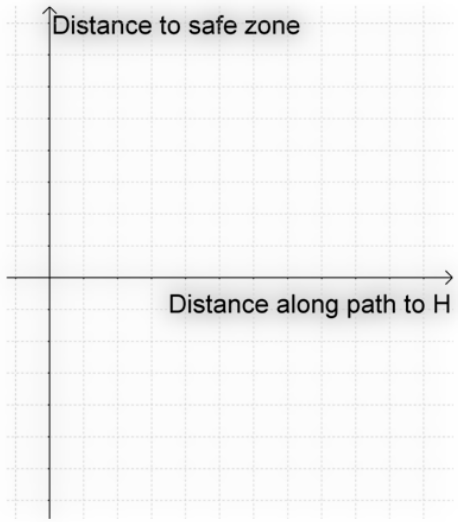
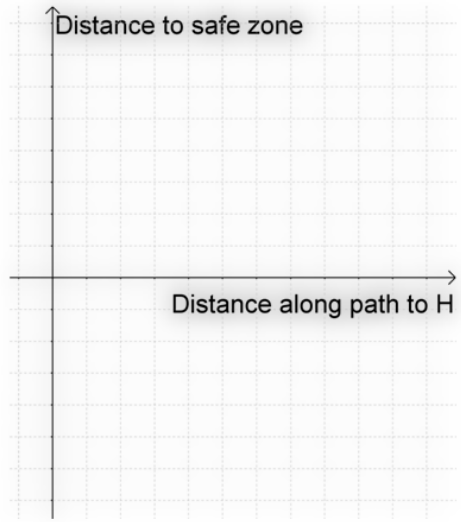
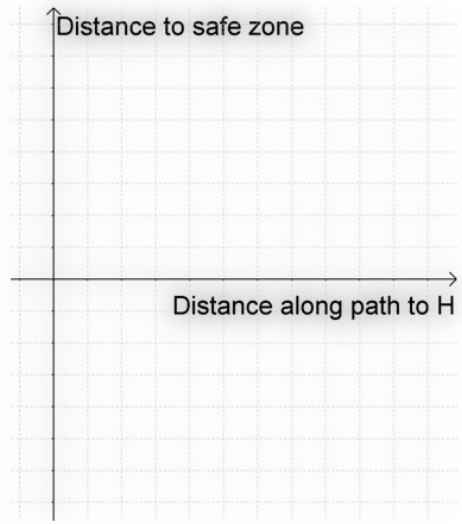


Figure 3a: Secret Agent Cody, Safe Zone, & Headquarters







Instructor Notes*:

Nine groups of three students (groups labeled A-I). It is best to have pre-prepared cards to place students in groups A1, A2, A3,...,C1,C2,C3, D4, D5, D6,..., F4,F5,F6, G7, G8, G9,...,I7,I8,I9. That is, members in groups A-C will also have a number 1-3, D-F will have numbers 4-6, and those in G-I will also have a number 7-9. Students will be placed groups by letter initially and then be asked to get into groups by number (this ensures 3 students per group in both scenarios) See Figure 2.

