

Setting the Stage for Interaction: A Tablet Application to Augment Group Discussion in a Seminar Class

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ABSTRACT

We present a tablet-based system to collaboratively track discussion topics and ideas in a seminar-style discussion classroom. Each student uses his or her own tablet to share text ideas in a synchronized, visual environment. The system is designed to promote diverse participation and increase engagement. Our findings are based on observations of twelve class sessions and interviews with participating students. Instead of simply introducing an additional text-based communication channel into the classroom, we find that the system creates a new “stage” (in the Goffman sense) on which students could perform in ways that the main spoken stage could not support. This stage coexists with spoken communication, and augments how students attend to the material and each other. We conclude that spoken participation alone poses barriers for some participants and the addition of a non-oral, text-based stage can help establish equitable and engaging discussions in the class.

Author Keywords

Computer mediated communication, backchannel, stage, tablet, small group discussion, education

ACM Classification Keywords

H.5.3 Information Interfaces and Presentation: Group and Organization Interfaces—*Synchronous Interaction*

INTRODUCTION

The physically co-located small group discussion is often viewed as the gold standard for effective collaboration and communication. It can provide a space for participants to voice their opinions and can readily lead to deliberation and collective problem solving [4]. Not surprisingly, it is often the case that designers seek to virtually reproduce the characteristics and norms of the small group discussion in technologically mediated communication media. Hollan and Stornetta [12] provide a valuable counterpoint to this approach arguing against viewing experiences mediated by the “physically proximate” reality as necessarily superior to those

mediated by technology. We have adopted the following challenge: instead of assuming that the small group discussion is good enough and the only appropriate design consideration is its preservation and replication, we seek to appropriately apply the unique properties of a technological system to the established affordances of a small group discussion. We would not deny that face-to-face interaction offers many substantial benefits when compared to interactions mediated by, for instance, a video conferencing system; nevertheless, we argue that there is room to improve the physically proximate small group discussion by intervening in the assumed normal frameworks of turn-taking and attention.

In this paper, we describe the design and enacted use of a tablet-based system for a discussion-based graduate seminar. Although this is not a common educational venue for intervention (lecture classes are a more traditional venue, e.g. [13] or [1]), it is one in which we identified a number of potential problems with pure face-to-face discussions that a tablet-based system might effectively address. We had two major goals for this work: first, create a class discussion context that encouraged more diverse participation in class; and second, to help students feel engaged and connected to the learning environment.

To meet these goals, we sought to expand notions of legitimate participation beyond speaking, using the affordances of a text-based communication system. Our system creates an alternate communication space within the learning environment. Typically, in group communication contexts, spoken participation is viewed as the primary or dominant interaction medium, one that is often the target of modification as in, for example, *Second Messenger*[6] or *Meeting Mediator*[16]. Like the *Cognoter*[23] system, our system placed emphasis on the combinatorial possibilities of text-based and verbal participation in a co-located group communication environment. Unlike *Cognoter*, however, we focus on enhancing the performative space of group interaction. Consequently, our goal was not to create alternate communication channels; instead, it was to expand the space of performance. As part of this conceptual shift, we argue for moving from the metaphor of a “front”, spoken channel and a “back” channel to the metaphor of a “main” performance stage and “side” performance stage.

This study seeks to understand how having simultaneously accessible stages in the context of a group discussion affects the methods and outcomes of participant engagement. We

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start by describing how our system, called *Tin Can*, is related to existing systems that similarly augment face-to-face communication. We introduce the idea of *stages* and contrast it to previous models of *channels*. We then describe in detail the critical design elements of the *Tin Can* application and the class context in which it was implemented. Then, we present the results of the study, based on class observations, process traces, and interviews. In our discussion, we return to the concept of stages and describe how this formulation of participation can be productive for thinking through how people can interact with additional stages introduced into the dominant context of face-to-face communication. Finally, we discuss some specific insights about the the tablet as a platform and describe the extent to which the design met our initial goals and how our results compare to those from past findings in the literature.

RELATED WORK

There is a rich field of research on the topic of augmenting co-present group communication with socio-technical systems. One significant area of investigation concerns how systems can “level the playing field” of face-to-face communication through reflecting information about a groups’ behavior back on itself. Karahalios and Bergstrom [14] refer to this as a “social mirror”, or a real-time visualization of social dynamics that is shared by the whole group and can cause changes in group dynamics. They suggest that “social mirrors become another channel for interaction (or a back channel) and, in the process, become a signal that influences interaction.” Their exemplar social mirrors focus on measuring behavior in an audio channel and visualizing different aspects of it on on shared Displays. This strategy is shared by *Second Messenger*[6] and *Meeting Mediator*[16]. In these systems, presenting real-time participation visualizations tended to close the gap between over-participating group members and under-participating members, although in most cases this effect was primarily from over-participating members decreasing their participation. This work demonstrates how visualizing main stage spoken participation in different ways can impact relative participation rates by encouraging individuals to censor or otherwise alter the nature of their communication to correspond with perceived group norms and group behavior.

