UNDERSTANDING GROUP DYNAMICS WITHIN A CLASSROOM USING SMALL GROUP NETWORKS AND EPISTEMOLOGICAL FRAMING

Katarzyna E. Pomian
DePaul University, kasia.pomian@yahoo.com

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UNDERSTANDING GROUP DYNAMICS WITHIN A CLASSROOM USING SMALL GROUP NETWORKS AND EPISTEMOLOGICAL FRAMING

A Thesis
Presented in
Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

November, 2018

BY

KATARZYNA E. POMIAN

PHYSICS DEPARTMENT
College of Liberal Arts and Sciences
DePaul University
Chicago, Illinois
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ABSTRACT

In this study, we examined interactions within student groups and between groups and instructors. A deeper exploration of group dynamics helps educators to more fully understand student groups and student learning within the classroom. Our data are from a two-week summer program for incoming college freshman that focuses on helping students develop metacognitive and self-assessment tools. With the intention of using Social Network Analysis (SNA), we took the novel approach of creating network graphs from video data as opposed to surveys. However, given the isolated nature of the groups, the quantitative measures of SNA were inappropriate for our small group networks, and we focused instead on a qualitative analysis of student interactions, distinguishing between on-topic and off-topic categories. This preliminary analysis identified several areas for further exploration, at which point we continued our analysis using epistemological framing, which is how people structure their understanding within an activity to make sense of what is taking place and how it is related to their knowledge. We analyzed group video data to assess verbal and non-verbal cues within student groups for two categories: the task category (on-task and off-task frames) and seriousness category (serious and silly frames). We explored the intersection between the frames, the time spent in these frames, the initiators of the frames, and roles that the on-task/silly frame serves for student groups. We found that groups’ epistemological framing involves an interplay between individual group dynamics, the nature of the activity, and how instructors interact with the groups. We also found that the on-task/silly frame can be categorized into purposeful roles demonstrating the usefulness of the silly frame in the classroom.
CHAPTER 1

Introduction

1.1 Overview

Researchers and educators have been strongly interested in understanding how students learn in a classroom. They have found that students actually begin to more fully understand concepts when working in groups where they are allowed to discuss their ideas [1]. We are getting a better insight into understanding student group dynamics in a classroom by studying student in-class interactions, how they are making sense of what is taking place, and how it is related to their knowledge.

At first we started analyzing small group networks to better understand the role of student interactions in the classroom. We wanted to know whether the interactions between students in the classroom were on-topic or off-topic, who the interactions were coming from, and who was receiving them. It was interesting to identify whether group behavior was as expected by the program or whether we could identify any unexpected behaviors. The program expectations were that the groups would have a healthy balance of on-topic and off-topic interactions.

After the small group network analysis, we were intrigued by episodes of student interactions when students were off-topic, but through laughter and joking they evolved into having on-topic interactions. We also noticed episodes where the students used silliness to direct attention to something they were working on or to relieve tension in the group while having on-topic interactions. We therefore considered the use of epistemological framing to analyze the ways in which students were
framing the activity when interacting with each other to solve classroom problems. Epistemological framing is the way students conceptualize ideas and portray them within a learning activity. We analyzed the relative seriousness of interactions, categorizing them as serious or silly because we were interested in episodes where students were laughing. Additionally, we decided to expand our categorization from small group networks to distinguish on-task interactions from on-topic interactions, giving three types of interactions: on-task, on-topic, and off-topic. However, upon initial analysis, we realized the most useful distinction was between on-task and off-task, where the off-task frame consisted of the redefined on-topic and off-topic interactions.

1.2 Research Questions

Our overall research question is:

What are individual group dynamics within a classroom?

To answer this question, we answer different questions within the two parts of this paper, and then we revisit this overall question and answer it.

1.2.1 Research Questions for Part 1: Small Group Networks (Ch. 2, 3 and 4)

1. How do the number of on-topic ties differ between groups over time?

2. What are the characteristics of the network for individual groups?

3. How does an individual student contribute to the group’s Network?
1.2.2 Research Questions for Part 2: Epistemological Framing (Ch. 5, 6, 7, 8, 9, and 10)

Broadly we are interested in when and how often do shifts happen within and across groups and activities. We are also interested in specifically addressing the following questions:

1. How does time spent in frames vary between groups and activities?
2. Within each group, who initiates frame shifts?
3. What purpose(s) does the on-task/silly frame serve in the classroom?

1.3 Context

1.3.1 IMPRESS program

The context for the present study is the Integrating Metacognitive Practices and Research to Ensure Student Success (IMPRESS) summer program, which is a two-week program for matriculating Rochester Institute of Technology (RIT) STEM students who are first generation college students and/or deaf/hard of hearing students (DHH) [3]. Students who are incoming college freshman and fall into the above mentioned categories are invited to apply to be a part of this program; twenty are chosen to participate. The IMPRESS program was designed to serve as a bridge program for students to learn how to reflect on, evaluate, and change their own thinking through intensive laboratory experiments, reflective practices, and discussion both in small groups (3-4 students) and with the whole class (20 students). The main objectives of the IMPRESS program are to engage students in authentic science practice, to facilitate the development of a supportive community, and to help the students reflect
on the science and themselves in order to strengthen their learning habits and lead them to a stronger future in STEM fields.

We are interested in exploring and characterizing this developing community. While it is difficult to track overall community development by simply observing interactions, we hoped that the quantitative aspect of Social Network Analysis (SNA) would allow us to better characterize the formation and evolution of the IMPRESS community. Social Network Analysis is a quantitative method analyzing group networks based on graph theory \[4\]. While we started with the analysis of the classroom networks using SNA methodologies, we realized that due to the nature of the activities we were observing, we were not able to get a reasonable classroom network for SNA. The students were seated in small groups (3-4) and primarily interacted with their group members and the instructors as the instructors roamed the classroom. Thus, we transitioned to analyze small group networks qualitatively.

We analyzed how the patterns of interactions varied over the course of an activity for different groups. In addition, we distinguished between the on-topic and off-topic interactions to help us characterize the amount of time students were engaged in the science versus time they were building social communities, noting that both of these practices support community building in science classrooms \[2\].

We were able to create individualized group network maps, which led us into the exploration of particular group dynamics. These group dynamics further led us to switch over to epistemological framing to study students framing in terms of the seriousness category of frames (serious and silly frames) and task category of frames (on-task and off-task frames) and the intersection between the frames.
1.4 Data Collection

The classroom had 20 students who were arranged into 5 groups sitting at 5 separate tables in groups of 4. The room set up is shown in Fig. 1.1. The program lasted nine days and ran for eight hours a day. Cameras were set up on mini tripods at four tables to observe activities and interactions in the groups. These cameras also captured the voices of the students. While the students were working on the assignments, the instructor and two student leaders (who were previous IMPRESS students) circulated the room interacting with different groups.

We focused on the ninth day of the IMPRESS program because this was the last day of the program, and the activities brought together all the previously learned topics. The students were already familiar with each other, the student leaders, and the instructor. This allowed us to see interactions where the students were more likely to be comfortable, as compared to the interactions toward the beginning of the program. All of the small group network analysis and epistemological framing was done on the morning session of the program which was split into 3 activities described in Section 1.4.2.

The cameras started recording before the first activity was announced by the instructor, and the recordings were stopped after the instructor announced the end of the morning session, which was after the third activity was completed. The times were synced on all cameras, so that all the data analysis began at the same time for all groups. The data was segmented into 5 minute clips, which made it easier to reference and handle.
1.4.1 Description of groups and group members

Prior to the beginning of data collection, all students were given a pseudonym and as a part of their application were asked to self report their gender, ethnicity, hearing status, and preferred method of communication. All the students and their self-identifications are reported in Table 1.1. The groups were self-selected and had been together since Day 4 of the program. The layout of the room is shown in Fig. 1.1 including where students were seated and where the cameras were placed. One of the tables consisted of completely deaf or hard hearing (DHH) students, one of whom did not wish to be a part of the study; therefore, data from this group are not used.

All groups had at least one student who identified as DHH. Groups 1 and 4 were mixed gender; Group 2 was all male; and Group 3 was all female. Groups 1, 2, and 4 each had four people, whereas Group 3 only had three because one of the group members were missing for the day.

Corey was the instructor and there were two student leaders, Nick and Jose. Both student leaders were male and hearing; however, Nick was in a wheelchair. The instructor and student leaders circled the room as the groups were working on the activities.

1.4.2 Description of Activities

As mentioned earlier, the particular video we looked at for our analysis was from the ninth day of the IMPRESS program, which was the last day of the program. The specific session we were analyzing was the morning session which was split up into three consecutive activities each with separate instructions, but the students were in the same groups throughout all the activities. The instructor, Corey, introduced all the activities by saying the instructions out loud (no written instructions) while an
Table 1.1: Self-identification of all students based on their gender, ethnicity, hearing status, and preferred method of communication. All students were asked to include this information when applying the IMPRESS program.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Students</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Hearing Status, communication method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Pat</td>
<td>F</td>
<td>White</td>
<td>DHH, Speech</td>
</tr>
<tr>
<td></td>
<td>Justin</td>
<td>M</td>
<td>White</td>
<td>hearing</td>
</tr>
<tr>
<td></td>
<td>Jessica</td>
<td>F</td>
<td>White</td>
<td>DHH, Speech &amp; ASL</td>
</tr>
<tr>
<td></td>
<td>Brittany</td>
<td>F</td>
<td>American Indian, Hispanic/Latino, White</td>
<td>hearing</td>
</tr>
<tr>
<td>Group 2</td>
<td>Herb</td>
<td>M</td>
<td>White</td>
<td>hearing</td>
</tr>
<tr>
<td></td>
<td>Jacob</td>
<td>M</td>
<td>White</td>
<td>hearing</td>
</tr>
<tr>
<td></td>
<td>BJ</td>
<td>M</td>
<td>Asian</td>
<td>DHH, Speech</td>
</tr>
<tr>
<td></td>
<td>Brett</td>
<td>M</td>
<td>White</td>
<td>hearing</td>
</tr>
<tr>
<td>Group 3</td>
<td>Grace</td>
<td>F</td>
<td>Asian</td>
<td>hearing</td>
</tr>
<tr>
<td></td>
<td>Sara</td>
<td>F</td>
<td>White</td>
<td>hearing</td>
</tr>
<tr>
<td></td>
<td>Jill</td>
<td>F</td>
<td>White</td>
<td>DHH, Speech</td>
</tr>
<tr>
<td>Group 4</td>
<td>Arya</td>
<td>F</td>
<td>African American</td>
<td>hearing</td>
</tr>
<tr>
<td></td>
<td>Tasha</td>
<td>F</td>
<td>African American, Hispanic/Latino</td>
<td>hearing</td>
</tr>
<tr>
<td></td>
<td>Daniel</td>
<td>M</td>
<td>Hispanic/Latino</td>
<td>hearing</td>
</tr>
<tr>
<td></td>
<td>Jack</td>
<td>M</td>
<td>African American, American Indian</td>
<td>DHH, ASL &amp; typing on computer</td>
</tr>
</tbody>
</table>
interpreter translated into American Sign Language (ASL). The groups all worked on the activities together and made their own notes in their journals.

On previous days, there were discussions of what carbon dioxide is, how it is formed and consumed. They also did experiments on decomposition, thermal absorption, Albedo effect, and solubility of $CO_2$. All these experiments used a variety of different materials, and involved the students making detailed measurements and observations.

Activity 1 was to develop an algebraic equation for how much carbon dioxide enters the atmosphere per year. The students were instructed to not use numbers, clearly define their variables, and think about why those variables are important. The students were not allowed to use the internet or any other outside source. Instead, they were to use the knowledge that they learned during the program. An example of Grace’s (member of Group 3) equation with descriptions of the variables is shown in Fig. 1.2.

Activity 2 was to draw a diagram, like they would see in a textbook, to represent all the different ideas about how climate change works. They were instructed to look back at the experiments that were done throughout the program from Day 1 until the current day of observation (Day 9) and the notes they took during these experiments in order to put everything together into their diagram. An example of a Grace’s diagram is shown in Fig. 1.3.