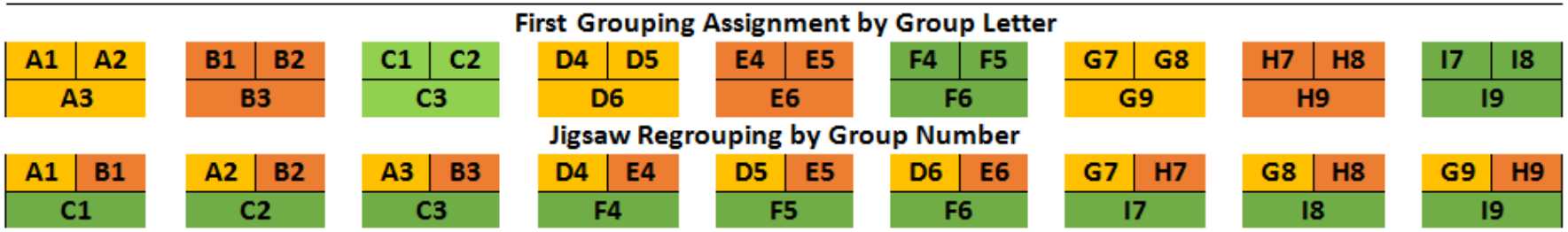


Figure 2. Visual Example of Jigsaw Strategy

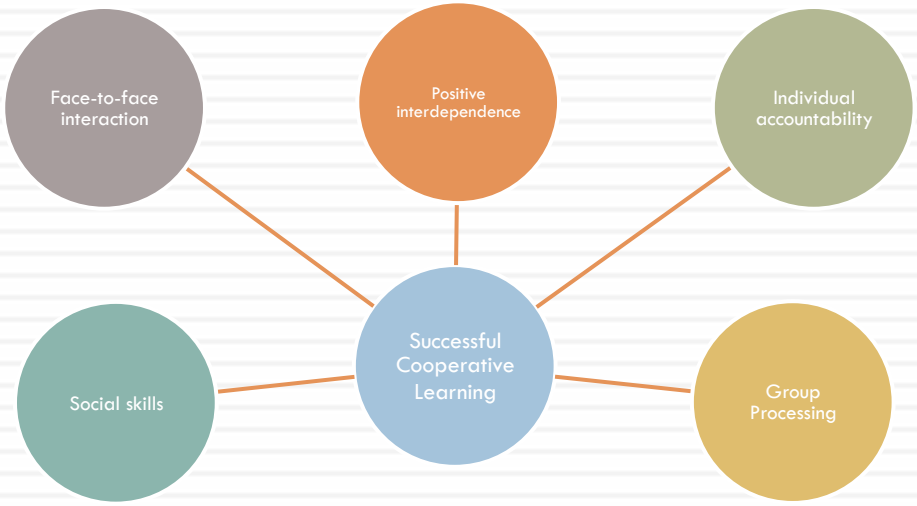
*From Álvarez, J.A.M., Jorgensen, T., & Rhoads, K. (2018). *Lesson 3: Qualitative Look at Graphical Representations*. Instructor Notes. Enhancing Explorations in Functions for Preservice Secondary Mathematics Teachers Project. The University of Texas at Arlington. Arlington, TX. This material is based upon work partially supported by the National Science Foundation Improving Undergraduate STEM Education (IUSE) program under Grant No. DUE #1612380. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the NSF.

Instructor notes:

- In their (letter) groups, groups A, D, and G will work on 3.1.1; B, E, and H on 3.1.2; and C, F, and I will work on 3.1.3.
- Once the groups have produced graphs for their assigned problem, ask them to shuffle into groups by number. In their groups they should explain to each other how they produced their graphs and then work on 3.1.4 and 3.1.5.
- Listen to the groups as they discuss their reasoning and provide scaffolding questions when needed. For example, in 3.1.5, it may be necessary to provide some scaffolding hints and pose questions such as "How does the location of Secret Agent Cody above or below the x-axis affect what the dispatcher sees?"

