Designing Supportive Technology for Teaching Assistants Monitoring Collaboration

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Abstract

Decisions made by user interface designers play an influential role in how people interact with software, this is especially true when it comes to the creation of tools to support teaching. As technology continues to play a more prominent role in schools, it poses an important question about how the design of learning tools influence what teachers do in classrooms. Data analytics is one opportunity technology offers for teachers to foster collaboration in student groups. Data analytics have the potential to provide teachers with a live view of what students are doing when using technology, which research shows is challenging to implement in classrooms. This paper focuses on the process to design a tool that assists engineering discussion session teacher assistants (TAs) to monitor collaboration within groups. We report on findings from interviews with TAs on what they anticipate they would need in order to support group work, and discuss how their responses influenced the design of this tool.

Engineering; Dashboard design; Teaching; Collaborative Learning

Introduction

The design of technology for learning is often influenced by current trends in design, rather than by the theory and research about how students learn and what teachers need to support them (Hirsh-Pasek et al., 2015). Research indicates there are a range of opportunities for technology to monitor and support collaboration (e.g. Dillenbourg & Evans, 2011; Roschelle & Pea, 2002), although, there is little research into how the technology can be designed to provide insight for teachers into collaborative processes. Including teachers in the design process can increase their comfort level when using the technology, which can lead to more successful implementation in the classroom (Cviko, McKenney, & Voogt, 2014). This process, user centered design, has become more prominent in the social sciences in the last few years; by placing the user in the design process there is a greater chance that their needs will be met and the design will be successful (Sanders, 2002). This study includes teacher assistants (TAs) in the design of an orchestration tool, which will be used in their classrooms in future semesters.

In this paper, we describe interviews conducted with TAs, as we are in the process of developing orchestration tools to be used in the classes that they teach. The tools allow TAs to monitor collaboration in an engineering discussion session, and provide insight to them for how to intervene in the groups. This paper builds on earlier work, which found that TAs rarely provided anything more than content-based support to groups, and had little understanding of what successful collaborations would look like or how to intervene when groups struggled

(Mercier, Shehab, & Kessler, under review). These findings indicate a need to assist TAs using collaboration in their classroom, with one possibility being to provide them with live insight into the groups' processes to help them understand what is going on in the groups, and how they might intervene if groups were encountering interaction difficulties. In this paper, we focus on the process of designing a TA tool that provides insight into group processes during class activities.

Literature Review

One important potential of technology is that it can be designed in such a way as to provide innovative forms of information for teachers in the classroom. When students use technology during collaboration, there is the potential to provide teachers with live data about student's activities that can benefit the learning process (Van Leeuwen, Janssen, Erkens, & Brekelmans, 2014), and emerging possibilities to use data analytics to provide live analysis of this data to help teachers understand the meaning of the data. Data analytics can be especially beneficial to support collaboration by visualizing information that may otherwise be invisible to teachers, allowing them to attend to activity and interactions that can be difficult to identify (Martinez Maldonado, Kay, Yacef, & Schwendimann, 2012). One example of this is a tool described by Mercier, (2016), where findings show that teachers were better able to notice patterns of activity and allowed them to intervene at the individual, group, or whole-class level as was deemed appropriate.

While there is ample research on the design of software using educational design principles for students (Frye & Soloway, 1987; Krumhansl et al., 2013; Lewis, Brand, Cherry, & Rader, 1998; Najjar, 1998), we know little about how the design of technology influences what teachers do in the classroom. According to Paas & Sweller, (2014) in order to create a successful multimedia experience, interface designers must create a tool to reduce cognitive load so that users are not overwhelmed with extraneous information while completing multiple tasks at once. Teaching is a complex endeavor, and teachers are already processing a high information load while attending to the students in the classrooms, creating the need for an intuitive and informative orchestration tool. One method to address this is to understand how the different components of the software influences the audience directly (Norman, 1983), often by including users in the design process. By including teachers in the creation of these tools, we gain a better understanding to what is needed in the classroom while also increasing their comfort and belief in the tool (Cviko et al., 2014). Another way to reduce extraneous load for the teacher, is to be conscious of the design decisions when creating representations. When using live data from a classroom, it is important to represent graphical information in an intuitive format that allows users to interpret information, notice patterns, and integrate it with their knowledge of what's happening in the classroom (Carpenter & Shah, 1998). There are various guidelines in the multimedia literature that have been created to facilitation the understanding of graphs (Ratwani, Trafton, & Boehm- Davis, 2008; Shah, Mayer, & Hegarty, 1999) and cue users to relevant information for their task (Richter, Scheiter, & Eitel, 2016; van Gog, 2014). By understanding and using these guidelines designers can create software that allows teachers to extract information without disrupting the classroom or their attention to their students. If tools are developed to provide insight into group work, it is necessary to ensure such tools provide only useful information, and are

visually designed to be simple and quick for users to understand what is being displayed and the appropriate actions they need to take based on the information they receive. In order to address these issues, the research questions addressed in this paper are:

1. What do teaching assistants (TAs) anticipate they need in order to successfully support collaboration?
2. How can their ideas, in tandem with design theory and classroom orchestration research, be used to inform the design of orchestration tools?

