RESEARCH
Chandaria Research Centre

Designing for Deep Inclusion: Exploring Student Engagement Through Technology-Supported Discussions in Traditional and Active Learning Environments

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Keywords: pedagogy, space, technology, active learning classrooms, technology-supported discussions, Parlay, middle school students, physical space design

INTRODUCTION

There has never been a better time to explore the connections between space, technology and Kindergarten–Grade 12 education design. We continually innovate spaces to foster high social engagement and help youth build their capacity to create, debate, discuss and collaborate. From acoustics to furniture to technological tools, every aspect is considered when improving classroom design. In 2020, the rapid adoption of virtual and HyFlex learning in many countries has bolstered interest in technologies that foster inclusion and community.[1]

Research on space design and technology has increased our understanding of the benefits of particular tools in facilitating interactive learning (McKeown & McGlashon, 2015). Digital learning tools such as polling apps and wikis help students enhance both their in-person experiences and their online learning. Of special interest are tools that help increase students' peer-to-peer interactions. Classroom discussions are one of the most effective ways to develop critical thinking, communication and relational skills.

In our quest for greater student engagement in the classroom, however, we often overlook the ways in which space and digital tools affect social inclusion. Extant research also neglects student and teacher perspectives. In this study, we explore this intersection of pedagogy, space design and technology, giving voice to participants' experiences.

This study is a three-way collaboration between Branksome Hall, Parlay and Steelcase Education. Our research explores teachers' and students' perceptions of Parlay Live RoundTable as a tool to promote inclusion and discussion in the classroom. It also examines students' and teachers' feelings and behaviour in technology-supported and non-supported discussions in different classrooms.

SETTING THE STAGE: STUDY PARTNERS

Branksome Hall: One of the few International Baccalaureate (IB) continuum schools in the world, Branksome Hall offers students in Kindergarten to Grade 12 (K–12) a program that centres on building social action leaders and globally minded citizens. The all-girls school has an international student population and offers a boutique-boarding program.[2]

Parlay: Parlay is an educational technology tool used by teachers across the world to facilitate student-driven discussions in their classrooms. For the purposes of this study, we have focused exclusively on Live RoundTable, one of three core Parlay components.

[1] *HyFlex (also known as hybrid) learning refers to classes where a teacher instructs both virtually and in person (students attend on campus, join synchronously or take up materials asynchronously).*

[2] *Please note that at Branksome Hall the term "girl" is broadly conceptualized as referring to cisgender, transitioning, transgender or gender diverse identities.*

Live RoundTable is a discussion tool that can be used in class or in conjunction with video conferencing tools (e.g., Zoom) in remote learning environments. In Live RoundTable, students use their own devices during a class discussion; when they want to contribute verbally they “tap in” to declare their intention to speak. Students choose if they want to “challenge,” “build on,” “share a new idea,” or “question” (see Figure 1). They can also click on icons to encourage peer participation, and take notes about any guiding questions.

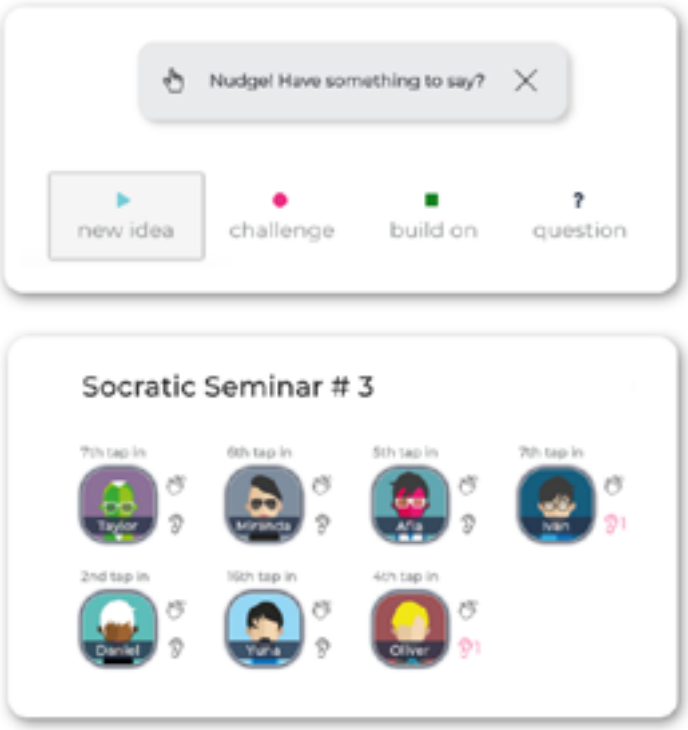

Figure 1: *Screenshot of Parlay Live RoundTable “tap in” feature and view of speaker roster.*

In Live RoundTable, teachers are also provided tools to help them oversee discussions. Teachers can view student notes, encourage student participation, take notes, run live polls and assess student contributions. After a discussion, teachers receive individual and class-wide summaries, which can be used to reflect on the nature of the discussion for future improvement as a group.