Five Essential Elements

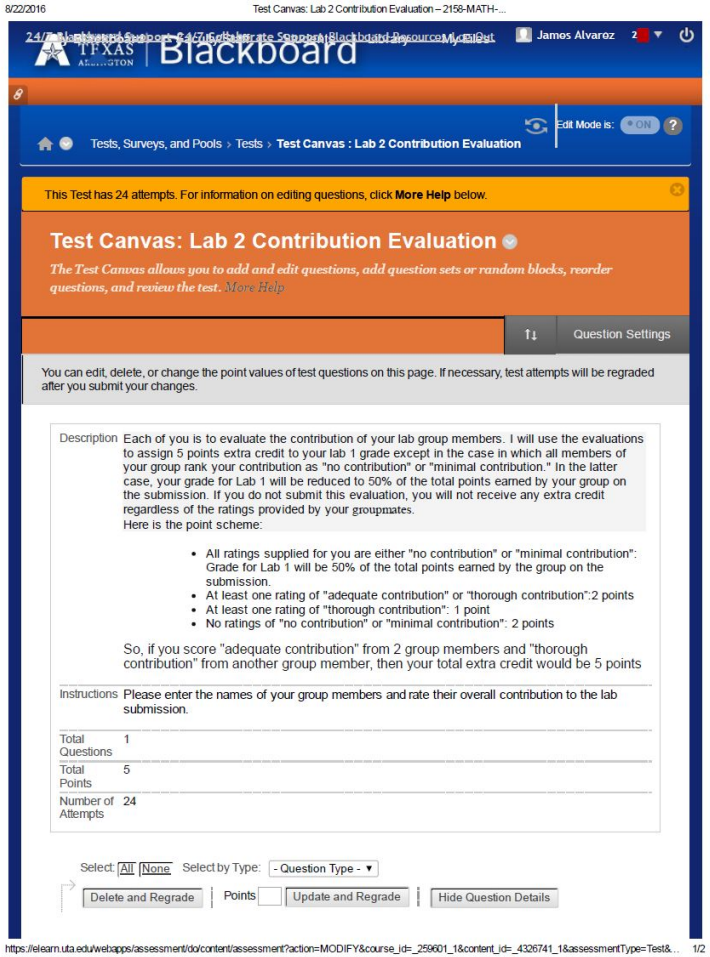
Positive interdependence: Group interaction is necessary for successful resolution of the question or task and for linking individual success and the success of the group.



Positive Interdependence

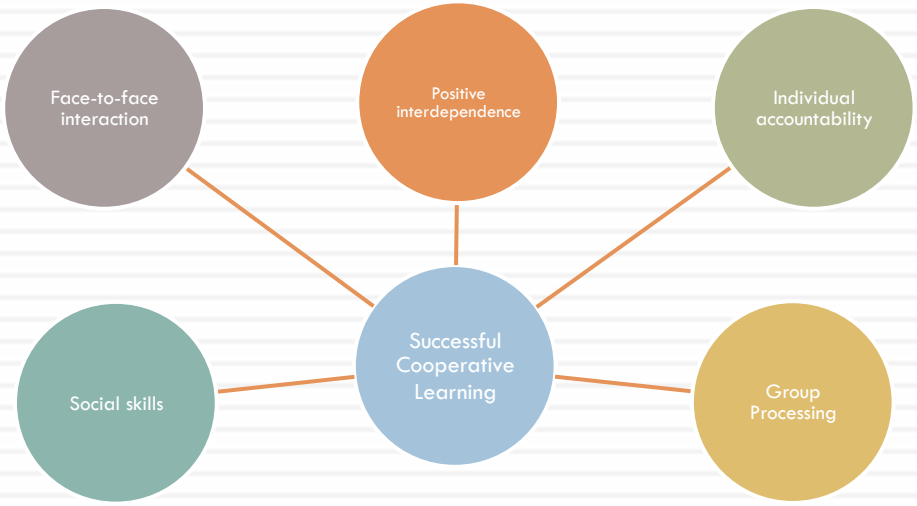
1. **Short Answer: Lab Member Rating: Enter the names (first and lastname r...**

Question	Enter the names (first and lastname required) of your lab members and rate their contribution. The contribution should be specified as (use only one): • no contribution • minimal contribution • adequate contribution • thorough contribution Here is an example of what needs to be entered: Lab Member 1: Jane Doe: No Contribution Lab Member 2: Nota Clue: Minimal Contribution Lab Member 3: Ima Genious: Thorough Contribution
Answer	