Research Method

This study took place in the context of a multi-year design research project (Anderson & Shattuck, 2012) situated in a large, introductory engineering course which is in the process of integrating collaborative problem-solving activities into discussion sections. The project focused on the design of tools to support the creation of joint representations within groups, and the design of tools to support the TAs in these classes. TAs were graduate or undergraduate engineering students, with minimal teaching preparation. This paper focuses on the design of the TA tools.

Participants

Fourteen engineering teacher assistants (TAs) participated in the study. All participants were working as teaching assistants at the time of the study and were recruited during their weekly TA meeting. Ten of the TAs were in their second semester as a TA; the remaining participants had completed between three and six semesters in their position.

Interviews were conducted with one or two participants at a time, for a total of ten interviews. Interviews were separated into two phases, with changes to the information and design between the phases. Each phase had 5 interviews. One participant from phase 1 also participated in phase 2, thus there were 8 participants in phase 1, and 7 in phase 2. Interviews were audio recorded, and consent was obtained from all participants prior to recording.

Teacher tool

Students in the discussion sessions work in groups of 3 or 4 to complete collaborative problems, using synced tablets that allow each member of the group to work on a tablet, while seeing the work of the rest of their group. A maximum of 8 groups participate in a class at one time, leading to a maximum of 32 students in the class. Log files from the tablets, paired with video analysis of the groups, are being examined to identify group processes and will form the basis of information provided in the TA's orchestration tool. This tool is not intended to replace normal in-person monitoring, but to help advise novice teaching staff, who lack the experience to easily identify the quality of group processes, to more effectively support groups. Our previous work has found that TAs, who are often the people tasked with implementing collaborative learning in STEM courses, lack experience in identifying collaborative processes, and provide little beyond content support to students, thus they may benefit from more explicit insight into group processes (Mercier et al., under review). In this stage of our work, we created different representations of an orchestration tool, to prompt discussion during the interviews.

The teacher tool displayed all eight groups in the class; each student in each group was represented as a color. The color of each group member was also displayed at the top of the app on each student's tablet to distinguish which student was which to the TA. The teacher tool presented the TAs with three categories of information for each group: activity, progress, and location. The three categories of information were derived from previously conducted focus groups with K-12 teachers who had experience using collaborative learning in their classroom. These initial focus groups provided insight into the types of things that more expert teachers looked for in their classrooms, although with recognition that their classrooms differed in terms of content, age of students and frequency, and length of relationship with the students (e.g. most k-12 teachers see their students multiple times a week, for at least one school year, and sometimes for multiple years, whereas TAs are likely to see the students for one 50-minute period a week, for one semester). Thus, their insight provided expert views on teaching collaboration, which needed to be adapted for the context of undergraduate engineering discussion sections.

The first category, activity, was used to visualize how much a student had written on the tablet and was displayed in two ways: student activity and group activity. The student activity (figure 1a) displayed how much a student had written on the tablet compared to the other three group members. The group activity displayed how much each group had written compared to the rest of the groups in the class (figure 1b). This was used to allow TAs to identify if one group was writing more or less than other groups.

The progress visualization indicated how much of the worksheet the group had completed (figure 1c). Finally, location displayed which page of the worksheet each student was on within their group (figure 1d). This was to indicate to the TA if a group was progressing through the worksheet at the same pace or if someone was working ahead or falling behind.

