

Different Zoom Breakout Room Methods and Techniques' Effects on Engineering Students' Learning Outcomes for Engineering Courses

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Effect of Zoom Breakout Room Factors on Student Comfort, Productivity, and Learning

Abstract

The Zoom application has become increasingly popular for online and hybrid teaching since the COVID-19 pandemic started in the spring of 2020. However, Zoom cannot simply replace all of the teaching techniques traditionally used during in-person lectures. In particular, student group problem solving and discussion is often replaced with a virtual version via the Zoom breakout room feature. This paper will investigate the effectiveness of these breakout rooms on student performance in engineering courses. A variety of breakout room strategies were conducted over the course of the fall 2020 semester in four engineering classes. Students were surveyed at the end of the semester to determine what strategies/factors most improved their individual comfort level, group productivity, and ability to learn the material. The results of this paper indicate that having small breakout room groups (i.e., 2-3 students), assigning specific tasks to the groups and individual students, and visiting the breakout rooms periodically have the most positive impact on the student's perception of the session.

1. INTRODUCTION

Over the last decade, a growing number of instructors have had to rely on the use of online lectures and tools to deliver class materials. To facilitate the communication and the interaction between students and teachers in higher education, online lectures have become increasingly popular. With the advancement of technology, online lectures provide a convenient method for meeting the demands of a more flexible educational system. Studying engineering courses online at any time from any location has become more attractive in recent years, but is not yet common throughout all engineering education programs [1]. In engineering, instructors often use blackboards and other tools to communicate and facilitate the learning objectives for students. For online engineering programs to be largely accepted and used, the quality of courses online must be equivalent to, or better than that of a regular classroom. Just in the last decade, a growing number of schools have started to offer degrees where entire programs are offered online through a synchronous process. Therefore, the need for tools that can map important aspects of face-to-face teaching to online has become increasingly important. Online learning techniques and tools, including blended learning and fully online courses, are some of the newest higher education resources in recent decades [2]. Online learning tools hold the promise of improving, expanding, and deepening learning for engineering students.

They are many platforms that have been adopted to convert regular class meetings to online such as Zoom. The use of Zoom as a tool to deliver online class has become very popular since the COVID-19 pandemic began in the spring of 2020. The Zoom platform has been largely adopted by institutions during the pandemic across the U.S. and around the world. It is used as a method to connect, present, and deliver lectures to students, and also as a way for students to interact with group projects during a time when learning in person has become potentially unsafe. Zoom is

commonly used to facilitate the communication and interaction between teachers and students, and also meets the demands for a more diverse/reliable educational system.

The movement to online teaching has taken on many different forms. Some institutions have adopted a fully online instructional approach, while others provide a blended learning type, using supportive systems and implementing tools such as Moodle, Blackboard, Atutor, and CanvasLMS, among others. Effective online class is important for achieving institutional goals of both teaching and learning in higher education. Previous research on e-learning was mainly conducted with an in-depth focus on certain e-learning dimensions such as technology, faculty, support, pedagogy, readiness, management, ethics, evaluation, planning, and institution [3]. This paper investigates Zoom's breakout room application and its effect on learning goals for students, including individual comfort level, group productivity and learning feedback, compared to not using the breakout room application. Before the COVID-19 pandemic, breakout rooms were rarely used by faculty and students for non-online courses, and therefore it is important to understand the best methods and techniques that should be used for better achieving learning objectives.

In the COVID-19 shift to online learning, synchronous video formats often replace face-to-face meetings in order to replicate a traditional class room. The COVID-19 situation has forced urgent transitions, and without adequate opportunities to design for a new method, some instructors have struggled during the pandemic. The breakout room in Zoom provides some opportunity for students to work on engineering problem-solving, and to get the experience to work with their classmates and gain some face-to-face (albeit virtual) learning that is missing. The breakout room can be efficient and achieve class objectives if correct techniques and methods are used. During the pandemic, many faculty are searching for methods that can provide the same level of instruction as traditional classrooms. However, constructivist methods are more difficult. Breakout

rooms offer one of the best ways to construct knowledge in teams, share, investigate, build, and present if the right approach is used. Moreover, breakout rooms offer an optimal way for students to gain engineering knowledge that is most similar to a traditional classroom.