Activity 3 was to critique published diagrams and figures that represent climate change from textbooks and determine if/how their own ideas were represented in them. The students needed to analyze the given figures and compare them to the ones that they were developing, discuss what the figures could do better, what they liked about each of the figures, and what they would have liked to see in an ideal figure. They were also asked to try to take the ideas from all the figures and turn
them into a better figure. They were instructed to pay attention to the details: what kind of information was included in the captions, what was their instant reaction when they looked at the figures, etc. Every student was given the same packet of scanned images from different textbooks. After they were finished discussing, they were instructed to write down their thoughts in their journal. At this point the coding was stopped. For this reason, Activity 3 lasted a different amount of time for each group. Figure 1.4 shows the reflective thoughts of Grace from Activity 3.
Figure 1.1: Schematic of the room setup. The black cameras indicated the placement of the camera at all the tables. The students are labeled with their pseudonym according to where they were seated during all 3 activities. The color denotes the gender of the student (teal=male, pink=female). The shape denotes the hearing status of the student (circle=hearing, square=DHH). The instructor (INST) and student leaders (SL) are labeled accordingly. The table that is labeled as not used included only students who were DHH; therefore, it was a signing only table and was not coded. We had no control of the seating arrangement when coding the data.
Figure 1.2: An example of Grace’s carbon dioxide equation that Group 3 worked on during Activity 1. She indicated where the variables were coming from, and what they represented.
Figure 1.3: An example of Grace’s carbon dioxide transfer diagram she drew in her journal during Activity 2 based on the equation she wrote (see Fig. 1.2). We can see the arrows indicating carbon dioxide transfer and labels.
Figure 1.4: An example of Grace’s reflection of Activity 3 about how she can improve her diagram (see Fig. 1.3).
CHAPTER 2

Introduction to Small Group Networks

Many studies have shown that student persistence and retention in college is strongly related to students’ sense of belonging and community [5, 6]. In recent years, there have been several programs developed to engage students in authentic science practice while fostering supportive communities [7]. In assessing the effectiveness of such programs, it would be useful to have a way of characterizing students’ interactions and connections within the community.

Social Network Analysis (SNA) is a quantitative approach used to measure and explore social interactions and communication between individuals within a group or network [4]. Typically, these networks are created using survey data where group members are explicitly asked to name individuals with whom they interact in some manner. We attempted a novel application of SNA by creating networks from qualitative analysis of classroom video data [8].

We approached our data with the intention of performing SNA for a network of the whole classroom. After generating the network graphs, we realized we had four isolated networks instead of one larger network, so we had to transition to look qualitatively at the individual small group networks.

The questions we ask using small group networks are:

1. How do the number of on-topic ties differ between groups over time? (Sec. 3.1)

2. What are the characteristics of the network for individual groups? (Sec. 3.2)
3. How does an individual student contribute to the group’s Network? (Sec. 3.3)

Mapping network graphs for individual groups allowed us to see if students were exchanging ideas that were on-topic or off-topic. We were also able to see how each group progressed with time; whether they stayed on-topic, stayed off-topic, switched regularly, or made drastic shifts. Finally, we were able to explore how individuals were contributing to their small group’s network.

We employed a novel approach to creating network graphs: extracting ties from a qualitative analysis of classroom video data. When using video data to extract interactional information, we were able to directly observe whether a student was talking to another students and whether that student was listening. We were also able to analyze the type and frequency of the interactions, compare them to other students’ interactions, and align the patterns with classroom or program goals.

As mentioned earlier, given the isolated nature of the small groups within our network, we focused on qualitative analysis of the small group networks. This work was continued with another collaboration, [9] which explored how these small group networks changed over the course of the program.

2.1 Theory of Social Network Analysis

Social Network Analysis (SNA) has its roots in quantitative sociology and is built on the idea of structural centrality, which is a measure of the closeness of individual entities to other entities within the network [10]. The core of all network analysis is the identification of nodes and ties. In a social network, the nodes represent individual people in the network. A tie is a link between two nodes and typically represents an interaction or communication transfer between two people. Sometimes ties are directional, where the person who initiates the interaction is called the source.
and the person who receives the information is the \textit{target}.

In network graphs, \textit{nodes} are typically represented as dots and \textit{ties} are represented as lines between two nodes, or as arrows if directional information is included. For networks where there are multiple \textit{ties} between nodes, the number or thickness of the \textit{ties} is used to represent the relative strength of the interaction between \textit{nodes}. For example, in Fig. 2.1, there are four \textit{nodes}: Jacob, Herb, Brett, and BJ. The arrows connecting them are \textit{directional ties}. We can see that more clearly when we look at the \textit{ties} between Herb and BJ. The arrow head points towards BJ meaning that BJ received the \textit{ties} sent to him by Herb, but Herb did not receive any \textit{ties} from BJ.

![Figure 2.1: An example of a network map of a group of students. There are four nodes: Jacob, Herb, Brett, and BJ. The arrows connecting them are directional ties. We can see these directional ties more clearly when we look at the ties between Herb and BJ. The arrow head points towards BJ meaning that BJ received the ties sent to him by Herb, but Herb did not receive any ties from BJ.](image)

In recent years, the Physics Education Research (PER) community has taken up SNA as a tool to characterize participation within communities of interest (e.g., a physics learning center [11] or the PER community itself [12]). In addition, several
studies have used SNA to quantify interactions in order to explore their impact on other constructs relevant to learning (e.g., course grades \[13\], self-efficacy \[14\], persistence \[15\]).

Traditionally, SNA has been studied using survey questions where participants self-reported their interactions \[11, 13, 14, 15\]. Responding to survey questions is very different than observing what is actually going on within the interactions. Some interactions that occur are significant to one participant, but almost non-existent to another, and therefore, get omitted when self-reporting. This means that when asked on a survey who you worked with, participant A may say they worked with participants B and C, while participants B and C would report that they only worked with each other, in which case, we would possibly interpret that as minimal interactions, or as one directional interactions. Using video data, these potential problems were solved.

### 2.2 Methods for Extracting Small Group Networks

When developing our coding instructions, we were focusing on aligning them with Social Network Analysis (SNA). We identified *nodes* and *ties* and created network graphs; however, after realizing we had four isolated networks instead of one larger one, we did not do traditional SNA because we were not able to acquire quantitative measures. Instead, we used the generated network graphs, and continued looking at our data qualitatively.

#### 2.2.1 Coding

To develop our coding, we focused on a single small group activity, Activity 1 (see Sec. \[1.4.2\]), on the ninth day of the program. After a preliminary inspection of the
video data, we chose to use two-minute clips as our unit of analysis. This was chosen based on how much information was gathered during the two-minutes, making sure that during this time we gathered an accurate representative sample of interactions. We began our coding as the instructor finished the instructions for the task and ended as he introduced the next task (42 minutes, 21 clips). For each two-minute clip, we coded only whether an interaction between two individuals occurred, but not how many times it occurred. Moreover, since our data represents conversations between students, we considered all interactions to be directional with an identified source (the person sending information) and targets (individuals that received the information).

In addition, we coded each interaction as either being on-topic or off-topic. On-topic interactions were those involving conversations related to the activity, to the IMPRESS program, and/or to STEM education; all other interactions not related to education were classified as off-topic. We included education related discussions under on-topic interactions because part of the goal for this program was to help these students create a learning community.

2.2.2 Inter-rater reliability for small group network coding

Interactions were coded using Behavioral Observation Research Interactive Software (BORIS) [16]. Within a group of collaborators, we developed a detailed codebook where we described what counted as an interaction and how it might vary for hearing and DHH individuals.

Recognizing the occurrence of interactions and classifying them as on-topic or off-topic depends on the interpretation of the codebook. To minimize the effect of such interpretations, we conducted inter-rater reliability tests. Seven random clips
of the video data were coded and compared by three coders with initial agreement of 88%. Discrepancies were discussed and the codebook was revised accordingly. The clips were then recoded by all three coders with the new coding definitions with 98% agreement. The remainder of the episode was coded by one of the coders.
CHAPTER 3

Analysis of Small Group Networks

For this preliminary analysis, we focused on the interactions within each small group. Thus, we removed all ties to instructors and between members of different groups.

In our analysis, we considered two cases: (1) interactions within individual two-minute clips (as described in Sec. 2.2.1) and (2) averaged interactions over multiple clips. For the averaged network, we aggregated four (non-overlapping) clips per bin (8 minutes). Due to an odd number of clips, the last bin contained five clips (10 minutes). We then plotted these individually and averaged data over time.

In this chapter, we will explore:

- Research Question 1: How do the number of on-topic ties differ between groups over time?
- Research Question 2: What are the characteristics of the network for individual groups?
- Research Question 3: How does an individual student contribute to the group’s Network?

3.1 Research Question 1: How do the number of on-topic ties differ between groups over time?

The first point of comparison between groups was how many interactions occurred overall. Given the differing numbers of group members, we normalized by the total
possible interactions for each group. There are 24 possible interactions for a 4-person group and 12 possible interactions for a 3-person group. These total interactions were possible for each two-minute clip. The data for the full episode are shown in Table 3.1. Based on this table, Groups 2 and 4 appear to interact slightly less than Groups 1 and 3, but examining normalized data over time (see Fig. 3.1) shows no clear discernible patterns of difference between groups.

We also wanted to explore how the frequency of on-topic and off-topic interactions changed over time. Figure 3.2 shows the percentage of on-topic ties for each group over time, both for individual clips and averaged data. Given that we began as the instructor was finishing the instructions for the task, we expected to see a relatively high (or increasing) number of on-topic interaction as the students began working on the activity and then an increase in off-topic interactions as groups began to wrap-up the activity. We expected this because when students are given a task, they often want to jump right into trying to solve it. Also, when students are finished with a task and are not given another task to work on right away, they tend to discuss things not related to the class, getting off-topic. The behavior of Groups 1 and 4 mostly follow this expected pattern. However, Groups 2 and 3 exhibit more unexpected behavior. The trend for Group 2 is strongly declining towards off-topic most of the time while Group 3 stays on-topic the whole time.

Table 3.1: Total number of ties during Activity 1 by group. Groups 2 and 4 appear to interact slightly less that Groups 1 and 3.

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total # of Ties</td>
<td>257</td>
<td>218</td>
<td>119</td>
<td>203</td>
</tr>
<tr>
<td># of Possible Ties</td>
<td>504</td>
<td>504</td>
<td>252</td>
<td>504</td>
</tr>
<tr>
<td>% of Possible Ties</td>
<td>0.51</td>
<td>0.43</td>
<td>0.47</td>
<td>0.40</td>
</tr>
</tbody>
</table>
Figure 3.1: Percentage of on-topic ties by group normalized and averaged by the total possible ties in each bin. There is no clear discernible pattern between groups.

3.2 Research Question 2: What are the characteristics of the network for individual groups?

To get a better sense for how individuals might be contributing to the overall patterns, we created weighted network maps for each bin, where each arrow represented a directed interaction and gender and hearing status were included as color and shape, respectively. Figure 3.3 shows the network graphs for the last bin (32-42 minutes) with (a) all ties, (b) highlighting on-topic ties, and (c) highlighting off-topic ties. This bin was chosen to highlight the differences in the groups, though we find it to be a good representative of the groups’ behavior at other times as well.

While it appears in Fig. 3.3 (a) that the students interacted with all group mem-
bers overall, Figs. 3.3 (b) and (c) indicate that some students are primarily interacting only on-topic (e.g., Jack, Daniel, and all of Group 3) or only off-topic (e.g., Herb).