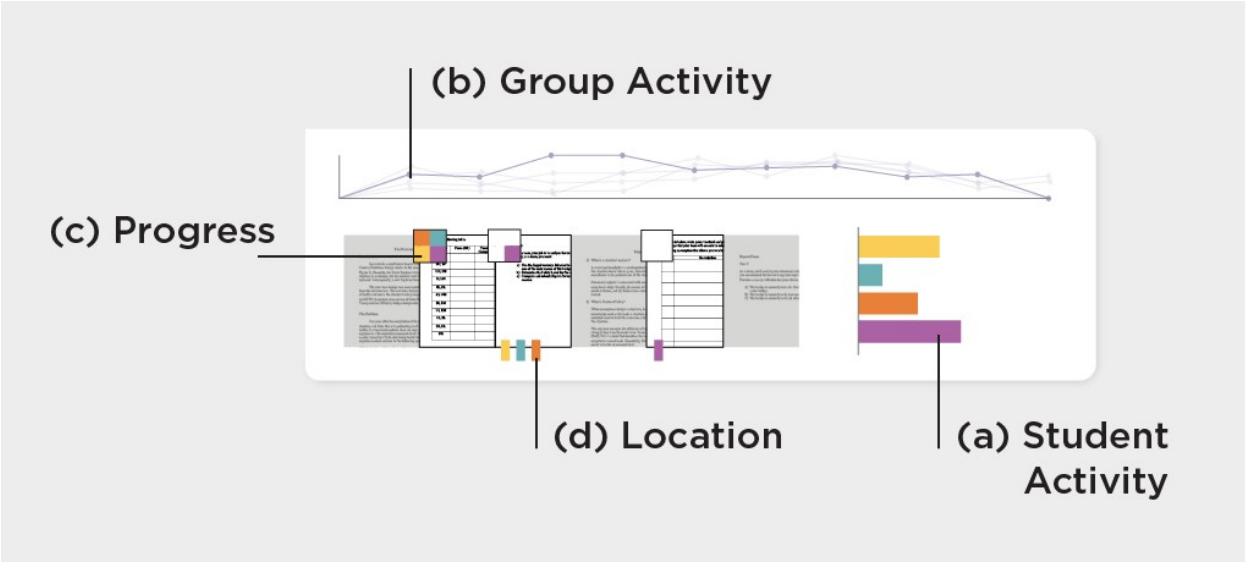

Figure 1: Categories of information in each design. Student activity (a), group activity (b), progress (c), and location (d).

Interview Protocol

Two members of the research team attended each interview, one was the interviewer and the

other took notes. The interviewer used a semi-structured interview protocol. Data was collected through notes and audio recordings. The interviewer gathered demographic information, explained the scope of the project, and introduced the participants to the information being visualized. Participants were presented with different designs for the teacher tool, one at a time, and asked the same questions about each. The questions focused on how participants interpreted the information from the designs and how they thought they would use it in their classroom.

To introduce each teacher tool design, participants were first told to take a few moments to look at all 8 groups being presented, then asked:

a) what can be inferred about these groups,

b) explain the process they would use to analyze the information

c) what would they do after viewing this information.

Once the information was familiar to them, the interviewer introduced the same teacher tool design populated with different data and asked to identify and explain what different groups were doing. The moderator completed the interview by asking:

a) which piece of information is most and least helpful during discussion sessions,

b) would they use the technology in their discussion session

c) what additional features would they want it to have.

Analysis

Emergent themes were identified using notes and audio recordings from the interviews, and discussed among the research team.

Phase 1 Design

Participants were introduced to different teacher tool designs during the two phases of interviews. Phase one (see figure 2) included a range of simplified representations. The first phase of the interview only included group activity, location, and progress; student activity was not included in this phase. Group activity was represented as bar and pie graphs; progress was represented as check boxes, on their own and overlaid on the worksheet pages; a student's location was represented as a dot under the worksheet pages.

