

# Structure and messaging techniques for online peer learning systems that increase stickiness

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## ABSTRACT

When students work with peers, they learn more actively, build richer knowledge structures, and connect material to their lives. However, not every peer learning experience online sees successful adoption. This paper articulates and addresses three adoption challenges for global-scale peer learning. First, peer interactions struggle to bootstrap critical mass. However, class incentives can signal importance and spur initial usage. Second, online classes have limited peer visibility and awareness, so students often feel alone even when surrounded by peers. We find that highlighting interdependence and strengthening norms can mitigate this issue. Third, teachers can readily access “big” aggregate data but not “thick” contextual data that helps build intuitions, so software should guide teachers’ scaffolding of peer interactions. We illustrate these challenges through studying 8,500 students’ usage of two peer learning platforms, Talkabout and PeerStudio. This paper measures efficacy through sign-up and participation rates and the structure and duration of student interactions.

## Author Keywords

Peer learning; online education; social learning.

## PEER LEARNING: VALUABLE YET UNDERUSED

Many online classes use video lectures and individual student exercises to instruct and assess students. While vast numbers of students log on to these classes individually, many of the educationally valuable social interactions of brick-and-mortar classes are lost: online learners are “alone together” [30].

Social interactions amongst peers improves conceptual understanding and engagement, in turn increasing course performance and completion rates [11, 20, 22, 26, 28]. Benefits aren’t limited to the present: when peers construct knowledge together, they acquire critical-thinking skills crucial for life after school [3]. Common social learning strategies include discussing course materials,

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ACM 978-1-4503-3411-2/15/03...\$15.00  
<http://dx.doi.org/10.1145/2724660.2724676>

asking each other questions, and reviewing each other’s work [2].

However, most peer learning techniques are designed for small classes with an instructor co-present to facilitate, coordinate, and troubleshoot the activity. These peer activities rely on instructors to enforce learning scripts that enable students to learn from the interaction [25].

How might software enable peer benefits in online environments, where massive scale prevents instructors from personally structuring and guiding peer interactions? Recent work has introduced peer interactions for summative assessment [23]. How might peer interactions power more pedagogical processes online? In particular, how might software facilitate social coordination?

## Three impediments to adoption... and remedies

Educational peer platforms connect students in massive online classes in order to discuss course topics, reflect on others’ ideas, and build esprit de corps [5, 23]. Over the last two years, three challenges have consistently recurred as we have introduced peer learning into massive online classes.

First, many courses falsely assume that students will naturally populate the peer learning systems in their classes: “build it and they will come”. This assumption often seems natural; after all, students naturally engage with social networks such as Facebook and Twitter. However, students don’t yet know why or how they should take advantage of peer learning opportunities. Peer learning platforms sit not in a social setting, but in an educational setting, which has its own logic of incentives: both carrots and sticks are required to keep the commons vibrant.

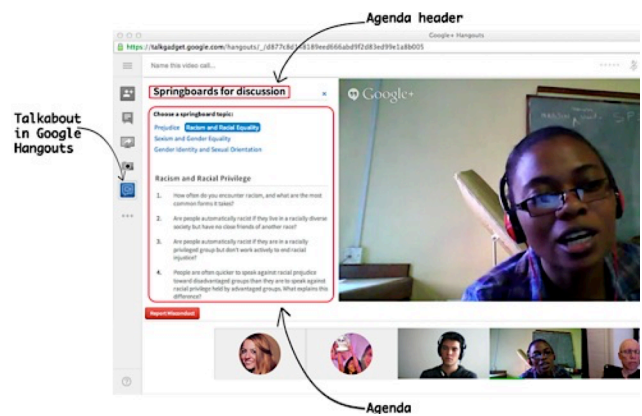
Participation in educational settings has a different incentive structure than a socialization setting. In particular, the benefits of participation are not immediately apparent. For instance, many American college graduates retrospectively credit their dorms as having played a key role in their social development [12]. Yet, universities often have to require that freshmen live in the dorms to ensure the joint experience. We encourage instructors to take a similar reinforcing approach online: integrating peer-learning systems into the core curriculum and making them a required or extra-credit granting part of the course, rather than optional “hang-out” rooms.