Another strain of this work is less interested in altering the verbal channel of group communication, and more focused on creating separate, productive backchannels. There are a variety of contexts where people have added communication channels. Yardi describes how a chat-based backchannel operates over a semester in a class [26], McCarthy et al. describe a similar approach at a conference [18]. This early work focuses on characterizing the kinds of use that occur in backchannels using existing systems like chat, but do not engage specifically with design issues in backchannels. Harry et al. [11] propose a new design for projecting question-oriented backchannels in panel presentations. Yankelovich et al. [25] discuss verbal backchannels during verbal meetings, and the “social translucence” research stream (*Ren-dezvous* [15] is most closely related to this work) explores the design of systems to represent engagement in different

kinds of mediated social situations.

Tin Can is designed specifically for use in a class, and is thus influenced by the systems designed for this specific context. Like much of the backchannel work described above these systems are typically concerned with creating new channels for communication in, for example, a large lecture hall. Bergstrom’s lecture class system [1] supports question-asking and commenting and Kam et al’s [13] *Livenotes* supports taking shared notes on lecture presentation slides. The *ActiveClass* project [21] creates a channel between students and instructors for asking anonymous questions during a lecture from PDAs. Each of these systems seeks to increase participation in very large group settings by establishing separate channels for participation. Work in this space is typically not focused on directly influencing spoken participation because the expectation is that there is none; the lecturer is (except for question-asking) the only legitimate participant.

In *Tin Can*, we take a different approach. We seek to expand the stage of participation by diversifying the sites of performance. In other words, we are not interested in creating better oral or better text-based channels; instead, through their correspondence, we seek to create a rich environment for participation composed of multiple, simultaneous stages. Perhaps the earliest research to explore this sort of approach is Tatar et al.’s [23] work on *Cognoter*. They pointed to some interesting problems with creating stages, namely the limits of the “parcel-post” model of communication—where a message is sent and subsequently received and interpreted. Although this model works well for written correspondence, they found that within *Cognoter*, because the written contributions were designed to be interspersed with verbal dialogue, it was difficult for users to understand them “within the time frame of the actual communication” unless the verbal conversation paused while written contributions were processed. In other words, in actual practice, users resorted to channel switching in order to accommodate the written or the verbal modes. Another example is the *Thoughtswap*[5] project which takes a much more structured approach by interspersing periods of engagement with the system with freeform discussion. In *Tin Can*, we employed a similar model of written communication to *Cognoter* and *Thoughtswap*, but we found that we were able to successfully create simultaneous stages for participation instead of stages one at a time. We will discuss the reasons for this disparity at more length in the conclusions. Work in this space on how alternate communication channels are selected and used owes a clear debt to Ochsman and Chapanis’s [20] early work on mediated collaboration.

SETTING THE STAGE

Platforms for discussion and commenting that are outside official discourse channels have widely been referred to as “backchannels.” Backchannels, traditionally defined, create a space where audience members to some “front channel” can share information with each other, typically about the content of the front channel. Audience members can alternate their attention between the two channels but are only legitimate participants in the backchannel. Presenters, on

the other hand, often have a very hard time staying aware of backchannel content if they are aware of it at all, which gives it its outsider flavor that can lead to snarky and disrespectful content [3]. In this configuration, the front/back channel distinction is a useful one because in a very practical sense the backchannel is usually somewhat covert or hidden and participants in the backchannel rarely have the ability or opportunity to communicate on the front channel.

Although this front/back channel metaphor works in situations where audience members have no access to the front channel, it is less effective in situations where the backchannel is intended to influence the front channel. As discussed in the related work, much recent work is focused on bridging these front and back spaces and we argue that a new metaphor is useful for understanding how these parallel communication spaces interact. We turn to Erving Goffman[9] for his description of *stages* to illuminate this new sort of situation. He uses the example of a waiter behaving politely with a problematic customer and then walking into the kitchen and complaining to the cook about the customer's difficult behavior. Each interaction is performative and represents the waiters' competence at performing his role appropriately for different audiences in a different setting. In the waiter example, these audiences are disjointed, and the door into the kitchen represents a gateway between the "front" performance space with customers and the "back" performance space among restaurant staff. The notion of stages shifts our attention from spaces where a small number of people can broadcast information to many recipients (like a lecture hall or conference) and instead focuses on negotiated sites of performance like the restaurant dining room and kitchen, where people can perform different aspects of their identity for different audiences.

A stages metaphor also more actively recognizes the way that audiences to a performance are themselves constantly performing in small ways, while a channel metaphor limits the audience to simply receiving a broadcast. For example, in a class, students learn what it looks like to be attentive to a teacher's performances and what it sounds and looks like to be engaged. In a large lecture hall, the nature of the individual performance is not that precise. If there is an open laptop policy, students might be checking their email or Facebook, or engaging in an official backchannel. They are able to, as Goffman says, "get away with going away," because the act of *going away* is an expected part of the front stage performance. But in a seminar environment, attentiveness and participation are more scrutinized because of the size and nature of the group. This suggests that integrating new communication technology into groups of smaller size might be more challenging because *going away* is more difficult to politely incorporate into the front stage performance.