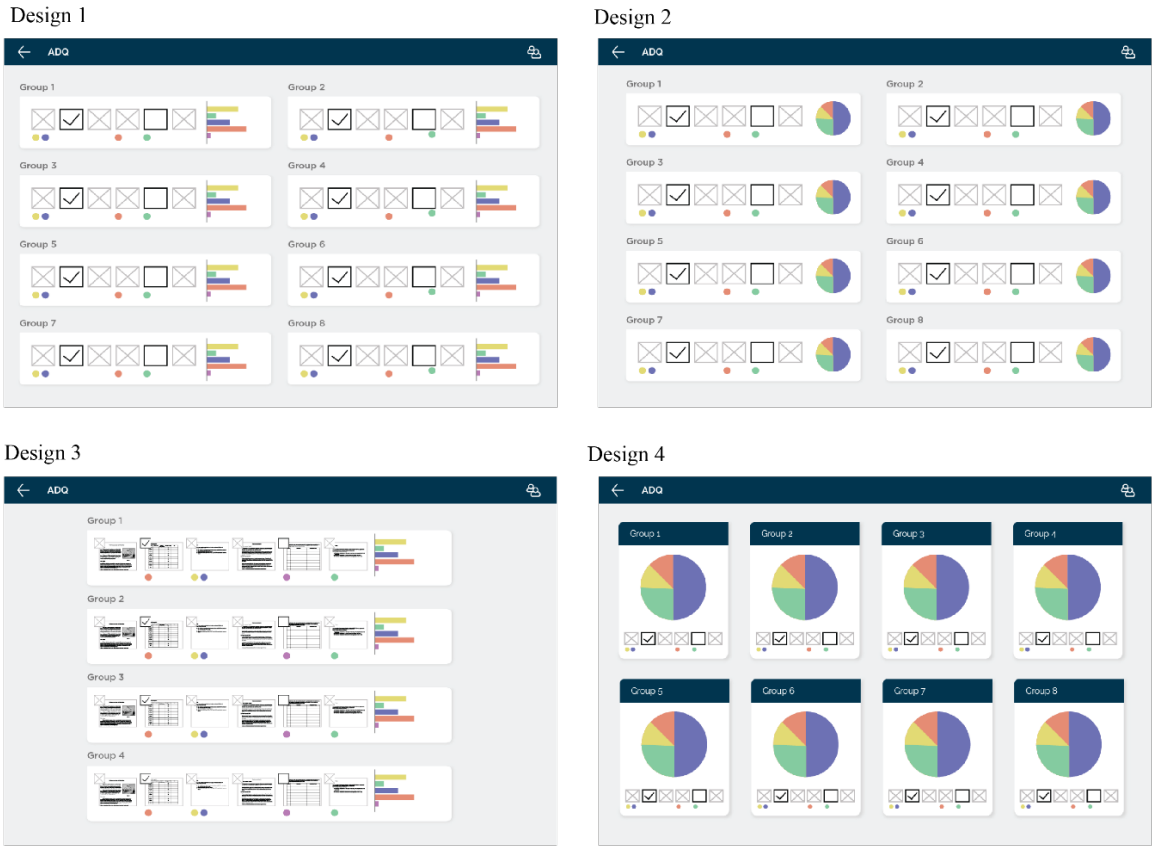

Figure 2: Teacher tool designs in the first phase of the interviews.

Phase 1 Results

During phase one most participants valued the bar chart over the pie chart, because they could easily identify who was working the most among groups. Most participants appreciated the third design because it displayed a preview of the content of each page, whereas in the remaining three options it was difficult to remember what the content of the page was.

In order to determine which category of information (group activity, progress, and location) was most useful, in the first phase participants also gave feedback on which of the three pieces of information would be most helpful in their classroom. Results indicate the majority of TAs preferred activity over the other two, but most saw potential in combination of all three. However, one significant suggestion from the first phase of interviews was to include the difference between individual and group activity. In this first phase, activity displayed how much each student had written compared to the rest of their group, but did not include how much each group had written compared to the others. This allows the TAs to identify groups that may not be working.

Phase 2 Design

With feedback from phase one, we were able to redesign and make changes to the teacher tool designs in phase two. In phase 2 of the interviews, participants were introduced to 4 more designs (see figure 3). Using feedback in phase one, phase two included student

activity and group activity, all designs displayed a preview of the worksheet pages, and used a square tag to indicate location on the pages rather than circles. Progress was visualized using the boxes in the upper left corner. Group activity was visualized as a line graph in all four designs. Student activity was visualized using three different graphs. Design 1 displayed student activity as a bar graph, design 2 as a Gantt chart, and design 3 displayed student activity as a bar graph within the location position, and design 4 excluded the student activity category. All four teacher tool designs included different visualizations and altered layouts for the information.

Figure 3: Teacher tool designs in the second phase of the interviews.

Phase 2
Results

In order to understand which design was most useful, participants in phase 2 chose which of the teacher tool designs was the best option to use in their classroom. Results show that there was a consensus across participants, as the majority of participants chose design 4. However, all participants preferred the student activity visualization in design 3, where it was combined with the student's location. Due to this feedback, the final teacher tool to be implemented in the classrooms was design 4 with the student activity visualization from design 3 (figure 4).