The second challenge is that students in online classes lack the ambient social encouragement that brick-and-mortar settings provide [14]. The physical and social configurations of in-person schools (especially residential ones) offer many opportunities for social encouragement [11, 22]. For example, during finals week, everyone else is studying too. However, other students' activity is typically invisible online, so students do not receive the tacit encouragement of seeing others attend classes and study [13, 15]. We hypothesize that in the minimal social context online, software and courses must work especially hard to keep students engaged through highlighting codependence and strengthening positive norms.

The third challenge we have encountered is that instructors can, at best, observe peer interactions through a telescope clouded by big data exhaust: there are few visible signals beyond engagement (e.g. course forum posts and dashboards) and demographics. Student information is limited online [29], and knowing how to leverage what demographics instructors do know is non-obvious. In-person, instructors use a lot of information about people to structure interactions [27]. For example, instructors can observe and adapt to student reactions while facilitating peer interactions. The lack of information in online classes creates both pedagogical and design challenges [21]. For instance, in an online discussion, do students completely ignore the course-related discussion prompts and, instead, talk about current events or pop culture? To address such questions, teachers must have the tools to enable them to learn how to scaffold peer interactions from behind their computers.

This paper addresses these three logistical and pedagogical challenges to global-scale peer learning (Figure 1). We suggest socio-technical remedies that draw on our experience with two social learning platforms – Talkabout and PeerStudio—and with our experience using peer learning in the classroom.

We report on these challenges with both quantitative and qualitative data. Quantitative measures of efficacy include sign-up and follow-through rates, course participation and activity, and participation structure and duration. Qualitative data includes students' and instructors' comments in



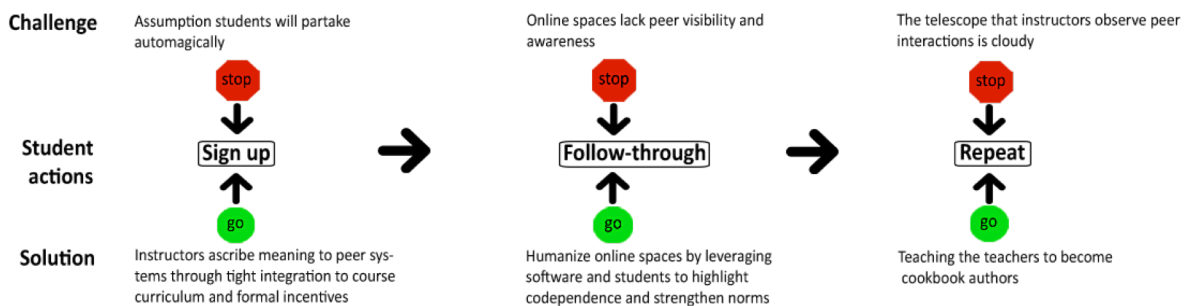
**Figure 2: Our experiences developing and deploying Talkabout, a tool that brings students in massive courses together, helps guide our discussion in this paper.**

surveys and interviews. We describe how peer learning behavior varies with changing student practices, teacher practices, and course materials.

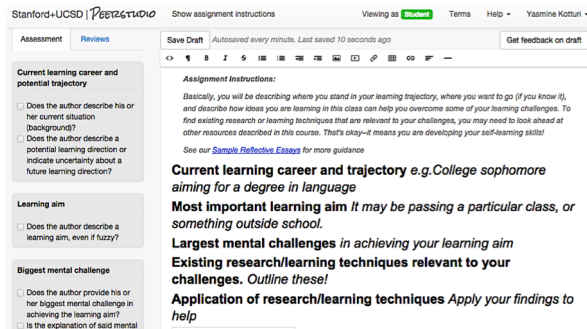
### How Students Use Two Peer Learning Platforms

Over the last two years, we have developed and deployed two large-scale peer-learning platforms. The first, Talkabout (Figure 2), brings students in MOOCs together to discuss course materials in small groups of four to six students over Google Hangouts [5]. Currently, over 4,500 students from 134 countries have used Talkabout in 18 different online classes through the Coursera and Open edX platforms. These classes covered diverse topics: Women's Rights, Social Psychology, Philanthropy, Organizational Analysis, and Behavioral Economics. Students join a discussion timeslot based on their availability, and upon arriving to the discussion, are placed in discussion group; on average there are four countries represented per discussion group. We have seen that students in discussions with peers from diverse regions outperformed students in discussions with more homogenous peers, in terms of retention and exam score [22]. We hypothesize that diverse discussions catalyze more active thinking and reflection.

