ABSTRACT

DYNAMIC MEASURING TOOLS FOR ONLINE DISCOURSE

by
Jeffrey S. Saltz

When evaluating participation within an Asynchronous Learning Network (ALN), current best practices include counting messages and reviewing participant surveys. To understand the impact of more advanced dynamic measurement tools for use within an ALN, a web-based tool, known as iPET (the integrated Participation Evaluation Tool), was created. iPET, which leverages Social Network Analysis and Information Visualization techniques, was then evaluated via an empirical study. This research demonstrates that using a tool such as iPET increases participation within an ALN without increasing facilitator workload. Due to the fact that active online discussion is a key factor in the success of an ALN, this research demonstrates that dynamic measuring tools for online participation can help ensure a positive outcome within an online learning environment.

DYNAMIC MEASURING TOOLS FOR ONLINE DISCOURSE

by
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To my family – who understand the importance of education and the pursuit of dreams.

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CHAPTER 1

INTRODUCTION

This dissertation first reviews online discussion forums and their use as an asynchronous learning network. This is followed by a brief overview of visualization and social network analysis, and how these domains have been applied to help understand participation within an online discussion context. Then, one application area, online learning, is explored. Within an online learning context, instructors need to establish mechanisms to understand, encourage and judge student participation – which usually requires devoting significant time and effort to review, measure and grade student participation. Included in the section reviewing online learning is a categorization of current methods used to measure online student participation.

A web-based tool, iPET (the integrated Participation Evaluation Tool), that was created as a result of this research, is then discussed. iPET aims to enable facilitators (ex. instructors) to more quickly and accurately understand, and where appropriate, grade participation within an ALN. A set of hypotheses are then explored and the results of an empirical study on the value of iPET within an online learning environment is then discussed and reported upon.

In brief, the results of the study demonstrate that when instructors have access to enhanced student participation information, their confidence in understanding student participation (and participation grades given to students) increases. Instructors gain this increased understanding without increasing their workload. In addition, when students have access to customized participation reports, their motivation for online discussion increases and they post more messages within the ALN (for discussion focused courses).

Taken together, this research demonstrates that using dynamic measurement tools for online discourse increases participation within an ALN without increasing facilitator workload. Due to the fact that active online discussion is a key factor in the success of Asynchronous Learning Networks [Hiltz & Turoff, 2002], this research demonstrates that dynamic measuring tools for online discourse can help ensure a positive outcome within an online learning environment.

CHAPTER 2

LITERATURE REVIEW

2.1 Asynchronous Learning Networks

An Asynchronous Learning Network is a collection of people that use asynchronous / different location Computer Mediated Communication tools to communicate, collaborate and in general, act as a knowledge repository for the group [Hiltz & Benbunan-Fich, 1997; Schrum & Benson, 2000]. These online communities are used in a variety of application areas including:

- *Public discussion boards*: Web sites such as groups.msn.com, groups.yahoo.com and internet newsgroups are widely used to ask questions and share information on a wide range of topics.

- *Corporate knowledge repositories*: Communities of practice are used within and across firms to capture and share information [Majchrzak, Rice, King, Malhotra & Ba, 2000]. While getting employees to share knowledge is often a challenge, discussion boards, or ALNs, can be a key tool used to capture and share that knowledge.

- *Online learning*: Distance courses have been the most common application of ALNs [Hiltz & Turoff, 2002]. The growth of online learning is compelling. For example, the current usage of online classes is triple the usage from just a few years ago [Galt, 2001].

This dissertation focuses on how one can better measure online discourse. First it describes some foundational computer mediated communication theories, the previous research related to understanding online discourse and some of the potential domains which could be useful to aide in understanding online participation. It then more deeply discusses the challenges in measuring participation within online learning. This is followed by an explanation of the research model and the key hypotheses put forth in this proposal. Finally, the paper concludes by describing a tool (iPET) and the methods used to test the hypotheses that were previously discussed.

2.2 Media Richness Theories

Media Richness theories examine the strengths and weaknesses of different media (ex. face-to-face, telephone, web conference boards). Understanding these theories provides a framework to better recognize the tradeoffs of various communication paradigms. One of the first media richness theories was the Information Richness Theory (IRT) [Daft & Lengel, 1986], which focuses on the 'bandwidth' (amount of information) that a communication channel can deliver (from sender to receiver). So, for example, one can communicate more information in a face-to-face discussion as compared to a telephone conversation (where one loses the ability to see facial expressions and body language).

Rice and Love [1987], as compared to Daft & Lengel, focused on 'social-emotional' content within Computer Mediated Communication. They examined the postings within a public computer conference and noted that approximately 30% of the postings had social-emotional content. In other words, while the communication was not as rich as Face-to-Face (F2F) discussions, people still found a way to communicate not just facts, but also broader social discussions. Ngwenyama and Lee [1997] expanded the view of social-emotional content by defining a Critical Social Theory (CST). CST states that understanding the reason behind the message is just as important as the actual message. More generally, Ngwenyama and Lee state that "CST views people not as passive receptacles of whatever data or information that is transported to them, but as intelligent actors who assess the truthfulness, completeness, sincerity, and contextuality of the messages they receive". In CST, email can have a higher media richness as compared to a written presentation, due to the fact that a dialog can occur so that the receiver of the information can test the validity claims of the message (in addition, the use of paralinguistic cues in messages are frequent with regular users and are used to convey social emotional content).

Finally, Media Synchronicity [Dennis & Valacich, 1999] extends IRT not by looking at the reasons and validity of the communication (as CST does), but rather, by categorizing the dimensions that one could use to rate a communication channel. So, where IRT had two dimensions for a 'rich medum', Media Synchronicity has five key criteria: (1) Immediacy and (2) Symbol variety are leveraged from IRT, but added to these are (3) Parallism (4) Rehearsability and (5) Reprocessability. Dennis and Valacich noted that to resolve equivocality, one must first convey information and then converge on an answer. Low Synchronicity media (i.e. media with high reprocessability and rehearsability – for example web boards) are best for conveying information, and high synchronicity media (i.e. media with high immediacy – for example face-to-face, phone) are best for converging to a common understanding.

2.3 Process Gains and Losses

Nunamaker evaluated the pros/cons of F2F and Electronic Meeting Systems in terms of process gains and process losses [Nunamaker, Dennis, Valacich, Vogel & George, 1991]. The key process capabilities that introduced process gains and losses were anonymity, parallelism, media effects (such as media richness) and group memory (including being able to think/rehearse before adding to the conversation, and being able to review/reprocess previous comments). In Media Synchronicity Theory, one can think of anonymity as a form of symbol variety (media richness). In other words, using the Media

Synchronicity Theory as a foundation, one can explain the intuitive observations concerning the trade-offs of F2F discussions with computer mediated discussions. Table 2.1 and the subsections below summarize Nunamaker's process gains/losses in the context of Media Synchronicity Theory applied to ALN.

Table 2.1 Media Synchronicity Theory Evaluation Criteria Applied to ALN

MST Evaluative Criteria	Process Gains (ALN strengths as compared to F2F)	Process Losses (ALN weaknesses as compared to F2F)
Immediacy		"login-lag"
Symbol Variety	Anonymous and "Pen-name" comments	Use of facial expressions and other "richer" media
Parallism	Student can respond without influence (ex. "hidden answer")	
Rehearsability	Review, edit before posting	
Reprocessability	Re-read discussion from instructor/student; encourages reflective thinking	

2.3.1 Gains Using an ALN

- *Parallelism* – The ability to let everyone respond to a question without bias. An instructor can post a question to a conference and let (or require) all students to respond to that question. In addition to letting all students respond to a question, an instructor can also 'hide' all responses until a certain date/time, thus enabling all students to respond before they can compare and contrast answers.

- *Reprocessability* – The ability to 'reread/study' a message/conversation. A computer conference provides a written record that people can re-read and allows one to reflect and review the information presented. F2F conversations do not have this attribute. This can be even more important when the discussion is in a language in which the student is not completely fluent.

- *Rehearsability* – Time to think/review an answer (i.e. to be able to reflect on an answer before providing the answer to the class). In a F2F class, one cannot ponder and edit a potential answer before supplying that answer to the class. Using ALNs, students do get the opportunity to review their answers before posting to the class.

- *Anonymity* – The ability to communicate without knowledge of who is posting which comment. In web conferences for example, one can often post a comment 'anonymously' or with a pen name. This allows people to not be influenced (either consciously or subconsciously) by other people's relative status and also allows people to more freely post ideas without, for example, having to worry about 'sounding stupid'.