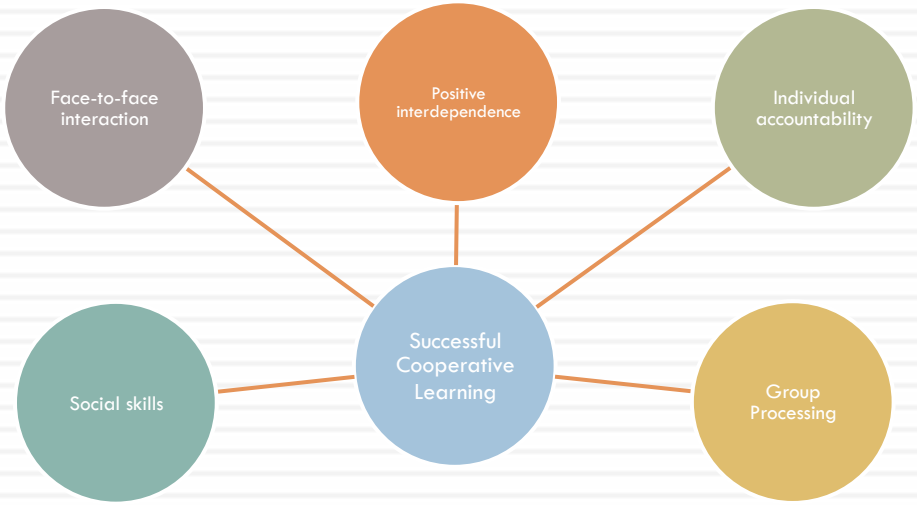
Five Essential Elements

Face-to-face interaction: Group interactions include discussing solution paths, important concepts, connections to prior knowledge, and facilitating words of encouragement and help when needed.



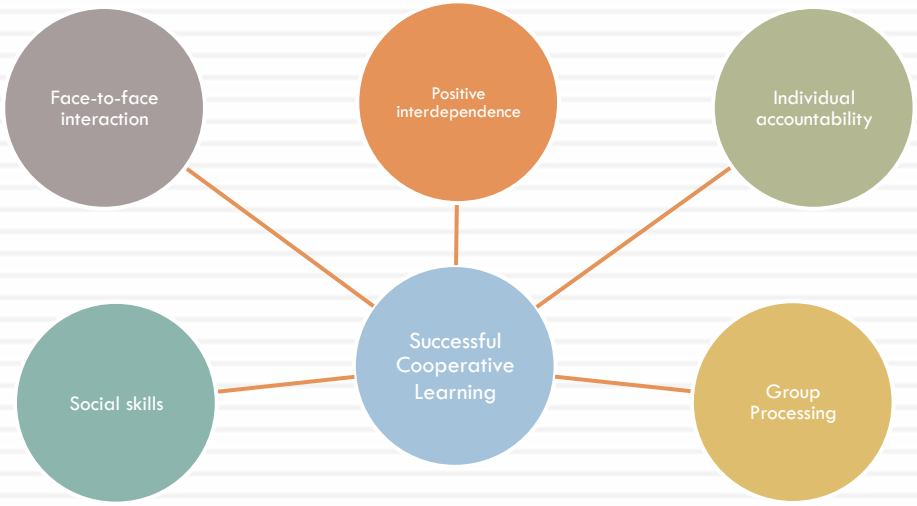
Five Essential Elements

Individual accountability: Students are held accountable for their share of the work in the group.