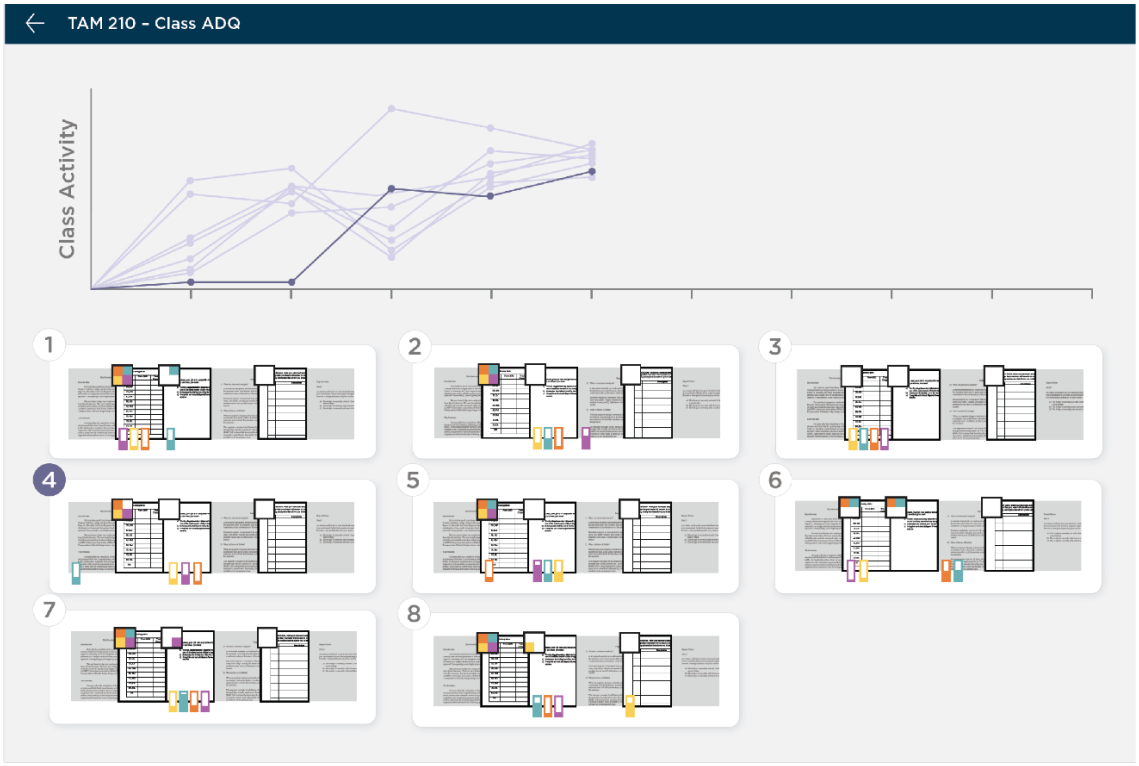

Figure 4: Final teacher tool design.

Discussion

This study set out to understand the perceived needs of TAs to inform the development of technology that will enable them to monitor group processes. To answer the research question, what do teaching assistants anticipate they need in order to successfully support collaboration, we analyzed interview responses. Our overall findings from both phases of interviews, suggest that TAs found more value in the activity category, but that in conjunction with the other categories (location and progress) the tool provides valuable insight to what is happening in groups that would not otherwise be observable. Although, as we know from prior research, TAs have little experience with collaborative work. This may indicate that additional prompts or visualizations may be necessary to help novice TAs know how to intervene with groups (i.e. observing before intervening), not just monitoring what is happening.

To answer our second question, we used the TA's responses in light of our understanding of the literature, to make changes to the design of the software. Many of the responses and ideas from the TAs were consistent with guidelines in the literature. For example, including worksheet pages in the visualizations will reduce working memory needed to remember the content of the pages, using line graphs to illustrate change over time allows TAs to extract patterns without difficulty, and implementing color to signal groups and students will reduce extraneous information from the TAs while also indicating groups that may need help.

Follow up interviews, as well as video analysis of the tool in use, will be used to inform the next stage of design. Future work of this software will investigate how to embed prompts for

TAs to not only identify when collaboration is happening, but understand how to intervene effectively without disrupting group work.

Conclusion

Designing tools for classroom orchestration requires that we consider not only the information we *can* provide, but the type of information that would be *most useful* to teachers, and the manner in which they can easily review this information and make pedagogical decisions based on the information. After completing this study, we also suggest TAs need flexible orchestration tools, where information can be quickly extracted, and adapted as they develop as teachers, in order to allow them to effectively monitor and support collaboration. We also want to emphasize the importance of user centered design. Including the TAs in the design process gave them the opportunity to reflect on their experiences and give feedback on a tool that will be used in their classrooms, this allows the research team to create a tool that addresses the needs of the TAs and their classroom. Bridging the gap between researcher and user introduces a successful collaboration between the two forms of expertise and increases the likelihood of a successful design.

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