2.3.2 Losses Using an ALN

- *Media Effects/Immediacy* – The feedback using asynchronous CMC (email, web conferences) does not occur as quickly as with F2F (ex. typing speed, 'login lag'). This can cause people to become frustrated, and in general, slow the pace of the conversation.

- *Media Richness/Symbol Variety* – Even with the web and its ability to use 'bold' and other text attributes, F2F meetings offer the ability to use body language and other forms of communication not possible using CMC. This "richer" communication can impact the conversation in a positive or negative way. Using CMC, one must actively read pages of text and then write responses to achieve an interactive dialog. This is typically more difficult than what is required for F2F discussions, where one needs to just listen to the conversation and respond naturally.

- *Anonymity* – The ability to communicate without knowledge of who is posting which comment can enable some of the class to 'free-ride'. Pennames can alleviate some of the free-riding.

From a Media Synchronicity perspective, the trade-offs comparing ALNs with traditional F2F can be summarized below.

- *F2F discussions*: Media Synchronicity suggests that F2F has high synchronicity. However, the high information content (i.e. rapid symbol variety) can lead to information overload for those who would benefit from the ability to reprocess the information presented.

- *ALN*: Media Synchronicity suggests that these tools are good for conveying information by allowing parallism, rehearsability and reprocessability, but low for synchronicity and hence, lower marks for converging on ideas (due to poor immediacy and information richness).

2.4 Factors that Impact Discourse Quality

While media richness theories help to explain some of the factors that can influence the discourse process, there are additional factors that also impact the quality and quantity of the discussion. For example, Hiltz [2005] notes three factors (Pedagogy, software, and motivation) that support the growth of an ALN. A related set of four factors is listed below:

- *Technology*: Since media richness theories focus on technology capabilities such as bandwidth, media richness theories just explain the strengths and weaknesses of potential communication media. However, how that technology (or communication medium) is applied also has an impact on participation quality. In other words, the user interface within an online discussion forum can encourage more active participation or confuse users and hinder their participation. For example, one study found that the reply size differed in systems with different interface designs because one design insisted on asking for a reply after every new item was delivered – so there were many short replies, while another design did not force a reply, and hence received fewer, but longer, replies [Hiltz & Turoff, 1981]

- *Social emotional factors*: While Ngwenyama and Lee's [1997] Critical Social Theory notes that understanding the intentions of each participant is an important factor to consider when evaluating communication media, group dynamics (such as trust and common goals) also have an impact on the level and quality of participation. For example, it has been noted that subject matter experts participating in a corporate knowledge repository can be hindered by employees feeling threatened by their loss of their 'unique' knowledge [Hariharan, 2002]. A related challenge exists in a learning environment, where students often feel they are competing for grades and are therefore less willing to cooperate (as compared to a situation where students were not concerned about grades).

- *Task and objective*: The actual topic, task and objective of the conversation directly drives (or inhibits) motivation. In other words, if people agree with the objectives of the collaboration, and are interested in the discussion topic, they are more active in the discourse than those who are not interested in the topic or do not agree with the objectives of the conversation [Williams & Pury, 2002].

- *Facilitation and leadership*: There is a clear correlation between leader facilitation / participation and group participation [Hiltz & Turoff, 1993]. In addition, within many settings, it is possible to require participation. For example, many instructors require class participation [Sener, 2001; Spiceland & Hawkins 2003; Schrum & Hong, 2002].

2.5 Measuring Online Participation

Measuring online discourse can improve participation by impacting social emotional factors – such as making it clear to students that their grade is a function of the quality and quantity of their participation; or, in a corporate knowledge repository, tying employees' quality and quantity contributions in the knowledge base to performance evaluation and salary increases. The sharing of participation evaluation information, to the individual contributors, has also been demonstrated to improve participation. Specifically, Hiltz & Turoff [1993] described the application of a simple measure (the 'number of questions answered by each participant'). Hiltz & Turoff explain that a group of a hundred legislative science advisors were collaborating in an online environment. Initially everyone asked questions to get information and very few supplied answers. Then, when the membership information was expanded to show, for each individual, how many questions each person asked and how many questions each person answered, there was a significant increase in the number of questions answered.

2.5.1 Dimensions of Measurement for Online Discourse

There are two dimensions that can be varied with respect to measuring online discussion:

- *Measurement window:* The time period for the dialog is being evaluated. For example, within a 'chat' session, one can measure who has contributed within the past 2 minutes. Within an ALN, one might measure participation during the past week, or cumulatively for the entire year.

- *Frequency of measurement*: How often one can / does perform the measurement. For example, if one uses questionnaires and other participation surveys, one can create a point-in-time snapshot / measurement of the discourse (discussion). However, if one can measure discourse by using system generated information (ex. log files, content of dialog), then it is possible to generate new measurement reports on a dynamic, as needed, basis (real-time or any desired regular interval).

This categorization is summarized in Table 2.2. The benefit of dynamic measurement is hypothesized to be that one can take a measurement at an instance of time which can provide insight into the evolving collaboration (i.e. while the discourse process is taking place). In addition, while it is valuable to have a measurement window of 'point-in-time' when using online collaboration such as chat, when using an ALN, it might be more valuable to understand the historical view of participation. For this reason, the rest of this paper focuses on measuring the dynamic historical view of online discussion forums.

Table 2.2 Frequency and Time Window of Measurements

		Measurement Window (Length of time for Measurement)	
		Point-in-time	Historical view
Frequency of Measurement	Static snapshot	List of users who responded to a specific question*	Survey based SNA**
	Dynamic	List of current users*	Log file / content based SNA**

* Can be performed repeatedly, but it still is a point-in-time snapshot.
** Social Network Analysis

2.5.2 Advanced Tools to Measure and Understand Online Discourse

A review of previous research aiming to improve productivity and accuracy with respect to understanding and measuring online participation yielded the categorization shown in Table 2.3. The two key domains that have been explored are social network analysis and information visualization. Before describing the research that yielded the categorization in Table 2.3, the next two sections provide a brief overview of social network analysis and information visualization.

Table 2.3 Categorization of Research Attempting to Understand CMC Postings

Area of Study	Visualization	Social Network Analysis (system-based)	Social Network Analysis (Survey-based)	Other
Newsgroups (includes chat)	Chang [2002], Donath [1999, 2001] Fisher [2000]	Chang [2002]		
Distance learning / ALN	Ramani [2000] Picciano [2002]	Aviv [2003] Nurmela [1999] Palonen [2000] Martinez [2002] Reffay [2002, 2003]	Haythornthwaite [1998, 2000] Martinez [2002]	Thaiupathump [1999] (agents) Anderson[2001] (content analysis)

2.6 Social Network Analysis

When computer networks link people, as is the case within an Asynchronous Learning Network, a social network is created [Wasserman, Salaff, Dimitroya, Garton, Gulia & Haythornthwaite, 1996]. This network can be defined by having a 'directed connection' from the student who wrote a reply to the student / instructor who wrote the initial message that generated the reply. Social Network Analysis (SNA) is used to study/understand the structure of social interactions within a group and focuses on the relationship between individuals (sometimes known as actors), as opposed to the individuals themselves or the actual content of the information exchanged between individuals [Wasserman & Faust, 1994].

2.6.1 Analyzing a Social Network

When describing a network (as opposed to the relations/ties within the network), one can discuss the network in general – whole networks, or focus on one specific person – the 'ego' centered network [Wellman, 1993].

- *Whole Networks*: Whole network analysis focuses on the occurrence and non-occurrence of relations among all members of the population. Whole network analysis can show which members of the network act as central figures, bridges between groups, or are not well connected to other members of the network. Whole network studies examine questions such as 'Who talks to whom'.

- *Ego-centered Networks*: An ego-centered network is one where the focal point of the network is an individual, and other members of the network are described with respect to the focal point of the network. The ego-centered approach works well if one wants to focus on a specific person, or if the population is large and hard to define.

2.6.2 Social Network Analysis Concepts applied to an ALN

The simplest and most intuitive social network calculation is *degree centrality,* which is the measure of interaction regardless of the send/receive directionality (i.e. it measures the volume of activity/messages) [Palonen & Hakkarainen , 2000]. Table 2.4 summarizes this calculation and some other simple and intuitive SNA measurements. It also explains how these calculations might be applied within an ALN context.