The traditional response to this has been an acceptance of the quality and sufficiency of the front stage in small groups and to eschew the addition of other communication channels because they might be distracting. A seminar class already adheres to the gold standard of face-to-face communication. It is often assumed that the pressures of the performance are



Figure 1. A screenshot of the *Tin Can* interface running on a tablet.

exactly what we want them to be—students talk and the professor evaluates. But there are two faulty assumptions here. The first is that engagement in a co-present discussion can be manifested only in established methods of performance, e.g. speech. And the second is that all students are equally capable of convincing performances. Social psychology research suggests that introverts rely more heavily on written communication to express themselves [22] [24]. But when there is only one legitimate kind of performance in a class, when there is only one way to perform on the front stage, the structure of the learning environment may not be as equitable as it could be, and it may not even be as productive as possible, even for extroverts.

Consequently, when designing for the seminar, we sought to intervene in the established norms of the front stage by adding a well-crafted additional stage. The goal was to create a context for the legitimate performance of the back stage without having to *go away* from the front stage. As such, we move away from the front/back distinction, preferring the notion of a main stage with a side stage. We sought to design a system where performers could be on both stages at once, where performances were simultaneous, not alternating. Furthermore, the front and back stage as Goffman uses it implies different audiences for front and back performances. Moving to main and side stages reinforces the shared audience of the two stages, which has a big influence on how people perform on each stage and makes it easier to integrate those performances in a meaningful way. We use the terms main stage (face-to-face, spoken conversation) and side stage (text input) to explain the context of performance created as a result of using *Tin Can*.

SYSTEM DESIGN

Tin Can is a tablet-based application to support class discussions. It provides a synchronous environment shared by the students and teacher. Each user has his or her own device and are physically co-located. Students arranged their tablet in different ways. Some kept them on their laps, some on the table in front of them. All users (including the professor and



Figure 2. The classroom environment. The student at the head of the table is presenting and controlling the projector. The professor is to the presenter's right.

researcher) had the same capabilities in the system. The system serves as a visualization of the current state of the group discussion. It focuses on three main parts of a class's process: topics, time, and ideas. Figure 1 shows the interface in action.¹

Topics

The topics pane in the UI collects past, current, and potential future discussion topics. These topics can be added using the "Add Topic" button at the bottom of the pane. The current topic is highlighted in a topic-specific color. All topics have a short text description. Past and current topics show a kind of clock pie chart, illustrating the start and end times of a discussion topic (or the current time in the case of ongoing topics). The total duration in minutes of past and current topics is also shown as part of the topic text. Topics can be tapped to bring up an interface for changing their state: starting future topics, stopping current topics, and restarting past topics.

Time

The clock in the center of the screen serves as a reminder both of the current time as well as a concise visual representation of the history of discussion topics covered in the class. The time spent on each topic is swept out radially on the clock such that large blocks of color represent topics that occupied a longer period of the class. When an hour of time has passed, the central area in the clock is cleared and the colored record of the previous hour appears at the edge of the clock. Up to four hours can be easily represented in this way. The clock is non-interactive.

Ideas

The ideas pane contains a time-sorted list of ideas. An idea is simply a text contribution. Although we had presumptions about what would be posted here (as indicated by the terminology we used in the interface). Ideas evolved to include statements, questions, recording main stage discussion

¹We have also provided a video figure with this submission, but it could not be easily anonymized. We leave its viewing up to your judgement.

themes, and a simple Twitter-like reply syntax. When entering an idea, the author of the idea could do one of two things: "add idea" or "add idea to group." The former option would store the idea in the user's "personal" idea drawer. The latter option would immediately put the idea at the top of the group idea timeline, as well as adding it to their personal drawer. Users can tap and hold to "like" an idea. The idea will flash and get a "+X" notation in its text, where *X* is the number of likes that the idea has received. Ideas in the group timeline have their author's name displayed in parentheses after the text of the idea. Ideas are colored based to match the color of the current topic.

Users

Each user logged in to the system is displayed on a tab around the edge of the screen. The arrangement is essentially random. Tapping a user extends that user's idea drawer. This drawer contains all ideas created by the user, whether shared or not. These ideas are differentiated in the list by "(shared)" being appended to ideas that have been shared. Any unshared idea in the idea drawer can be dragged from the drawer to the group idea area, even if the user didn't originally author the idea. Ideas dragged by other people are attributed differently in the main timeline. For example, an idea created by Alice and shared by Bob would say "(Alice, shared by Bob)". By design, personal folders are not private. They are semi-public spaces meant to give users some choice in how their contributions are read by the group.

Archive

All ideas and topics are recorded on the server. At the end of each class session, the server emails everyone who attended the class with a list of their personal ideas and a link to a shared Web page that had a list of all student ideas sorted by topic and by user.