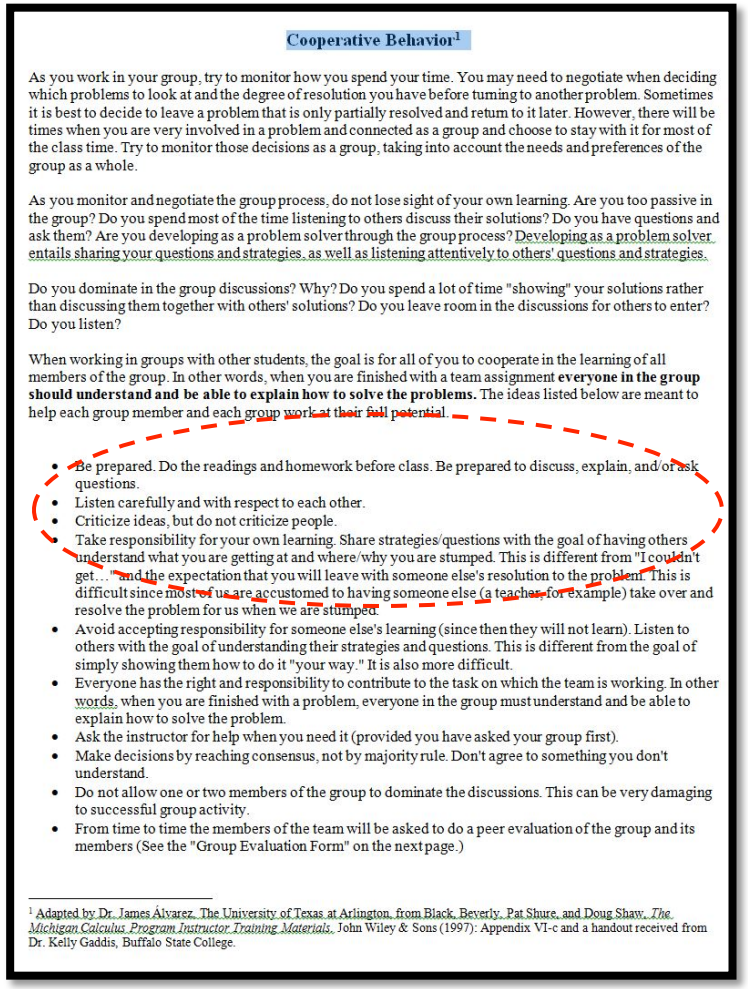
Five Essential Elements

Social skills: Group interaction requires interpersonal, social, and collaborative skills. Instructors must provide students with guidance on how to effectively interact in a small group.



Social Skills

- Be prepared. Do the readings and homework before class. Be prepared to discuss, explain, and/or ask questions.
- Listen carefully and with respect to each other.
- Criticize ideas, but do not criticize people.
- Take responsibility for your own learning. Share strategies/questions with the goal of having others understand what you are getting at and where/why you are stumped. This is different from "I couldn't get…" and the expectation that you will leave with someone else's resolution to the problem…



Cooperative Behavior[1]

As you work in your group, try to monitor how you spend your time. You may need to negotiate when deciding which problems to look at and the degree of resolution you have before turning to another problem. Sometimes it is best to decide to leave a problem that is only partially resolved and return to it later. However, there will be times when you are very involved in a problem and connected as a group and choose to stay with it for most of the class time. Try to monitor those decisions as a group, taking into account the needs and preferences of the group as a whole.

As you monitor and negotiate the group process, do not lose sight of your own learning. Are you too passive in the group? Do you spend most of the time listening to others discuss their solutions? Do you have questions and ask them? Are you developing as a problem solver through the group process? Developing as a problem solver entails sharing your questions and strategies, as well as listening attentively to others' questions and strategies.

Do you dominate in the group discussions? Why? Do you spend a lot of time "showing" your solutions rather than discussing them together with others' solutions? Do you leave room in the discussions for others to enter? Do you listen?