Table 2.4 Key SNA Measures Mapped to an ALN

Methodology	Description	Application to ALN
Whole Network Analysis		
Network Density	The ratio of the number of observed ties in the network to the number of possible ties [Garton, Haythornthwaite & Wellman, 1997].	Limited application
Network Clustering	Identifying sub-groups in the network (also known as cliques) [Reffay & Chanier, 2003].	Observe whether work teams create clusters
Ego Centric Analysis		
Degree Centrality	Volume of activity, regardless of send/receive directionality [Palonen & Hakkarainen , 2000]	Count messages written and replies to those messages
In Degree	How much a person is the recipient of directed messages from others [Palonen &Hakkarainen, 2000].	Number of replies generated by a student's messages
Out Degree	Number of messages sent by the person [Ramani & Rocha, 2000]	Number of posts by a student
Number of Relations	Number of unique people that sent messages to that student [Palonen & Hakkarainen, 2000].	Number of different students responding to a student's postings

2.7 Information Visualization

Information visualization addresses the transformation of non-spatial or behavioral data into visual images [Bederson & Schneiderman, 2003; Tegarden, 1999]. In other words, information visualization is concerned with generating images (often interactive applications) for data that does not have an inherent geometric representation (ex. number of messages, grade per message). A glyph (or symbol) can be considered the basic building block within visualizations [Bullen, Chang, & Ham 2002; Stump, Yukish, Simpson & Bennett, 2002]. For example, the symbols in Figure 2.1 are possible building blocks for creating visualizations. Some glyphs can connote information within the actual glyph (ex. happy face vs sad face).

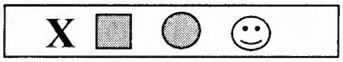


Figure 2.1 Sample glyphs.

Bertin [1983] introduced the concept of encoding information within a graphic, in what he called *retinal variables* (ex. color, size, position). Determining how to encode information within a visualization often requires understanding the type of attribute one is trying to encode. Specifically, a data element can be statistically described as having one of the following four levels of measurement [Stevens, 1946]:

- *Nominal*: An unordered set of categories. For example, gender {Male, Female} has two categories that have no order associated with the two categories.

- *Ordinal*: An ordered set of categories where differences can not be calculated (or are not meaningful). An example could be student letter grades {A, B, C,...}.

- *Interval*: The data is continuous and differences are computable, but there is no inherent absolute zero. An example would be calendar dates or a Likert-type scale on a survey.

- *Ratio*: The data is continuous and both differences and ratios can be computed. Ratio data has an inherent absolute zero. An example would be average number of replies.

Nominal and ordinal data provide less information content than ratio data. However, nominal data is the easiest for humans to accurately estimate. While one can compute a median and quartile rankings for nominal and ordinal data, computing means and differences is not possible. A ratio is meaningless for interval data – a student with a 4.0 GPA can not be said to be twice as good as a student with a 2.0 GPA. However, one could state student "1" had twice the average number of replies as compared to student "2". Combining the statistical properties of data attributes with Bertin's key retinal variables (such as color and size) creates the following potential mapping from data attributes to retinal variables.

2.7.1 Color

One can modify the color of a glyph to represent a change in a data attribute. The attribute could be nominal, ordinal, interval or ratio. For example, as shown in Figure 2.2, nominal data can be shown as a set of distinct colors. Ordinal data can be shown as distinct colors, with the same hue and varying the amount of brightness/lumination. Finally, interval and ratio data can be shown as a continuous range, again by varying the brightness/lumination.

Nominal Data	Ordinal Data	Interval, Ratio Data
		

Figure 2.2 Use of color.

It is important to note that 8% of the male population, and 0.5% of the female population, have some form of color deficiency, mainly red-green colorblindness [Hess, 2000]. One way to mitigate this problem is to use a gray scale (i.e. varying from black to white).

2.7.2 Size

The size of a glyph can also represent a change in a variable (attribute) that is ordinal, interval or ratio. However, size should not be used for nominal data, in that size implicitly suggests an implicit ordering. As shown in Figure 3, ordinal data can be displayed as distinct sizes, with the larger sizes representing "more of the variable". Interval and ratio data can be shown as a continuous range, again by changing the size.

However, care must be taken when using size, since it is often not clear what visual variable is being manipulated. For example, in Figure 2.3, the size attribute could be used to define either the area of the circle or the radius – hence size is better at showing trends, but exact comparisons are difficult (i.e., it is not clear if one should compare the area or the radius).

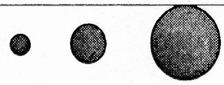
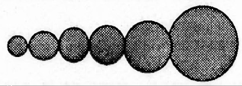
Nominal Data	Ordinal Data	Interval, Ratio Data
Not Applicable		

Figure 2.3 Glyph size.

2.7.3 Position

In creating a visualization with multiple glyphs, a key encoding attribute can be how those glyphs are positioned within the visualization. Attributes that are nominal should not be displayed using position / location information – typically the location implies an ordering. While ordinal data attributes can be used to map glyphs to a location, interval and ratio data are usually more appropriate. This is due to the fact that location is typically a continuous attribute.

While the debate of using 2D or 3D position (and hence 2D or 3D visualizations) has been studied extensively [Sebrechts, Vasilakis & Miller, 1999; Schronhage, Van Ballegooijy & Eliens, 2000], there does not appear to be one correct answer on which is better [Gershon & Eick, 1998]. Since 3D offers an additional degree of freedom, the use of 3D enables designers to create visualizations that express more information within the same image. However, the key question for the design of a visualization is not how much information can a visualization expert put into an image, but how easily a user can understand the information presented in the image [Saltz & Steinbach, 1997].

Complicating this discussion is that, as has been noted by Sebrechts et al., inexperienced users are significantly less comfortable with 3D visualizations (as compared to experienced users). Since many information visualizations are focused on conveying information to people who might not be conversant with 3D manipulation, 2D visualizations might be more appropriate.

This challenge in using 3D visualization has been confirmed by a case study of business process visualization [Schronhage, Van Ballegooijy & Eliens, 2000] in which an application using a 2D visualization was compared to a similar application that used 3D visualization and 3D interaction widgets. The results of the study showed that while it is possible to display additional information within a 3D visualization, there is an increase in visual complexity and an associated increase in the amount of user training required. For many people, understanding 2D visualizations is simpler because it is easier to navigate through the visualization, there is no occlusion of the visualization, and users do not tend to become disoriented (as they do when viewing a 3D visualization). While there are situations in which using 3D graphics might be appropriate, for users not used to 3D navigation, 2D information visualizations are likely to be more effective and easier to understand.

2.7.4 User Interaction

Many of today's visualizations can be thought of as visual data mining, where one creates interactive visualization systems [Eick, 2000]. These interactive systems offer interaction techniques such as filtering, zooming and multiple views [Bederson & Schneiderman, 2003]. Due to presenting less information "on the screen", these techniques make it easier to understand the information presented.

By integrating user interaction within visualizations, one is able to create effective data insight and navigation information systems [Stolte, Tang & Hanrahan, 2002]. One way to achieve filtering for ordinal and ratio data is through the use of dynamic filters [Ahlberg & Schneiderman 1992, Ahlberg & Schneiderman 1994], which allow the user to interactively eliminate unwanted values (i.e. through the use of sliders).

CHAPTER 3

RESEARCH ON THE MEASUREMENT OF ONLINE DISCOURSE

To measure and understand participation within an online discussion forum is a time consuming task [Lazarus, 2003]. The problem is not gaining access to data (each message is easily viewable within a web conferencing system), but rather, having too much data (too many messages to easily understand the participation patterns) or information being presented in a non-intuitive manner (e.g., can only view one message at a time). This is an example of information overload, which is a well documented and growing problem [Nelson, 1997], and was previously discussed with respect to computer-mediated communication [Hiltz & Turoff, 1985].

Visualization can be an effective way to ease information overload [Keim, Rothleder & Simoudis, 2002] and can be used to help unlock the insight that can be gained through the use of advanced analytics (such as Social Network Analysis) [Kohavi, Rothleder & Simoudis, 2002; Stolte, Tang & Hanrahan, 2002]. As was previously discussed, Table 2.3 shows the reported research that uses social network analysis and/or visualization to try to improve one's ability to understand participation. This research (to better understand and measure online participation) has been applied to two main domains – online learning and participation within internet newsgroups. These research ideas are summarized in the following sections.

