Social Comparison Visualization for Fostering Participation in Online Learning

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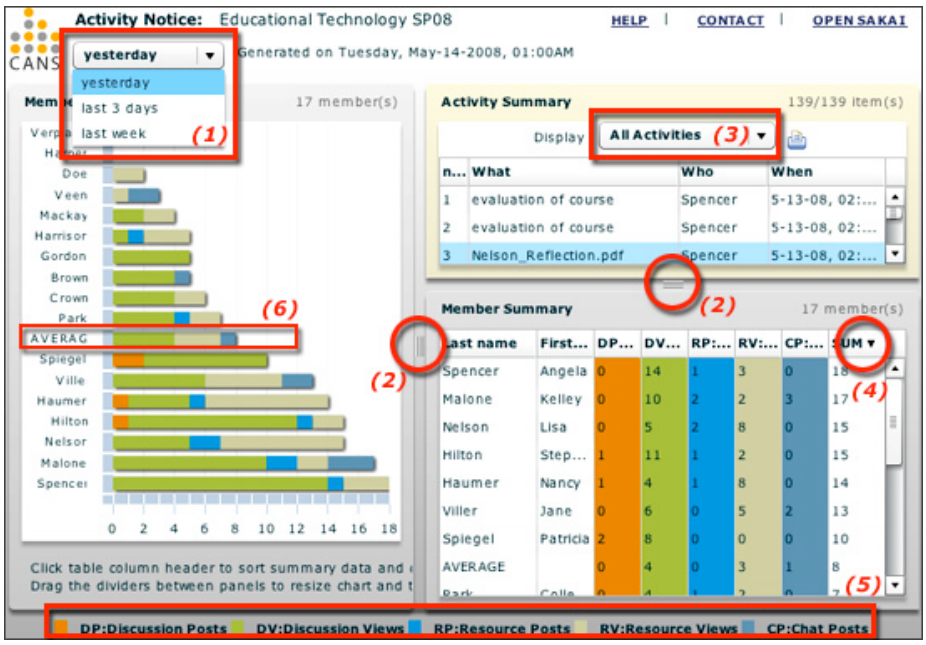
This paper describes the design work and early testing of an interactive visualization tool (IVT) and the use of this tool in online learning and teaching to provide social comparison information. Data were collected through usability testing, interviews, open-ended online discussion and survey methods to examine usability and usefulness of the IVT. We have learned that the IVT helped the students (1) monitor how active they were compared to others, (2) see a whole picture of what was going on in class, and (3) track group member actions while working on group projects. However, some students felt as if they were being monitored and were concerned about creating a sense of competition.

The purpose of this paper is to describe a study of the use of social comparison information and visualization techniques to foster and support active student participation in online learning. The study is part of a broader and long-term design research project to develop a context-aware activity notification system (CANS) to support online learning (Laffey & Amelung, 2007; Amelung, Laffey & Turner, 2007; Amelung, 2005). CANS is a notification system first developed in 2005 being used within the Sakai learning management system (LMS) in order to improve the processes and quality of online education by providing activity awareness information. CANS operates by monitoring activity in the LMS and then providing notifications, such as who has read what documents or what documents are most frequently read, based on rules and subscriptions that intend to make the notification information salient within the context. A key challenge in developing a notification system is the method of delivery so that the information fits the work and learning styles, needs and preferences of the instructors and students. CANS has a number of mechanisms for notification including email digests, static web page reports and online widgets. The study reported here examines an innovative approach to using dynamic visualization techniques along with social comparison information.

This paper describes the design work and early testing of an interactive visualization tool (IVT) and the use of this tool in online learning and teaching to provide social comparison information. The first implementation (Period 1) is the winter of 2008 in which the IVT with social comparison visualization was explored through a usability study with representative users and a pilot test with two online courses, and the second implementation (Period 2) is the summer of 2008 in which the IVT was implemented in an online course throughout the semester.