In this study, analysis of the following variables was completed: 1) size of group, 2) time in breakout room, 3) did you have your video on, 4) did your group members have their videos on, 5) did someone in the group (including yourself) share their screen during the session, 6) did the instructor assign specific tasks/duties to the group/individuals, and 7) did the instructor visit the breakout room periodically. The breakout room variables were analyzed, and their effect on the student's productivity, knowledge and comfort level was investigated. Students were surveyed in four engineering classes, two of which are junior-level major courses, and two of which are sophomore-level major courses.

2. STUDY MODEL

In each of the four courses analyzed, different methods were used in the Zoom breakout room during the problem-solving sessions throughout the semester. All four courses were taught in a 100% online synchronous format during the first six weeks of the semester, and hybrid for the remaining ten weeks. The survey was sent to the students for the following courses: Strength of Materials, Materials and Processes and two sessions of Fluid Mechanics. The response rate was 92% for a total of 83 respondents. In the survey, students were asked to comment on how much they agreed or disagreed on whether each breakout room variable affected their individual comfort level in the session, productivity of the breakout room group, and ability to learn the material. For each combination, the students could select one of the following: "strongly disagree", "disagree", "neutral", "agree", or "strongly agree". The students were encouraged to answer thinking of their broad experiences with breakout rooms in all of their engineering courses.

The first variable used in the study is the size of the group of students in the breakout room. The size of the group can impact student productivity, as many students are either Sophomores or Juniors usually know their classmates from previous classes, social networking events at the engineering building, or activities on campus. The size of the group during problem-solving sessions can also impact the productivity of the students since not every student has the same level of knowledge on the subject. Having a large group can also impact student comfort level, especially when a student is solving problems on their own computer, tablet, or on paper. Some students may be too shy to ask questions to their classmates if they have difficulties solving problems in a large group. Small groups may make students more comfortable to ask questions and may promote good communication flow throughout the entire breakout room session. Small groups also can affect students on class learning outcomes, as it is related to comfort level; if a student is comfortable to ask questions and share ideas, and good communication flow was created, this will make the session beneficial for the student.

Another variable that could also affect student productivity and learning outcome is the amount of time in the breakout room session. Previous research conducted on meeting times show that shorter meetings tend to be more effective and attendees pay more attention [4]. It is important for the breakout room session to be organized by the instructor so it can be conducted in a shorter time frame, which will allow for more problem-solving in following sessions. The first and possibly most important step is to ensure beforehand that all breakout sessions are planned and purposeful, so that students enter and leave with a feeling of accomplishment and purpose.

The impact of individuals having their own video on during the session was investigated. The purpose of this technique is to investigate how one's video can affect the productivity of the students during the problem-solving sessions. To the author's knowledge, there has not been any

study that investigates the effect of one's own camera on meeting productivity. Likewise, the effect of group members having their video on was studied.

Another variable that can affect the student breakout room session is if anyone in the group shares their screen. Sharing the computer screen during problem-solving sessions can affect students' productivity and learning outcomes. Since COVID-19, many institutions have no other choice but to go remotely, and problem-solving sessions in engineering courses are very important. Sharing the screen during the meeting can lead to better productivities of the group members. It's more important than ever to take advantage of tools that make collaborating, communicating and brainstorming during the problem-solving sessions in breakout rooms more efficient.

The effect of instructors assigning specific tasks to the group and individuals was also investigated. This could mean a variety of things from assigning a group leader or recorder to giving the group as whole concrete deliverable items. Group work can be a valuable tool when used as a catalyst for productivity in the workplace. Due to COVID-19, face-to-face meetings have lessened in class as well as outside of class in office hours. Therefore, having a leader assigned for a group meeting is helpful [5]. A leader in a group can give rise to a sense of collective identity among group members and, by doing so, may strengthen the commitment of students to their task. On the other hand, poorly run breakout rooms can have a huge influence on group productivity, which causes students to lose a sense of purpose for the task. A breakout room that is not productive can create dissatisfaction among the students to the point where they may feel the need to quit the breakout session. The session leader can influence the extent to which attendee members perceive meetings to be enjoyable and productive. Previous research shows that the leader of a meeting is likely to satisfy attendee ratings of meeting satisfaction and productivity, and attendee needs [6]. A number

of studies performed on the leader in a general meeting show that one way to create satisfaction within meetings is for meeting leaders to fulfill the needs of those attending [7].