RESEARCH CONTEXT AND METHODS

We deployed the *Tin Can* system in two sections of a graduate seminar on media and social theory taught by one of the authors at a liberal arts college. One section met in the morning, the other in the afternoon, twice a week. Class assignments were reading-based. Each discussion class was usually lead by a student or pair of students. While what it meant to lead class changed somewhat over the course of the study, the pre-study norm was to prepare a slideshow and accompanying media (images and video were quite common) and present it to the class. The morning session had eight regular students and the afternoon session had eleven regular students. In total, thirteen students were male, six were female. There were five non-native English speakers in both classes.

Our study lasted for six weeks and utilized mixed methods, including classroom observations, capture of text inputs, and semi-structured interviews.

Throughout the deployment, user interactions were captured. This did not, notably, include live recording of class audio, only text-based interactions with the *Tin Can* system itself. We made the decision not to record audio because

we felt that this would make students self-conscious and would be too disruptive to main stage interactions. In lieu of audio recordings, for most class sessions, a researcher other than the professor was present to observe the class. We employed a form of direct observation known as continuous monitoring, where the researcher documented everything he saw throughout the study period, including the description of the environment and participant actions, as well as inferences about their meaning [19]. The researcher’s observations were not prescribed before the study, because of the exploratory nature of this first deployment. We did not know what to expect, so the observations were designed to be generative and not conclusive. We documented patterns of student attentiveness to peers and professor; interactions with tablets (i.e. position of tablets on the table or in laps); and correlations between speaking and writing. The students were aware that their use of *Tin Can* was being studied and they were aware of the presence of the researcher. Because the students were invested in the use of *Tin Can*, the presence of the researcher was not disruptive, but instead added to the excitement they had about testing a new system. The field notes were recorded by hand and subsequently transcribed and shared with the teaching researcher.

All text inputs into *Tin Can* were recorded over 22 hours of usage across twelve class sessions. Each class was about two hours long, but classes often had a non-discussion logistical content from the professor at the beginning of sessions. The average *Tin Can* session was 105 minutes long. After the deployment, the inputs were categorized into types, including topics and ideas, shared and non-shared.

Finally, at the conclusion of the discussion-based component of the class, the researchers conducted semi-structured individual interviews with fifteen of the nineteen students (79%). Interviews were conducted by the non-teaching researcher to alleviate student concerns about sharing judgements about the teaching researcher, although there were no sections of any of the interviews that students did not want to be shared with the teaching researcher. All interviews were recorded and transcribed and entered into *De-doose*, a qualitative analysis tool. Because we view this work as generative, we iteratively coded the transcribed interviews, letting themes (and codes) arise organically as we reviewed the interview data, observational data, and process traces from the class. This strategy closely resembles Glaser and Strauss’ [8] grounded theory approach. All names mentioned in interviews or shown in screenshots have been obscured or changed to pseudonyms to protect the identities of those participating in the research.

PROCESS TRACES

Over the course of the deployment of *Tin Can*, 839 ideas and 119 topics were created. The majority of ideas created were shared: 72% of ideas were shared on creation. Another 5% were private ideas that were turned into public ideas by being dragged by another user from a users’ personal idea drawer to the public idea area. The balance, 23% of ideas, were never shared. The distribution of these different idea types on a per participant basis can be found in figure 3.

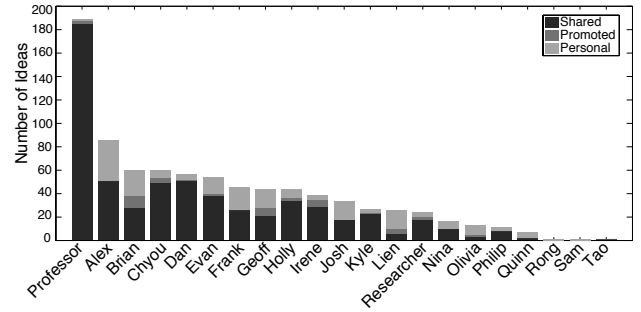


Figure 3. Distribution of ideas per participant per idea type: personal, promoted, and shared.

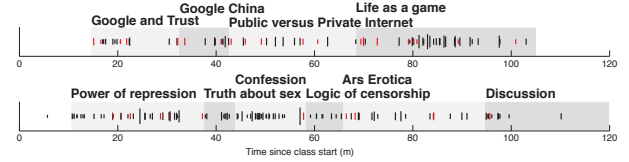


Figure 4. Timeline of topics and ideas posted in two example class sessions. Ideas posted by students are in black, ideas from the professor are in red. The height of the line indicates the length (in characters) of the idea. Topic names are shown above their corresponding section of the class.

Over the course of the study, 119 topics were created in total. Of these, 79 were actually discussed and the remainder were raised as potential topics but never actually used. The average class had 6.5 started topics, with a standard deviation of 2.3. Topic duration had a much wider variation: the average topic lasted 851 seconds with a deviation of 673 seconds. This is skewed largely because of very short topics.

A deep analysis of temporal patterns within the data is beyond the scope of this paper, but to provide a rough sense of what topic and idea posting activity looked like we have provided two example timelines in figure 4. The most striking thing about the data from this perspective is that the temporal distribution is very uneven. In Kleinberg’s terms, we see a bursty structure [17] in idea posting. This is a common structure in communication systems and it is no surprise that it appeared in our study results.