The second platform, PeerStudio (Figure 3), provides fast feedback on in-progress open-ended work, such as essays [23]. Over 4,000 students in two courses on Coursera and



**Figure 1: The challenges and remedies of adoption of peer learning systems presented in this paper.**



**Figure 3: We also draw from our experience developing and implementing PeerStudio, a peer assessment tool that gives students rapid feedback on in-progress open-ended work.**

OpenEdX have used PeerStudio. Students submit a draft, an essay for example, and are then prompted to review two other drafts. After completing two reviews, they can access the feedback on their essay. With PeerStudio, students can receive formative feedback on their draft work within hours. A randomized controlled experiment showed students created better revisions when they have rapid feedback from their peers, on average 20 minutes in our deployments at scale.

### **SOCIAL CAPABILITIES DO NOT GUARANTEE SOCIAL USE**

Peer learning systems share many attributes with collaborative software more generally [16]. However, the additional features of the educational setting change users' calculus. Throughout the deployments of our platforms, we've observed different approaches that instructors take when using our peer systems with their material.

Often, instructors dropped a platform into their class, then left it alone and assumed that students would populate it. For example, one course using Talkabout only mentioned it once in course announcements. Across four weeks, the sign-up rate was just 0.4%, compared to a more successful sign-up rate of 6.6% in another course; sign-up rate being the number of students who signed up to participate in the peer system out of the number of active students (students who watched a lecture video in the course). Low percentages represent conservative estimates as the denominator represents students with minimal activity. When this theme recurred in other Talkabout courses, it was accompanied with the same outcome: social interactions languished. Why would instructors who put in significant effort developing discussion prompts introduce a peer learning system, but immediately abandon it?

Through discussions, we noticed that instructors assumed that a peer system would behave like an already-popular social networking service like Facebook where people come en masse at their own will. This point of view resonates with a common assumption that MOOC students are extremely self-motivated, and that such motivation shapes their behavior [4,17]. In particular, instructors were *not*

treating the systems like novel learning technology, but rather as bolted-on social technology. The assumption seemed to be that building a social space will cause students to just populate it and learn from each other.

However, peer learning systems may need more active integration. The value of educational experiences is not immediately apparent to students, and those that are worthwhile need to be signaled as important in order to achieve adoption.

Chat rooms underscored a similar point of the importance of pedagogical integration. Early chat room implementations were easily accessible (embedded in-page near video lectures) but had little pedagogical scaffolding [9]. Later, more successful variants that strongly enforced a pedagogical structure were better received [10].

### **Peer software as learning spaces**

Even the best-designed peer learning activities have little value unless students overcome initial reluctance to use them. Course credit helps even students to commit, and those who have committed, to participate. Consider follow-through rates: the fraction of students who attend the discussion out of the students signed up for it. In an international women's rights course, before extra credit was offered, Talkabout follow-through rate was 31%. After offering extra credit, follow-through rate increased to 52%. In other classes, we've seen formal incentives raise follow-through rates up to 64%.

Faculty can signal to students what matters by using scarce resources like grade composition and announcements. We hypothesize that these signals of academic importance and meaning increase student usage. For example, in a course where the instructors just repeatedly announced Talkabout in the beginning, 6.6% of active students signed up, a large increase from the 0.4% sign-up rate when there was only one mention of Talkabout.

We saw similar effects with PeerStudio. When participation comprises even a small fraction of a student's grade, usage increases substantially. In one class where PeerStudio was optional, the sign-up rate was 0.8%. The fraction of users was six times higher in another class where use of PeerStudio contributed to their grade: the sign-up rate was 4.9%. To maintain consistency with insights from Talkabout, sign-up rates for PeerStudio also represents the number of students who signed up to participate out of the number of active students (students who watched a lecture video in the course).