(1) Select date range for *Member Visualization* and *Activity Summary*
(2) Drag space dividers to resize tables for customizable views
(3) Use drop menu to filter activities in tools
(4) Click column headers to sort table
(5) Display legend for *Member Visualization*
(6) Display average activity of student participation to compare in class

FIGURE 1. *Screenshot of Interactive Visualization Tool*

The IVT (see FIGURE 1) is an interactive way to see and compare student activities within a course in the Sakai LMS. The interaction allows users to customize how they visualize the quantity and relative levels of participation; for example, individual postings and views of discussion, chat and resource tools can be viewed in comparison bar graphs and tables for different time periods (yesterday, last 3 days, last week). It is intended to: (1) provide a quick overview of what is going on in an online class, (2) help students know how much they are doing compared to others, and (3) encourage participation and equality of participation via social comparison visualization. The research questions that guided our design research for this phase are:

1. Is IVT perceived to be easy to use?
2. Is IVT perceived to be useful?
3. How do students use the IVT in online learning?

Theoretical framework

According to social comparison theory, people are driven to compare themselves with others to evaluate themselves (Festinger, 1954). In addition, people often like to know what others are doing in order to perform self-evaluation. For example, Buckingham and Alicke's study (2002) found that social comparison feedback significantly affected self-evaluations of performance.

The social comparison information is essential for group performance (Forsyth, 2000). Ringlemann (1913) first documented the loss of group productivity and social loafing (e.g., free-riding effect), and found that not all people work hard in groups. In other words, group members often compare themselves to other group members; if they perceive the other members are not as hard-working, they tend to decrease their effort. On the other hand, if they find others are hard-

working and by being aware of the individual contributions of the other group members, they tend to work more.

In many online environments, it is often difficult to find such social comparison information. In the design of online LMS, designs which facilitate and encourage online participation is an important but challenging requirement. Several studies show that visualizations can provide social comparison information. For example, Janssen (2007) used visualization that showed each group member's contributions to online communication; this resulted in increasing overall participation rates during computer-supported collaborative learning. George (1992) found that task visibility that shows individual effort tends to reduce social loafing in groups.

Visualizations facilitate analysis and communication of information by amplifying cognition (Ware, 2004). In other words, visualizations help support more abstract cognitive processes, (such as those encountered in social comparison in online environments) by supplementing one's own cognition with a "helper" in the form of a visualization tool. In doing so, the visualization becomes a more natural form from which to glean information and support other decision-making processes. There have been numerous successful implementations of visualizations to support other difficult cognitive processes, such as pictures, animations, diagrams, or concept maps within the field of education. In this study, we implemented visualization to provide social comparison information to support self-evaluation and foster participation in online learning.

Methods

Period 1

Usability testing methodology was used to evaluate the IVT. The usability testing (Nielsen, 1994) involved having representative users perform realistic tasks using the system, while investigators observed and recorded their behaviors and comments. Usability testing was conducted at the Information Experience Lab. To collect data on participants' use of the IVT, we utilized the Morae software. Morae is a comprehensive usability testing and analysis program which enables the simultaneous capture of a user's keystrokes, mouse actions, audio comments and video of the user's facial expressions during computer interaction.

The think aloud method (van Someren et al., 1994) was used to help us understand user actions and gain insight into the design of the IVT. Participants were asked to think aloud what they were attempting to do while engaged in the IVT. These sessions lasted approximately 45 minutes, and brief semi-structured interviews were conducted immediately after each session.

Lastly, we conducted a system pilot testing over a two-week time period in two online courses, and sent out an online survey to get the student feedback. We also created open-ended discussions in the two courses in order for students to freely post any comments and for us to learn about the students' perceptions about using the IVT. Following the usability testing and pilot testing, quantitative and qualitative data were analyzed and summarized, and revisions for design of the IVT were made.