3.1 Previous Research Visualizing Newsgroup Postings

Similar to many web conferencing systems used for ALN-based distance learning, newsgroups are threaded asynchronous discussions. Donath [Donath, Lee Boyd & Boler, 1999; Donath, Karahalios & Viegas, 2001] focused on identifying rhythms in an online conversation. Donath noted that it is hard to see rhythms when reading old postings of an online conversation and that this causes a loss in conversational context. Donath calls the visualizations created *social visualization* (visualization of social information, which deals with inexact subjective material). This is contrasted to *data visualization* (where at least the actual numbers to understand are well-defined). Two social visualizations that might be useful within a DL context are the conversation landscape and the loom:

Conversation landscape: Each person is represented as a vertical line (the x-axis represents different people), and time is represented by the y-axis (as shown in figure 3.1). Each comment is represented as a horizontal line (longer lines are for longer messages), at the height representing the creation time for the message. The user of the system can select a message, and the conversation thread (across people) will become highlighted.

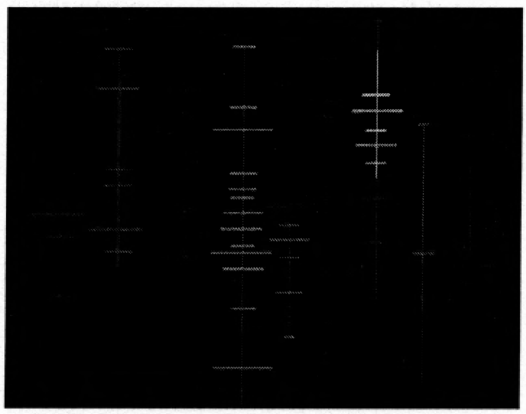


Figure 3.1 Conversation landscape.

Loom: Like the conversation landscape, students are represented across the x-axis and the y-axis is time. However, rather than lines for each student, one can think of the Loom as a grid, and the grid element has a color if the student wrote a message at the specified time/date. The color code can represent type of content (as was done in the article), or another attribute such as number of replies (as was done by Ramani and Rocha [2000] within a DL context).

Fisher [2000] created newsgroup visualizations to help readers understand the 'branches' of the conversation within the newsgroup. This was done by showing how the thread branched out into multiple conversations. This visualization can be seen in figure 3.2, where a small part of alt.folklore.urban is shown. Time is represented along the x-axis, and the y-axis represents different authors of a newsgroup. By viewing the structure, as opposed to the content, Fisher's visualization follows a social network analysis approach. While this visualization can show the interaction between authors for a given thread, for many casual observers, this visualization can appear non-intuitive. In other words, this visualization shows the challenges of trying to display a large amount of 'conversation' in visualization.

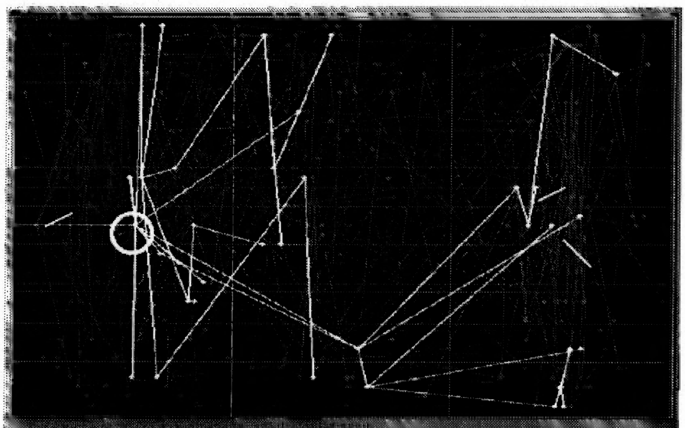


Figure 3.2 Fisher's branches of newsgroup threads.

3.2 Previous Research Visualizing Student Participation within an ALN

Picciano [2002] provides an example of current practices for displaying student participation (Figure 3.3). In this view, the cumulative number of postings (messages) written by each student (i.e. outDegree) is shown in a simple line chart.

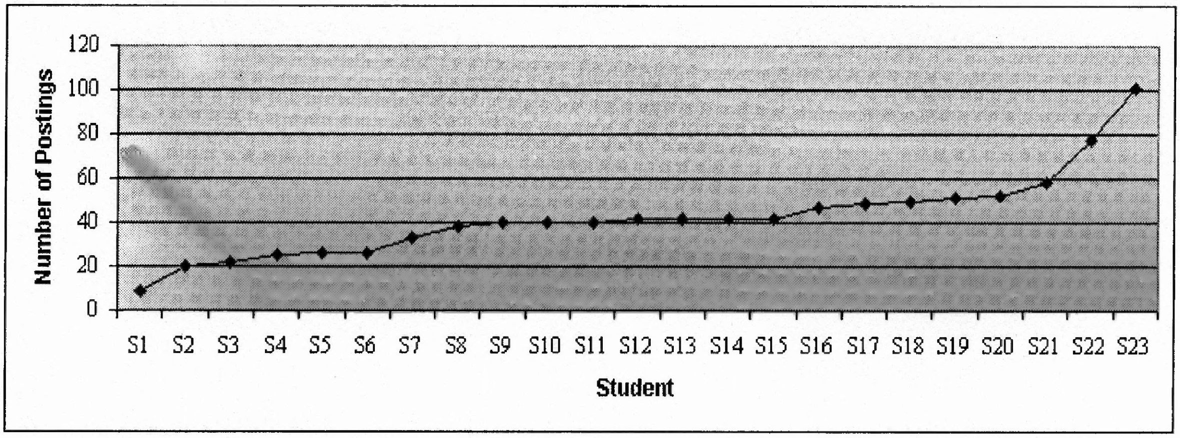


Figure 3.3 Picciano's charting of the number of messages for each student.

Ramani and Rocha [2000] describe software developed to allow an instructor to easily see student participation within a DL class by using charts and graphs to display student participation over different time periods. The tool allows the instructor to understand, for example, which students were not actively participating in the class. Ramani states that in a F2F class, it is easy to see if/when a student withdraws from the class (body language, not showing up to class, ...). However, in an online distance course, tools need to be created to allow instructors to easily see which students are withdrawing from the conversation. The graphs created by Ramani are based on number of messages/replies to messages and provide a simple way to get a quick understanding of the *frequency* of student postings. The visualizations include:

View 1: A barchart (one bar for each student, the height is the number of messages in the specified time period). The teacher is shown in a different color.

View 2: a 2D grid (heatmap) is shown in figure 3.4, with each cell representing a student for a given day. The students vary across y-axis, the different days (ex. for a semester or for a month) vary across the x-axis. The cells are color coded by the number of messages, displaying which students are active posters on a regular basis. This view could also be used with the cell representing the number of messages in a given time frame (ex. weekly).

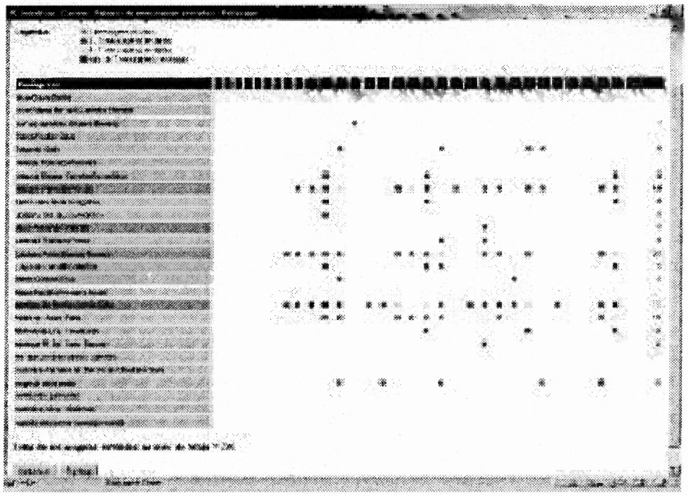


Figure 3.4 Ramani's heatmap of student participation.

View 3: A graph is shown, where a node represents each person. An edge exists between two nodes if there was a message between those two students. When a node is selected, that node and its edges are highlighted (to show who has interacted with that student).

View 4: This visualization tries to show the 'reply/nested' structure of conference systems. For each person, one can have color-coded dots, where a green dot represents a posting of a root item, and red dots represent follow up replies. This can be shown in a table where students are up and down the y-axis, and the x-axis represents different message categories. Within a cell (a specific student for a specific topic), one could have one green dot and several red dots (i.e. follow-up postings).

3.3 Previous SNA Research Applied To Internet Newsgroups

Chang [Chang, Chen & Chuang, 2002] described a new way to browse newsgroups that is based on information visualization and social network analysis. Chang viewed the whole network (i.e. all the people posting in a newsgroup) through a visualization (shown in Figure 3.5), in which:

- Each node represents an author
- The node size represents the number of articles written by the author
- Edges between two nodes represent that there have been messages between the two authors

- The node's gray level represents a 'prestige degree'. Note that if a person has a high prestige, then that person gets more attention from others. It is related to the number of people reading and responding to posted articles, and also how prestigious are the people who did respond (it is a recursive definition).