When looking at the on-topic ties in Fig. 3.3 (b), the most striking thing is that Herb, in Group 2, does not initiate or receive any on-topic interactions during this ten-minute time period. This suggests Herb’s involvement in the group’s dynamic may be one of the reasons for Group 2’s off-topic trend towards off-topic conversations that was noted in Fig. 3.2.
In Fig. 3.3 (c), we see the students in Group 3 exclusively interacting on-topic. In fact, this group had no off-topic interactions amongst themselves during the entire activity (see Fig. 3.2), which suggests that this table may not be actively developing as a community or they need more time to focus on on-topic interactions.

Figure 3.3: Network graph for the last bin (32-42 min) (a) showing all ties, (b) highlighting on-topic ties, and (c) highlighting off-topic ties. Node color denotes the gender of the student (blue = male; pink = female). Node shape indicates hearing status (circle = hearing; square = DHH). Group 3 has no off-topic ties, and Herb, in Group 2, does not send or receive any on-topic ties.

3.3 Research Question 3: How does an individual student contribute to the group’s Network?

In order to more closely examine Herb’s role in the group, we compared the total number of outgoing ties for on-topic and off-topic interactions for each student in Group 2. As can be seen in Fig. 3.4, Herb has more outgoing off-topic ties (48) than any other group member, including Jakob (41) and Brett (31), who had more ties overall. Even more telling is that he initiates significantly more off-topic (84%)
interactions than on-topic interactions (16%). This provides additional evidence that Herb may be at least part of the cause of Group 2’s off-topic trend.

Figure 3.4 also shows that although BJ initiated more on-topic than off-topic interactions, he contributed to the discussion much less overall than the other group members. Since BJ was the only member of Group 2 who identified as DHH, this result suggests a closer look at how student identities impact their participation.

![Figure 3.4](image)

Figure 3.4: Number of outgoing ties for each member of Group 2 based on whether they were on-topic or off-topic. 84% of Herb’s outgoing ties are off-topic while only 16% are on-topic indicating that Herb may have be the cause of Group 2’s tendency towards being off-topic. BJ has the least amount of out-going ties as compared to the rest of his group, and the majority of them are on-topic.
CHAPTER 4

Conclusions of Part 1: Small Group Networks

Social Network Analysis (SNA) is a wonderful tool for quantifying interactions between individuals in a group. While SNA has historically used data from surveys where participants self-report connections, in our study we used video data. We explored the networks for one activity from the IMPRESS summer program at RIT to test our approach. However, given that our classroom was segregated into small isolated groups, we were unable to see the full classroom network and the individual networks were too small to continue using SNA.

We believe using SNA with classroom video data could be a very useful approach. We have shown that it is possible to extract network data from classroom video to create and analyze social networks. However, in order to be able to truly use SNA, the classroom would have to be interacting as a whole, as opposed to only within small groups. SNA allows for a quantitative approach by measuring centrality, density, tie strength, etc. However, here we used its core of node and tie identification to create representations. Thus, our analysis here focused instead on a qualitative analysis of the small group networks.

In our case the use of nodes and ties to create network graphs allowed us to visualize and analyze the interactions between groups and individuals within our network. More importantly, our distinction between on-topic versus off-topic interactions helped us to begin to assess whether the group behavior was as expected - with a balance of engagement with science and community formation - or whether
there were some groups or individuals that exhibited unexpected behavior. Graphing on-topic ties over time identified one table that may not be developing as a community in the way the program intended. The network graphs pointed to a possible cause of another group’s trend toward off-topic interactions: the student named Herb. Looking at directional information supported this conclusion but also revealed a more complex group dynamic.

After seeing how isolated the groups were from each other, we shifted from looking at individuals to looking at groups, and began asking questions more aligned with Epistemological Framing (EF). Episodes where the groups were acting silly stood out. For instance, there was an episode where a group of students were working on an experiment and were given a lamp. They did not know what to use the lamp for. One of the students said that the lamp reminded her of a lizard lamp. The group started joking about the lizard lamp stating that it was needed to keep the lizard warm and give it light. Through the use of laughter, the lamp became a more approachable topic that soon created a mutual understanding. This episode would be coded as being off-topic, but there was a building of understanding through silliness.

Thus, we wanted to explore times when the groups were using laughter and silliness in the classroom along with further exploring the topicality of their interactions. Therefore, in Part 2, we expanded the topic categories used in Part 1, and added a seriousness category adapted from Irving et al. [2] to further explore the group dynamics in this context.
CHAPTER 5

Introduction to Part 2: Epistemological Framing

Research has found that students actually begin to more fully understand concepts when working in groups where they are allowed to discuss their ideas [1]. Researchers have been using epistemological framing to more fully understand the ways in which students frame their knowledge in the classroom and have found that educators’ better understanding of student framing can greatly influence students’ ability to learn, choice of learning, and enjoyment of learning [17].

Epistemological framing, which comes from cognitive linguistics, is about the source and forms of knowledge [18]. It describes how people structure their understanding within an activity to make sense of what is taking place, and how it is related to their knowledge [19] [18]. Certain epistemological frames can better help students to complete activities or distract them from activities. Researchers have studied frame shifts within a classroom [18] [19] and outside of class activities, but related to classroom work [2].

In the past, researchers have typically used a fusion of body language and discourse to analyze shifts in frames [1] [2] [19]. Sherr and Hammer claimed that verbal and non-verbal displays reinforce each other, giving an example from their data that changes in the vocal register are connected to student body language [19]. This led them to separate students into frames that were characterized by behavioral clusters identified from both body language and discourse.

Scherr and Hammer [19] identified four frames based on the behavioral clusters:
discussion frame, worksheet frame, TA frame, and joking. Irving et al. [2] expanded two of these frames (discussion and joking) into two continuous axes of framing: expansive vs. narrow and serious vs. silly. Our coding adopted their seriousness axis, but allowed for clear distinctions such that our serious and silly frames are discrete instead of continuous. Instead of using Irving et al.'s [2] expansive vs. narrow framing, we looked at the task levels: on-task and off-task (redefining and the productive vs. unproductive frames [17]).

Langer-Osuna et al. [20] looked at the functions of the off-task participation of students in a fourth grade mathematics problem-solving classroom. The silly frame is many times interpreted as being inherently off-task, but we will examine the functions of the silly in on-task situations by examining intersection of the on-task/silly frame in the classroom.

We used body language to code the seriousness category (serious vs. silly) and discours to code the task category (on-task vs. off-task). We examined the evolution of the frame shifts within each group and who initiated frame shifts. We also explored the role of instructors and students leaders on a group’s framing.

Studies looking at epistemological framing primarily use video data [19, 17, 2, 1, 21]. The use of video data, as opposed to real time coding or field notes, allows for a more controlled and intimate exploration of data [22], which can greatly benefit the coding and analysis of the data. Video data also allows for progressive refinement of coding. Researchers can easily adjust their research questions, do more accurate inter-rater reliability, hold discussions about certain episodes that are more interesting, and more easily reference this data to recode with new aspects in mind. For example, we were able to code for different categories of frames during two separate iterations. With epistemological framing, researchers often want to identify appropriate frames before fully coding, and this cannot be done while live coding. Also, since
most frames are identified using a combination of discourse and body language, written assignments or surveys would be unsatisfactory for this study. Some researchers have recorded meetings of a student with a teacher and used the transcript to identify student framing, using discourse alone to determine the framing [18].

Most researchers who have focused on specific framings have studied groups of 3-4 students as a unit of analysis because that is the way that their classrooms were set up following the studio style classroom [2, 1, 21], and because the group unit of analysis is the most useful and accurate way of determining how students frame their knowledge. Being able to hear what student are saying when interacting with each other and observe their body language by watching them on video helps researchers to identify how students are framing what they are working on. Even the studies that look at an individual’s framing focus on the interplay between individual cognition and group dynamics [19, 18]. Coding on an individual level was always done within the context of coding the group as a whole. Therefore, the individual framing could only be determined within the group interaction. We coded the epistemological framing of a group of students as a whole (as opposed to individuals) focusing on two categories of discrete frames.

In previous studies where the joking frame was analyzed, instructors were present the entire time during some of these classroom activities [2, 19]. In another study the instructor circled the room [23], but this focused on problem solving frames. Our context involves the instructor and two student leaders circling the whole classroom, going into and out of conversations.

Previous studies looked at instructors as the cause for frame shifts, and how instructors initiated the frame shifts. Irving et al. [2] looked at how instructors’ framing influenced the student framing and vice versa in a class where the instructor was present during the entire time the group worked together. We looked at the
frames into which the instructors shifted the groups and the percentage of shifts they initiated in each group.
CHAPTER 6

Methods of Epistemological Framing

6.1 Data Collection and Coding

The same video data was used for epistemological framing as for the small group networks described in Chapters 2-4. However, we expanded the data collection to include all three activities on day 9 (described in Section 1.4.2). We coded two categories of frames: seriousness and task. These categories were coded separately using an Excel spreadsheet while watching the video. The unit of analysis for epistemological framing is the group as a whole; therefore, we coded for how the group shifted frames; not the individuals. Thus, a shift was coded only if the majority of the group agreed to the frame shift.

6.2 Coding of Task Category of Frames

The task category of frames was built off the categorization of interactions used in the analysis of the small group networks. However, we added a third frame that split up the on-topic interactions into on-topic and on-task. This was because we noticed that Group 3 was on-topic throughout the majority of Activity 1, yet there seemed to be a significant amount of time that the group was not talking specifically about the task, but instead were discussing the IMPRESS program and their classes.
6.2.1 What does it mean to be in the on-task frame?

A frame was considered to be on-task when the conversation directly pertained to the task that the students were supposed to be working on. This was the task that was introduced by the instructor before the video segment was coded. The specific tasks varied between activities, and they are described in Section 1.4.2.

6.2.2 What does it mean to be in the on-topic frame?

A frame was considered to be on-topic when the conversation did not pertain to the task that the students were working on, but it did relate to the general sciences, to the IMPRESS program (which does include some social bonding activities), or to the classes they were enrolled in or planning on enrolling in. Discourse in this category was typically about who their instructors would be in the Fall or what time their classes were.

6.2.3 What does it mean to be in the off-topic frame?

A frame was considered to be off-topic when the conversation did not relate to the program, science, classes, or the task being worked on. Anything that did not fall into the on-task or the on-topic frames, was categorized as being in the off-topic frame.

6.2.4 How do we code a shift between task frames?

When each episode began, we determined which frame the students were in by listening to the first few remarks; after that was determined, we coded every time the group shifted into a different frame. A shift between the task frames was coded when two rules were satisfied: (1) there were at least three remarks in the new frame and
(2) the majority of the group were listening to or participating in the conversation. For the first rule, a remark was either a statement or a short utterance such as “yeah,” “uh huh,” “hmm,” etc. The three remarks had to be made by at least two different people; for example, if one person made two remarks and a second made one, the first requirement would be satisfied. For the second rule, the majority meant three students in a group of four, or two students in a group of three.

A frame shifted when a member of the group proposed a “bid” to switch into a new frame. By “bid” we mean that a student changed the discourse to correspond to a different frame then they were in. If another member of the group “accepted” that bid by reacting to it in the proposed frame and a third utterance was made in that frame, then we satisfy the first rule. By “accept” we mean that another group member’s discourse corresponded to the discourse of the bid. If at least three students were listening, then the second rule was met. With these two rules satisfied, we knew the frame shifted. The new frame was coded as starting from the time that the first person proposed the bid.

For example, if the group was in the on-topic frame, and Student 1 said something that was off-topic, after which Student 2 responded to that in the off-topic frame and a third response was made (from either Student 1, 3, or 4) also in the off-topic frame while at least three students in that group were listening (even if they did not participate), then the group will be coded as switching over to the off-topic frame starting from Student 1’s first comment.

If only two members of the group switched over into a different frame, but the other two members stayed in the previous frame, and after a short time (approximately <5 seconds), the whole group continued to be in the previous frame, then this was not coded as a shift. For example, the group was in the on-topic frame, and Student 1 proposed a bid by switching over to the on-task frame. Student 2 accepted
the bid and transitioned into this frame. However, Students 3 and 4 continued in the on-topic frame and showed they were not listening and not responding. Then Students 1 and 2 came back into the on-topic frame. In this case, there was no shift.