Students look up to their instructors, creating a unique opportunity to get and keep students involved. One indicator of student interest is if they visited the Talkabout website. Figure 4 shows page views after instructors posted on the course site discussing Talkabout, and a decrease in page views when no announcement is made. Talkabout traffic was dwindling towards the end of the course, so the instructor decided to offer extra credit for the last

Talkabout discussion. During the extra-credit granting Talkabout discussions, page views increase around two-fold the previous four rounds.

To understand how pedagogical integration and incentives, and follow-through rate interact, we divided 12 Talkabout courses into three categories, based on how well Talkabout was incentivized and integrated pedagogically (see Figure 5). Courses that never mentioned Talkabout or mentioned it only at the start of the course are labeled “Low integration”. Such courses considered Talkabout a primarily social opportunity, similar to a Facebook group. Few students signed up, and even fewer actually participated: the average follow-through rate was 10%. The next category, “Medium integration,” was well integrated but poorly incentivized, classes. These classes referred to Talkabout frequently in announcements, encouraged students to participate, and had well-structured discussion prompts, but they had no formal incentive. Such classes had an average follow-through rate of 35%. Well-incentivized and integrated classes, “High integration,” offered course extra credit for participation and continuously discussed Talkabout in course announcements, and averaged 50% follow-through rate. This visualization highlights the pattern that the more integrated the peer learning platform is, the higher the follow-through rate is. We have found that offering even minimal course credit powerfully spurs initial participation, and that many interventions neglect to do this. As one student noted in a post-discussion survey, “I probably wouldn't have done it [a Talkabout session] were it not for the 5 extra credit points but I found it very interesting and glad I did do it!”

The Talkabout course with the highest follow-through rate not only offered Talkabout for extra credit, but also offered technical support, including a course-specific FAQ (Talkabout has an FAQ but it is not course specific). Looking at the forums, the role of the FAQ became apparent: many students posted questions about their technological difficulties and the community TAs and even other students would direct students to this FAQ—loaded with pictures and step by step instructions to help these students understand what Talkabout is and how it's relat-

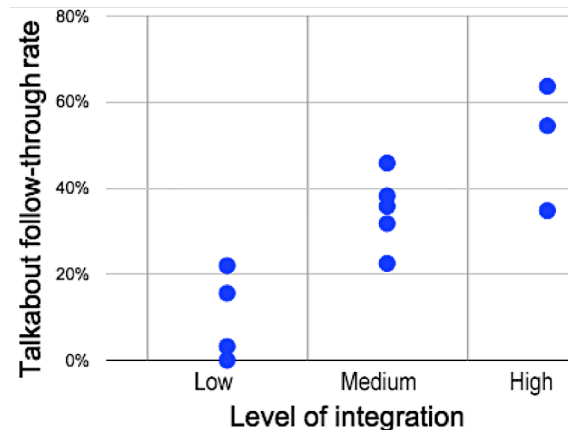


Figure 5: Follow-through rate from 12 Talkabout courses increases as integration increases.

ed to them. Moreover, the course support team answered any questions could not be answered by the FAQ, ensuring that anyone who was interested in using the peer learning platform got the chance to do so.

However, online classes must also accommodate students with differing constraints from around the world. For instance, Talkabout is not available to some students whose country (like Iran) blocks access to Google Hangouts. Other students may simply lack sufficient reliable Internet bandwidth. One course offered small-group discussions for credit that were held either online (with Talkabout) or in-person in order to combat this challenge. When the strongest incentives are impractical, courses can still improve social visibility to encourage participation.

### SOCIAL TRANSLUCENCE IS LIMITED ONLINE

Online students are “hungry for social interaction” [17]. Especially in early MOOCs, discussion forums featured self-introductions from around the world, and students banded together for in-person meet-ups. Yet, when peer-learning opportunities are provided, students don't always participate in pro-social ways; they may neglect to review their peers' work, or fail to attend a discussion session that they signed up for.