DISCUSSION

Much of the existing literature on backchannels focuses on situations in which the audience has one stage to perform on and the presenter has a separate one. [26] [18] *Tin Can*’s symmetry, where anyone can use either stage at any time, is the focus of our analysis. In this section, we use the stages metaphor introduced earlier to describe how students managed their attention to stages. Then, we discuss how students made decisions about when and how to perform on the available stages.

Attention

Attention, for our purposes, is best understood not as an innate characteristic of someone’s behavior, but as a value-laden socially situated performative behavior. “We are al-

ways to a certain extent in a state of distraction,” according to sociologist Emile Durkheim. [7] Every situation is composed of stimuli that disrupts some fictional conception of undivided attention. Likewise, every situation requires some aspect of performance, as individuals are required to communicate their attentiveness in response to specific social contexts. In a lecture, attentiveness is typically demonstrated by looking at the presenter and potentially taking notes. In a small group discussion, attentiveness might be expanded to include looking through class reading material or looking at other people.

Traditional approaches to managing attention in education tend to take as their starting point the desire to maximize audience attention on the presenter through the physical architecture of lecture spaces, presentation media, and rhetorical strategies. Gordon and Bogen [10] argue that attention and distraction are best understood as being “hand-in-hand. The very same new technologies and landscapes that cultivate a state of distraction are themselves directed simultaneously toward the cultivation of attention.” Educators tend to look to technology (broadly construed) to help manage overwhelming sensory inputs while simultaneously blaming the lack of attention of students on that same technology.

Of course, it is not simply a definitional matter to decide what constitutes attention in a class using *Tin Can*. To understand how students and professor understood attention in this context we can look to how they talked about attention and distraction. Students predominantly viewed participation as obligatory. Speaking to his motivation to use *Tin Can*, one student said “to be part of the class I had to use it.” Students were never admonished for interacting with tablets, and didn’t report feeling like they needed to minimize their performance on the side stage to avoid negative perceptions of themselves by the professor or others, except to the extent that students felt like over-participation on either stage might crowd out other students. A student who was particularly active on the side stage worried that “I take so much space that people that are shy...have more problems ... standing up when they have personal ideas [to share].”

To the extent that students were concerned with attention, the most common problem was not being viewed as inattentive, but struggling to track performances on both stages simultaneously. Although students were not concerned with annoying the professor, they were worried about offending their peers who were presenting that day: “It is a little tough to keep your attention on both [stages], and sometimes you get a running conversation on *Tin Can*, which can be interesting but it is maybe a little unfair to the presenter.” Although this perspective represents a pull towards enacting traditional models of attention, it wasn’t enough to significantly diminish involvement (either as a performer or an audience member) on the side stage. Student presenters often used *Tin Can* as a way to gauge interest in future discussion topics and to decide on whom to call.

In resolving the conflict between compelling simultaneous performances, students could fall back on the persistence of

performances on the side stage. In making a choice to attend to the main stage, they could, in Josh’s words, “have a comfort that you’re not going to miss anything because you can always go back and see other people’s posts whenever.” Still, there seemed to be a difference between browsing posts later and being part of the live conversation. This came up most frequently when students expressed frustration with text entry on the tablet and missing the right moment to post something: “I didn’t get it out as fast as I’d hoped and it was already passed and it wasn’t worth typing it anymore.”

Deciding between stages was really only a problem when both stages were compelling. If only the main stage was compelling, students could freely attend to that. The reverse was also common, and students frequently reported attending to the side stage as an escape from an un-engaging main stage, as in this quote from Quinn:

“I can remember a particular ... presentation that he was doing a lot of PowerPoint, I think he was completely oblivious to the *Tin Can* conversation and [the *Tin Can* conversation] ended up going in a very good direction ... as a result, I do not remember anything he said, because ... the conversation on *Tin Can* was a little more engaging”

Moments like this highlight the extent to which our characterization of stages as “main” and “side” is itself a product of attention. The presence of a system like *Tin Can* does not automatically create a side stage, nor does the ability for spoken communication guarantee that such communication will create a main stage. The addition of a mediated communication platform simply creates the *possibility* of a new stage. Whether or not it becomes a viable stage, and whether the mediated stage is a main stage or a side stage is all the result of people’s attention to the system. Furthermore, the designation “main” or “side” is not fixed. The situation Quinn describes is a moment where the main stage ceased, for a little while, to command people’s attention and *Tin Can* took on some main stage properties. Although such moments were rare, they point out how stages are not created by technology or decree: they are designated and sustain by the collective attention of people using them.

The professor’s high level of activity on *Tin Can* throughout the class can be seen as playing a role in setting the main/side distinctions. His activity was a way of giving students permission to take the side stage seriously, both because it was clear that he was going to notice contributions from students, but also because he was frequently entering ideas himself and not looking at the current speaker. This underlines the extent to which this was an ideal context for testing a system like *Tin Can*. Had we deployed in a class where the professor was neutral or hostile to people attending to *Tin Can*, traditional class expectations of attention would more likely have been practiced by students, reinforcing those norms and making a side stage much less viable.