The last variable in this study was whether or not the instructor visited the breakout room during the session. When an instructor visits the breakout room, he or she tends to create an energy in the group by asking them questions and answering any of the group's questions or concerns regarding the problem. However, some feel as though periodic visits break up the work flow of the group.

3. RESULTS AND DISCUSSION

3.1 Student Individual Comfort Level

Students were asked to state on a scale of 1 – 5 (i.e., strongly disagree – strongly agree) whether a number of breakout room factors/variables helped them feel individually comfortable to partake in a group breakout room problem-solving session. The combined results from the four classes polled are provided in tabular form in Table 1 and graphical form in Figure 1. Note, the numbers 1 – 5 in Table 1 correspond to strongly disagree, disagree, neutral, agree, and strongly agree, respectively. The number under each column represent the number of respondents selecting that level. The right-most three columns group strongly disagree and disagree responses as general disagreement, similarly with agree and strongly agree responses. The numbers under these three columns represent the total percentage of respondents. Any percentages between 50% and 70% are highlighted yellow. Any percentages above 70% are highlighted red. These disagree, neutral, and agree percentages are shown graphically in Figure 1.

Table 1. Poll results for student individual comfort level in breakout room.

Individual Comfort Level								
Variable\Agreement (1-5)	1	2	3	4	5	Disagree	Neutral	Agree
Small group	2	9	4	41	20	14.47%	5.26%	80.26%
Large group	3	22	16	18	16	33.33%	21.33%	45.33%
Short time	7	12	14	19	24	25.00%	18.42%	56.58%
Long time	10	18	13	19	15	37.33%	17.33%	45.33%
You have video on	5	14	22	16	18	25.33%	29.33%	45.33%
You have video off	5	14	32	16	9	25.00%	42.11%	32.89%
Group have video on	3	4	29	19	21	9.21%	38.16%	52.63%
Group have video off	12	14	39	7	4	34.21%	51.32%	14.47%
You shared screen	4	11	23	23	13	20.27%	31.08%	48.65%
Group shared screen	2	2	25	30	15	5.41%	33.78%	60.81%
Instructor assigned specific tasks	0	9	15	25	27	11.84%	19.74%	68.42%
Instructor visited room	1	10	21	21	21	14.86%	28.38%	56.76%
Instructor did not visit room	12	14	34	10	3	35.62%	46.58%	17.81%

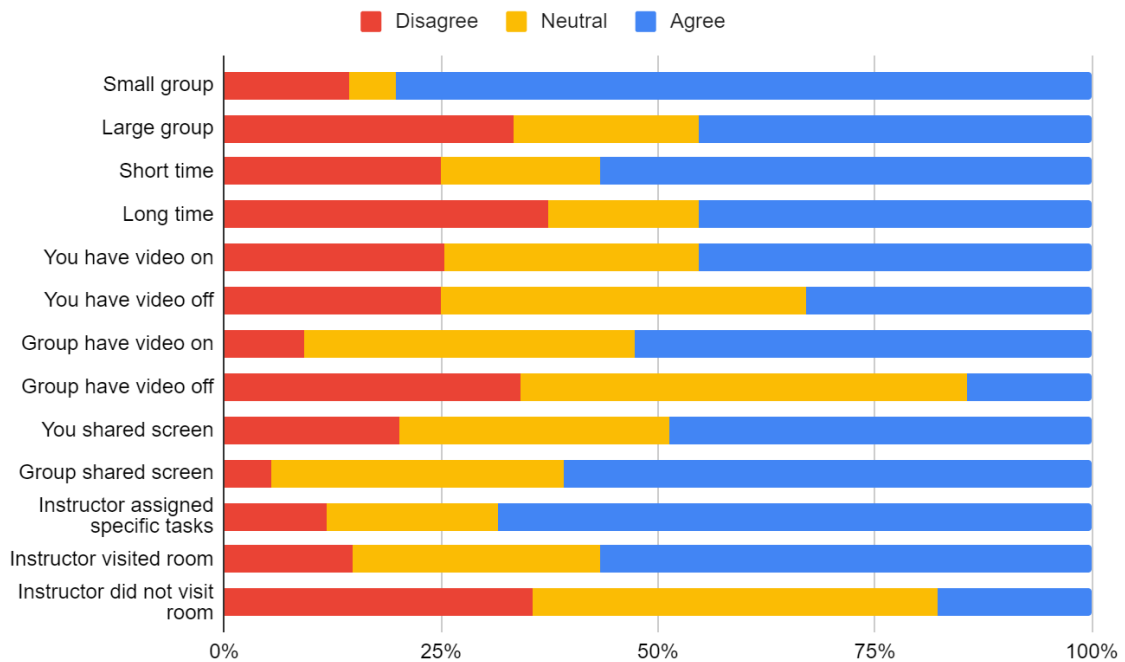


Figure 1. Poll results for student individual comfort level in breakout room.