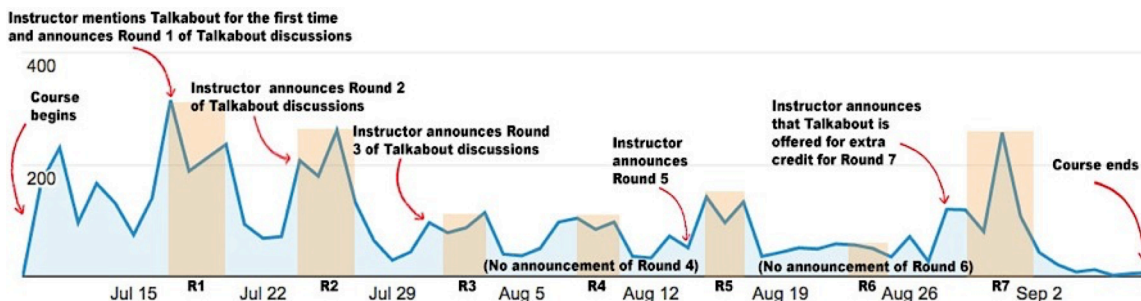


Figure 4: When instructors highlight peer learning software, students use it. Talkabout pageviews of a women's right course. Instructor announcements are followed by the largest amount of Talkabout pageviews throughout the course. R1 represents Round 1 of Talkabout discussions, and so on, with orange rectangles framing the duration of each round. When the instructor did not mention Round 4 and 6, pageviews were at their lowest.

We asked 100 students who missed a Talkabout why they did so. 18 out of 31 responses said something else came up or they forgot. While many respondents apologized to us as the system designers, none mentioned how they may have let down their classmates who were counting on their participation. This observation suggests that social loafing may be endemic to large-scale social learning systems. If a student doesn't feel responsible to a small set of colleagues and the instructor instead diffuses that responsibility across a massive set of peers, individuals will feel less compunction to follow through on social commitments.

To combat social loafing, we must reverse the diffusion of responsibility by transforming it onto a smaller human scale. Systems that highlight co-dependence may be more successful at encouraging pro-social behavior [8]. In a peer environment, students are dependent on each other to do their part for the system to work. Encouraging commitment and contribution can help students understand the importance of their participation, and create successful peer learning environments [21].

### Norm-setting in online social interaction

Norms have an enormous impact on people's behavior. In-person, teachers can act as strong role models and have institutional authority, leading to many opportunities to shape behavior and strengthen and set norms. Online, while these opportunities diminish with limited social visibility, other opportunities appear, such as shaping norms through system design. Platform designers, software and teachers can encourage peer empathy and mutually beneficial behavior by fostering pro-social norms.

Software can illuminate social norms online. For instance, when PeerStudio notices that a student has provided scores without written feedback, it reminds them of the reciprocal nature of the peer assessment process (see Fig-

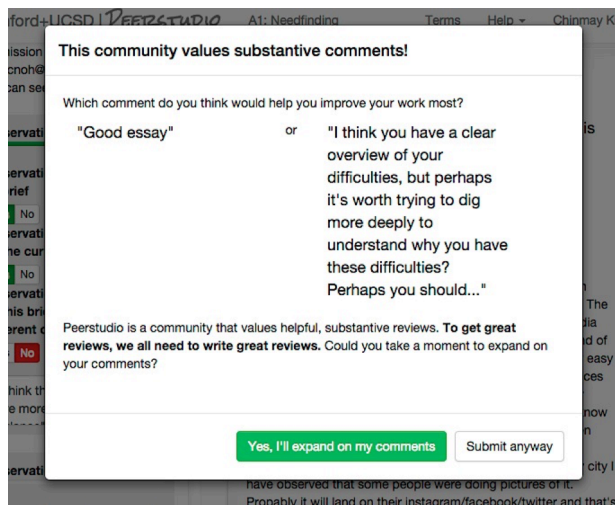


Figure 6: When PeerStudio detects a review without comments, it asks the reviewer if they would like to go back and improve their review by adding comments.

ure 6). As a different example, students that are late to a Talkabout discussion are told they won't be allowed to join the discussion, just as they'd not like to have a discussion interrupted by a late classmate. Instead, the system provides them an option to reschedule. Systems need not wait until things go wrong to set norms. From prior work, we know students are highly motivated when they feel that their contribution matters [2, 24]. As an experiment, we emailed students in two separate Talkabout courses before their discussion saying that their peers were counting on them to show up to the discussion (see Figure 7). Without a reminder email, only 21% of students who signed up for a discussion slot actually showed up. With a reminder email, this follow-through rate increased to 62%.