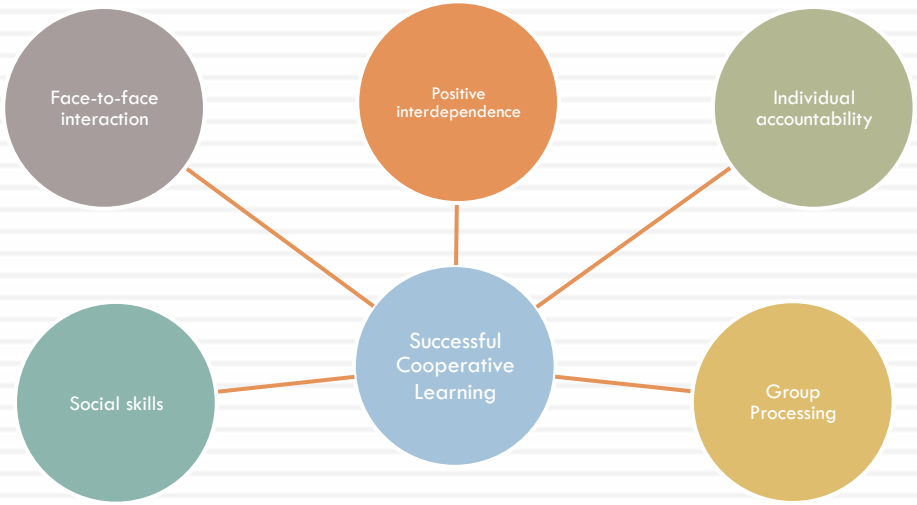
When working in groups with other students, the goal is for all of you to cooperate in the learning of all members of the group. In other words, when you are finished with a team assignment **everyone in the group should understand and be able to explain how to solve the problems.** The ideas listed below are meant to help each group member and each group work at their full potential.

- Be prepared. Do the readings and homework before class. Be prepared to discuss, explain, and/or ask questions.
- Listen carefully and with respect to each other.
- Criticize ideas, but do not criticize people.
- Take responsibility for your own learning. Share strategies/questions with the goal of having others understand what you are getting at and where/why you are stumped. This is different from "I couldn't get…" and the expectation that you will leave with someone else's resolution to the problem. This is difficult since most of us are accustomed to having someone else (a teacher, for example) take over and resolve the problem for us when we are stumped.
- Avoid accepting responsibility for someone else's learning (since then they will not learn). Listen to others with the goal of understanding their strategies and questions. This is different from the goal of simply showing them how to do it "your way." It is also more difficult.
- Everyone has the right and responsibility to contribute to the task on which the team is working. In other words, when you are finished with a problem, everyone in the group must understand and be able to explain how to solve the problem.
- Ask the instructor for help when you need it (provided you have asked your group first).
- Make decisions by reaching consensus, not by majority rule. Don't agree to something you don't understand.
- Do not allow one or two members of the group to dominate the discussions. This can be very damaging to successful group activity.
- From time to time the members of the team will be asked to do a peer evaluation of the group and its members (See the "Group Evaluation Form" on the next page.)

[1] Adapted by Dr. James Álvarez, The University of Texas at Arlington, from Black, Beverly, Pat Shure, and Doug Shaw, *The Michigan Calculus Program Instructor Training Materials*, John Wiley & Sons (1997): Appendix VI-c and a handout received from Dr. Kelly Gaddis, Buffalo State College.

Five Essential Elements

Group processing: Group members discuss effectiveness in reaching their goals and in working together.