The size of the group has the largest impact on individual comfort level, with just over 80% of respondents indicating that small groups (i.e., 2-3 students) made them feel comfortable in their breakout room. It is hypothesized that this is linked to students feeling like their contributions are valued and needed. The data indicate that there is not a strong link between the amount of time spent in the breakout room and individual comfort. Likewise, there is not a clear trend of video usage (either individual or of group members) with individual comfort; however, less than 15% of respondents indicate that groups members having their video on made them feel uncomfortable in the breakout room. In general, a majority of respondents indicated that they felt more comfortable in their breakout room when someone in their group shared their screen, the instructor assigned specific tasks to the group and its members, and/or the instructor visited the room. Less than 15% of respondents felt like any of those three factors hindered their individual comfort level.

3.2 Group Productivity

Students were asked to state on a scale of 1 – 5 (i.e., strongly disagree – strongly agree) whether a number of breakout room factors/variables helped their breakout room’s group productivity to accomplish the task at hand. The combined results from the four classes polled are provided in tabular form in Table 2 and graphical form in Figure 2.

Table 2. Poll results for group productivity in breakout room.

Group Productivity								
Variable\Agreement (1-5)	1	2	3	4	5	Disagree	Neutral	Agree
Small group	2	5	6	30	21	10.94%	9.38%	79.69%
Large group	4	17	11	22	10	32.81%	17.19%	50.00%
Short time	9	14	11	21	8	36.51%	17.46%	46.03%
Long time	5	15	12	20	12	31.25%	18.75%	50.00%
You have video on	2	6	27	15	14	12.50%	42.19%	45.31%
You have video off	10	13	33	4	4	35.94%	51.56%	12.50%
Group have video on	2	3	28	16	15	7.81%	43.75%	48.44%
Group have video off	11	11	35	5	2	34.38%	54.69%	10.94%
You shared screen	0	7	19	23	15	10.94%	29.69%	59.38%
Group shared screen	0	2	18	27	17	3.13%	28.13%	68.75%
Instructor assigned specific tasks	0	3	12	25	23	4.76%	19.05%	76.19%
Instructor visited room	0	2	15	23	23	3.17%	23.81%	73.02%
Instructor did not visit room	12	18	25	5	3	47.62%	39.68%	12.70%

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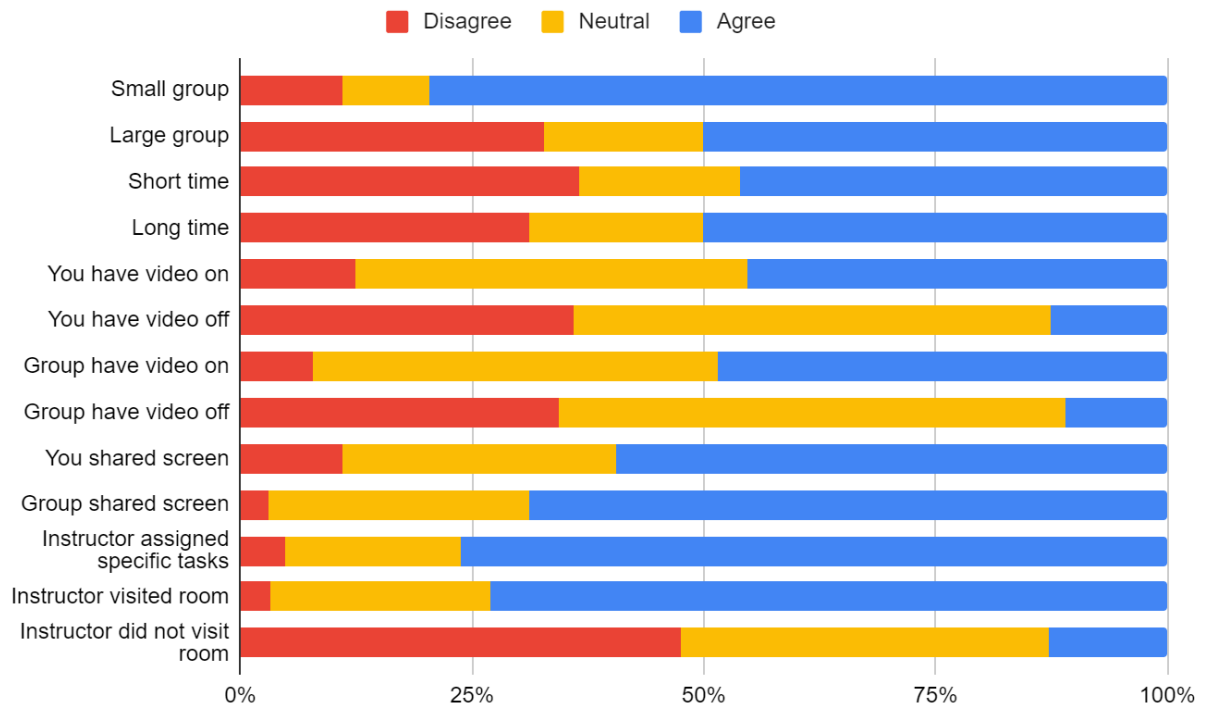