### How can we leverage software and students to highlight codependence and ascribe meaning?

PeerStudio recruits reviewers by sending out emails to students. Initially, this email featured a generic request to review. As an experiment, we *humanized* the request by featuring the custom request a student had made. For example, the generic boilerplate request became the personalized request that the student had written before submitting his draft. Immediately after making this change, review length increased from an average of 17 words to 24 words.

Humanized software is not the only influencer: forum posts from students sharing their peer learning experiences can help validate the system and encourage others to give it a try. For example, one student posted: "I can't say how much I love discussions...and that's why I have gone through 11-12 Talkabout sessions just to know, discuss and interact with people from all over the world." Although unpredictable [7], this word-of-mouth technique can be highly effective for increasing stickiness [1]. When students shared Talkabout experiences in the course discussion forums (2000 posts out of 64,000 mentioned Talkabout, 3%), the sign-up rate was 6% (2037 students), and the follow-through rate was 63%. However, the same course offered a year later, did not see similar student behavior (260 posts out of 80,000 mentioned Talkabout, 0.3%). The sign-up rate was 5% (930 students)

### Your Talkabout discussion attendance matters!

Hi Yasmine Kotturi,

We are excited to see that you have signed up for a talkabout discussion for Giving 2.0: The MOOC! Arrillaga-Andressen and her collaborators have set up an awesome agenda for your discussion, which you can preview [here](#).

\*Remember, your peers are counting on you to show up! Without you, another student might not have a discussion partner. If you can no longer attend the discussion you've signed up for, you can always reschedule [here](#). Just click on "Change discussion session" in the upper-right hand corner.

Happy talking!

the talkabout team

Figure 7: An email sent to students prior to their discussion to remind them of the importance of their attendance.

and follow-through rate was 55%. Although influenced by external factors, this suggests that social validation of the systems is important.

### Leveraging students' desire to connect globally

Increasing social translucence has one final benefit: it allows students to act on their desire for persistent connections with their global classmates. For example, incorporating networking opportunities in the discussion agenda allocates times for students to mingle: "Spend five minutes taking turns introducing yourselves and discussing your background." However, we note that this is not a "one-size-fits-all" solution: certain course topics might inspire more socializing than others. For instance, in an international women's rights course, 93% of students using Talkabout shared their contact information with each other (e.g. LinkedIn profiles, email addresses), but in a course on effective learning, only 18% did.

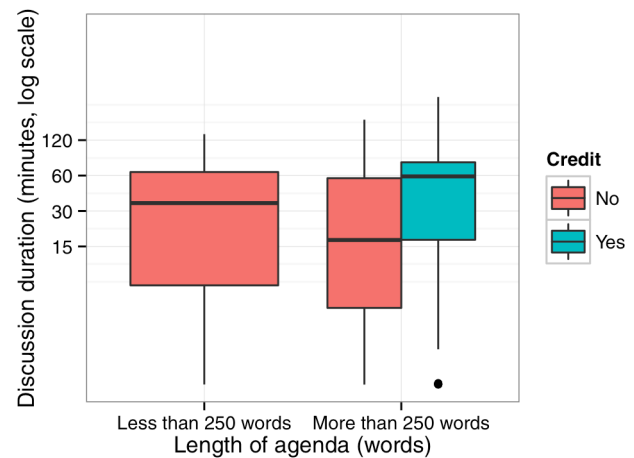
### DESIGNING & HOSTING INTERACTION FROM AFAR

Like a cook watching a stew come to a boil and adjusting the temperature as needed, an instructor guiding peer interactions in-person can modulate her behavior in response to student reactions. Observing how students do in-class exercises and assimilating non-verbal cues (e.g., enthusiasm, boredom, confusion) helps teachers tailor their instruction, often even subconsciously [18].

By contrast, the indirection of teaching online causes multiple challenges for instructors. First, with rare exceptions [6], online teachers can't see much about student behavior interactively. Second, because of the large-scale and asynchronous nature of most online classes, teachers can't directly coach peer interactions. To extend—and possibly butcher—the cooking metaphor, teaching online shifts the instructor from the in-the-kitchen chef to the cookbook author. Their recipes need to be sufficiently stand-alone and clear that students around the globe can cook up a delicious peer interaction themselves. However, most instructors lack the tools to write recipes that can be handed off and reused without any interactive guidance on the instructor's part.