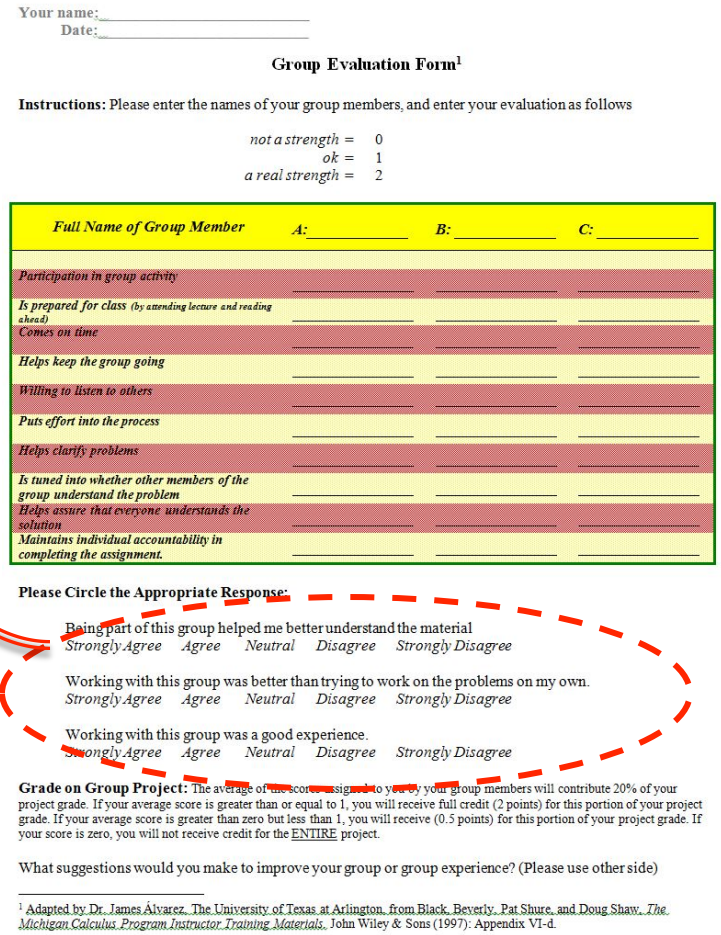
Group Processing

Please Circle the Appropriate Response:

Being part of this group helped me better understand the material
Strongly Agree Agree Neutral Disagree Strongly Disagree

Working with this group was better than trying to work on the problems on my own.
Strongly Agree Agree Neutral Disagree Strongly Disagree

Working with this group was a good experience.
Strongly Agree Agree Neutral Disagree Strongly Disagree



Your name:_____
Date:_____

Group Evaluation Form[1]

Instructions: Please enter the names of your group members, and enter your evaluation as follows

not a strength = 0
ok = 1
a real strength = 2

Full Name of Group Member	*A:*_____	*B:*_____	*C:*_____
Participation in group activity			
Is prepared for class (by attending lecture and reading ahead)			
Comes on time			
Helps keep the group going			
Willing to listen to others			
Puts effort into the process			
Helps clarify problems			
Is tuned into whether other members of the group understand the problem			
Helps assure that everyone understands the solution			
Maintains individual accountability in completing the assignment.			

Please Circle the Appropriate Response:

Being part of this group helped me better understand the material
Strongly Agree Agree Neutral Disagree Strongly Disagree

Working with this group was better than trying to work on the problems on my own.
Strongly Agree Agree Neutral Disagree Strongly Disagree

Working with this group was a good experience.
Strongly Agree Agree Neutral Disagree Strongly Disagree

Grade on Group Project: The average of the scores assigned to you by your group members will contribute 20% of your project grade. If your average score is greater than or equal to 1, you will receive full credit (2 points) for this portion of your project grade. If your average score is greater than zero but less than 1, you will receive (0.5 points) for this portion of your project grade. If your score is zero, you will not receive credit for the ENTIRE project.

What suggestions would you make to improve your group or group experience? (Please use other side)

[1] Adapted by Dr. James Alvarez, The University of Texas at Arlington, from Black, Beverly, Pat Shure, and Doug Shaw, *The Michigan Calculus Program Instructor Training Materials*, John Wiley & Sons (1997): Appendix VI-d.

Adapted by Dr. James Álvarez, The University of Texas at Arlington, from Black, Beverly, Pat Shure, and Doug Shaw, *The Michigan Calculus Program Instructor Training Materials*. John Wiley & Sons (1997): Appendix VI-d.

Final Thoughts

- Incorporating cooperative learning strategies can be challenging.
- Attend to the five components discussed—there are many ways to do that, I've only given you a glimpse.
- Try it more than once! You get better at it!

Thank you!

james.alvarez@uta.edu