Period 2

To explore social comparison through visualization in online learning, we conducted a mixed analysis of quantitative and qualitative data. We implemented the IVT in an online class to evaluate in-context usefulness of the tool. We asked the students to use the IVT throughout the online course, and conducted an online survey at the end of semester. For the quantitative analysis, we employed the Technology Acceptance Model (TAM) questionnaire that contains perceived ease of use and perceived usefulness in using a system within social context (Venkatesh & Davis, 2000). The TAM has been widely used to elucidate user intentions and social impacts in using information technologies.

Data Collection

To investigate usability and usefulness of the IVT, we collected data through usability testing, interviews, online discussion boards and online surveys over the two periods.

Period 1

In the winter of 2008, we developed a high-fidelity prototype and conducted usability testing with representative users using scenarios and think-aloud techniques. We then implemented the IVT into two online classes between April 14th and May 14th for a system pilot testing, and conducted an online survey to get student feedback. We requested a total of 34 students, who were taking the classes, to do the survey and collected 16 responses. Based on the usability study results and feedback, we modified the IVT between May 1st and June 6th.

Period 2

In the summer of 2008 starting on June 16th, we implemented the modified IVT in an online class and asked students to use the system throughout the summer semester. An online survey was distributed via email to 35 students who were taking the online course, and 31 responses were collected at the end of the semester. The questionnaire included 33 questions, grouped into four categories in the following orders: (1) TAM-perceived ease of use, (2) TAM - perceived usefulness, (3) open-ended questions, and (4) demographic questions. In order for us to gain a more in-depth understanding of using the IVT in class, we interviewed five students, who agreed to participate our study, and conducted a focus group interview with three instructors at the end of semester.

Results and Implications

Period 1. Usability Testing Results

From the usability testing, we found that the interface of the system was friendly, easy to understand and pleasing to use, and the users liked the visually appealing graphs and interactivity of the system. The users preferred visual representations of activity awareness information as the most useful and effective method when compared to the textual formats used in our email digest.

With the visualization, the users reported that they were able to quickly get a snap shot of the activity of class, which had been a difficult and time-consuming process in other online classes. However, the users did not immediately recognize interface features, such as space dividers and sorting, and they found some abbreviations in the tables difficult to remember. For design improvement, we decided to add mouse-over tips and video tutorials to the IVT (see APPENDIX A).

Period 1. Pilot Testing Results

The online survey responses from the system pilot testing showed that 100% agreed that the IVT was easy to use, 87.5% agreed that the IVT was visually appealing, and 62.5% said they would recommend the IVT to others. However, 50% chose to disagree to use the IVT frequently. The analysis of the student survey data and feedback (Table 1 and Table 2) showed that the students experienced positive feelings about visualization features and interactivity but at the same time they reported negative emotions, such as privacy concerns and competition, in using the IVT.

TABLE 1. *User Survey* (n=16)

Questionnaire	Mean Value	Standard Deviation
1. I would use IVT frequently	2.81	1.42
2. IVT is easy to use	4.25	0.45
3. IVT visually appealing	4.19	0.83
4. I would recommend IVT to others	3.16	1.20

Note. 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, 5 = strongly agree

TABLE 2. *Student Feedback Summary and Design Considerations*

Summary	Student Comments	Design Considerations
Prefer visual format and interactive features comparing to text format of email digest	"I like this more than the emails because it is interactive and more visual." "What's nice about having a visualization tool to represent collected data is that you're able to start looking at various patterns of action" From a teacher's perspective, I can see how I would find it useful. I see the report as making learning visible.	Enhance visualization in more comprehensive, informative and intuitive ways
Lead to social comparisons	"This is very useful. I think there are obvious and interesting social comparison questions to be asked. Am I more motivated to read and post, now that this is there? Yes" "I think the report naturally leads to some social comparisons… Having the IVP aggregate the digest solves this problem and lets you easily see how you compare with the others."	Visualize comparisons more effectively without feeling of competing or threatening
Concern about privacy issue - feeling like being monitored	"It's probably pretty obvious by now that I don't like being monitored." "It feels like a huge invasion of privacy for me." "My beliefs regarding privacy feel violated by such reports. I believe that each person has the right to internalize knowledge in a private manner unless they explicitly give up the right to do so."	Consider privacy issues and create more friendly environment, for example, wording "Activity Trends" rather than "Activity Report"
Do not mind privacy issues	"I don't mind the privacy issues. You get a sense of how active people are in this class anyway." "I don't have much of a problem with privacy with the IVT, unless instructors started trying to use activity counts as a means of assessment." "I don't have any trouble with the privacy. To me, anything you do on the	