### Guidelines for writing recipes: scaffolding peer interactions from behind a computer

Most early users of Talkabout provided both too little student motivation and discussion scaffolding. Consequently, usage was minimal [22]. Unstructured discussion did not increase students' academic achievement or sense of community [9]. To succeed, we needed to specifically target opportunities for self-referencing, highlight viewpoint differences using boundary objects, and leverage students as mediators [22]. To understand this range of structure, we looked the discussions from 12 different courses and compared agenda character length and discussion duration. We split discussions into two categories: long and short discussion agendas, with 250 words as the threshold, and compared credit-granting and no credit dis-

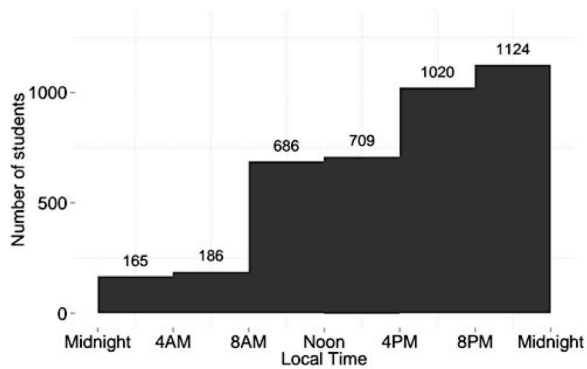


**Figure 8. Longer discussion agendas incentivize students to discuss longer; but only when they are accompanied by course credit for participation.**

ussions (see Figure 8). Average discussion duration was 31 minutes for short agendas. All agendas asked students to discuss for 30 minutes; students were staying the extra time voluntarily. However, only those long agendas that awarded credit successfully incentivized students to discuss longer: the average with credit was 49 minutes, and without was 30 minutes.

We worried that over-structuring an interaction with lengthy and tiresome agendas would leave no space for informal bond-building. However, even with sufficient structure, students can easily veer from the schedule and socialize, exchange social networking information, and offer career advice.

Software systems, platforms, and data-driven suggestions each play a more active role in helping teachers create effective recipes. While most early Talkabout instructors provided too little discussion scaffolding, our data showed instincts led early Talkabout instructors to worry too much about scheduling. For example, time zones are a recurring thorn in the side of many types of global collaboration, and peer learning is no exception. Every Talkabout instructor was concerned about discussion session times and frequency, as this a major issue with in-person sections. Instructors often asked if particular times were good for students around the world. Some debated: would 9pm Eastern Time be better than 8pm Eastern Time, as more students would have finished dinner? Or would it be worse for students elsewhere? Other instructors were unsure of how many discussions timeslots to offer. One instructor offered a timeslot every hour for 24 hours because she wanted to ensure that there were enough scheduling options. However, an unforeseen consequence of this was that the participants were too spread out over the 24 discussions, and thus some students were left alone.



**Figure 9. Data from nine classes and 3400 students shows that most students discuss in the evening, but there are students that will discuss at all 24 hours.**

Analyzing when students participate in discussions taught us that most students prefer evenings for discussions. Yet, different students prefer different times, with every day of time being preferred by someone (Figure 9). This data suggests that it is unimportant for instructors to find a particular scheduling “sweet spot,” and instead their time is better utilized elsewhere: creating the discussion agendas, for example. In summary, these examples illustrated where intuitions can lead teachers and system designers astray. Data-driven suggestions are important to transform expert cooks into cookbook authors.

### TEACHING TEACHERS BY EXAMPLE

Even fantastic pedagogical innovation can be hamstrung when there is a mismatch between curricular materials and platform functionality. When curricula did not match to the needs of the setting, the learning platforms languished. We emphasize the importance of *teaching by example*: creating designs and introductory experiences that nudge instructors toward the right intuitions. While always true with educational innovation, the online education revolution is a particularly dramatic change of setting, and instructor scaffolding is particularly important.