Steelcase Education: Steelcase Education works with educational institutions to create effective learning environments. Physical space and design set the stage for classroom activities, including discussions. Historically, traditional learning classrooms (TLCs) in schools have been designed to optimize instructor transmission, regardless of specific student needs. In recent decades, however, there has been a move to create active learning classrooms (ALCs)—flexible spaces in which furniture can be easily reconfigured for a range of activities and technology is seamlessly integrated. Steelcase Education is a leader in active learning classroom design and research.

Figure 2: *Traditional learning classroom at Branksome Hall*

Figure 3*: Active learning classroom at Branksome Hall*

THE RESEARCH STUDY

This study involved 37 middle school student participants and one social studies teacher. One group of students (n=18) were located in an active learning classroom (ALC) and another group (n=19) were in a traditional learning classroom (TLC). Both groups of students participated in the same lessons delivered by the teacher over the course of the study. The research design enabled us to examine four different conditions according to the type of classroom (ALC or TLC) and the nature of the discussion (with Parlay or without). Data was collected using a mixed methods approach over the course of six weeks, by means of Parlay software click behaviour, classroom observations, teacher interviews, student surveys and focus groups (see Figure 4).

The study itself fulfills the call by mathematics teaching and space design experts Talbert and Mor-Avi (2019) to address the lack of research in school settings. They claim that research on pedagogy, technology and space supports "a continuing evolution of our understanding of active learning spaces" and helps "the promise of active learning reach its full potential" (p. 18).

CLICK BEHAVIOUR	ONLINE STUDENT SURVEYS	STUDENT FOCUS GROUP	TEACHER INTERVIEW	CLASSROOM OBSERVATIONS
Determine the level of student interaction with Parlay Live RoundTable	"Pre" and "post" surveys evaluate student engagement and sense of inclusion	Understand the impact of Parlay tool and furniture on the learning experience and sense of inclusion	Understand the impact of Parlay tool and furniture on the learning experience and sense of inclusion	Frequency and quality of student discussion activity Student engagement Understand how the environment and Parlay support the learning experience

Figure 4: *Research methods*

RESEARCH HIGHLIGHTS

1. Participant inclusion in discussions

- **Discussions using Parlay were more equalized, less likely to be dominated by a core group of participants and featured less visible competition for the floor**
- **Parlay features, such as speaking notes and rostering, provided a sense of security for some participants, thereby bolstering student self-confidence and encouraging student voice in discussions**

This section highlights our study's key findings and speaks to our understanding of how space, technology and pedagogy inform inclusive discussions.

In this study, the classroom discussions offered students an opportunity to explore social studies course content and to make connections to their own lives. The data showed both the limitations and potential for discussion, as well as the ability of discussion tools to foster inclusion. The findings speak specifically to considerations for student engagement and how to help establish a sense of security to participate in discussions. In our research, we found that participation rates differed in the two environments. Student participation rates were higher in the active learning classroom than in the traditional learning classroom. We also found that discussions without Parlay yielded higher participation (see Figure 5).

	WITH PARLAY	WITHOUT PARLAY
Active Learning Classroom	95%	100%
Traditional Learning Classroom	74%	86%

Figure 5: *Discussion participation rates*

Face-to-face classroom discussions make use of a variety of verbal and non-verbal cues—such as facial expressions, glances, tone and hand gestures—which contribute to a higher level of socialization and a feeling of togetherness (Aspden & Helm, 2004; Rovai & Jordan, 2004). Computer-mediated communication (CMC) differs in several important ways. CMC is an umbrella term for various forms of human communication mediated through, or facilitated by, networked computer programs. These can be synchronous or asynchronous and involve one-to-one, one-to-many, or many-to-many exchanges of text, audio/speech and/or video messages (Lee & Oh, 2017).

In alignment with our own findings, computer-mediated communication equalizes the conversation by removing some of the verbal and visual social status cues that individuals use to compete for the floor (Amichai-Hamburger & Barak, 2009; McKenna, 2008). However, as other scholars have also observed, we noted that the lack of sufficient perceptual cues (Chiu et al., 2010) can make discussions awkward or stilted (Gutwin & Greenberg, 1999) or isolating for participants (Pilkington, 2001). Scholars acknowledge that there is a distractibility factor when students have screens in front of them. In our study, the teacher chose to focus on the students who were speaking to ensure they had someone to engage in conversation.

The need to rely on visual and verbal cues is a significant barrier to fostering inclusion. The absence of cues can be disorienting for students who benefit from visual anchors (Ruberg et al., 1996; Sapp & Simon, 2005) and can give rise to misunderstanding (Hara, 2002). However, research also suggests that the absence of these very cues may also enable more equal group discussions by encouraging participation by those who would normally be reluctant to do so.

Traditional face-to-face discussions are often controlled by a core group of high-status, high-ability and typically extroverted students (Asterhan & Eisenmann, 2011; see discussion of peer status below). Their dominance over the discussion leads to reduced participation among other students (Gaudioso & Boticario, 2003). Despite lower overall participation rates in our study's discussions with Parlay, when we examined how often individual students contributed, we found a more equal distribution of comments. The altered social dynamics within the classroom appear to have influenced how comfortable the majority of the participants felt to speak at a given time.