We always assumed that the group members were listening unless:

- They were looking at their phone.
- They were talking to someone else.
- They were writing something down and completely focused on it.

6.2.5 Combining the on-topic and off-topic frames into one off-task frame

After some initial analysis (see Appendix B), it was noted that if we combined the on-topic and off-topic frames, none of the major patterns changed. Therefore, for the rest of this thesis the on-topic and off-topic frames will be combined into the off-task frame. This allows us to more directly relate our work to literature on off-task interactions [20].

6.3 Coding of Seriousness Category of Frames

While the task category of frames was primarily identified by the content and discourse of the conversation, the seriousness category of frames was coded primarily by body language and tone, see Fig. 6.1. In most instances, this frame could have been coded without audio. This category was split into the serious and silly frames.

6.3.1 What does it mean to be in the serious frame?

A frame was considered to be serious if the students were not laughing, smiling or joking. It is when the students were focused, directing their attention towards
the materials they were working with. In this frame the students mostly had their bodies directed towards the table, leaning over, or looking down at the materials they working with. They were sometimes looking at their partners during discussions. A shift into this frame was usually initiated by someone saying something more loudly, or starting to say something with “alright” or “okay.” This usually meant that they were marking verbally that they were going to change their frame into something that they should have been talking about (typically accompanied by on-task shift) or directing attention towards the equipment.

6.3.2 What does it mean to be in the silly frame?

A frame was considered to be silly when the students were laughing or giggling while saying something funny or sarcastic. Attention might be focused on equipment, on other group members, or around the room. Students in the silly frame typically had more relaxed postures and smiles or grins on their faces. A shift into this frame usually started by someone saying something while smiling, saying something in a sarcastic tone, or introducing ideas in a lower voice. The sarcastic tone was only considered to be sarcastic by the reaction that it received from others (judged by body language).

6.3.3 How do we code a shift from serious to silly or vice versa?

When each episode began, we determined which category the students were in by looking at the body language of the majority of the group; after that was determined, we coded every time the group shifted into the next frame. A shift was coded by when the majority of the group members shifted over to the new frame.

A shift happened when a member of the group proposed a “bid” to switch into
a different frame. By “bid” we mean that a student changed their body language to correspond to a different frame then they were in. If the majority of the group “accepted” that bid by reacting to it in the proposed frame, then the frame shifted. By “accept” we mean that another group member’s body language corresponded to the body language of the bid.

For example, if a group of four was in the serious frame (not smiling giggling or laughing), and Student 1 made a joke while smiling, then Student 1 proposed a bid. If Student 2 and Student 3 also laughed, smiled or grinned (showed some sort of switch in their body language corresponding to the silly frame), then the group was coded as switching over to the silly frame. The new frame was coded as starting from the time that Student 1 proposed the bid, even if the bid was unintentionally posed.

If only two members of the group switched over into a different frame, but the other two members stayed in the previous frame, and after a short time (approximately $<5$ seconds), the whole group continued to be in the previous frame, then this was not coded as a shift. For example, the group was in the serious frame, and Student 1 proposed a bid by switching over to the silly frame. Student 2 accepted the bid and transitioned into this frame; however, Students 3 and 4 continued being in the serious frame, then Student 1 and 2 came back into the serious frame, there was no shift.

### 6.4 Inter-rater Reliability Process

The coding instructions were written first by one coder. Then a second coder coded the data based on the instructions. The coders then compared their codes and discussed any discrepancies and the instructions were modified accordingly. Then, a
different set of data was coded by both coders, and they met again to resolve any discrepancies. This was repeated until there was 96% agreement between the coders. The rest of the data were then split between two coders to code based on the finalized instructions, which can be found in the Appendix A.
Figure 6.1: Example of Group 3 in the seriousness category of frames. We can see how the seriousness category of frames is coded based on body language. The top image is characterized as *serious* because the group members have serious expressions and are directing their attention toward the equipment they are working with. The bottom image is characterized as *silly* because the group members are all smiling, grinning, or laughing.
CHAPTER 7

Overview of Analysis for Epistemological Framing: Timelines

The overall research questions we will answer in the next few chapters are:

- Research Question 1: How does time spent in frames vary between groups and activities? (Chapter 8)
- Research Question 2: Within each group, who initiates frame shifts? (Chapter 9)
- Research Question 3: What purpose(s) does the on-task/silly frame serve in the classroom? (Chapter 10)

We begin our analysis with a discussion of the most raw representation of the data, the timeline graphs. From there we will take a step back and look at the total time that was spent in certain frames through pie chart representations. We will then look at who initiated the frame shifts within the groups. Finally, we will zoom into certain episodes where the students are in the intersection of the silly and on-task frames. Looking at these different components will help us to better answer the question: What are the individual group dynamics within a classroom?

7.1 Analysis of timelines of different activities for different groups

Timeline graphs show how frames shift over time. They have time across the horizontal axis, and are divided vertically by the task categories: the top is on-task and
the bottom is off-task. Within the task frames, they are color coded based on the seriousness category where green is serious and magenta is silly. The timelines in Fig. 7.1 show many different aspects about the ways each group was framing what they were doing. This representation helps us begin to answer the following questions:

1. When are shifts happening?

2. How often are shifts happening? (Further explored in Ch. 8.)

3. To and from which frames are groups shifting? (Ch. 9 explores who is initiating shifts)

4. How are the seriousness and task categories of frames connected? (Ch. 10 will specifically look at the intersection of the on-task/silly frame.)

Some things to note in Fig. 7.1 are:

- Group 2 is shifting most often across all activities, while Group 4 is shifting least often across all activities.

- Activity 2 has the most intersections of the on-task/silly frame for all groups.

- Activity 3 has the longest periods of the off-task/silly frame for all groups and has the fewest shifts overall for all groups.

Table 7.1 numerically verifies the observation of the first item above, showing that indeed Group 2 was shifting the most often with 2.55 shifts/minute, while Group 4 was shifting the least often with 0.56 shifts/minute, as compared to the other groups.

The first item on the list above is related to the nature of the group. Who the group members are and how they interact with each other are possible reasons for the differences between groups.
Table 7.1: The total number of times each group shifted, the total time each group spent working on all activities, and the average shifts per minute for each group. Group 2 was shifting the most often with 2.55 shifts/min, while Group 4 was shifting the least often with 0.56 shifts/min. This confirms what is seen observationally in the timelines (see Fig. 7.1).

<table>
<thead>
<tr>
<th>Group</th>
<th>Total number of shifts (shifts)</th>
<th>Total time for all activities (min)</th>
<th>Average shifts per minute (shifts/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>147</td>
<td>102</td>
<td>1.44</td>
</tr>
<tr>
<td>2</td>
<td>242</td>
<td>95</td>
<td>2.55</td>
</tr>
<tr>
<td>3</td>
<td>150</td>
<td>120</td>
<td>0.68</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>90</td>
<td>0.56</td>
</tr>
</tbody>
</table>

The last two items on the list above have to do with the nature of the activities (see Sec. 1.4.2). Activity 2 was oriented around the groups creating diagrams of the carbon dioxide cycle. It may be that the nature of the activity as a drawing exercise led all the groups to interact in the intersection of the on-task/silly frame more often. However, we would need additional analysis to determine this.

Activity 3 was oriented around the groups comparing their diagrams to published diagrams, and it allowed for the groups to finish the activity at different times. Activity 3 also had the longest periods of the intersection between the off-task/silly frame. During the time they were working as a group on the activity, all groups seemed to shift much less than during the other activities. These characteristics may have to do with the nature of the activity being a comparative study, or because it was the end of the morning session and students were tired.
Figure 7.1: Timelines of all groups and activities: green is serious, magenta is silly. The t-axis is the number of seconds. Activity 1 lasted about 42 minutes, Activity 2 lasted about 33 minutes, and Activity 3 lasted about 27 minutes for Group 1, 20 minutes for Group 2, 45 minutes for Group 3, and 15 minutes for Group 4. Note there are different times for Activity 3 because all groups finish Activity 3 at different times, see Sec. 1.4.2. Group 2 is shifting most often across all activities, while Group 4 is shifting least often across all activities. Activity 2 has the most instances of the on-task/silly frame for all groups. Activity 3 has the longest periods of the off-task/silly frame for all groups. Activity 3 has the fewest shifts overall for all groups. See Appendix B Fig. B.1 for on-topic comparison.
7.2 Discussion of timelines for each group

7.2.1 Group 1

When looking at Fig. 7.1, it can be seen that Group 1 started off in the off-task frame during Activity 1 and then continued to jump back and forth between the on-task/serious frame and the off-task/silly frame. About two-thirds of the way through Activity 1, Group 1 went into a longer episode of being in the off-task/serious frame, and ended Activity 1 in the on-task/serious frame.

During Activity 2, Group 1 started off primarily in the off-task frame, and then transitioned into being primarily in the on-task frame. About two-thirds of the way through Activity 2, Group 1 began shifting between the on-task and off-task frames.

Activity 3 was very different for Group 1. Group 1 did not shift as much as they did in Activities 1 and 2. As noted earlier, this was a common characteristic for all groups during Activity 3. Group 1 started briefly in the on-task frame, then spent a large amount of time in the off-task frame, going back into the on-task frame briefly, and finally, spending the entire second half of Activity 3 in the off-task frame. The nature of Activity 3 seemed to keep the group more in the off-task frame. This was similar to Group 2 and Group 3, where these groups also spent the majority of the second half of Activity 3 in the off-task frame. There were longer portions of the second half of Activity 3 during which Groups 2 and 3 were in the silly frame as well as in the off-task frame. Because the three groups had a similarity in the way they spent their time, it is reasonable to conclude that the nature of Activity 3 was such that it drove students to stop being on-task part-way through Activity 3. A possible reason for this may be because this was the end of the morning activities.

Group 1 seemed to be silly primarily when they were in the off-task frame; however, there were a few times when they were silly in the on-task frame; these situations will be examined more in Ch. 10.
7.2.2 Group 2

Group 2 started off jumping between the on-task and off-task frames during Activity 1, primarily being in the serious frame when on-task and in the silly frame when off-task. Towards the second half of Activity 1, Group 2 spent most of their time in the off-task frame.

Throughout Activity 2, Group 2 seemed to shift between the on-task and off-task frames, ending primarily in the off-task frame. There were many times that the group was in the intersection of the on-task and silly frames, which will be further discussed in Ch. 10. The most instances of the off-task/silly frame occurred in Activity 2 for all groups, suggesting that there was something about the nature of Activity 2 that prompted this framing.

During Activity 3, Group 2 did not shift very often. They started off briefly in the off-task frame, then shifted between the on-task and off-task frames but spent larger chunks of time within the frames as opposed to the shorter lasting shifts that were more common during Activities 1 and 2. This again supports the previously stated claim that Activity 3 promoted the fewest overall shifts for all groups.

7.2.3 Group 3

Group 3 spent the first two-thirds of their time in the on-task frame with only a few brief shifts into the off-task frame. During this time, they were also primarily in the serious frame. The last third of Activity 1 was spent in the off-task frame.

Group 3 was in the on-task frame throughout the entirety of Activity 2, with very short jumps into the off-task frame like the other groups. Group 3 also had more intersections between the on-task and silly frames during Activity 2 than in either Activity 1 and 3.
Activity 3 had a dramatic shift in the middle across during which Group 3 shifted from being on-task into only off-task.

Looking at all the activities suggests that Group 3 preferred to stay on-task until they were finished completing the assigned task, and then they felt comfortable to shift into the off-task frames. During the first two activities, there were almost no shifts into the off-task frame, while during Activity 3, Group 3 spent almost half of their time in the off-task frame, but only at the end.

7.2.4 Group 4

Like Group 3, Group 4 little time in the off-task frame. Activity 1 and Activity 3 had brief moments during which Group 4 spent some time in the off-task frame during the second half of the activities. They typically began to be silly only towards the second half of all three activities (other than one on-task/silly shift towards the beginning of Activity 2). Group 4 was primarily silly when in the on-task frame. This was different from the other groups who were primarily silly in the off-task frame; however, Group 4 was almost never in the off-task frame, which may account for the difference.