One of the most robust techniques we have found for guiding instructors is to provide successful examples of how other teachers have used the learning platform. In many domains, from design to writing research papers, a common and effective strategy for creating new work is to template off similar work that has a related goal [19]. During interviews with Talkabout instructors, a common situation recurred: the instructor was having a hard time conceptualizing the student experience. Therefore, to help instructors navigate the interface and create effective discussion prompts, we added an annotated example of a Talkabout discussion (see Figure 2). Still, we observed that many instructors had difficulty creating effective discussion agendas, e.g. they were very short and did not leverage the geographic diversity Talkabout discussions offer. As an experiment, we walked an instructor through Talkabout – in a Talkabout – and showed an excellent ex-

| Prejudice   | Racism and Racial Equality | Sexism and Gender Equality | Gender Identity and Sexual Orientation |
|---|----------------------------|----------------------------|--|
| <b>Cross-Cultural Dialogue</b>  |                            |                            |  |
| <ol style="list-style-type: none"> <li>1. How much prejudice is there in your country compared with other countries?</li> <li>2. Which forms of prejudice are declining in your country, and which ones aren't?</li> <li>3. In your country, which forms of prejudice are the most socially acceptable, and which ones are the least acceptable? Why are some forms more acceptable than others?</li> <li>4. What are the biggest barriers to social justice in your country, and how can psychology lower them?</li> <li>5. Are there specific practices that have increased social justice in your country and might work well if adopted in other countries? (Note: Such practices could be at the individual, group, community, or societal level, and could be psychological, educational, legal, political, or economic in nature.)</li> <li>6. In your opinion, what would the ideal degree of racial and ethnic integration be in your country? Is the same ideal shared by people of all races in your community?</li> </ol> |                            |                            |  |
| <b>Learning Theories</b>  |                            |                            |  |
| <b>Constructionism</b>  |                            |                            |  |
| <ol style="list-style-type: none"> <li>1. What examples of constructionism, either from your own experience or things you have heard about, strike you as effective ways to teach and learn?</li> <li>2. What do you see as some of the challenges in using constructionist approaches and tools?</li> </ol>  |                            |                            |  |
| <b>Active Learning</b>  |                            |                            |  |
| <ol style="list-style-type: none"> <li>3. What examples of active learning, either from your own experience or things you have heard about, strike you as effective ways to teach and learn?</li> <li>4. Do you think active learning techniques are commonly used? Would you hope for more educators to adopt these strategies? What might help them do that?</li> </ol>   |                            |                            |  |

**Figure 10. Two discussions prompts: top used as a template to show new Talkabout instructor an excellent example. Bottom prompt generated based off the example.**

ample agenda from another class. This helped onboard the new instructor to working with Talkabout: she was able to use the example as a framework that she could fill in with her own content (see Figure 10). Next, we showed example course announcements describing Talkabout using layman’s terms and offering pictures of the Talkabout discussion. Since course announcements are viewed by most online students, it is important to describe peer learning platforms in basic terms to convey a straight forward message.

The next step was to help instructors gain an understanding of what occurs during student discussions. To do this, we showed an instructor a video clip of a Talkabout discussion along with a full discussion summary. In response, the instructor said, “The most interesting point was around the amount of time each student spoke. In this case, one student spoke for more than half of the Talkabout. This informs us to be more explicit with time allocations for questions and that we should emphasize that we want students to more evenly speak.” By helping her visualize the interactions, she was able to restructure her discussion prompts in order to achieve her desired discussion goal; in this case, encouraging all students to have equally share their thoughts.

### CONCLUSION

This paper provided evidence for three challenges, and offered three corresponding socio-technical remedies. We reflect on our experience from developing, designing and deploying our social learning platforms: Talkabout and PeerStudio, as well as our experience as teachers in physical and online classes. We looked at student practices,

teacher practices and material design, and assessed the relationship between those and peer learning adoption. When peer systems and curricula are well integrated, the social context is illuminated, and teachers' and system designers' intuitions for scaffolding are guided by software, students do adopt these systems.

#### ACKNOWLEDGEMENTS

We are grateful to Scott Plous, Ed Hutchins and all instructors who used Talkabout and PeerStudio for their thought-provoking discussions and feedback; Coursera and Open EdX teams for help integrating platforms; the many students who interacted with their peers and shared their stories with us. This research was funded in part through NSF grants #1351131 and #1444865 and the Hasso Plattner Design Thinking Program. This research was conducted under the Stanford IRB protocols #30319 and #30324.

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