	web is NOT private."	
Do not see meaningfulness in learning	"I don't see the value of allowing students to monitor each other's clicks. It has nothing to do with learning." "I am not sure that it would be meaningful or purposeful for me. It seems to make the class into a contest." "I'm more concerned with what people produce and the depth of their thinking than with how many things they click in the online environment."	Make visualization more meaningful in doing coursework
Concern about misuses	"I think statistical and notification tools could be misused by instructors who don't understand their nature.... and end up disenfranchising a student." "I'm also curious to see if students will manipulate the statistics and change their behavior online in ways that don't contribute to the value of the discussion." "I haven't started changing my behavior online, but I'm starting to think about it. I used to print out class materials but now I just take a look online instead of wasting paper."	Provide a clear purpose of the system use to avoid any misuses.

Period 2. User Experience Study Results

The online survey result showed that students found (1) the IVT was easy to use, (2) using the IVT helped them to be more productive students, (3) the information provided by the IVT helped them gain a big picture of the learning tasks and activities in the course, and (4) the information provided by the IVT gave them a clear sense of what others were doing in the learning activities. In the following, the qualitative analysis results of users' responses from the open-ended questions and interviews about the experiences of the IVT are presented according to the research questions.

Background of Participants

The backgrounds of participant experiences in online courses ranged from low (their first online course) to high (over twenty courses), and the participation level in their current course ranged from low (logging in only one or two times a week) to high (logging in several times a day). There was no distinct pattern evident in the participant responses based on experience or participation level.

Beneficial Aspects of the IVT Overall

Two large beneficial aspects arose regarding the use of the IVT: (1) the ability to see who, what, where, and when and activity occurred, and (2) having the site activity distilled into one location. Those that found these aspects beneficial were able to make decisions based on purposes that were important to themselves and their roles, such as where to go or what was important to view.

The IVT allowed participants to see who was active, who looked at what object or item (e.g. discussion post, chat post, resource item), and around which objects or items there seemed to be a lot of activity. Students found it very useful to use the Activity Summary, which represented which individuals were looking, opening, viewing, or replying various "objects" (e.g.: discussion forums, chats, resources, assignments). However, it was less important for

students to know who was doing the activity than it was important to know what they all were doing. As one student stated, it was the "wisdom of the masses."

> "I thought it was a really good idea as far as being able to judge where people were really focusing, especially the discussion, showing where the discussion was."

> "I would just see who and what was going on. Discussion posts, resource posts, stuff like that. Like what was everyone checking? What were the most clicked-on? During the semester there would be a whole bunch of people's unit five, that's what they had opened."

However, instructors were more interested in seeing the activity of the individual. The IVT helped instructors to answer such questions as: "Is this student active?", "Did this student read the Unit 1 directions?", and "Who participated in Forum A?". Instructors could then provide more appropriate and customized feedback or assistance to students based on the information they received from the IVT.

> "Usually I only look at this [visualization] so I can see, 'Oh, this student is reading the discussion board or not. Oh, this student is reading the resources or not.' That's it. So if I can see that the student is reading something, it means they're doing something."

