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Big or Small? Examining the Influence of Group Size on Discourse Patterns in a Virtual, Collaborative, Informal, STEM-focused Learning Community

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Abstract: Literature on group sizes in traditional education settings indicates that small groups yield a better learning experience among students. This paper examines how small and large group sizes impacts discourse among adolescent students in an online, collaborative, informal STEM-focused learning community. Transcripts of discourse from four video conference calls, known as online global meet-ups in this community, were examined using epistemic network analysis (ENA) to identify key patterns among small group and large group sizes. Discourse patterns for both large and small groups were fairly vibrant, and there were no statistically significant differences between the two groups. However, a subtracted network model showed that the small groups' discourse patterns generally were stronger, and the facilitator and technical difficulties seemed to have more influence in the larger groups. Overall, this gives insight on how this unique learning environment can provide vibrant discourse independent of group size.

Introduction

Technology has continued to give people around the globe the chance to interact and collaborate for a variety of purposes. In 2020, the pandemic forced the relevancy of virtual learning and interaction in education settings, including ways to collaborate and work together in groups. In emerging digital collaboration spaces, student dynamics can be affected by many factors, including the size of a group in a virtual environment.

In most literature, smaller group sizes in education settings have broadly demonstrated overall improvement in student engagement through increased attentiveness and effective contribution. With fewer participants per group, students have the opportunity for deeper connection through feedback, dialogue, and posing questions (Afify, 2019). Students in small group discussions are able to express their thoughts and get to know each other better when compared to large, class-wide discussions (Hamann et al., 2012). Additionally, small group size has been proven to influence learning participation and overall student satisfaction (Shaw, 2013). An increase in student to teacher interactions and student-to-student interactions were noted in smaller class sizes along with an increase in attention, increase in student initiated responses, and lower off-task behavior (Pedder, 2006). While smaller group size provides the opportunity for better results, further research suggests that additional intersecting factors can also influence the group dynamic and student engagement outcome.

In a study conducted with high school chemistry students, group size variations for project-based learning demonstrated no apparent disparity when analyzed alone. However, when layered against intersecting constructs, such as social environment and type of learning, a smaller group size was shown to increase the depth and level of student engagement for advanced learners (Apedoe et al., 2012). Another study on students in upper elementary small groups demonstrated that a neutral to positive affective state such as feeling calm, happy, or even excited within the group dynamic was positively correlated to improved student interactions (Linnenbrink-Garcia et al., 2010). More recent research with high school biology students analyzed the intersection of similar findings. The study concluded that the relationship between content, social, and affective themes influenced small group dynamics whereby affirming interactions within the social and affective verticals positively impacted content engagement outcomes (Nieswandt et al., 2020).

Positive interactions and engagement have also been noted when the teacher takes the position of being a coordinator of learning rather than a dispenser of learning (Audrain et al., 2022). Teachers of small groups who acquiesce to this approach to learning allow for the sharing of students' personal views and ideas making for a more meaningful experience within groups (Xu & Pan, 2021). Students in small groups who are empowered to exchange meaningful ideas and views eventually create rapport as well as trust. Establishing rapport and trust in a group can contribute to greater behavioral and cognitive engagement in addition to the integration of multiple perspectives (Poort et al., 2020).

Literature generally focuses on small group trends in in-person classroom settings. This paper seeks to examine group size in conversations among adolescent students in a virtual STEM-focused informal learning environment, and whether observations in literature are also seen in the discourse patterns of interactions in this particular context. The students in this learning setting hail from over five countries and four continents to participate in informal, after school clubs where they develop multimedia projects to teach each other STEM-related topics. Each week, students have the opportunity to share their projects and interact with peers from other countries in synchronous video conference calls called online global meet-ups. A facilitator is present to help support/coordinate the conversation. Global meet-ups build knowledge about STEM topics and media creation as well as fosters a sense of community.

Methods

The data used in this analysis consisted of discourse from transcripts of four online global meet-ups that took place in July 2020 (12 students), two in March 2021 (4 students, 6 students) and April 2021 (12 students) with participants from Brazil, Cameroon, Kenya, Mexico, Namibia and the U.S. These meet-ups were divided into two categories, based on the group size: small (6 students or less) or large (10 students or more). This resulted in two meet-ups designated in each category. In the case of the small group meet-ups analyzed, this was originally a large group meet-up that was divided into small groups. The transcriptions were coded using a codebook developed from a grounded analysis of the data, seen in Table 1, which included Content Focus, Curiosity, Feedback, Inclusive Disposition, Information Sharing, Participatory Teaching, Self-Awareness, and Social Disposition. Coding for each transcript was done independently by two raters who then came together in a process of social moderation to reach agreement on the coding (Herrenkohl and Cornelius, 2013).