Performance

The presence of an additional participation stage complicates the experience of being a member of the class. When should you submit an idea on the tablet rather than say it out loud? When is the right time to say something? Should you share an idea or make it a personal idea? The enacted (and self-reported) answers to these questions can provide some insight into the experience of using the system as well as deepen our understanding of the stages metaphor. In many cases, students viewed the side stage as complementing the main stage and valued its presence in situations where a range of problems with the main stage impeded their participation. In this way, *Tin Can* acted as a kind of escape valve: when the main stage was working for people, they used it; when they felt like they could not use it or did not want to use it, they turned to the side stage and valued its complementary affordances.

Performance on the main stage was widely viewed as more challenging and having higher stakes than side stage performance. Among the students who were reluctant oral participants in class, this was particularly acute. Geoff, a very rare oral participant in class before *Tin Can*, was particularly frank on this point: “I don’t really talk a lot in class because I’m scared of sounding stupid.” Geoff was a more frequent side stage participant. Although he would still rarely speak up directly in class, he was often called on by others in class to speak about ideas he had posted on *Tin Can*; he would happily speak in those instances. This change in behavior on his part was frequently brought up by other students as being a major benefit of using *Tin Can* because they valued the opportunity to hear and see what he was thinking. Irene, a more talkative student, characterized Geoff as a member of a “good chunk of people who I think are thinkers and they would just think and write down what they were thinking” as opposed to speaking on the main stage. This feeling was common among people who were comfortable on the main stage, who acknowledged that “not everyone feels comfortable speaking in class, so I think [*Tin Can*] definitely allowed for certain ideas to be shared that probably would have been either suppressed or just ignored or forgotten.”

Students’ comfort with the different properties of the main stage and side stage played a role in which stage they chose to participate. Students for whom English was a native language were more comfortable in the spoken conversation, and when faced with complicated ideas preferred to express them orally, turning to *Tin Can* to express simpler ideas because typing complicated ideas was slow and difficult. Students who did not speak English natively had the reverse logic, preferring to type complicated ideas so they could, according to Rong, “organize my language a lot before I actually talk because I want my thoughts to be systematical and clear, I want people to get it.” In both groups, though, students viewed the revisability of written contributions as a potential benefit: “[*Tin Can*] gave me the advantage of thinking it through in a writing sense a little bit before I vocalized the idea.”

A lack of confidence about one’s performances was not the only reason to choose the side stage over the main stage.

Students had a clear sense of etiquette surrounding when they could participate on the main stage and in what ways. Because only one person could be talking at once and conversations were fundamentally linear, students often felt like speaking up themselves would be changing the flow of the conversation in an inappropriate way. Instead, students would prefer to write their comments on the side stage instead of “interrupting” on the main stage. This was intertwined with ideas of timeliness. Performances seen as being closely related to the current main stage conversation were more appropriate than performances that might drag the conversation in a significantly different direction. Although similar, these concerns are not precisely the same. The worry about interruption was primarily a desire to not unduly influence the path of the conversation because that was perceived by some students as the role of the professor or presenter, not the role of the individual student. In contrast, ideas that were seen as “not quite as relevant [and not] really [fitting] into the conversation” were not really valid performances on the main stage at all because not only would they move the conversation significantly, they did not necessarily have anything to do with the existing main stage conversation.

Both of these worries, though, led to the same thing: increased use of the side stage. Because turn-taking was not a concern on the side stage, it easily supported ideas going in different directions simultaneously. To the extent that those directions were interesting to other people, they could serve as the basis for future ideas. If they were not, it was not seen as problematic to have put them there in the first place. When an idea did not seem to lead to any future ideas, students “didn’t think anything of it. Not all ideas are great.”

Sharing and Promotion

Key to our argument about stages is moving from a model where we view people as “tuning in” to a single channel to one where we recognize that computer-mediated communication systems offer new simultaneous stages on which we can perform and be observed. It is critical, then, that we describe how performances shifted between stages, influencing what students said and how they said it. One common pattern was the positive reception to ideas on the side stage encouraging those ideas to be performed on the main stage. This same process happened even within *Tin Can*, when personal ideas were dragged by someone (usually the professor; 57% of ideas promoted from personal to shared were promoted by the professor) to the public idea timeline. Students also viewed “likes” and replies as good indicators of interest in their ideas. Geoff, the quiet student discussed earlier, captured the impact of these promotions nicely: “At first I started just putting them in my box [i.e. making them personal ideas] without even sharing with the class. Then I saw that [the professor] started dragging them out and putting them in discussions so afterwards I was more open to sharing my ideas within the class discussion.”