As with other groups, Group 4 spent the most time in the on-task/silly frame during Activity 2 compared to Activities 1 and 3. However, this group also stayed in their frame longer than other groups.

In several ways, Group 4 was distinctly different than Group 1, 2, and 3. Thus, it would be useful to do additional research to identify if there are other groups with similar patterns and to identify what distinguished this group.
CHAPTER 8

Research Question 1: How does time spent in frames vary between groups and activities?

Stepping back from the timelines, we wanted to see if the percentage of time spent in the different frames was consistent or different between the groups. This will help address whether framing is more related to the nature of the group or the nature of the activity they are doing. We started off by looking at the overall percentages that the groups spent in each category of frames (seriousness and task) and then we broke them up by activity.

8.1 Analysis of total time spent in a certain frames

Figure 8.1 shows that all groups spent most of their time in the serious frame throughout all activities. This is something that most educators expect to happen in the classrooms. We can also see that, of all groups, Group 2 spent the most time in the silly frame, whereas Groups 1, 3, and 4 spent a comparable amount of time in the silly frame. We see similar patterns when breaking up the percentage of time spent in the seriousness frames for each activity.

In Figure 8.3, we also see that the percentage of time each group spends in each of the seriousness frames does not vary much across activities. Each groups shows consistency across activities in terms of the amount of time they spent in the serious and silly frames; therefore, it seems that the nature of the group is more important than the nature of the activity for determining seriousness framing.

From Figure 8.2 it can be seen that Groups 1 and 2 were overall split between being on-task and off-task while Groups 3 and 4 were primarily on-task during all
Figure 8.1: Percentage of overall time (for all activities) spent in the *serious* and *silly* frames per group. All groups spent most of their time in the *serious* frame throughout all activities. Group 2 spent the most time in the *silly* frames as compared to the other groups.

three activities. These differences may be due to the nature of the groups themselves. However, when looking at the percentage of time spent in the task frames separated by activities (Fig. 8.4), we can see that there was much more variability across activities for all groups with task frames than with seriousness frames (compare to Fig. 8.3).

In Figure 8.4 it can be seen that all groups spend the most amount of time in the *on-task* frame during Activity 2 compared to Activities 1 and 3.

Groups 2 and 4 were more consistent between activities in the task category of frames whereas Groups 1 and 3 are more variable across activities suggesting group dynamics play a larger role for Groups 2 and 4 than for Groups 1 and 3.

Both Groups 1 and 3 spent the most amount of time in the *off-task* frame during Activity 3 compared to Activities 1 and 2. Group 1 goes from spending 35.9% of their time in the *off-task* frame during Activity 2, to spending 80.6% of their time in
Figure 8.2: Percentage of overall time (for all activities) spent in the on-task and off-task frames per group. Groups 1 and 2 are approximately split between the on-task and off-task frames, while Group 3 and 4 spend most of their time in the on-task frame. This suggests that the nature of the group may be playing a role in the groups’ framing. See Appendix B Fig. B.2 for comparison with the on-topic frame.

The off-task frame during Activity 3. Group 3 goes from spending 5.7% of their time in the off-task frame during Activity 2, to spending 52.2% of time in the off-task frame during Activity 3. These huge changes may have to do with the fact that the first activity was more engaging for the students, or because students are getting tired.

Groups 2 and 4 are also most off-task during Activity 1, while Groups 1 and 3 are most off-task during Activity 3. This supports the idea that the nature of the group still plays a role in determining the task framing of groups, but that there is some interplay between group and activity.

Figure 8.4 shows that during Activity 2 all groups spent the most amount of time in the on-task frame. This indicated that Activity 2 may have features to make it more on-task. This is interesting because, when looking at timelines (Fig. 7.1), we
also saw that Activity 2 had the most intersections between the *on-task* and *silly* frames. This may have to do with the fact that all groups are spending more time *on-task* during this activity.

Overall, with the seriousness category, the nature of the group seems to have a stronger influence on the distribution of frames than the nature of the activity. However, with the task category, there seems to be more of an interaction between the nature of the group and the nature of the task in determining the distribution of frames.
Figure 8.3: Percentage of time spent in each of the seriousness category of frames separated by activities. All groups show consistency between activities suggesting that the nature of the groups influences group framing. During Activity 2, all groups spend the most amount of time in the silly frame as compared to the other activities, suggesting there are characteristics of Activity 2 that may influence this.
Figure 8.4: Percentage of time spent in each of the task category of frames. The task frames are more variable than that seriousness frames (see Fig. 8.3). Groups 2 and 4 are more consistent across activities as compared to Groups 1 and 3. All groups spend the most time in the on-task frame during Activity 2 as compared to the other activities. This suggests an interplay between the nature of the group and the nature of the activity influencing framing. See Appendix B Fig. B.3 for comparison with the on-topic frame.
CHAPTER 9

Research Question 2: Within each group, who initiates frame shifts?

Zooming into a particular aspect of frame shifts by looking at the initiators of frame shifts, we examine if there were students more prone to controlling the group or not controlling the group. We also examine the roles of the instructors initiations.

When comparing the seriousness histograms with the task histograms (see Fig. 9.1), we can see that the percentages do not vary much for Groups 1, 2, and 3. This means that that students who were primarily initiating the seriousness category shifts were also primarily initiating the task category shifts. Group 4 was the only one that showed a difference. In the seriousness category of frames, Jack and Tasha initiated approximately the same percentage of shifts, and Daniel initiated less. On the other hand, in the task category of frames Jack was dominating the shifting, followed by Daniel, then Tasha.

When looking at Figure 9.1 we can see that in Group 1 and Group 3, there was one member of the group that dominated shifts in both the seriousness and task categories; in Group 1, Justin was the primary initiator of shifts while in Group 3, Jill was the primary initiator of shifts. Initiating shifts was one way of controlling the group; therefore, it seems these students were trying to control the group. When looking at Group 2 and Group 4, there are three people sharing the bulk of the shifting, while one person shows little shifting: BJ in Group 2 and Arya in Group 4.

When looking at the right column of Fig. 9.1 the task category of frames, we can see that in Groups 1, 2, and 3, all students predominantly shifted to the off-task frame while Group 4 predominantly shifted to the on-task frame. The only exception was Sara, who shifted mostly into on-task in Group 3. This is interesting because it
relates to the fact that Groups 1 and 2 spent more of their total time for all activities in the \textit{off-task} frame (see Fig. 8.2). This however is not the case for Group 3, which spent most of their time in the \textit{on-task} frame. It is important to realize that the total time spent in a frame does not have to be directly related to having more shifts in that frame because there may be more shifts, but it is the amount of time that a group spends after the shift is made that makes the difference.

When considering the roles of the instructors, we can see that Corey was shifting more than for other groups when interacting with Group 1. We can also see that the student leaders (SL), Jose and Nick, were shifting more into the \textit{silly} frame when interacting with Groups 3 and 4 than with Groups 1 and 2. Jose initiated many shifts in Group 1, and they were primarily into the \textit{off-task} frame. When looking at the total percentages of instructor initiated frame shifts in Table 9.1, we can see that Group 1 had the most amount of shifts initiated by instructors (28.5\% for seriousness and 27.1\% for task) and Group 4 had the least (11.1\% for seriousness and 12.9\% for task), as compared to the other groups. There was a wide range in the percentage of frame shifts from 11\% in Group 4 in the seriousness category of frames to 28.5\% in Group 1 for the seriousness category of frames, suggesting that instructors interacted with a purpose, seeing a need to interact with certain groups more than with others.

Table 9.1: The percentage of frame shifts initiated by the instructor and student leaders in each group for each category of frames. Group 1 had the most amount of shifts initiated by the instructor and student leaders, while Group 4 had the least, as compared to the other groups.

<table>
<thead>
<tr>
<th></th>
<th>Seriousness</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>28.5%</td>
<td>27.1%</td>
</tr>
<tr>
<td>Group 2</td>
<td>14.9%</td>
<td>15.0%</td>
</tr>
<tr>
<td>Group 3</td>
<td>22.7%</td>
<td>22.6%</td>
</tr>
<tr>
<td>Group 4</td>
<td>11.1%</td>
<td>12.9%</td>
</tr>
</tbody>
</table>

When instructors interacted with groups who were not as \textit{silly} (Groups 3 and 4),
they tended to shift them more into the *silly* frame, while they shifted the groups that were more *silly* (Groups 1 and 2) into the *serious* frames. The instructors were possibly trying to align the groups with the goals of the program: to foster community and build metacognitive skills, so they were making sure all the groups were interacting in both frames.

In Groups 1 and 2, Jose initiated more frame shifts than Nick, and in Group 3 Nick initiated a lot more frame shifts than both Jose and Corey, the instructor. It may be that Nick was the most comfortable initiating shifts within the all female group, or he saw the greatest need to initiate shifts. In order to begin to address this, we can look at the types of shifts that Nick initiated in Group 3. Most of the shifts were into the *silly* frame, and the task category was split between *on-task* and *off-task*. This suggests that Nick was trying to foster their community growth or become friends.

Overall, differences seem to be independent of gender difference and disability.
Figure 9.1: Percentage of frame shifts in the seriousness category of frames (left column) and task category of frames (right column) by all members of the group, the instructor, and student leaders. Groups 1, 2, and 3 have similar patterns when comparing the two columns, as opposed to Group 4, which has a noticeable difference between initiators of seriousness and task. Also, Groups 1 and 3 have one group member who primarily initiates shifts, Justin and Jill, respectively. On the other hand, Groups 2 and 4 have three group members that share initiation, Jacob, Brett, Herb in Group 2, and Tasha, Daniel, and Jack in Group 4, while having one group member who barely initiates any shifts, BJ and Arya, respectively. Corey initiates most shifts in Group 1, and Nick initiates most shifts in Group 3 as compared to the other groups. See Appendix B Fig. B.4 for comparison with the on-topic frame.
CHAPTER 10

Research Question 3: What purpose(s) does the on-task/silly frame serve in the classroom?

After analyzing the frames independently, we wanted to more deeply analyze the intersection between the on-task and silly frames which we will from now on refer to as the on-task/silly frame. The on-task/silly frame was very interesting because from preliminary observations we were able to see that this frame played many different roles in student interactions and understanding of concepts. We wanted to see if we would find any patterns for the roles of the on-task/silly in the classroom.

10.1 Types of Roles for on-task/silly Frame

Using the timeline graphs (see Fig. 7.1), we identified the times during which students were in the on-task/silly frame; figure 10.1 shows the identified cases. After these cases were identified, each was watched more closely and described in detail, focusing on group interactions and reactions using detailed descriptions, see Appendix C for these descriptions. Using these detailed descriptions, the episodes were categorized into 3 emergent categories: (1) directing attention to an area that needs expanding or clarification, (2) transitioning from the off-task frame, and (3) adding a laugh.

After this initial categorization, each episode was observed again. At that point, the first two categories were reaffirmed while the third category was split into two: (3) epistemic distancing and (4) relieving tension. All the identified cases were categorized into these four categories and they will be explained in more detail below. Since this was a preliminary analysis of the on-task/silly frame, we did not conduct inter-rater reliability.
Group 4 primarily communicated on the laptop or through an interpreter, due to the fact that Jack was DHH. There was enough information to code for the epistemological frames; however, due to the limited information, a more in-depth analysis of the on-task/silly episodes was not possible. Thus, we did not categorize the role of these shifts for Group 4.

10.1.1 Directing attention to an area that needs expanding or clarification

A shift into the on-task/silly frame was categorized as having the role of directing attention to an area that needs expanding or clarification when the shift was made due to the initiator noticing an area that the group needed to clarify or expand, or where they had a misconception. A shift with this role was typically made by the instructor or a student leader.