Table 1

Codebook of Constructs Included in the Analysis

Code	Description	Example
Discourse Codes		
Content Focus	Dialogue focused on the meet-up's STEM-related educational content	*"So you can see that one of the properties of ethane gas is that, yes, it is colorless, but you also have a sweet smell."*
Curiosity	Seeking clarification or further information for better understanding of STEM-related content or project	*"How many people are you going to have in your sample or how many people are you going to research this on?"*
Feedback	Communicating one's opinions/ideas or sharing suggestions on projects	*"We were just talking about giving more explanation of the terms and definitions of the new terms that you had in your presentation."*
Inclusive Disposition	Encouraging participation of specific individuals in the discussion (if they have not been previously speaking)	*"Awesome, [participant name], do you have anything else to add on that?"*
Information Sharing	Sharing of personal experiences or contextual information relevant to the discussion (not explicit STEM facts)	*"We don't have to pay a lot of money after installing it we just have to maintain it. But it is true that to get it is a little bit expensive…"*
Participatory Teaching	Helping others to learn STEM subject matter by providing factual information/content in explanation	*"A heat pump is a device whose operation is based on thermodynamics, it consists of transporting energy from the heat of the environment that it will be air, water, or soil."*
Self-Awareness	Indicative of the state of recognition, realization or emotion about oneself, particularly those that are temporary or short-term (should be self-referential)	*"Yeah, yeah, I'm really bothered before exams. Maybe an exam that I didn't rehearse or not ready for. And sometimes when there's a really big event that is happening soon I'm going to take part I was really a bit anxious."*
Social Disposition	Demonstrating pro-social tendencies, especially in expressing appreciation, acknowledgement or validation	*"So thank you so much for sharing that we really appreciate it."*

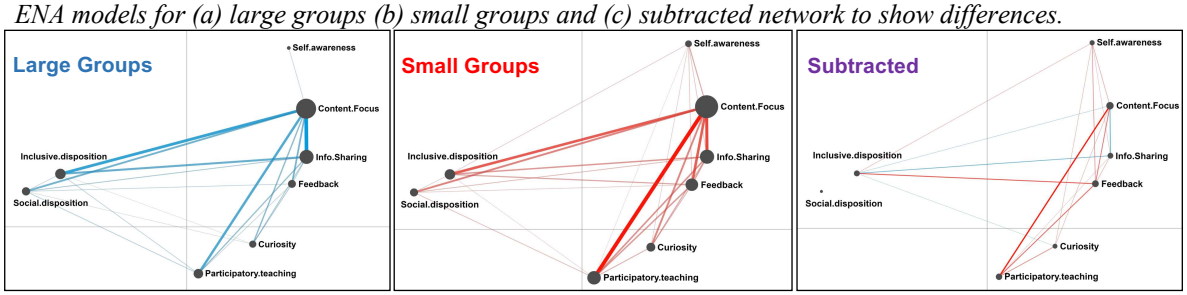
After coding, the data was examined using epistemic network analysis (ENA), an approach in quantitative ethnography to visualize data through statistical methods, to identify patterns in the student discourse. ENA creates models of the connections among relevant constructs in the data by quantifying the frequency of their co-occurrences within conversations (Shaffer, 2017). For this study, each utterance (separated by turn of talk) was used as the unit of analysis, and each meet-up constituted a conversation to which the connections were limited. A moving stanza window of 7 lines (each line plus 6 previous lines) was used to model the connections made between constructs occurring within the recent temporal context (Siebert-Evenstone, 2017). While facilitators were part of the meet-ups, only patterns of student discourse were examined.

Results

The resulting ENA models of discourse patterns for each group category of students can be seen in Figure 1. The nodes/dots represent each coded construct and lines between the nodes, known as edges, represent the strength of the connection between each construct as defined by the window size. A thicker line indicates a stronger connection between constructs while a thinner line represents a weaker connection. A minimum edge weight of .01 was applied to the generated models, and edges scaled to 1.8. The X axis of the model is defined by Social Disposition on the left and Content Focus and Info Sharing on the right. The Y axis of the model is defined by Participatory Teaching on the bottom and Self-Awareness at the top.