> "One time, with one of the assignments the resource was already there from the second assignment. This was about mini project 2. He said, 'Oh, I couldn't find it!' But I knew it was already in that unit. So I was curious; I tried to find it [in the IVT] and then I saw the student already read it! I could see that this student didn't pay attention. I didn't say that I was spying on him from here, I just told him the information and that I believed he already read it...That way I can answer the student's questions since I already know the student read it before."

While it might seem that there was a dichotomy between how students and instructors used the IVT, when the students were involved in online collaborative group work, the students began to also focus on the activity of the individual. Those involved in collaborative group work often found the social comparison information a useful tool for knowing if their group members were working, present, and active.

> "I have mixed feelings about the activity notice, but there are good things about it. Especially when working in groups. It's nice to be able to see if your partner has logged in, and what's going on."

Another useful aspect of the IVT was its ability to compile information about the entire course activity into one place. Participants who sometimes felt information was scattered about throughout the site often felt that using the IVT enabled them to get a quick overview of the activity, what was important, where to go, and what likely needed to be done next.

> "I really enjoyed being able to see what was going on in one page without having to make fifteen or more clicks to see all of the information like how many posts there were, or where people were going."

Ambivalence Regarding Social Comparison Visualization

Participant experiences of the social comparison visualization, both at the student and instructor levels, involved enjoyment of the social comparison, confusion, and even dislike or aversion. The variation in responses was not only across individuals but also within individuals. Often confusion about the visualization's purpose, intent, and possible interpretation were underlying the vacillating responses of participants.

Depending on the participant's perspective of the visualization, their sensitivity about the tool and influence by the tool would differ. Three main views were held by participants: (1) IVT as an awareness tool, (2) IVT as a means to judge others and be judged by others, and (3) IVT as a form of comparison or possible competition. Depending on the view they held, their reaction to the visualization would differ.

The smallest number of participants viewed the tool as a means solely to gain awareness of social activity. These students felt comfortable with their name being represented with their activity level and each action performed. Additionally, instructors who saw this as an awareness tool also were comfortable with showing their activity to students.

> "[I mainly looked at] what my participation level was compared to other people's. That's really about it. I saw that I was kind of obsessed about looking at the discussion and stuff."

The next largest number of participants viewed the tool as a means to measure amount of performance against another to compare or possibly compete. Usually these students thought of the graph more as a game and wanted to "out participate them all."

> "It makes me want to step up my 'active' discussion and chats when I look at the activity of a few other students...I have a way to document my participation and view others as a means of comparison and to better help understand what I could or should be doing more of on Sakai."

However, the largest number of participants seemed to fear that the tool may be used as a means to judge others and be judged. Some students logged out early to not appear at the top of the list and seem "like a teacher's pet", while others tried to restrict their clicks to ensure they would stay "average" and not "look like a weirdo." Many students were afraid that the instructor would interpret high participation to mean the student is working harder or producing higher quality work, and felt that the bar graphs were "unfair." Some instructors did not want their participation shown online fearing that students may judge or interpret their type or level of activity negatively.

> "I didn't want to appear like I was on it all day, so I started logging out...I didn't want to be the person who spent an enormous amount of time on it."

> "I used it to just make sure that I wasn't overdoing the class. Like I didn't want to be the person who was on there the longest. I wanted to make sure I was kind of average. I didn't

want to be the teacher's pet. It really stuck out if you spent too much time looking and browsing."

"One thing the activity notice can do for you is it can tell you quantity but it can't say anything about the quality of posts."

Most participants did not fall into one category completely, and most said they enjoyed looking at the social comparison information, even though most students thought it was "an invasion of privacy" or "gossipy." The enjoyment of seeing the visualizations combined with a feeling of violation or invasiveness often led to confusion as to the purpose and fear about how it would be interpreted.

"I thought it was something that was really cool...but I don't know if it was totally useful. It's really cool...but I'm not sure that it really fulfilled my needs. I was impressed, but I wasn't sure if it would be useful or not."

"I like the bar that showed you how much activity you had compared to other people. But my question always was...what does that mean?"