An example of this category in Group 1 was Case D. During Activity 2, Corey came to see how the group was progressing and made a comment about Justin’s pictures saying “Why is that throwing up into a beaker?”, after which the whole group started laughing. Justin began to more clearly explain what he was trying to illustrate through his drawing. The whole group then started explaining and clarifying their drawings. Corey’s question, posed in the on-task/silly frame, worked to direct the group into further clarifying and describing their diagrams.

10.1.2 Transitioning from the off-task frame

A shift into the on-task/silly frame was categorized as having the role of transitioning from the off-task frame when prior to the shift the group was in the off-task frame, and the initiator used the on-task/silly frame to transition into being in the on-task frame.

An example of this category in Group 3 was Case P. During Activity 1, the group was in the off-task/serious frame discussing the classes and professors they would
be taking in the fall. Jose, the student leader, came over and asked the group “So how’s it going?” in a sarcastic tone with a smile and giggle. The group began to laugh and Jill and Grace said, “We expanded it even more” referring to the equation and pointing to it. The group continued the conversation about the equation in the on-task/silly frame. After Jose left, the group returned to the off-task/serious frame. This case functioned as a transition from the off-task frame, but it was initiated by the student leader and did not last long after his departure.

10.1.3 Epistemic distancing

*Epistemic distancing* is a term adapted from Conlin and Scherr’s work [24]. They introduced the idea that hedging, quoting, or joking allows students to distance themselves from or downgrade their stance, and therefore, shield themselves from any impending conflict that may arise from their comment, which they call *epistemic distancing*.

A shift into the on-task/silly frame was categorized as having the role of *epistemic distancing* when the initiator wanted to create distance between themselves and what they are saying. The role of *epistemic distancing* was to avoid associating themselves with any negativity that might be directed toward their statement.

An example of this category in Group 2 was Case F. During Activity 1, Herb was looking at the computer and trying to understand what the other group members typed. He started reading the equation out loud and asking what it stood for. He proposed writing the equation simpler in a sarcastic tone, and the group started laughing. Herb seemed to be unsure if his suggestion was correct; therefore, he turned his suggestion into something funny, which distanced him from the comment. After this, the group temporarily jumped into the off-task/silly frame, but then went back into the on-task/serious frame when talking about the equations. Remembering that Herb seemed to be the group member who was most lost during the activity, it
seemed that he wanted to propose his idea without taking full responsibility for it. He used *epistemic distancing* to do this.

10.1.4 *Relieving tension*

A shift into the *on-task/silly* frame was categorized as having the role of *relieving tension* when there seemed to be tension and/or silence within a group right before the shift, and it was broken by a group member’s use of the *on-task/silly* frame. After the initial shift, the whole group would transition into more relaxed postures and expressions.

An example of a case in Group 2 was Case I. During Activity 2, Corey was talking with the group about how everyone should contribute something to the drawing of the CO$_2$ cycle. This was a delicate way of informing Herb to start participating more in the group activity. Herb took the journal and began drawing on the diagram that the group had. The whole group was silent and tense. Brett was looking over the table and started giggling asking “What is that?” initiating the shift into the *on-task/silly* frame. The rest of the group started laughing, indicating releasing tension. Herb became more relaxed as well and began giving an explanation. In this case, Brett was the one that shifted the group into the *on-task/silly* frame in order to address the tension from Herb’s overreaction to Corey’s hint.

10.2 *Analysis of the role of the on-task/silly frame.*

We found that we were able to categorize all *on-task/silly* episodes into four roles. Table 10.1 shows how the cases were distributed by the role they play.
Figure 10.1: Labeled cases of the on-task/silly frames for Groups 1, 2, and 3. Green is serious, magenta is silly. The t-axis is the number of seconds. Activity 1 lasted about 42 minutes, Activity 2 lasted about 33 minutes, and Activity 3 lasted about 27 minutes for Group 1, 20 minutes for Group 2, 45 minutes for Group 3, and 15 minutes for Group 4. Note there are different times for Activity 3 because all groups finish Activity 3 at different times, see Sec. 1.4.2. Activity 2 has the most on-task/silly frames for all groups.
10.2.1 Group 1

When examining the times during which Group 1 is in the on-task/silly frame, it was found there were only two initiators who initiated a shift into this frame: Justin, (Cases A, B, and C) and Corey, the instructor, (Cases D and E). Both of Corey’s shifts played the role of directing attention to an area that needed expansion or clarification. Two of Justin’s shifts were transitioning the group from the off-task frame and one served to relieve tension.

As seen in Fig. 10.1, Group 1 did not have any instances of the on-task/silly frame during Activity 3.

10.2.2 Group 2

In Group 2, three of the group members actively shift the group in the on-task/silly frame: Herb, Jacob, and Brett. Additionally, Jose, the student leader, shifts into the frame one time when interacting with this group.

Two of the shifts were a directing attention toward area that needs expanding or clarification (Cases G and H), one caused by Jose, the student leader, and one caused by Jacob. This is the only time that a student was the one to initiate this type of shift (Case H). There was only one shift transitioning from the off-task category (Case J), and it was initiated by Brett. Two shifts were epistemic distancing (Cases F and L), and three shifts were relieving tension (Cases I, K, and M), and all had a mixture of Herb, Jacob, and Brett initiating.

10.2.3 Group 3

Like Group 2, Group 3 exhibited all four of the categories of roles described in the reasons for shifts. However, the overwhelming majority of the on-task/silly frames were relieving tension in the working group (Cases N, Q, R, S, V, and W). Five out of six of these shifts were caused by Jill, and the other by Nick (Case V). There were
two cases where student leaders were directing attention toward an area that needed expanding or clarification (Cases O and T), one by Nick and one by Jose. Two were caused by epistemic distancing (Case U and X), both initiated by Jill. One was transitioning from the off-task category (Case P) and was caused by Jose.

Overall, we found that the role of the on-task/silly frame seems to have one of four roles: directing attention to an area that needs expanding or clarification, transitioning from the off-task frame, epistemic distancing, or relieving tension. From this categorization, we see that the on-task/silly frame has several positive purposes in group interactions.
Table 10.1: Grouping of cases by reason for shift into the *on-task/silly* frame. The grouping of these cases into purposeful roles demonstrates the usefulness of this frame in the classroom.

<table>
<thead>
<tr>
<th>Reason for Shift</th>
<th>Explanation of reason</th>
<th>Group 1 Cases</th>
<th>Group 2 Cases</th>
<th>Group 3 Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directing attention to an area that needs expanding or clarification</td>
<td>When the shift to the <em>on-task/silly</em> frame is made due to an identified misconception, an area that needed more explanation, or to point the group to clarify something. This shift is typically initiated by the instructor or student leader.</td>
<td>D, E</td>
<td>G, H</td>
<td>O, T</td>
</tr>
<tr>
<td>Transitioning from the <em>off-task</em> frame</td>
<td>When the shift to the <em>on-task/silly</em> frame is made as an easy way out of the <em>off-task</em> frame. Usually initiated by a student in the group.</td>
<td>A, B</td>
<td>J</td>
<td>P</td>
</tr>
<tr>
<td>Epistemic distancing</td>
<td>When the shift to the <em>on-task/silly</em> frame is sandwiched between <em>on-task/serious</em> frame, and serves to distance oneself from the statement. Usually initiated by a student in the group.</td>
<td>F, L</td>
<td></td>
<td>U, X</td>
</tr>
<tr>
<td>Relieving tension</td>
<td>When the shift to the <em>on-task/silly</em> frame is made when the group perceives tension and wants to eliminate it. Usually initiated by a student in the group.</td>
<td>C</td>
<td>I, K, M</td>
<td>N, Q, R, S, V, W</td>
</tr>
</tbody>
</table>
CHAPTER 11

Conclusions and Future Work

A group’s epistemological framing with regard to seriousness and task involves an interplay between the individual group dynamics, the nature of the activity, and how instructors interact with the group.

In the past, studies have shown how groups working on the same activity differ due to the nature of the group. Pomian et al. [8] found overall group characteristics can be influenced by group members. We intertwined the study of the group and activities focusing on aspects of the group that influenced epistemic framing, and the influence of different activities on the groups’ epistemic framing.

We found Group 2 was shifting most often and Group 4 was shifting least often, supporting the strength of the individual group dynamics (Fig. 7.1). Also, Activity 3 and Activity 2 shared similar aspects across all groups, supporting the idea that the nature of the activity impacted the groups a lot more during certain activities, see Sec. 7.1.

We saw that groups were very consistent across activities in terms of the percentage of time they were in the serious versus silly frames. While there were small differences between groups, all groups spent the vast majority of their time in the serious frame (Fig. 8.3, Fig. 8.1), but they did not necessarily spend the most time in the on-task frame.

There was much more variability, both between groups and within groups, in the task category of frames as opposed to the seriousness category of frames between activities (Fig 8.4). This highlights the interplay between the nature of the group and nature of the activity. The intricacies of the ways in which groups frame their
work vary, and the impact on the epistemic framing of individual group dynamics, and the design of the activity cannot be separated.

While we cannot fully separate the impact of individual group dynamics, we found that there seemed to be certain activities that influenced all the groups to tend towards certain frames. Activity 2, which required drawing a diagram, tended to have groups be more on-task and more silly. It would be interesting to explore the nature of that activity in more detail to determine what features caused more groups to be in the on-task/silly frame.

Irving et al. [2] looked at a classroom in which a tutor was seated with the group and they found that the tutor initiated 66% of the transition between epistemological frames. This is very different from what we found because we had student leaders who were circling the room. Our instructor initiation of shifting ranged between 11.1% and 28.5%. Having a tutor be seated and working directly with the group is very different and seems to be more influential on the groups’ shifting as opposed to a tutor roaming the room. However, it is more common for the student leaders and teaching assistants to be circling the room and going in and out of conversation, which is why we think our work reflects a more standard classroom setting (Fig. 9.1, Table 9.1).

We looked at the frames into which the instructors shifted the groups and the percentage of shifts they initiated in each group. We saw that instructors influenced some groups more than others, and they changed the frames that they shifted into depending on group (Fig. 9.1).

We saw that instructors seemed to more often interact with the groups that were not as silly (Groups 3 and 4) by shifting them into the silly frame, while they shifted the groups that were more silly into the serious frame. It would be interesting to explore the question of why instructors are shifting into those frames, and what about the different groups cause them to shift differently.
We also found that Group 4 was distinctly different from the other groups: being primarily on-task throughout most activities and the most on-task/silly. One key difference in this group was Jack, who was DHH, and interacted with the group through an interpreter or using a computer. This difference in communication may have contributed to the difference between this group and the others and could be explored in more detail in the future.

Interactions between the seriousness and task frames are compelling, and we can begin to identify and categorize the roles of the on-task/silly frame, demonstrating the usefulness of this frame in the classroom. It is useful for teachers and educators to understand if and when the silly frame plays a role in the classroom when conducting group activities in the class.

In the past, researchers have touched on the exploration of the joking frame. Scherr and Hammer [19] introduced the joking frame and treated it as an off-task frame, and Irving et al. [2] expanded the joking frame into a continuous axis from serious to silly where silly also had an off-task connotation.

In our work, we were able to adopt serious and silly as discrete frames. We identified seriousness and task frames using body language and discourse, respectively. We saw the silly frame benefiting learning by making tasks more approachable. Our preliminary analysis of the on-task/silly frame showed different purposes for switching into this frame and the usefulness of allowing students to use the silly frame in the classroom. In particular, we saw evidence of the frame being used for epistemic distancing. Conlin and Sherr [24] found that epistemic distancing plays an important role in group interactions, and our research suggests that this is a fruitful area for further research. We plan on further exploring the on-task/silly frame’s role (including appropriate inter-rater reliability) in order to provide better guidance for teacher use in the classroom.
APPENDIX A

Coding Instructions for Epistemological Framing

A.1 Epistemological Framing: Seriousness

A.1.1 General Information

An important thing to note is that the unit of analysis is the group as a whole; therefore, we are coding for how the group as a whole shifts frames; not the individuals. Majority Rule: 3/4 or 2/3 have to switch over (more on this later)

A.1.2 What does it mean to be in the serious frame?