In this study, the teacher observed these discussion dynamics in her own classroom: "There are some big personalities, they want to share what they want to share, but there are also those that are happy to … take more of a backseat and … listen and then sometimes share as well" (Teacher interview). A number of student study participants also referred to "a core group of around … seven to ten students who are … constantly circulating" and "are most comfortable with saying stuff." In this study, the dominance of the discussion by a core group of students was slightly lowered with the use of Parlay and the discussion was therefore more equalized.

The equalization could be attributed to certain differences in how inclusion is experienced in Parlay-assisted and traditional face-to-face discussions. Two students, who described themselves as shy when speaking in a large group, shared that Parlay's note-taking feature helped them feel more prepared to share their ideas. In other studies, researchers have suggested that CMC can encourage wider participation by providing a sense of security to the more peripheral members of the group. It may "assist introverts in expressing themselves more freely" (Blau & Barak, 2012, p. 13) and may also mitigate other factors, such as a lack of oral fluency or of confidence therein, as well as discomfort in speaking out (Warschauer, 1995). CMC strategies such as threaded discussion have been "found quite promising in promoting educational equity" and "intercultural learning" (Merryfield, 2000, p. 503). Digital technology tools can essentially serve as "amplifiers" of a student's voice (Gallagher & Riviere, 2011, p. 113).

Parlay Live RoundTable is different from traditional computer-mediated communication tools in that it uses a dashboard or computer interface in a live discussion. While students may be able to use Parlay's features to tap in their intention to participate in the discussion, they must still speak to participate. An important aspect to consider, then, is their comfort to engage in large group discussions and explore ideas.

A survey administered at the outset of the study showed that students expressed a strong sense of comfort in the classroom. The students were also asked to grade their feelings of inclusion on a five-point scale (one being low and five being high). Of those survey respondents, 75% of students indicated good to high comfort in participating in discussions in the ALC; 85% indicated the same in the TLC. Figure 6 shows the students' comfort in discussions with and without Parlay. Across the board, students indicated high ratings and made little change in their responses regarding their comfort to participate and their sense of encouragement to explore ideas.

This data underscores the idea that the teacher had already established a safe classroom discussion space prior to the introduction of Parlay. It is noteworthy that the students felt strongly supported in the classroom and discussions, with or without Parlay. In-class oral participation is a product of teaching methodology, social inclusion and student voice, not simply linguistic ability or cultural factors (Mack, 2012). The teacher and the students jointly develop the norms around inclusive classroom participation, which are primarily shaped by the teacher's attitude and ability to moderate the discussion, the classroom atmosphere and student behaviours (Roehling et al., 2011). The teacher in this case had already laid the foundations for an inclusive and safe environment, and it may be for this reason that the observed changes in discussion patterns were not large.

Our data indicated that Parlay altered the nature of how students took turns speaking and added a sense of security for some around their comfort in participating. Parlay did not completely eliminate competition for the floor, but reduced it to some degree through its specific features. Tapping in allowed speakers to indicate their intent to participate and rendered the conversation more inclusive by showing how many students wanted to speak. As one student described,

"I think that everybody's voice was heard. The fact that we can just tap in [and] tap out and don't have to be called on ... is really, really helpful ... [W]e can just start speaking instead of being worried what other people [think] ... Do they want to hear from you? ... Do they not?" (ALC).

Other students appreciated the structure provided by the creation of a roster of participants:

"I think that Parlay is ... a great way to get people to speak because some people are ... shy with speaking in front of a class ... And I think that it's ... very structured in the way that it lets anyone who wants to speak, speak at ... whatever time. So I think that it helps other people that would be a little bit more shy, it helps them to be okay with speaking" (ALC).

PRE AND POST SURVEY RESULTS

Participate + Explore

***Figure 6**: Student comfort to participate in discussion and explore ideas*

Furthermore, having the tap-ins visible to the entire group may also have contributed to discussion equalization. As other researchers have also noted, when participants are made aware of their speaking behaviour in a group setting, they tend to adjust their participation to make the conversation more balanced: more active contributors speak less and more reticent participants speak more (Terken & Sturm, 2010).

Parlay's note-taking feature, which enables students to write out their oral responses in advance, also gave students a strong sense of security:

"Parlay was really, really good for inclusion because with people like me who ... can't remember stuff, you can just write it down. I felt much more ... confident that I knew what I was going to say and that I could actually put forward some good ideas" (Student, ALC).

According to students, with Parlay "everyone was able to contribute a lot more," and a "positive space" was created as "everyone who wants to participate is really included in the whole class discussions" (ALC). Thus, while overall discussion participation did not increase with Parlay, its use did create more equal space for participation by a larger number of participants.

2. Peer status and norms in discussions

- **At times, existing social norms in middle school classrooms were reinforced during Parlay live discussions through the voting features**
- **In a few cases, however, students used Parlay's celebration, ear and voting features to encourage their peers to participate**

In middle school classrooms, pre-existing peer status dynamics and norms shape peer-to-peer interactions. Peer status becomes especially salient during adolescence, when youth begin to spend more time with their peers and use their relationships as primary sources for social comparison and self-appraisal (Furrer, 2010). Research suggests that peer social status may be related to achievement, likeability, "coolness" or admiration (Oldehinkel et al., 2007), and creates status hierarchies (North et al., 2019).