Figure 2. Poll results for group productivity in breakout room.

Similar to above, the size of the group has the largest impact on the group's productivity. It is possible that larger groups discourage participation and make it easier to "sit in the corner" without contributing. The data indicate that there is not a strong link between the amount of time spent in the breakout room and group productivity. A majority of respondents indicated that having their video on and group members having their videos on did not negatively affect productivity; however, it is inconclusive that videos on significantly increased perceived productivity. A majority of respondents expressed that someone (including themselves) sharing their screen during the session increased productivity. It is hypothesized that screen sharing helped organize discussion and kept students on track. Approximately three-quarters of the respondents indicated that group productivity was high when the instructor assigned specific tasks and/or visited the breakout room during the session. Less than 5% of respondents said that either of these two factors decreased productivity. Assigning specific tasks helps students stay on track and have a clear direction of movement. Although instructor visits are sometimes perceived as an obstruction to group discussion/progress, these data indicate the opposite – instructor visits help the group's overall productivity. These visits likely hold the students accountable to participation, both at the individual and group level.

3.3 Learning Outcome

Students were asked to state on a scale of 1 – 5 (i.e., strongly disagree – strongly agree) whether a number of breakout room factors/variables helped them learn the material covered during the breakout room session. The combined results from the four classes polled are provided in tabular form in Table 3 and graphical form in Figure 3.

Table 3. Poll results for learning outcomes in breakout room.

Learning Outcome								
Variable\Agreement (1-5)	1	2	3	4	5	Disagree	Neutral	Agree
Small group	5	6	9	28	15	17.46%	14.29%	68.25%
Large group	7	12	18	13	13	30.16%	28.57%	41.27%
Short time	14	10	15	18	6	38.10%	23.81%	38.10%
Long time	5	11	14	24	9	25.40%	22.22%	52.38%
You have video on	5	4	25	15	14	14.29%	39.68%	46.03%
You have video off	12	11	34	1	5	36.51%	53.97%	9.52%
Group have video on	4	6	25	16	11	16.13%	40.32%	43.55%
Group have video off	11	12	35	2	3	36.51%	55.56%	7.94%
You shared screen	3	8	21	15	16	17.46%	33.33%	49.21%
Group shared screen	3	7	19	18	16	15.87%	30.16%	53.97%
Instructor assigned specific tasks	2	7	11	23	19	14.52%	17.74%	67.74%
Instructor visited room	1	5	15	24	17	9.68%	24.19%	66.13%
Instructor did not visit room	12	18	24	4	3	49.18%	39.34%	11.48%