A frame is considered to be serious if the students are not laughing, smiling or joking. It is when the students are more focused, directing their attention towards the materials they are working with. The students mostly have their bodies directed towards the table, leaning over, looking down. A shift into this frame is usually seen by someone saying something more loudly, start saying something with “alright” or “okay,” (meaning that they are marking verbally that they are going to change their frame into something that they should be talking about (typically accompanied by on-topic shift) or directing attention towards equipment.

A.1.3 What does it mean to be in the silly frame?

A frame is considered to be silly when the students are laughing or giggling while saying something funny or sarcastic. Attention can be focused on equipment, but discussing equipment as not related to the task they are completing. Typically more relaxed posture and smiles on faces, and looking up towards each other. For
example, there is a moment where the group picks up the lamp which is a piece of their equipment. A group member says that she has a lamp like that that she uses for her lizard. They begin referring to this as the lizard lamp and laughing about it. Therefore, their attention is directed toward the equipment; however, they’re discussing in the *silly* frame. A shift into this frame usually starts by someone saying something while smiling, saying something in a sarcastic tone, or introducing ideas in a lower voice. Coding of sarcastic tone: it is only considered to be sarcastic by the reaction that it receives from others (judged by body language).

Overall the *serious* vs. *silly* axes are primarily judged by the body language of the group. This frame will also be judged on a continuous spectrum as opposed to a discrete one, more on this later.

A.1.4 When do we code a shift from *serious* to *silly* or vice versa?

A shift is coded by when a member of the group proposes a “bid” to switch into a different frame. If another member of the group “accepts” that bid by reacting to it in the proposed frame and a third member of the group also switches over to that frame, then we say that the frame has shifted. For example, if the group is in the *serious* frame and Student 1 makes a joke which switches the group over to the *silly* frame, and Student 2 and Student 3 also laugh, smile, or grin (show some sort of switch in their body language), then the group will be coded as switching over to the *silly* frame. The new frame will be coded as starting from the time that the first person proposed the bid, even if the bid was unintentionally posed. If only two members of the group switch over into a different frame, but the other two members stay in the previous frame, and after a short time (approximately <5 seconds) the whole group continues to be in the previous frame, then this is not coded as a shift. For example, the group is in the *serious* frame, and Student 1 proposes a bid by switching over to the *silly* frame. Student 2 accepts the bid and transitions into this
frame; however, students 3 and 4 continue being in the serious frame, then Student 1 and 2 come back into the serious frame there is no shift. Exceptions:

1. If one of the group members walks away from the table, there only needs to be two members that agree to a shift (accept the bid).

2. If there is an extended interaction between two group members in one frame and the other two group members in different frames, we may have to revisit this; therefore, please note if and when this interaction takes place; however, code as instructed above.

A.1.5 How do I code frames when an instructor and/or student leaders approach the group?

If an instructor approaches the group and the frame is shifted by him/her, then we code that shift and put him/her as the initiator. We follow the same rules, there still must be the majority of the group that switches over (3/4 or 2/3) the student leaders and instructors do not raise the group number (group number is constant). If they just approach the group and conform to the frame of the group then there is no frame shift.

A.1.6 How do I code when there is a table with (a) DHH student(s)?

If there is a interpreter at the table or a student who is interpreting, then this will be coded the same way as the group with 4 hearing students. This means that if the student is fully participating in the conversation. If the student is not fully participating in the conversation (ie writing on their own or talking with interpreter about something) code as if you are coding the split group (section E) with one group being 3 students and the deaf student as one group, then recombine when he/she starts participating again.
A.1.7 How do I start coding?

Start by identifying what frame the group is in (serious or silly). Put that at time 0. Then continue with coding when frame shifts. When you identify a switch in frames, identify what time the beginning of the switch occurs. In other words, not when everyone expects it, but from the moment the first person makes a bid.

A.1.8 What is the group is split (2 people and 2 people) for a long amount of time?

When the group splits, note the time and which group members are in each subgroup. Code two group separately (following same coding instructions) until they recombine as one. And again, please note the time that they recombine.

A.1.9 What do I use to code?

We will start by using an excel spread sheet and set it up as described below. Note we will be skipping Column (C) during this iteration of coding. 2nd line: time00:00=XXX real time Note: Time 00:00 is right after the instructor has finished giving instructions. It is important to make sure that the times are synced for all the clips.

- Column (A): segment number
- Column (B): seriousness frame into which the group switched (serious or silly)
- Column (C): topicness frame into which the group switched (task, on, off) (not coded yet)
- Column (D): initiator of the bin switch (who made the first bid) NOTE: If it is unclear who initiated the change, code as unclear.
- Column (E): time adjusted to time zero
• Column (F): real time at which the frame shifts (the time when the first bid is made)

• Column (G): a description or observation of the content of the frame

• Column (H): miscellaneous information

Figure A.1: An example of the spread sheet for coding seriousness

A.2 Epistemological Framing: Topicness

A.2.1 General Information

An important thing to note is that the unit of analysis is the group as a whole; therefore, we are coding for how the group as a whole shifts frames; not the individuals.

While previously we were coding the seriousness framing as primarily indicated by body language and sarcastic comments, here, coding topic-ness, we will be primarily focusing on the content of the conversation.

A.2.2 What does it mean to be in the on-task frame?

A frame is considered to be on-task when the conversation directly pertains to the task that the students are supposed to be working on. This is the task that is introduced by the instructor before the video segment starts being coded.
A.2.3 What does it mean to be in the on-topic frame?

A frame is considered to be on-topic when the conversation does not pertain to the task that the students are currently discussing and working on, but it does relate to the general science they may be discussing or to the IMPRESS program they are a part of (which does include some social activities) or to the classes they are enrolled in or planning on enrolling in.

A.2.4 What does it mean to be in the off-topic frame?

A frame is considered to be off-topic when the conversation does not relate to the program, science, classes, or the task being worked on.

A.2.5 When do we code a shift between frames?

A shift is coded when two rules are satisfied: (1) there must be at least three remarks in the new frame (remark can be a statement or an utterance such as “yeah,” “uh huh,” “hmm,” etc.) These remarks must be done by at least 2 different people (there can be two remarks by one person) and (2) a majority of the group are listening to or participating in the conversation. A frame may start shifting when a member of the group proposes a “bid” to switch into a new frame. If another member of the group “accepts” that bid by reacting to it in the proposed frame and a third utterance is made in that frame, then we satisfy the first rule. If at least 3 students were listening then the second rule is met, then we say that the frame has shifted. The new frame will be coded as starting from the time that the first person proposed the bid. For example, if the group is in the on-topic frame and Student 1 says something that is off-topic, and Student 2 responds to that in the off-topic frame and then there is a third response (from either Student 1, 3, or 4) also in the off-topic frame, and at least three of them were listening (even if they did not participate) then the group will be coded as switching over to the off-topic frame starting from Student...
1’s first comment. If only two members of the group switch over into a different frame, but the other two members stay in the previous frame, and after a short time (approximately \(<5\) seconds), the whole group continues to be in the previous frame, then this is not coded as a shift. For example, the group is in the *on-topic* frame, and Student 1 proposes a bid by switching over to the *on-task* frame. Student 2 accepts the bid and transitions into this frame. However, Students 3 and 4 continue in the *on-topic* frame and show they are not listening and not responding. Then Students 1 and 2 come back into the *on-topic* frame. In this case, there is no shift.

Exceptions:

1. If one of the group members walks away from the table, there only needs to be two members that agree to a shift (accept the bid).

2. If there is an extended interaction between two group members in one frame and the other two group members in different frames, we may have to revisit this; therefore, please note if and when this interaction takes place; however, code as instructed above.

A.2.6 How do you know if a group member is listening?

You assume they are always listening except if:

1. They are looking at their phone.

2. They are talking to someone else.

3. They are writing something down and completely focusing on it.
A.2.7 How do I code frames when an instructor and/or student leaders approaches the group?

If an instructor approaches the group and the frame is shifted by him/her, then we code that shift and put him/her as the initiator. We follow the same rules, there still must be the majority of the group that switches over (3/4 or 2/2) the student leaders and instructors do not raise the group number (group number is constant). If they just approach the group and conform to the frame of the group then there is no frame shift.

A.2.8 How do I code topicness at tables with (a) DHH student(s)?

This will have to be coded based on translations (if interpreter present) and/or responses of students to the computer. There is a part where the deaf student, Jack, gets a computer so he can type to everyone what he thinks and they can type back. We do not see the screen, but we can infer form student reactions.

A.2.9 How do I start coding topicness?

1. Open the first segment of seriousness and identify the initial topic-ness

2. During each seriousness frame, code any shifts between topic-ness.

Note: these are discrete shifts as opposed to the continuous ones of seriousness

A.2.10 What if the group is split (2 people and 2 people) for a long amount of time?

When split note the time and which group members are in each subgroup. Code two group separately (following same coding instructions) until they recombine as one. And again note time that they recombine.
A.2.11 What do I use to code?

We will use the same excel spreadsheet with the seriousness coding. We will now fill in the column (C) just after the seriousness frame. 2nd line: time00:00= XXX real time

Note: Time 00:00 is right after the instructor has finished giving instructions. It is important to make sure that the times are synced for all the clips.

- Column (A): segment number
- Column (B): seriousness frame into which the group switched (serious or silly) (already coded)
- Column (C): topicness frame into which the group switched (task, on, off)
- Column (D): initiator of the bin switch (who made the first bid)
- Column (E): time adjusted to time zero
- Column (F): real time at which the frame shifts (the time when the first bid is made)
- Column (G): a description or observation of the content of the frame
- Column (H): miscellaneous information

An example of the spreadsheet:
Figure A.2: An example of the spreadsheet for topicness

<table>
<thead>
<tr>
<th>Segment</th>
<th>Frame: Seriousness (serious or silly)</th>
<th>Initiator</th>
<th>Time adjusted to time zero</th>
<th>Real time</th>
<th>Description of observation</th>
<th>Miscellanea</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 Serious</td>
<td>off</td>
<td>Justin</td>
<td>0:00</td>
<td>1:30</td>
<td>Justin talks about air conditioning</td>
</tr>
<tr>
<td>2</td>
<td>on</td>
<td>Put</td>
<td>1:00</td>
<td>2:30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2 Silly</td>
<td>on</td>
<td>Justin</td>
<td>2:00</td>
<td>3:30</td>
<td>Justin makes sarcastic comment Jessica begins laughing</td>
</tr>
<tr>
<td>4</td>
<td>talk</td>
<td>Justin</td>
<td>2:03</td>
<td>3:32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2 Serious</td>
<td>talk</td>
<td>Put</td>
<td>2:05</td>
<td>3:36</td>
<td>Directing attention toward equipment</td>
</tr>
<tr>
<td>6</td>
<td>on</td>
<td>Brittany</td>
<td>2:15</td>
<td>3:45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>talk</td>
<td>Justin</td>
<td>2:30</td>
<td>4:00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>off</td>
<td>Brittany</td>
<td>2:48</td>
<td>4:18</td>
<td>&quot;You know City never gives us answers&quot;</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX B

Analysis of Epistemological Framing with *On-Topic*
Figure B.1: Timelines of all groups and activities: green is serious, magenta is silly. The x-axis for all is the number of seconds spent in a certain activity. Where “task” stands for the on-task frame, “on” stands for the on-topic frame, and “off” stands for the off-topic frame. Compare with Fig. 7.1.
Figure B.2: Percentage of overall time spent in the on-task, on-topic, and off-topic frames per group. Compare with Fig. 8.2.
Figure B.3: Percentage of time spent in each of the topicness frames. Compare with Fig. 8.4
Figure B.4: Number of frame shifts in the topicness frame by all members of the group, the instructor, and student leaders. Compare with Fig. 9.1.
APPENDIX C

On-task/silly Frame Cases

Group 1

Case A: Justin brought in the on-task/silly frame into Activity 1 (description in Section 1.4.2) early on. This was when the group was lost during a discussion with Corey, the instructor, and the other group members. Justin said a sarcastic comment in response to the instructor, saying “variables are like x, y, z” which got the group laughing and Brittany asked, “So how many people exhale?” with a laugh. This got the group talking about population and concluding that they should use the variable $p$ to represent population as one category. At that point, the instructor left the group. Therefore, in this case, the on-task/silly initiation functioned as a response to the instructor, but also as a way to open up discussion about a topic that the group was silently uncertain about. It was clear that the instructor was hovering to hear if the group would get on the right track, and when they did, he walked away.