Peer norms reflect the expected and accepted behaviour within a social group. These norms are established by high-status students, who are highly visible, often the centre of attention, and whose opinions matter to their peers (Jonkmann, Trautwein & Lüdtke, 2009). Because they are often seen as role models, their peers tend to imitate their behaviour.

Both peer status and peer norms, especially relating to popularity, play an important role in the classroom discussions captured in this study. Parlay Live RoundTable does not use a fixed speaking order; instead, students click on the ear icon to vote on which students they want to hear from. In our study, at times this voting was determined by the pre-existing social norms characterizing this group, with students voting for their friends or the more popular students to speak. As one student described it, "It's like a popularity contest—who's your friend?" (ALC). Certain students get selected to speak more often "because everyone wants to hear from those people because they're their friends," while others who "want[ed] to be heard 15 minutes ago never get heard" (Student, ALC).

The absence of an established speaking order eliminates some competition for the floor, as discussed above, but also requires students to enter the conversation themselves. This entry is also affected by pre-existing social dynamics, with the quieter students needing further encouragement

from the teacher or their peers. For instance, the teacher recalled a student having

"... [T]apped in and raised her hand, and then I would kind of look to her to say, 'You can go.' Like almost [giving] that ... extra reassurance, like, I'm almost bumping you up in the line [by saying] 'Go ahead,' and then she did. So it was interesting to see that, because if she had to take the initiative by herself and see six people tapped in, that would probably be a struggle for her to voice her comment over those six people, who sometimes are big personalities and want to take more of the stage."

A number of students also reported voting for classmates who had not yet had a chance to participate. They spoke about using the Parlay tool to encourage each other to speak and provide positive feedback. One student noted:

"I look at how many [times] someone tapped. Even if someone ... I think they'd have a good idea, but I've already heard from them a lot of times ... I wouldn't ... tap on them right away to listen because some people ... might be on their first tap in and they never really get heard. So I really ... look at who has been heard. And even if I think someone has a good idea, I sometimes wait because I feel like some people are shy ... more shy than others" (TLC).

Parlay does not eliminate pre-existing classroom social dynamics and competition. However, it has the potential to disrupt how these pre-existing social norms influence who participates in the discussion, such as students with lower social status or those students who may need the extra encouragement.

3. Discussion quality and engagement

- During Parlay live discussions, student and teacher experiences did not reflect highly inclusive discussions or a high degree of engagement

***Figure 7**: Screens in both learning environments were strong centres of gravity*

The Parlay live discussions captured in this study were not highly inclusive or characterized by attentive listening, meaningful engagement in the conversation and reflective responding. Students appeared prone to distraction as a result of the open laptops in front of them. The teacher noted:

"When we set up in that configuration I don't see the screens, so it's hard to know … are they typing notes or are they doing something else? I think students talked about the computer being a huge distraction throughout the discussion."

Students used their laptops during discussions to take notes, navigate Parlay and consult the roster of speakers; laptop screens essentially became the locus of their attention, which had the effect of discouraging consistent eye contact among peers. The teacher reported her students not "feel[ing] heard when they had the computer in front of them because most students were looking at their computer and they were not making eye contact." In contrast, in traditional classroom discussions without Parlay, most students were not actively using their laptops.

The teacher also felt that Parlay use prevented her from making eye contact with her students and providing them with the support they might have needed. She said: "When we're having a discussion … I think I need to be facilitating that and I need to be engaged in that, and if I'm not engaged then maybe the students are less engaged;" because she "wasn't focused on them, making eye contact with them, I think [they] might have felt even more kind of alone or like they weren't a part of this … big group discussion." (It should be noted that the teacher did not make use of the Parlay tool's nudge feature to encourage students to participate.)

Students' participation in the discussion also appeared to become more mechanical and less engaged, due to both the constraints imposed by Parlay and the altered nature of the discussion itself: interaction increasingly became teacher-to-student rather than student-to-student. Furthermore, after students tapped in and spoke, they seemed to disengage from the discussion. As one student described it:

"A lot of the time, as soon as you answer the question, you only get maybe two chances at most to answer one question and there's about 20 students in the class. So for those other 20 times you're sitting with nothing to do" (ALC).

The teacher also emphasized this point:

"People spoke, but … to me it almost felt like once they were done, there was a feeling that, 'Check, I said my thing. I'll let the conversation run and maybe I'll come back when question two is on the table.'"

Once students disengaged from discussion they became susceptible to further distraction. One student said, "People … get pretty distracted …. They're doing something on their laptop and stuff like that" (TLC). During discussions, researchers observed some students using programs and applications other than Parlay on their laptops, offering corroborating evidence of this tendency.