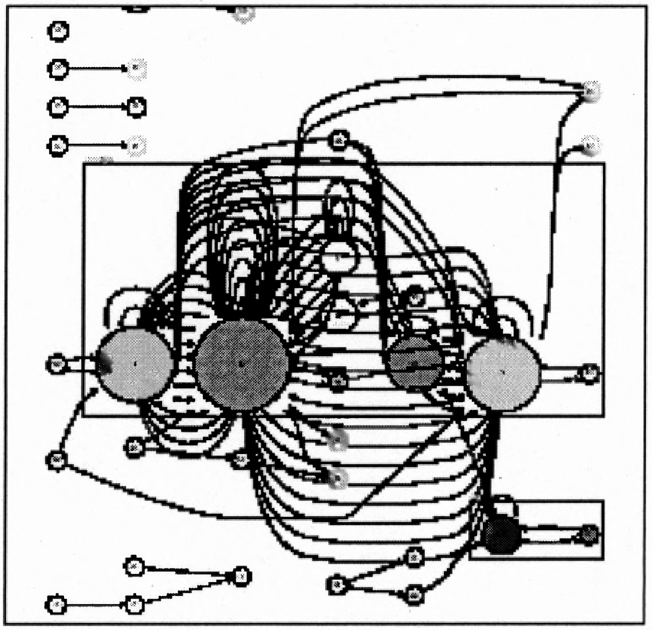


Figure 3.5 Chang's graph of a newsgroup.

3.4 Previous SNA Research Applied to ALN

While there has been some research on applying Social Network Analysis to Distance Learning/ALN, much of that work has been focused on understanding the entire network of the DL class. In other words, research on SNA applied to ALN has been focused on trying to understand the network created within the DL class (i.e. whole-network analysis).

Haythornthwaite [1998, 2000] investigated computer mediated communication and distance learning by using traditional social analysis data gathering techniques such as conducting a survey on a class of DL students and then analyzing the network. Using the framework described in Table 2.3, this can be thought of as an historical static measurement of participation. Specifically, four small classes (~15 DL students) were surveyed three times during a semester. Each student was surveyed on how often they worked with other members of the class, received information from other students, gave advice to other students, or exchanged emotional support with other students (during the previous month). Haythornthwaite noted that students tended to maintain contact with 11 to 13 other students. In addition, Haythornthwaite found that students with strong ties were more satisfied with the class.

Nurmela [Nurmela, Lehtinen, & Palonen, 1999] examined log files created during an online class of 18 students. The students were given 18 case assignments to be done in pairs using a web-based collaboration tool. The log file for the web-based tool supplied “log-events” for tasks such as "Finished making a new document", "Finished editing a document", "Reading a document" and "Added a comment, question, link or keyword to a document". Nurmela reported results using UCINET [2003] network calculations for degree centrality (also known as Freeman’s degree) and betweeness for each class member. The degree measures gave a good intuitive description of how active a student was in the network. For example, some students were active in both sending and receiving messages and others mainly just received messages from the instructor. Nurmela’s main result was noting that using log files, one can get an understanding of the pattern of interaction within a web-based discourse, and in particular, identify central figures within the discourse.

Palonen and Hakkarainen [2000] described the interaction of 28 students who were in 5th and 6th grade. The social network was constructed by determining the direction and frequency of interaction between students (i.e. reviewing the electronic messages written by the students). UCINET [2003] was used to calculate standard SNA calculations (ex. density, centrality, MDS). This information was then used to understand patterns of interaction within the class (such as boys tend to send few messages to girls, and boys tended to interact with average and above average boys – which was different than for girls, who interacted with other girls of all ability levels).

Martinez [Martinez, Dimitriadis, Rubia, Garrachn & Marcos, 2002] described a system for converting event logs from a DL class, of approximately 100 college students using a web conferencing system, into an adjacency matrix. Martinez conducted a whole-network analysis (ex. density and centrality) on the resulting matrices. In addition to examining log files, student surveys were also administered to the class. It was observed that the DL tools were mainly used as a means for communicating information between students and the instructor (with occasional use between students).

Aviv [Aviv, Erlich & Geva; 2003] examined web conference usage through social network analysis to compare two different ALN-based distance-learning paradigms (structured vs unstructured ALNs). Each condition was used within one college-level business ethics class. In the structured condition (which had 18 students), active participation was required. In the unstructured condition, students could choose to use the ALN, but it was not required, nor was credit given for participation (19 students chose to participate). Aviv computed network attributes such as centrality and cliques to demonstrate that structured ALNs create a better learning environment because in the structured ALN class, more students belonged to more than one clique. This "bridging of cliques" allows for greater information sharing between students.

Finally, Reffay and Chanier [2002, 2003] discussed a Distance Learning Management System (DLMS) to decrease the workload of the instructor (when teaching a distance learning class). The analysis was conducted on a class of 40 students (divided into 4 sections) during a professional development course on "French as a foreign language". It was suggested that the system could show the structure of learning groups – and help identify warning signals in student interaction (i.e. when a student needs to become more involved). Just as with other published research in this area, Reffay did not focus on the individual student, but on the activity of the group as a whole. In particular, using email messages (but ignoring conference postings), Reffay identified clusters and cliques within the DL class, as shown in figure 3.6. Furthermore, Reffay investigated networks with and without the instructor. As one might expect, the instructor was an active participant in the class, and without the instructor, different/smaller cliques were identified (as compared to doing network analysis with the instructor as part of the class).

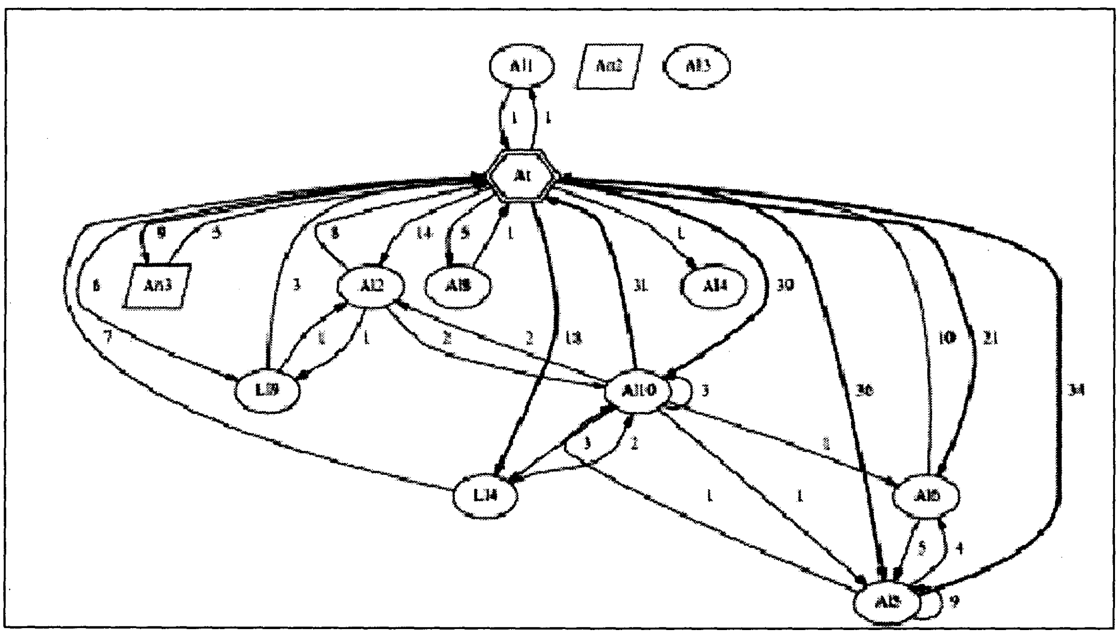


Figure 3.6 Reffay & Chanier's network for a subset of students in a DL class.

CHAPTER 4

AN EXAMPLE: ALN-BASED DISTANCE LEARNING

This section explores ALN-based distance learning, which, as was previously mentioned, is one of the more common uses of online discussions [Hiltz & Turoff, 2002]. The section starts by providing some background information on distance learning and then discusses the importance of active participation within an ALN-based course. It concludes by explaining why providing dynamic measuring tools can help improve instructor productivity, while at the same time, increase the quality of the participation grade and the quality of the actual student participation.