"I actually felt like I was spying on other people, and it kind of bugged me. It kind of bugged me throughout the entire semester."

"It's an extremely impressive application, but it feels like a huge invasion of privacy for me. More importantly, I don't see the value of allowing students to monitor each other's clicks. It has nothing to do with learning."

Usability

The usability feedback was highly positive regarding the visual nature of the IVT interface, but differed greatly between students and instructors regarding its usability. Participants thought the IVT interface was "colorful", had "cool" interactivity, was highly visual in nature, and provided more information than the traditional email digest. While students often felt the IVT was easy to use, instructors often felt frustrated at its lack of flexibility to search or filter content, focus in on certain students or "drill down", or export data for further analysis. Most participants mentioned the inability to click on an item in the activity summary and be brought to that item (e.g.: chat post, resource, discussion forum).

"I would make these linkable for sure. I would make whatever that was referencing, it would be a link to that. And hopefully as far as possible, not just the topic or the discussion topic, but it would be as deep as you could go. Ideally, it would be a link like if I clicked on the unit, it would pop up so I could download the PDF so I wouldn't have to mess around."

Depending upon the participants' bandwidth, the IVT could be experienced as bulky, heavy, or sometimes "taking forever to load," which led to negative impressions and lessening use of the IVT.

Improvements needed for future

Students expressed a desire to have less "individual-oriented" features (a visualization on student participation) and more "object-oriented" features (visualizations on activity level of forums, chats, downloaded resources, etc.) In this manner, they felt the IVT would then serve as a one-stop location where all the important activity to them is distilled. The inability to click on an object and be brought to that object was something to be improved.

> "If it said [in the visualization] for unit 5 there was a whole bunch of people checking that, that's exactly what you're looking for. You're like, 'I know, I should probably be checking this...' Wherever people were, that would be a good indicator of where you should be in general. Because you don't really need to know how much someone is posting, I mean I don't know what that is even important."

Instructors liked the social comparison visualization, but needed much greater flexibility in regards to searching, filtering, exporting, selecting particular students to view, and drilling down into the data for further exploration.

Design Implications

Based on participants' experiences, the following design considerations summarize the major lessons learned from our study.

- *Keep the privacy level high*. Provide an object-oriented view of class activity rather than an individual-oriented view (e.g., showing individual names) to avoid privacy concerns and feeling of competition.
- *Address flexibility needs of instructors*. Provide searching and filtering mechanisms for greater flexibility and customization.
- *Locate where the information is*. Include direct links to course materials and discussion boards acting as another way of social navigation using social comparison information.

Educational Importance of the Study

Online learning in education is becoming more ubiquitous. Due to the lack of face-to-face interaction, the need to facilitate awareness of what others are doing and to foster participation is key in improving the quality of online experience. By providing activity awareness notifications, students are able to be aware of what others are doing around them such as who read what documents or what documents are most frequently read, and therefore are able to make informed inferences about their environment and their peers.

While previously this information has been displayed in text form, the IVT displays this information visually. The visual nature of the IVT takes tremendous cognitive load off of the student by summarizing the activity of peers and displaying it in a manner which encourages social comparison.

Social comparison has been a way for helping students self-evaluate their own progress and participation. By making this visual as well as interactive, students are able to quickly and easily support their own self-evaluation of progress self-adjust their participation according to that self-assessment.