Case B: Another instance during Activity 1 that the group went into the on-task/silly frame was towards the end of Activity 1. The group was in the off-task frame for some time and then Justin made a sarcastic comment about putting a plus into an equation, to which Pat responded by explaining what they have written in their equation. The group continued to joke about certain aspects of equations and what they should use to represent their ideas. The joking turned into everyone saying their ideas and talking about mathematical equations in other classes and eventually comprehension. Afterward, the group began to be serious and on-task to
finish working on their equations. In this case, the *on-task/silly* functioned as a way to break out of the off-taskness that the group was in for some time before that. It was unclear whether this was done on purpose, but it was effective.

**Case C:** During Activity 2, Justin again was the one to break the group into the *on-task/silly*. Here the group was working in the *on-task* and *serious* intersection of frames for a while and Justin exclaimed, “It’s so bad!” Referring to his drawing, this gets the group laughing, but the group returns to the *on-task* and *serious* frame right after. Therefore, this did not distract the group from the work, it simply added a silly element and served as *relieving tension* in the group.

**Case D:** Soon after this, the group again went into the *on-task/silly* frame when Corey came by to see how the group was progressing and made a comment about Justin’s pictures saying “Why is that throwing up into a beaker?” After this comment was made, the whole group started laughing. Justin went on to more clearly explain what he was trying to illustrate through his drawing which helped the whole group with their diagrams, and they all started editing them. After this, the group continued to be *on-task* but shifted into the *serious* frame.

**Case E:** The group was *on-task* and *serious* while huddling trying to finish up their diagrams. Corey came by and began looking over their shoulders. He commented, “Yeah I can’t read that either.” The group started laughing, and Justin clarified that he wanted to show that “It passes the ozone layer.” This began a discussion about the ozone layer, and how to represent it. In this case, it seemed that the instructor wanted to interrupt the group because he saw a need to classify something, and he thought the best way to do that was to make a *silly* comment that was *on-task*, bringing attention to an area that the group needed to spend more time on.

Group 1 did not have any *on-task/silly* frames during Activity 3.
Group 2

**Case F:** During Activity 1, Herb was looking at the computer and trying to understand what the other group members typed. He started reading the equation out loud and asking what it stood for. Unsure, he proposed writing the equation simpler in a sarcastic tone, and the group started laughing. Herb seemed to not exactly be sure if his suggestion was correct; therefore, he turned his suggestion into something funny which distanced him from the comment. After this, the group temporarily jumped *off-task* and *silly* frames, but then went back into the *on-task/serious* frame when talking about the equations. Remembering that Herb seemed to be the group member who was most lost during the activity, it seemed that he wanted to propose his idea without taking full responsibility for it. He used *epistemic distancing* to do this.

**Case G:** Later during Activity 1, Jose, the student leader, was sitting with the group for a while in the *on-task* and *serious* frame asking the group about their equation. He asked specifically about the amount of $CO_2$ in the water, and Jacob responded by explaining that there is too much $CO_2$ in the water and it is dissolving the shellfish. Jose asked how the $CO_2$ got into the water, and the group members all replied, “from the atmosphere.” Jose the asked, “So the atmosphere just comes and dives into the water and dissolves the shellfish?” this was the trigger for the *on-task/silly* frame because all of the group members started laughing and sarcastically saying “Yes, that’s exactly how it works.” At which point Jose left the group, and the group started to get upset that Jose left. Their dissatisfaction with Jose leaving led them to get *off-task*. In this case, Jose’s question was a stimulating question that made the group realize the part of their equation they should have worked on more; however, he left so suddenly that it actually drove the group *off-task*. This was an attempt at a redirection of a misconception, but it didn’t work well.
Case H: Towards the end of Activity 1, the group was discussing what they should include in the equation with Jose, the student leader. Jose giggled at how the group members were all talking at one time. After the giggles the group focused and began working on the equation and talking one at a time. In this case, Jose’s giggle made the group jump into the on-task/silly frame in order to realize that they have to slow down in their communication to be more effective. This giggle was redirecting the group towards the right path.

Case I: During Activity 2, Corey was talking with the group about how everyone should contribute something to the drawing of the CO$_2$ cycle. This was a delicate way of informing Herb to start participating more in the group activity. Herb took the journal and began drawing on the diagram that the group had. Brett was looking over the table and started giggling asking “What is that?” initiating the shift into the on-task/silly frame, and the rest of the group started laughing and Herb was giving an explanation. Therefore, in this case, Brett was the one that shifted over the group because he was laughing at Herbs overreaction to Corey’s hint. In a way, he was trying to relieve the tension that arose in the group. This case was similar to Case C because the group is on-task before and after the interaction, this just adds a little laughter in between.

Case J: Soon after during Activity 2, Brett was adding things to the diagram of the CO$_2$ cycle while the group was in the on-task and serious intersection of frames. Brett said, “I put a dead fish right here” shifting the group into the on-task/silly frame. The group members giggled and acknowledged his drawing, and Jacob suggested, “Then put a dead fish on land!” The on-task conversation continued to be about the different parts of the cycle. This shift was a way to get the group back into the task at hand because prior to that comment the group was in the off-task frame.

Case K: A short while after Case J, the group was still discussing the cycle,
and Jacob said, “A little arrow into him, and a little arrow out of him on the other side with the CO$_2$” with a smile shifting the group into the on-task/silly frame, and the rest of the group began to giggle. This instant was similar to Case C; a small disturbance to lighted the mood and relieve the tension.

**Case L:** Again, a short while after Case K, during Activity 2, Corey came up to the group and asked about the group’s diagram. He asked if it represented all the concepts that they learned during the 2 week program. Brett replied, “Well I guess I can draw a little soda bottle right here” shifting the group into the on-task/silly frame. This sparked a conversation about the activity that they did with the soda bottle, and what they could have used from that activity. Therefore, this shift was a way for Brett to suggest an idea, without putting the pressure of being correct, distancing himself from it.

**Case M:** During Activity 3, there was only one instant where the group was in the on-task/silly frame, and it was about half way through the activity. During this time, the group was talking about the charts they were given with Corey, and Herb said, “This one is just way to complicated for me” referring to the chart he had in front of him and shifting the group into the on-task/silly frame. The group members laughed and continued to discuss the diagrams with less tension. This interaction functioned and succeeded to relieve tension.

**Group 3**

**Case N:** The first time that Group 3 went into the on-task/silly frame during Activity 1 was towards the end of the activity, after they have been in the on-task and serious frames for a while. This shift occurred during a conversation with Corey about how they were almost done with their equation. Right after Cory steps away, the group looks at each other confused and, Jill comments, “so we should simplify
it and Jose showed us to make it more complicated” while laughing; therefore, she shifted the group into the on-task/silly frame. The rest of the group started giggling, and they seemed less tense about the instructor’s comment. They continued working in the on-task/silly frame editing the equation. This was a comment that caused the group to laugh and relieve tension.

**Case O:** The next instance happened soon after Case N, when Nick, the student leader, stepped in, looked at the group’s equation, and started laughing. The group laughed with him and explained their equation in the silly frame. Nick pointed out something that they need to change. After this, the group returned to the on-task and serious frames to make the changes. This was a way for Nick to address a misconception that the group had in their equation.

**Case P:** The last on-task silly frame for Group 3 during Activity 1 was while the group was in the off-task and serious frames discussing the classes they will be taking, and the professors they will be taking them with. Jose, the student leader, came over and asked the group “So how’s it going?” with a smile. The group began to laugh and say “We expanded it even more” referring to the equation and pointing to it. They continued the conversation about the equation in the silly frame. After Jose left, the group returned to the off-task and serious frame. This case function as transitioning from the off-task frame, and was done by the student leader and did not last long.

**Case Q:** During the beginning of Activity 2, Group 3 was working on their diagrams. When Jose started approaching the group Jill said, “Don’t look, it’s bad” with a smile and everyone started laughing shifting the group into the on-task/silly frame. She was being self-conscious about her drawings and wanted to relieve the tension. Soon after, the group members started talking about their drawings. The group stayed in the silly frame and for a moment transitioning into the off-task frame discussing a class they, but they went right back into the on-task frame continuing
to discuss their diagrams. The group is in the on-task frame before and after, and this shift into the silly was lightening their mood and relieving tension.

**Case R:** During the first part of Activity 2, there was a time that the group was working in the on-task and serious frames, and Jose came up to look at the diagrams they were making. When he came up, Jill covered her work and said, “Stop looking” while laughing, transitioning the group into the on-task/silly frame. The group was a bit self-conscious about their drawing abilities; they started laughing about what everything was supposed to represent. They went back into the on-task and serious frames right after. This interaction served to relieve tension.

**Case S:** Soon after Case R and after being in the on-task and serious frames discussing their drawings, the group returned into the on-task/silly frame while Jill again started laughing about her drawing of a pine tree. The group returned to the on-task and serious frames and continued working for a longer time in this frame. This case did not take away from the group’s on-taskness, it just added an element of silliness into the group, and continued to serve as a tension reliever.

**Case T:** A little over half way through the Activity 2, Jose went around looking at Group 3’s work. He pointed to a picture with a smile and asked, “What is that?” shifting the group into the on-task/silly frame. The group laughed about the quality of the picture, but added notes to annotate what it was they were trying to illustrate. Jose walked away while the group continued laughing and describing what they have in their graphics. This was a way for Jose to realign a mistake that the group was having. In order to make proper diagrams, there need to be labels. He wanted to point out that their labels were missing, and this caused all the group members to start adding the proper labels.

**Case U:** While the group was working on writing explanations, Jill asked how they would write something and started gigging, shifting the group into the on-task/silly frame. Grace answered and Sara clarified if they need to write explanations
for everything. This was a way for the group to open up a line of communication in a silly way. Jill distanced herself from her comment. They were most likely thinking about Case T in which they were all laughing about the captions because it happened not long before this case.

**Case V:** The group was discussing their diagrams and Nick, a student leader, came by and asked “Are you done?” with a smile, *transitioning* the group into the *on-task/silly* frame because the whole group started laughing, and Jill responded “I’m done, do you want to see it?” The group started laughing and talking about their diagrams with Nick, and then they went back into the *on-task* and *serious* frames.

**Case W:** The group ended Activity 2 in the *on-task/silly* frame when some students stopped by their table, and they started laughing about their drawings. This was another case of the group just laughing and enjoying the activity to relieve tension.

**Case X:** During Activity 3, there was only one instant Group 3 was in the *on-task/silly* frame and that was towards the beginning of the activity. The group was *on-task* and *serious* before and after discussing the different charts they were given. Jill switched the group into the *on-task/silly* frame by commenting “I mean mine looks pretty much like this if I had better drawing skills” her group members started laughing and she continued saying, “I mean if I just add arrows it’s pretty much the same.” Her group members continued finding similarities. This was a case that through which Jill wanted to distance herself from her comment.

**Group 4**

Group 4 was a group that primarily communicated on the laptop or through a translator due to the fact that Jack was deaf. The *on-task/silly* shifts that occurred
were unable to be categorized and organized because if they occurred on the computer screen, we were unable to read the context, and if it was translated through the interpreter the interpreter was not heard because she was standing behind the camera microphone. Therefore, Group 4’s on-task/silly frame shifts were not analyzed in this manner.
REFERENCES