4. Idea sharing in discussions

- **Students were explicitly building on each other's ideas in classroom settings where the Parlay technology was not present**

In classroom discussions, students introduced new ideas but did not actively build on, challenge or question the ideas of their peers using Parlay's various features, as seen in Figure 8. This was true in both the active learning and traditional learning classrooms. The note-taking feature offered advance planning for students, but also led some students

to read their written comments aloud. A potential factor could be the fact that classroom discussions were relatively new for these students as the social studies units they were engaged in at the time were especially content heavy.

CLASSROOM SETTING	OBSERVED NUMBER OF BUILD-ONS IN THE DISCUSSION
Traditional (TLC) without Parlay	15
Traditional (TLC) with Parlay	5
Active (ALC) without Parlay	10
Active (ALC) with Parlay	0

Figure 8: *Number of build-ons in the discussions*

Research also tells us that in live discussions, information seeking, information providing and social commenting tend to dominate the discussion, while discussion generating, experience sharing and idea explanation tend to occur more frequently in asynchronous discussions (Schallert et al., 2009). We saw this dichotomy play out in the discussions observed in this study. The teacher recalled that some contributions in the Parlay-assisted discussions "were stand-alone comments that didn't necessarily interact with one another [or] the actual content," or weren't "necessarily helpful or a correct answer or [didn't] add to the discussion." In contrast, students felt that traditional discussions had a more "natural" flow and made them feel "more engaged."

The "new ideas" nature of the Parlay discussion could also be attributed to the fact that the teacher generated the three prompts to structure the discussion. Research tells us when discussion is peer-led, the comments can be more explorative and offer more self-generated explanations and ideas (Hogan, Nastasi & Pressley, 2000). Feelings of being heard by others, engaging with peers and the ability to build on others' ideas can support greater inclusion.

5. Space as a vehicle for inclusion

Physical classroom space fostered inclusion and participation in the classroom by:

- **advancing communication and comfort**
- **improving sightlines**
- **incorporating movable furniture for easy reconfiguration and**
- **recognizing the energy contributed by overall design (amplified with Parlay)**

Scholars have examined the relationship between architectural design and pedagogy and found evidence of the positive impact, in particular, of active learning spaces on student outcomes and overall classroom success (Brooks, 2011, 2012; Brooks & Solheim, 2014). Harvey and Kenyon (2013), comparing different types of active learning classroom layouts, found that those furnishings that enabled mobility were the most highly rated aspects of the student classroom experience. Students perceive new advantages for movement, communication, collaboration and thinking in the active learning spaces. In our study, the majority of ALC furniture had wheels that allowed for easy classroom reconfiguration. According to Talbert and Mor-Avi (2019), students in similar spaces find the spaces "... better for sight lines to the screens, in motivation to learn, in building relationships with other students, and other key facets of connectedness" (p. 16).

This connectedness has important implications for inclusion. Talbert and Mor-Avi (2019) claim that "by being freer to move and have physical and visual contact with each other in a class meeting, students feel more connected to each other and more connected to their instructor" (p. 17). The digital tools used in the ALC, as well as its characteristic polycentric layout, which focused student attention in a variety of directions when a digital item is on display, have also been observed to improve student learning (Byers & Imms, 2016; Connolly & Lampe, 2016).

In this study, the physical environment was an important factor in classroom discussions, facilitating participation and enhancing student communication and experiences of inclusion. It should be noted that the spaces that we refer to here as traditional classroom spaces challenge what research considers as "traditional": learning spaces characterized by fixed, fragmented row-by-column seating (Park & Choi, 2014). However, in the TLCs in Branksome Hall's middle school, the desks are uniform single tables with standard chairs that are often arranged in clusters of four so that students can work together on projects, rather than placed row by row. The circular configuration of the furniture, in both the TLC and ALC, was seen as inclusive and welcoming by the students:

"I like the circle that we make for all the discussions—it makes it a lot more inclusive for everybody. But I wish all the desks and chairs w[ould] … be at one height because I feel … [that] if everyone was … at the same height we'd all feel … equal" (Student, ALC).

The question of furniture height and sense of inclusion was also raised by the teacher. She spoke about her sense of comfort in the traditional room as opposed to the active learning classroom, as the cushion seat she sat on in the ALC tended to be lower than the student desks. She would sit on her foot to raise herself so that she was able to be at the same level as students.

The arrangement of the furniture also reinforced the importance of sightlines. In a circle, speakers and listeners gained a better view of each other during the discussion. Figure 11 shows the sightlines for each of the two classrooms, with the configuration in the ALC maximizing sightlines.

One student described how the circle also made it "easier" for her to speak: "I could share my ideas without having to stand up or feel nervous, and just speak and everyone could see and hear me. It made me feel like I was being heard more and it was easier" (TLC). Other students agreed: "The circle we formed helped us to see and hear everyone during the discussion" (TLC), which "positively impacted the discussion" (ALC). They appreciated being able to "see everybody and make eye contact with them" (ALC). One student noted: "I was talking to everyone since everyone [was] facing me!" (ALC).

However, not all students appreciated being placed in full view of their peers during the discussion, especially when they were speaking. One student recalled that the classroom setup was "stressful, because if one person is talking then everyone is staring at you, and if you say the wrong thing then people can judge you" (TLC). Another reported that she did "not like [the] classroom layout because I feel like when everyone can see you sharing your opinion it adds more pressure" (ALC). Another interesting observation was that the students sitting furthest from the instructor and on the circle's periphery contributed less to the conversation than other students.