Figure 1

ENA models for (a) large groups (b) small groups and (c) subtracted network to show differences.



(a) (b) (c)

In examining both the small group and large group network models, they share many similar patterns. Both exhibit overall strong connections related to content (with social disposition, participatory teaching, feedback and info sharing) and social disposition (with participatory teaching, info sharing, feedback). A Mann-Whitney test which showed that the small student group (Mdn=0.02, N=115) was not statistically significantly different at the alpha=0.05 level from the large student group (Mdn=0.02, N=147 U=8458.50, p=0.99, r=0.00) along the X axis and similarly the small student group (Mdn=-0.27, N=115) was not statistically significantly different at the alpha=0.05 level from large student (Mdn=-0.27, N=147 U=8570.50, p=0.83, r=-0.01) along the Y axis. While there is no statistically significant difference between the two groups, the network models help visualize the similarities among the discourse patterns. The subtracted network model provides further insights on the subtleties of how the two compare. The small group has stronger connections between the constructs, yielding a more vibrant network model for the discourse. However, the large group has stronger connections between inclusive, content, and info sharing, which seems to indicate a more intentional inclusive efforts to share about the topics being discussed.

Discussion

The overall the patterns between small and large group sizes in this online, informal collaborative learning context are more similar than different, especially since there was no statistically significant difference between the two. While patterns of both groups have a lot overlap, the network models help to see a little more of the subtle difference. In particular, the small group network models had stronger connections and were more varied, especially related to content, feedback, self-awareness, curiosity and participatory teaching. These four constructs were coded frequently together within the specified stanza window. Participants readily enriched the group discussion with feedback pertaining to STEM topics while incorporating their personal reflection on the subject matter. Examples of this connection were amplified in one of the small groups during presentations on anxiety and cell phone addiction due to the more personal nature of those topics. Additionally, a very interactive presentation on math formulas in the other small group further solidified this trend. Both small groups experienced interactions that expanded participatory teaching and info sharing beyond the initial presentations. One participant presented on Python concepts, and another group member shared additional knowledge on the topic as feedback. Meanwhile, members in the other small group asked clarifying questions which encouraged the presenters to expand on personal and factual knowledge. Self-awareness was only coded during one of the small groups, heavily influenced by the topics of anxiety and cell phone addiction. Still, it is worth considering whether the students would have engaged in such a high level of vulnerable introspection in a larger group.

The large group meet-ups had patterns very similar to the small groups, especially rated to content and social disposition, though content connections were not as strong as the small groups. As seen by the subtracted network, large group-meet-ups had its stronger connections between Inclusive Disposition, Content, and Info Sharing. The facilitators in both of the large meet-ups would ask specific students to speak to help transition

between introductions, presentations, and feedback, which is likely what contributed to the variety of strong ties with inclusive disposition. One of the meet-ups experienced repeated technical difficulties, which interrupted student media presentations and feedback several times. Between the technical issues and several presentations to cover, there was not much time for feedback and most student responses were in turn surface-level and social ("It was great and really practical."). In contrast, the other large meet-up had less technical difficulties, allowing students to provide more substantive feedback and engage with presenters.

This study found that in the interactions of this online, informal, global learning setting, there seems to be similarity between the large and small groups, indicating that size has limited impact in this particular environment. Large and small groups generated fairly vibrant student discourse patterns. While this data set did not find a statically significant difference between the two, smaller group size seemed to allow for slightly stronger connections among most constructs. In the large groups, the role of facilitator seems to play a more important role in including students in the conversation and the distraction of technical difficulties are magnified, as it can deter more substantive contribution. There are several limitations to this analysis, as trends in discourse are likely not solely attributed to group size, but other factors. As described in the above interpretations, facilitators, content, and cross-cultural aspects likely play a factor in conjunction with group size and are not fully explored, but will likely be examined in future study. The use of epistemic network analysis models illustrate the intersecting factors of this unique online, informal, global learning setting on student discourse and outcomes, to hopefully give insight on how different approaches (such as this context) can enhance the learning experience of students.

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