Activity on the side stage was sometimes explicitly moved onto the main stage. In most cases, the professor or student presenter called on someone based on something they had said on *Tin Can* and asked them to re-perform the idea

on the main stage. The professor might say, for instance “Olivia, you had a nice point here on *Tin Can*, do you want to expand on it?” and Olivia could elect to take a speaking turn (and nearly always did). The other common strategy was for a speaker (particularly a student presenter) to use an idea recorded on the side stage as a starting point for a comment of their own or to introduce a topic known to be of interest to students based on side stage activity. Promotion moves by the professor were valued over those by other students, but both were appreciated and clearly remembered by students.

In the stages framing, we can understand note-taking as moving performances from the main (verbal) stage to the side (text) stage. For example, these were ideas entered into *Tin Can*: “Play is no longer having fun, it is work”, “Question of self-efficacy in public sector” or “Consumption leads to feeling good about yourself.” When posted by students, ideas of this form were frequently attempts to move the discussion, but when they were posted by the professor they were seen as records of the main stage. Students characterized the professor’s role in this process as “the note taker person so if ... the presenter said something [the professor] would summarize what they just said.” This was seen as a valuable contribution by the students that showed interest in reviewing the archives after class: “I liked the way [the professor] used it. Because that also meant that I didn’t need to take notes ... because he posted it in *Tin Can* and I could get access to that later.”

As is evident from figure 3, the professor was a significant outlier in terms of his performance on *Tin Can* and his participation clearly had a big impact on how students understood and used the tool. Beyond his role as a note-taker, students also viewed his performances as oriented towards trying to guide the main stage conversation in particular ways. Students characterized this use pattern as, variously, “guiding”, “influencing”, or “driving.” He was particularly interested in “[initiating] conversation”, primarily by posting thought-provoking questions like “Why do we feel responsible for a corp’s feelings?” or “What is the role of god in modernism?” Most students avoided starting or stopping topics (or proposing them at all), arguing that it was the professor’s job to do that, although some students took more active roles in administering topics when they were in the presentation role. In total, 53% of topic-related state changes were done by the professor.

On the main stage, the professor was also a frequent promoter of side stage activity. Sam characterized the professor’s role in a particularly evocative way:

“I feel like [the professor] would be a speaker for people who couldn’t speak, you know. The fact that he was really into *Tin Can*, so he would read something that [a student] had written and be like oh, I want to quote this or talk about it and [act] as a spokesman for people who aren’t really comfortable speaking”

This underlines the professor’s role as a bidirectional bridge

between the stages. By taking notes on main stage performances, he reinforced *Tin Can*’s note-taking role. By speaking out about side stage performances and drawing people into the discussion based on written ideas, he legitimated their side stage performances. It is very hard to imagine *Tin Can* being as well integrated into the class as it was without the extensive involvement of the professor. This does not, in our minds, diminish the contributions of this work. Although we cannot speak to how a skeptical teacher might react to the system, having a fertile classroom situation gives us an opportunity to make important insights into the potential for this design space that we might not have otherwise been able to access.

Hardware

While one could easily imagine *Tin Can* working on a laptop, its deployment on tablets substantially affected use and outcomes in a variety of ways. First, there is a simple visual benefit to using tablets. Unlike laptops, which can create strong visual boundaries between people, tablets lie flat (or nearly flat) on the table or in people’s laps. When organized around a rectangular seminar table, tablets do not disrupt sight lines between people. In general, laptops give people something to hide behind while tablets more strongly signal availability.

Accordingly, tablets offer less privacy than laptops. Participants can easily see when other participants are using the system, and typing is easily distinguishable from browsing other people’s ideas. Surprisingly, we frequently saw students looking at other students’ tablets while they interacted with them, even though everyone’s view of the space was the same. Students seemed to be interested in knowing how other people were using the system.

Because of the way the tablet program was administrated at the school, students did not have any particular ownership over a specific tablet. This inhibited any sense of ownership; students talked about the tablets as being essentially disposable, e.g. “sometimes the [tablet] would run out of battery and kick you off and you’d have to get a new one.” The benefit of this lack of ownership was that it limited the tablets’ non-*Tin Can* uses. Unlike a laptop, on which the Web and communication tools were a click away, the tablets were not personalized. Even using Web tools was tedious, because they had to log in to each one which was both slow and obvious to people around them.

The biggest challenge with tablets is data entry. The most frequent complaint about the system was how slow and difficult they found accurate text entry to be. Students complained about slow typing speed making it hard to post timely ideas (“I didn’t get [an idea] out as fast as I’d hoped and it was already passed and it wasn’t worth typing it anymore”) and distracting them from the main stage (“it takes time to type on the [tablet] and so probably it takes you away from the presentation sometimes”). We also saw a number of ideas correcting typos and autocorrect mistakes in previous ideas. These problems mitigate the system’s utility as a conversational stage and seemed to depress overall use.

CONCLUSIONS

In deploying *Tin Can*, we had two major goals: increase the diversity of participation and increase engagement. We feel that we were successful in each of these goals.