PRE AND POST SURVEY RESULTS FOR AFFECTIVE DIMENSIONS OF INCLUSION

Valued + Supported, Affective

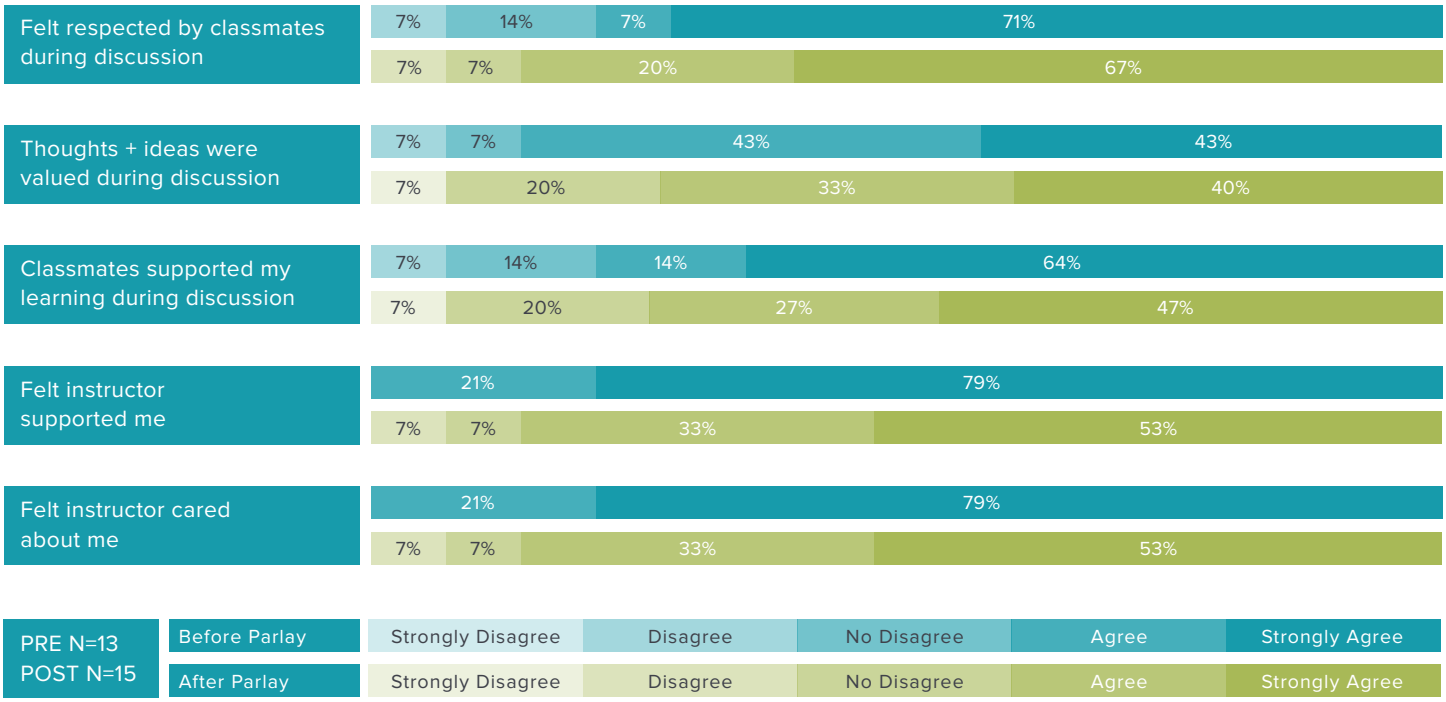

Figure 9: *Traditional learning classroom results*

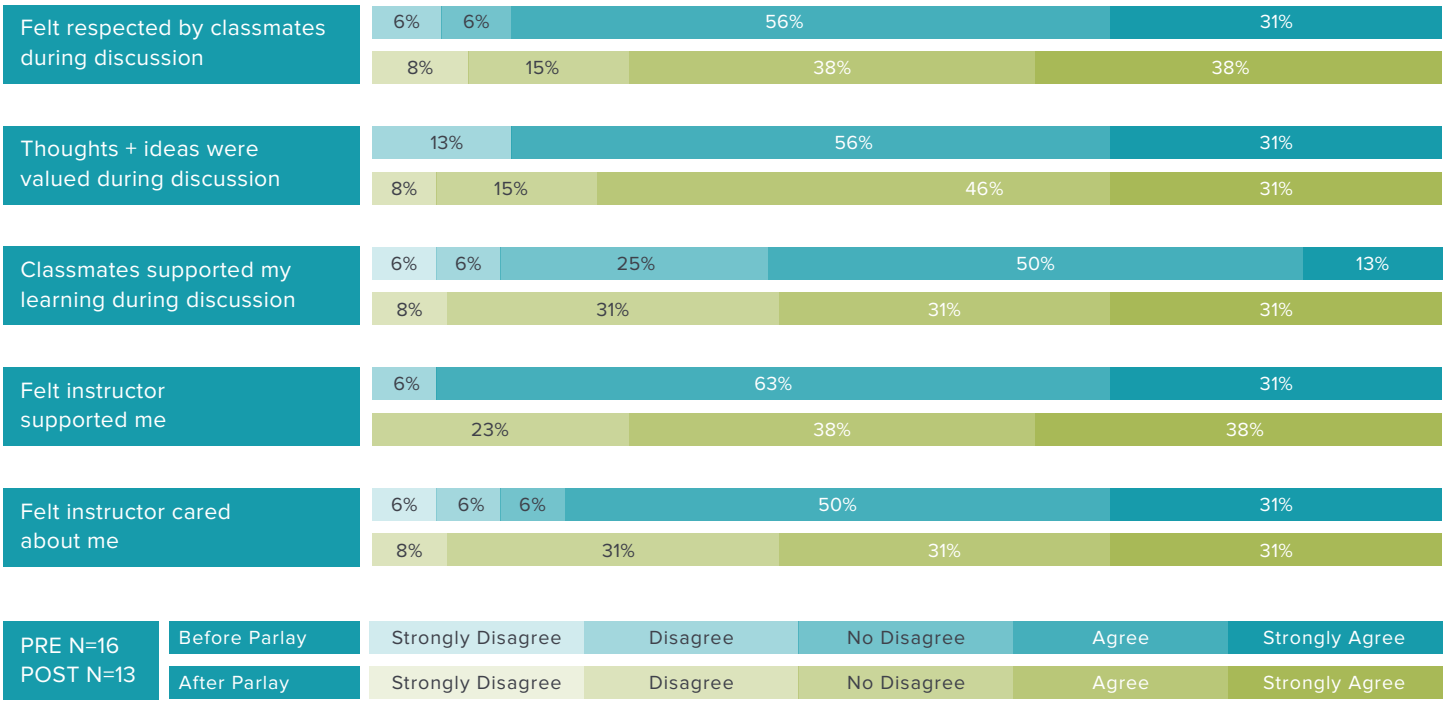

Figure 10: *Active learning classroom results*

*** Percentages in the figures above have been rounded to the nearest integer value*

The flexibility of the furniture arrangement made student participation easier. Students appreciated how "it allows us to easily move our desks into whichever different formation or grouping [is] best suited for the day's activities and discussions" (ALC), and how it made "the environment that we were in … very comfortable and flexible" (ALC). One student noted:

"The [ALC] classroom setup is really helpful for Parlay because you can really easily … move the desks into a circle … to get right into the Parlay discussion. And … you can all be focused on the person who's talking because it's in an inclusive circle (ALC)."

The ALC furniture also allowed students additional personal mobility that further augmented students' participation in the discussion: "It felt better being able to move around in my chair. It helped me focus" (ALC). For another ALC student, this movement increased comfort so that she felt she could "be more involved in the conversation."

At the same time, however, not all students appreciated the ALC's features. Some students reported that "the furniture can sometimes feel overwhelming and messy because it is never organized" (ALC); others felt that while "the environment is nice because it is very flexible for different students … it can feel cluttered and disorganized at the same [time]" (ALC). Student comfort, either in an educational setting or with a given peer group, is essential to establishing security and to developing the emotions necessary for feelings of inclusion.

Finally, the study showed that the overall design of the active learning classroom contributed an energy to learning and teaching that was amplified with the use of Parlay. The students contrasted the ALC to the traditional classroom, which was described as "bland" with "desks … all exactly the same" (TLC), and how, because "everything is an off-white colour, [it] makes it for my mind to not be able to expand to the maximum capacity" (TLC). In contrast, the ALC was described as "my favourite classroom … because there's so many different places to go." This feeling was corroborated by researchers' observations, which saw "students rush[ing] to pick particular chairs" (ALC). Students' pre and post survey results also reinforced the impact of the physical environment on their reported behaviours of movement and comfort in the ALC.