4.1 Importance of Active Student Participation

Over the years, much has been written about the effectiveness (or lack of effectiveness) of distance/online learning. Active participation is important for two reasons. First, it is a critical component of collaborative learning and second, it helps increase the immediacy of the ALN: in order to be in a collaborative environment, one must be actively involved in dialog. In addition, by ensuring active communication (ex. student participation through web postings) in the ALN, the immediacy increases, and so, the class's ability to converge to a common understanding of the information being studied is improved.

Based on these ideas, it is not surprising to find that when investigating distance classes that use collaborative online learning (i.e. properly using ALNs), the evidence is compelling. For example, it has also been shown [Coppola, Hiltz & Rotter; 2004] that to ensure a successful online course, instructors need to establish trust early in the semester.

Understanding and facilitating student participation early in the semester can be a key to establishing this trust. In fact, there is a consistent theme reported: for students to get the most out of online learning, the students need to be active participants within the ALN [Achtemeier, Morris & Finnegan, 2003; Brown 1997; Hardless, Lundin & Nulden, 2001; Ragan 1999; Roblyer & Weickie, 2004; Shea, Fredericksen, Pickett, & Petz, 2001; Spiceland & Hawkins 2003; Swan 2001]. Hiltz [Hiltz & Turoff, 2002] sums up these findings as

> "when students are actively involved in collaborative (group) learning on-line, the outcomes can be as good as or better than those for traditional classes. When individuals are simply receiving posted material and sending back individual work, the results are poorer than in traditional classrooms".

As an example of these findings, Hiltz [Hiltz & Turoff, 2002] reviewed nineteen studies comparing ALNs with traditional F2F classes. The studies used measures ranging from objective grades to subjective surveys. Hiltz reported that the "evidence is overwhelming that ALNs tend to be as effective or more effective than traditional modes of course delivery at the university level". In fact, a strong correlation has been found between an instructor's requirement for discussion and a student's perceived learning [Jiang & Ting, 2000]. In a related finding, Diaz & Cartnal [2000] reported that online students would collaborate more if the instructor provided more structure/guidance.

4.2 Student Participation Paradigms

To ensure all students are active participants, many instructors require class participation [Sener, 2001; Spiceland & Hawkins 2003; Schrum & Hong, 2002]. This is partly because some students will try to avoid posting and partly because some students do not have a realistic understanding of their actual level of participation. For example, Picciano observed that students with low interaction thought that they actually had a high level of interaction [Picciano, 2002]. Hence, it would be helpful to give those students (i.e. the ones with lower participation) active feedback (in an unthreatening manner) on how they are participating, and/or require active participation by all students.

There are many different ways in which an instructor can require class participation. Most of these methods can be thought of as a form of the 'Digital Socrates' method of instruction [Coppola, Hiltz & Rotter, 2002]. Below, some of the more common Socratic participation methods are described.

4.2.1 Group Question – Hidden Answers

Using the group question – hidden answer technique, everyone has to post an answer by a certain date. However, none of the answer postings are visible until after the due date. The hidden answer reduces the domination/influence of the early class replies and forces independent thinking on a complex problem. One can then build an active dialog by having other students respond to the postings and discuss the differences of their answers.

Vinaja and Raisinghani [2001] describe two related web conferencing student interaction techniques. In the first technique, the instructor posts a question and then each student answers the question. In the second technique, students are required to post questions, which are then answered by other students. These two interaction methods serve different purposes – having students create questions gets students to broadly review the material in the course, while answering a question tests if a student understands a particular concept. Vinaja noted that students using the first technique read more message postings, but students using the second technique obtained higher grades in the class. As one can tell, these techniques can be used in conjunction with the 'hidden answer' capabilities previously discussed as well as the critique method discussed in the next section.

4.2.2 Question – Answer – Critique

Ehrmann and Collins [Ehrmann & Collins, 2001] describe a 'best-practice' interaction paradigm. This method requires that each week, each student would (1) post a question, (2) respond to another question, and (3) comment on another response. A related technique, described by Shen for use in final exams, can be used as a general participation paradigm [Shen, Hiltz, Cheng, Cho & Bieber, 2001]. In this technique, a student posts a question, another student is assigned to answer the question, and then the first student critiques (or grades) the answer. This is similar to the Ehrmann & Collins method, but the third comment is a critique of the answer to the question that student posted.

4.2.3 Chunking

The act of requiring students to post comments on a key point of the lecture (or chapter in the text book) is known as chunking – the student has to write about a specific 'chunk' of text. Compared to the other forms of participation, this technique often generates less student participation. This is because, while each student does generate a posting once per week (or whenever required), other students usually do not read the postings, and very few replies to student postings are generated – in other words, there is often very little dialog among students.

4.3 Instructor Workload

As one might expect, monitoring, responding to and grading student postings can be a time consuming process for the instructor. For example, Lazarus [2003] reported that when teaching an online class, participation in discussion groups and grading student postings takes more than 50% of the instructor's total time to teach the class. This time commitment can be demonstrated in the following example – if there are 25 students in a class, and each student posts five messages/week, then the instructor must read 125 postings/week (assuming the instructor reads all the student postings). If it takes, on average, two minutes to read each message (some postings are long, and some require the instructor to respond to the message), then it will take 250 minutes/week (4.1 hours/week). Note that currently, instructors might have to read postings twice – once to review and possibly answer the posting, and then again when it is time to grade the student's class participation grade. Note also they might average more than 2 minutes/student posting.

The demand on instructors teaching online courses has been noted in many articles, and was summarized by Crumpacker [2001], who provided an overview of the literature related to this topic. In one extreme case, professors reported spending 40-60 hours per week for a 2 credit class [Schrum & Benson, 2000]. Typical of current practices for running a DL course was the practice described by Bramucci [2001], which noted "at the end of the semester, use searches to collate each student's contributions to the discussion boards (overall quality is easier to assess if all the messages are grouped together)".

4.4 Measuring Student Participation

In comparing the results of different teacher-student ALN interaction paradigms, Vinaja [Vinaja & Raisinghani, 2001] used the number of messages posted and the number of messages read. There was no effort to review/quantify the quality of the postings, nor the impact the postings had on other students. While "number of messages" is a possible measurement of student participation, when an instructor requires student postings, one must be careful to avoid rewarding students who are posting simple comments with little value. In other words, as noted by Jaffe [1997], in order to achieve a good grade, some students will generate "superficial and non-substantive" postings.

To better understand the alternatives currently used to measure student participation, an analysis was performed in fall of 2003 on the reported distance-learning empirical studies documented in the knowledge repository at www.alnresearch.org [Zhang & Hiltz, 2003]. This knowledge base contains more than 100 studies and aims to include all published empirical studies of ALN that meet a minimal set of conditions (e.g., present results, include at least 20 subjects). Table 4.1 describes the seven participation evaluation methods as well as the number of studies using each method.

Table 4.1 Review of Reported Results of ALN Studies on www.alnresearch.org

Participation Evaluation Method	Description	Number of Articles*
Student Survey	Ask students for perceived level of participation (of themselves or other students)	34
Count Messages	Number of messages written by each student	19
Count Replies	Number of replies received from other students (for a student)	3
Log File Analysis	Evaluate log files from the computer conferencing system (ex. number of logins, time using the system)	7
Coding	Content Analysis using expert Judges	11
Observation	Case or field study with observations from researcher	9
Advanced	Methods such as automatic content analysis, social network analysis, visualization	1

*an article can use more than one method

While the majority of DL-based studies did not mention how to measure or understand student participation, the two methods most commonly used to understand participation were *counting messages* and *student surveys*. A third, *log files analysis*, is closely related to counting messages. As has been discussed previously, both counting messages and student surveys have inherent challenges. When counting messages, one will count / value superficial messages [Jaffe, 1997]. When using student surveys, one can obtain biases. For example, students with a low number of postings may perceive and report a higher number of postings than they actually contributed, and conversely, students with a high level of interaction perceived themselves to have made fewer postings than they actually made [Picciano, 2002]. In short, Picciano found that "student perceptions of their interaction in a course need to be viewed with a bit of caution".

Another participation evaluation method, *content analysis*, was used by eleven studies and does provide an accurate means to understand student participation. In fact, Lazarus [2003] describes a grading criterion that is a form of content analysis. Lazarus's analysis includes initiating a new (relevant) topic, posting to a topic more than once, using personal/professional experiences as examples, and responding to/extending another classmate's message in a way that carries the concept a step further. However, performing content analysis is well known to be a time consuming task, and it is not typically done within a distance learning class. Methods to improve instructor productivity when reading / grading student postings are discussed in section 5.

The research described in Table 2.3 presents examples of the 'advanced participation evaluation method' in Table 2.6. Note that, due to the fact that there has been no empirical study on the effectiveness of these concepts/tools, the papers describing these advanced concepts (i.e., the methods discussed in Table 2.3), were not part of the categorization discussed in Table 2.6.