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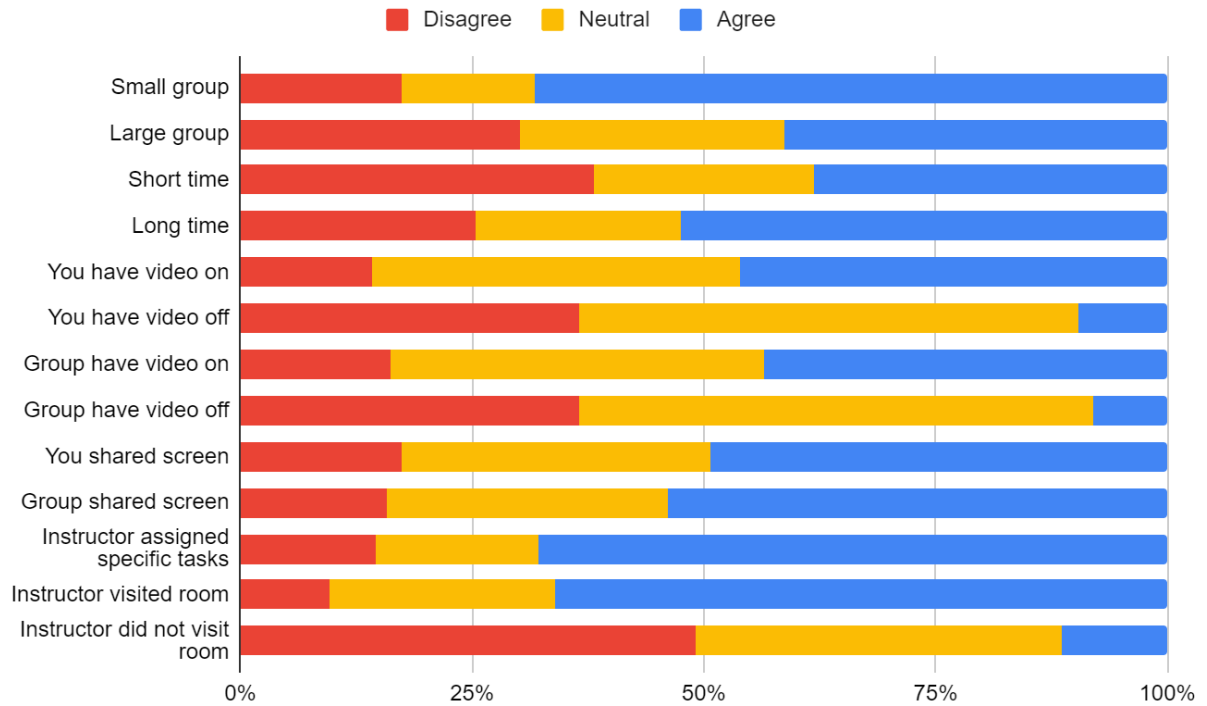


Figure 3. Poll results for learning outcomes in breakout room.

As with the previous two sections, the size of the group has the largest impact on the student's perception of learning the material during the breakout room session. Individual students inherently have more responsibility in smaller groups, which likely helps them learn and retain the material being covered. There is not a strong link between the amount of time spent in the breakout room and the learning outcomes being achieved. A majority of respondents indicated that having their video on and/or group members having their videos on did not negatively affect productivity; however, it is inconclusive that videos on significantly affected student learning. Around half of the respondents expressed that screen sharing, either by themselves or group members, assisted in their learning. Again, a majority of respondents suggest that learning improves in the breakout room session when the instructor assigns specific tasks to the group/students and/or visits the room throughout the session.

4. CONCLUSIONS AND SUGGESTED BEST PRACTICES

This study investigated the effectiveness of different Zoom breakout room factors/variables on individual student comfort level, productivity of the group, and learning objectives. Students were asked at the end of a semester of online teaching/learning to comment on the extent to which each of these factors/variables affected their perception of comfort, productivity, and learning.

Firstly, the students in this work consistently indicated that smaller groups (i.e., 2-3 students) improved their breakout room experiences. This was the most consistent and highlighted finding. Secondly, it is suggested to take time to assign the group/individual students specific tasks. This provides the students with clarity on what is expected of them by the time they are finished. Likewise, because the purpose of the session is less vague, it fosters discussion/participation amongst students. Assigning students to do specific things within the group (e.g., recorder, screen

sharer, etc.) assists in the important task of providing every student within the group with a purpose and responsibility. Thirdly, students somewhat surprisingly do better in breakout room sessions when the instructor periodically pops in to see how things are going/ask questions. Our preliminary dataset indicate that instructors should focus on these three things more than agonizing over how long to give the students and/or encouraging them to have their videos on.

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