CLASSROOM BUILT ENVIROMENT

Distance, Sightlines + Student Contributions

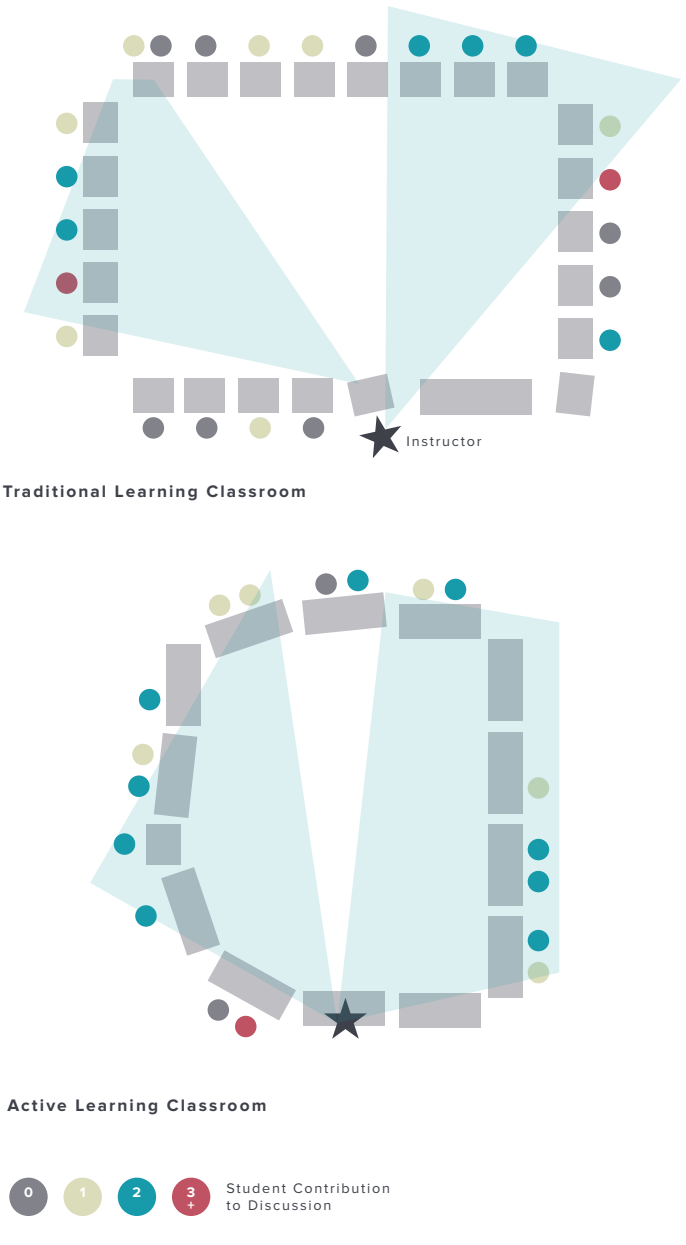

Figure 11: *Distance and sightlines impact interactions*

IMPLICATIONS

The results of this study have important implications for educators, administrators, technology developers and space designers. First, in the context of a classroom discussion, it is teachers and students who are ultimately responsible for attending to the implicit aspects of inclusion (underlying group dynamics, attentive listening, comfort and confidence in participating), as well as the explicit (who speaks, who doesn't, how often). When technology is used to facilitate discussion in the classroom, it is imperative that teachers set expectations prior to using tools such as Live RoundTable, including (but not limited to) active listening, maintaining eye contact and offering different types of contributions. Teachers should configure the classroom (and their place within it) to optimize student engagement and students' ability to drive the conversation. Students should also be encouraged to take active roles in the discussion.

This study also highlights the challenges inherent in the use of discussion software in content-heavy subjects, both for teachers and students. Having a set of guiding questions for the discussion, especially those that relate to personal or group identity and/or preferences, may help facilitate more inclusive discussions. For middle schoolers, it also helps them navigate the social dynamics within the classroom context, which can play out in conversational dominance in class discussions. Technology tools have the potential to disrupt such norms.

Post-discussion reflection also has significant pedagogical potential. Parlay provides data on various aspects of the discussion, which can help both students and teachers reflect on interactions and how they can be improved. For example, instructors can use the post-discussion summary data to teach the structural features and dynamics of argumentation, and to focus on building skills around inclusive peer interaction.

For technology developers, this study's implications begin with the recognition that any educational technology that aims to facilitate and measure peer-to-peer engagement must consider the inherently organic nature of this process. As such, a balance must be struck between structure and flexibility. Developers should recognize that technology must be designed with more than just the right pedagogy: they must be actively aware of the space and context in which the technology is to be used and attend to the comfort and familiarity of students and teachers with the tool and the processes it supports. For instance, in this study, Parlay's nudge feature may have helped shape the discussion, but was not used by the teacher. Developers can also plan to provide additional resources, guides and training for teachers and students to ensure that discussion expectations are established, best practices are understood and adopted, and that post-discussion reflection is conducted effectively. The study also highlights the strong gravitational pull of single devices for students, and the high potential for disengagement they represent. Developers must consider these devices' intrinsic powers of distraction as they design more tools with the purpose of optimizing inclusion and participation in classroom discussions.

This study suggests that space design and technology implementation both need to be deliberately aligned with pedagogical goals. The physical environment and the configuration of space contributed to a feeling of inclusion in the classroom. The aesthetics of the space, including the variety of seating, furniture options and bright colours, were seen to promote a positive classroom energy. In contrast, the sameness and formality of a classroom space can equally limit classroom energy. Distance and sightlines can affect student participation. These considerations must be kept front of mind in the design of classroom spaces, not only for flexibility and ease of configuration, but also for their effects, both behavioural and affective, on student engagement.

The rapid adoption of virtual and HyFlex learning in many countries recently has bolstered interest in technologies and the ways that we foster inclusion in school settings. This study offers insight into the specific experiences of middle school students and their teacher but holds currency at all levels of education. Inclusion in the classroom is shaped not only by interactions, but also by the very tools and design of our learning environments. Space designers, technology developers and educators can collectively champion high social engagement, deep inclusion and help youth build their capacity to create, debate and collaborate.

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