CHAPTER 5

DESCRIPTION OF THE DYNAMIC MEASURING TOOLS

A web-based set of tools for measuring online discussion, known as the integrated Participation Evaluation Tool (iPET), has been built to support the process described by the integrated participation evaluation framework. Within a distance learning environment, the tasks in which iPET can be used include:

- *Course startup*: During the first few weeks of the semester, instructors need to quickly identify students not actively participating. iPET can be used to quickly identify students not active in the dialog, or just posting contentless postings. The instructor would use this information to reach out (perhaps through email) to those students not participating at the desired levels of quality and quantity.
- *Throughout the course*: During the course, the instructor will be reading and responding to student postings. With the use of iPET, the instructor can quickly add a grade or comment to all, or just a subset of student postings. Since the grading feature is integrated within both the iPET browser and the web conferencing software, the time taken to add these student grades/comments is very small.
- *Semester grading:* At the end of the semester, and perhaps several times during the semester, the instructor needs to determine a class participation grade. iPET can be used to facilitate understanding each student's class participation. To determine a class participation grade, the instructor could view the student postings and associated grades within any of the student views – most typically either within the message timelines or the expandable list views

5.1 System Architecture

Figure 5.1 shows the logical components of the system. The tool is implemented using a combination of Java and JavaScript, and can be seamlessly integrated with commercial web conferencing systems.

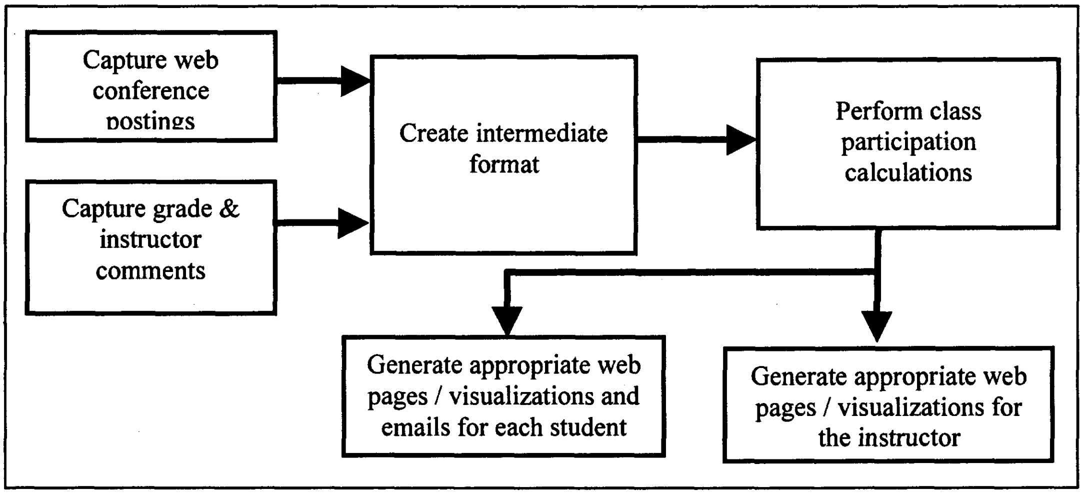


Figure 5.1 Key system components.

The first component of the system (which can be implemented as a standalone module), is to use an 'input parser' to read and parse a message board system (ex. webBoard or webCT). This component creates a generalized posting format. The use of the 'capturing of conference postings' allows the rest of the algorithms/code that is developed to be independent of the actual distance learning/conferencing tool.

The output of the parsing is a data structure (that is currently stored as a file) that contains one record (or line in a file) per message posting. Each record/line has the level of nested replies, the title of the posting, the author, date and the URL for the actual note (relative to the root URL which is the first line in the file). A sample of the file is shown below in Figure 5.2. In addition to the message list data structure (or file), there is an object (or file) created for the actual content of the messages. There is currently one object (file) for each message (i.e., the contents of each message are stored in a unique object / file).

<1><Nuggets, Turds, & Mumblings><Mike Smith><2/1/2003><read?8005>
<2><Objectives and reply root><Fred Jones><2/1/2003><read?234425,8005>
<3><Turd: Specialization><Mike Smith><2/9/2003><read?236920,8005>
<4><Turd: Specialization><Jane Doe><2/11/2003><read?237632,8005>
<4><Re:Turd: Specialization><Fred Smith><2/23/2003><read?241288,8005>
<5><Job Security><Kevin Raines><3/29/2003><read?248531,8005>
<4><Turd: Specialization><Thomas Jones><4/24/2003><read?255014,8005>
<3><Nugget: Turoff's cycle model><Mike Chang><2/11/2003><read?237630,8005>

Figure 5.2 Sample tool independent message list.

5.2 Features / Capabilities

Below, the key features of this system are described. By describing these features, one can gain an understanding of the participation measurements as well as the web pages / visualizations created by the system. These features are seamlessly integrated into a web conferencing system (webBoard), in effect creating a powerful 'teachers edition' of the webBoard software.

iPET incorporates social network analysis, visualization and a rule-based system to provide modules that aide in the understanding of the whole web conference board, individual participation and discussion within specific conferences. Key features include the ability to easily (1) access a 'quick-review/grade plug-in' within a web conferencing system, (2) define participation rules and (3) view community and individual details.

5.2.1 Integrated Evaluation/Grading Module

A 'quick review' feature has been implemented so that facilitators (ex. managers, instructors) can easily record an evaluation (such as a grade) for each posting. When a message is read, using either a commercial web conferencing system or within iPET, there are a set of buttons displayed for each posting that the facilitator can use to select a grade (and also enter an optional note) for that message. With the default configuration, for any given message, that message will either have a 'not graded' attribute, or one of the following possible reviews (A, B, C, or U – unacceptable). The grades can be viewed in many of the community and participant views described below. One way to share this information with the participant is through a participant report capability described later in this section.

5.2.2 Rules-Agent Module

A rule-agent has been implemented, that can, for example, be used to check that an introduction posting has been created by all participants by a certain date. Rule-agents are also used to monitor more in-depth interaction. For example, an interaction can include a participant posting a question in a specific web conference, then answering a different question, and finally responding to participants that answered their original question. The rule-agent can note which participants have taken (or missed) which steps and can send, through the participation reports described below, an email to each participant to show their completion on the participation rules.

The description of the attributes of a rule includes a start date, end date, frequency (ex. once or repeating weekly), required number of messages written by student, required number of messages written by the student as replies to other students, and which conferences (discussion topics) count for posts/replies. Comments by participants who receive an unacceptable grade are not counted toward satisfying the rule. The results of the rule analysis are shown in many of the community and participant views described below.

5.2.3 Automated Customized Reports

Customized participant reports use the participant visualizations, the results of the rule-agents and any grades / comments entered by the facilitator(s) related to the postings written by that participant. The reports also use some of the community visualization so each person can understand their participation in the context / relative to the other people in the community. An important characteristic of the community views supplied in the participant report is the ability to keep the other students names anonymous (i.e., a participant's name is changed from "Fred Jones" to "id 1").

5.2.4 Community View Module

In trying to understand general community participation, for example to quickly identify people "at risk" due to lack of participation, it is useful to view participation at the community level, and then 'drill down' to better understand a specific participant's participation. The system provides the following views of the community

The *weekly by conference* and *weekly by participant* views show a heatmap (2D grid). The columns represent different weeks in the semester, and the rows represent either each person or each conference. The number and color in each cell represents the number of messages for that week for the person or conference specified by that row. Figure 5.3 shows an example of the 'weekly by participant' view. One can see the activity level for different participants ('student 18', for example, is very active in the community – which happens to be a class of students). This view does not count postings that were graded as 'unacceptable'.

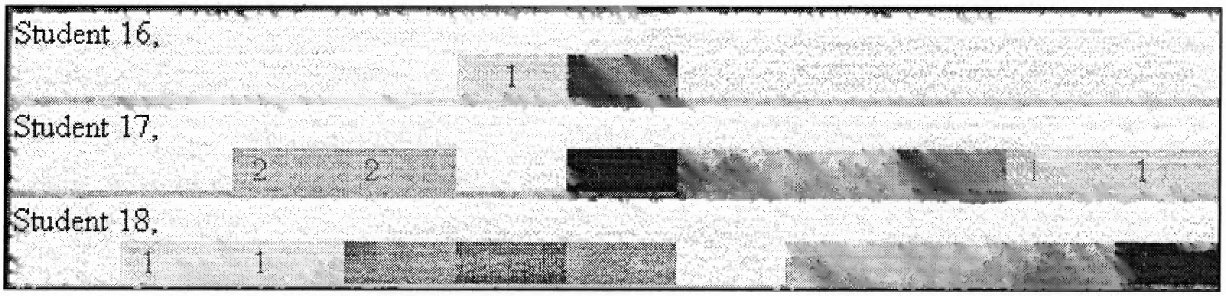


Figure 5.3 Class weekly by participant visualization example.