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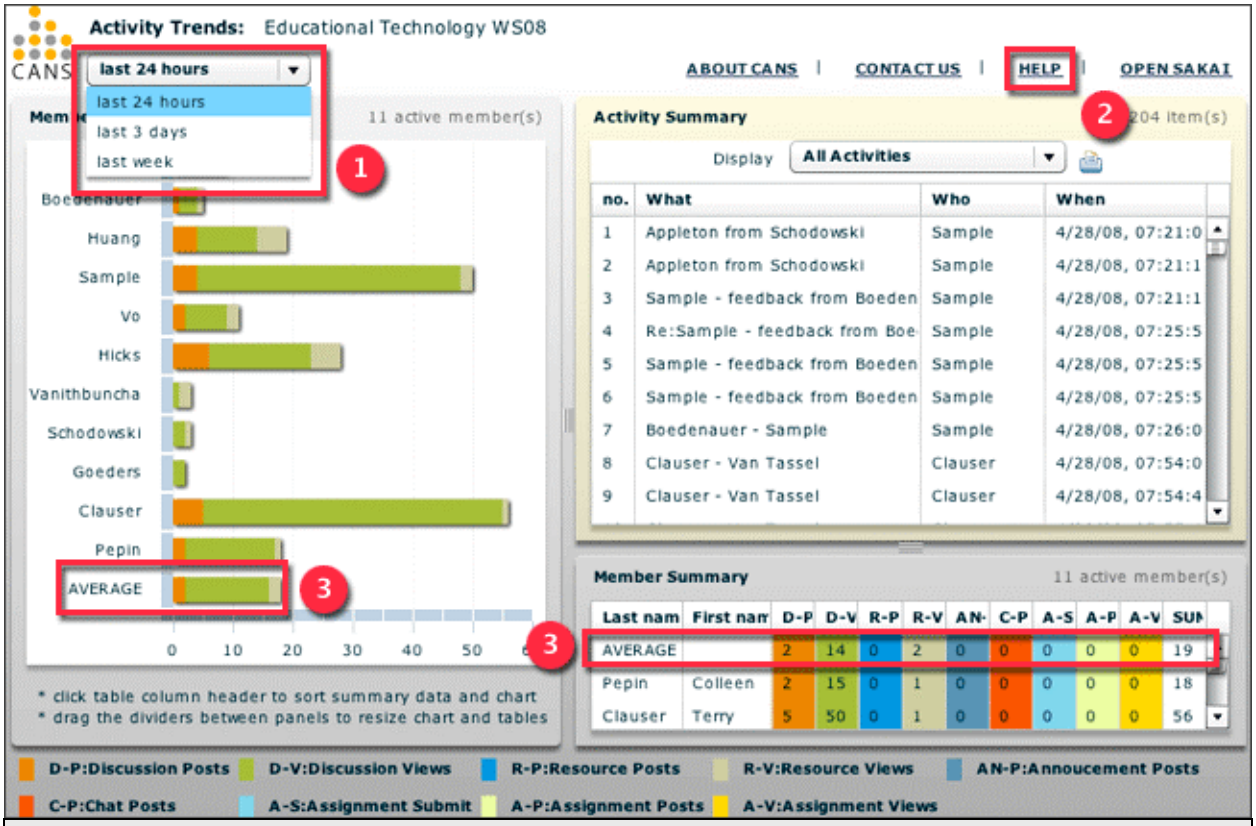
APPENDIX A: Period 1. Usability Testing Results - IVT Design Revision



❶ Add 2 more view options – last 3 days, last week
Even though the daily activity report provides useful information, 100% of users mentioned the desire to see a longer period of activity information.
❷ Add HELP (see the HELP content in the next page)
The users did not immediately recognize the table sorting function and space dividers to resize the chart and tables.
❸ Add the average of activity to the member summary and visualization
Some users mentioned the desire to see the average of activity in the visualization tool.
❹ Remove line chart
The line chart did not provide useful information.
❺ Add tool tips with full description over the table column headers in the Member Summary
The users mentioned the desire to see tool tips over the column headers (DP, DV, etc.) tell what each stood for so that they don't have to scroll down to see the legend.
❻ Replace the title with *Activity Trends*
Some users felt like an invasion of privacy with the visualization tool, and some users felt like being graded. Using words, such as report or monitor, provided a judgmental or uncomfortable feeling. Delivering a friendlier, informative and sociable environment will be the most important and central challenge in further development.