When judging participation, we consider activity on each stage. In terms of the main stage, we saw some evidence that people who might not have spoken up in class were prompted to speak by *Tin Can*. Most often, this came from the promotion processes described earlier. This moderately increased the diversity of participation on the main stage. Side stage participation was viewed by both students and teacher as a legitimate way to be a class participant, and we saw much broader participation in *Tin Can* than we saw on the main stage. The distribution of side stage participation was relatively flat, setting aside the professor, especially when compared to the steep power law reported in a chat backchannel[26]. Based on our discussion of how and when students chose to participate, it is clear that the distinct affordances of the main stage and side stage meant that each captured kinds of participation that would not have been effective on the other. It is not the case that adding *Tin Can* detracted from the main stage and that there is a simple conservation of participation across all formats; we saw a more subtle case in which having a communication outlet with different properties drew out contributions that otherwise would not have happened at all.

This system was consciously designed for students who were less likely to participate verbally in class. We were surprised at the extent to which attitudes about the system aligned along active oral participant / reluctant oral participant lines. Active oral participants tended to be indifferent about how *Tin Can* affected their personal participation in class. However, they acknowledged its effect on less active participants. Members of this group almost always commented on the increased diversity of involvement that *Tin Can* promoted, with observations like: “it tends to be a certain group of people who would talk and a certain group of people who were thinking but not talking. So I would like to see what they were up to.” Philip, an active oral participant with essentially zero *Tin Can* participation noted of reluctant oral participants “maybe [reluctant participants] would have something to say but maybe there’s like some sort of reluctance to actually to speak the thing aloud. So it gave another sort of channel to express ideas.” Knowing that reluctant participants had a place to participate made active participants feel less guilty about their own participation on the main stage.

Reluctant oral participants broadly relished the opportunity to participate in new ways with which they were more comfortable. Students described the system as “more efficient”, it “gave more people a chance to say things that they wouldn’t say”, and it helped students “feel more connected to the other students.” Olivia poignantly described the system as “something that was on my side, so to speak. You know what I mean? ... Like it was a resource.”

This dynamic between reluctant and active main stage participants suggests a new view on the findings of DiMicco et

al. [6]. They found that although visualizing participation decreased participation among over-participants, it did not boost participation of under-participants. In contrast, we found that although *Tin Can* did not decrease oral participation among active oral participants, it *did* boost oral participation among reluctant participants by letting them try out potential comments in a less intimidating medium and gather support for those ideas before speaking about them to a wider audience. Furthermore, if we include non-spoken participation, reluctant participants increased their participation substantially. This suggests that a lack of participation is not simply an issue of under-participants not finding conversational space to jump in, but can represent low conversational confidence that needs to be specifically addressed to boost participation.

We can also compare this boost in participation to Bergstrom and Karahalios’ [2] finding that under-participants on the verbal stage were also under-participants in voting. Our findings suggest that if participation rates are strongly correlated, perhaps the votes do not represent a different stage. This would fit with Tatar et al.’s [23] findings with *Cognoter*; although *Cognoter* had more communication opportunities than *Conversation Votes*, participation in *Cognoter* nonetheless frequently stalled audio conversation while discussants processed the contribution. Simply providing another communication venue does not necessarily create a stage.

Our findings are also surprising in light of Tatar et al.’s analysis[23] of the “parcel-post” style of communication. Although it would be fair to describe ideas in *Tin Can* as parcel-post, we did not observe any of the breaks in main stage participation resulting from submitted ideas that were observed in *Cognoter*’s use. Students frequently talked about waiting to read ideas when there was down-time on the main stage, something Tatar et al. view as a central problem with the parcel-post model in a face-to-face environment. We suspect that the main difference is group size. At small group sizes (like Bergstrom’s table-based work and the *Cognoter* studies) it is quite difficult to maintain separate stages because participation on the side stage is so conspicuous and attracts immediate attention. In Goffman’s terms, it is a venue where it is difficult to “get away with going away”. At larger group sizes like those we observe in this work, it is difficult to constantly participate on the side stage (either as a reader or a writer), so immediate awareness or consideration of all side stage contributions is simply not feasible. In fact, this lack of obvious immediate attention on each contribution could be a big part of why reluctant participants were more comfortable making side stage contributions.

Based on our study, we conclude that the introduction of a tablet-based system into a seminar classroom can have positive effects on the engagement of students and diversity of their participation without sacrificing the primary mode of interaction: spoken conversation. Unmediated face-to-face group discussions can be high pressure situations. Participating in face-to-face discussions requires participants to perform “live” (performances cannot easily be composed in advance); they also typically come with predetermined no-

tions of etiquette to which one must adhere in order to preserve the integrity of the performance. We wanted to design for this context in order to take advantage of the rich texture of participant attention and performative attributes the seminar setting presents. Our study demonstrated that *Tin Can* gave a voice to students who otherwise were not confident enough to perform on the main stage or who needed to “test out” ideas before sharing them on the main stage. It also demonstrated a need for a new model of thinking about how computer mediated communication systems can work in face-to-face discussion settings. *Stages* are not tied to particular technologies, nor are they predictive of specific behaviors. They are a way of conceiving of modes of communication within situations that are flexible and that emerge from participant performance.

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