The *participation plot* shows the impact each person is having within the community by displaying a scatter plot. As shown in Figure 5.4, each person in the class is positioned in the scatter plot as a function of how many comments were posted by that person and how many comments others posted in response to comments written by that person. The scatter glyph itself is defined by a stacked barchart, showing the number of messages in each of the grading categories (for messages written by the student).

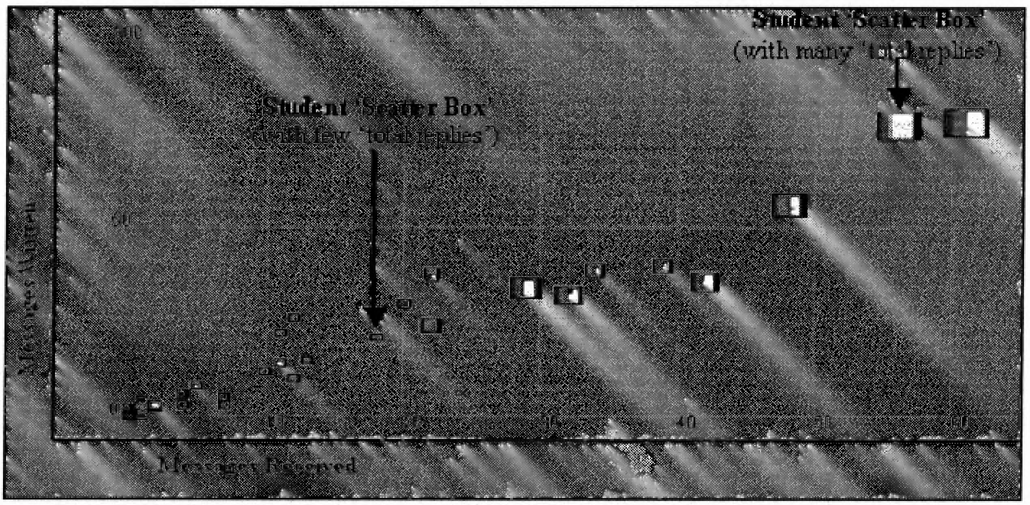


Figure 5.4 Participation scatter plot visualization example.

The *summary bar chart* view shows a bar chart of participation. For each person, one can see the number of messages reviewed as an “A”, “B”, and so forth represented as a stacked bar chart. In addition, another bar shows the number of replies received by that person (i.e., messages in response to comments written by that participant). Figure 5.5 shows an example of the summary bar chart for a specific student.

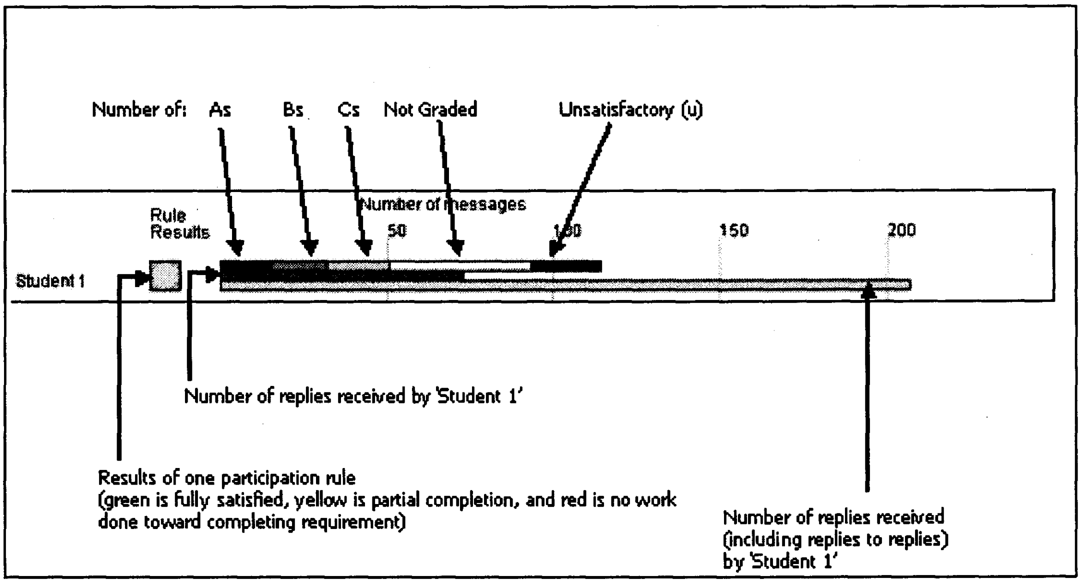


Figure 5.5 Summary bar chart explanation.

Finally, the *summary data table* view enables the participation information (ex., number of messages written, number of messages received) to be downloaded into an excel spreadsheet.

5.2.5 Participant Detailed View Module

For each of the participant postings (messages), one can view any combination of:

- Actual posting
- The posting which caused the person to reply
- The postings generated by this post (i.e., all comments 'under' this posting)
- The private comments/grades

There are three main sections within the detail view. A list of participants is displayed in the *selection area* (i.e., the left column in the window). These views are similar to those available in the community overview, such as *weekly by participant* and *summary barchart*, with the goal of being able to determine which participant an instructor wants to "drill down on" based on their participation attributes. Participant specific visualizations, described below, are shown in the *Visualization Area* (the upper right part of the window). Finally, the *Message Area* shows the actual text of the posting (in the lower right part of the window). The message area can show either all of the postings for a student, or a subset that has been selected from the visualization area. The following views are available in the *visualization area*:

- The *summary* displays basic information on the selected participant, such as the total number of messages written, and the review/grade distribution of that person's comments, and the number of messages written by others in response to this participant's messages.

- The *Expandable List* displays a 'folder view' of postings. As shown in Figure 5.6, for the selected person, one can view a list of all messages written, a list of messages written within each conference or the list of messages written that were used to satisfy a specific rule.

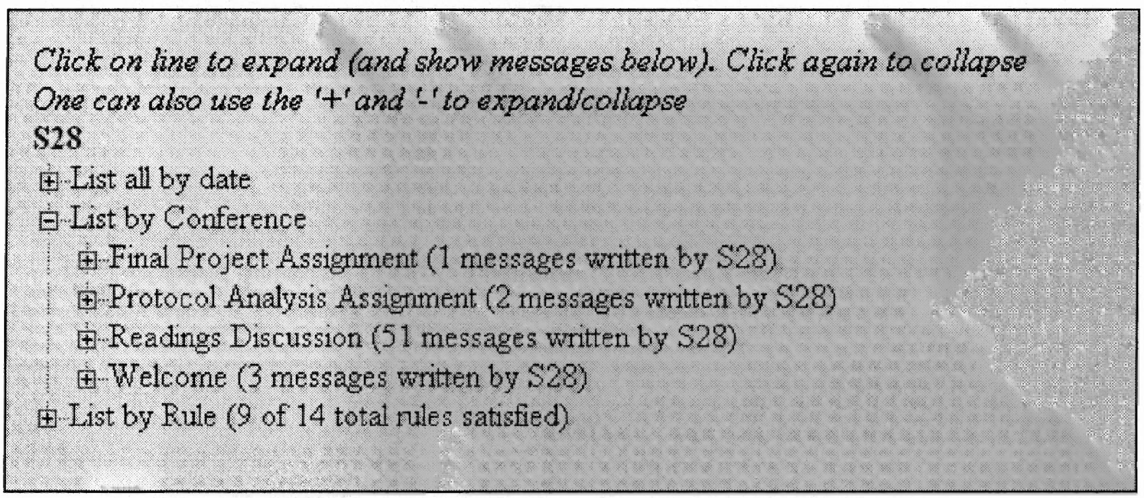


Figure 5.6 Expandable list example.

- The *Message Timeline* displays each message written by a participant as a series of rectangles that are positioned along the x-axis as a function of when the message was written. As shown in Figure 5.7, the height of each rectangle represents the number of replies to that message. The messages themselves are color-coded based on the grade/review provided by the instructor ('not graded' is considered one of the grades). The section on the 'MessageTimeline case study' has a more complete explanation of the message Timeline view.

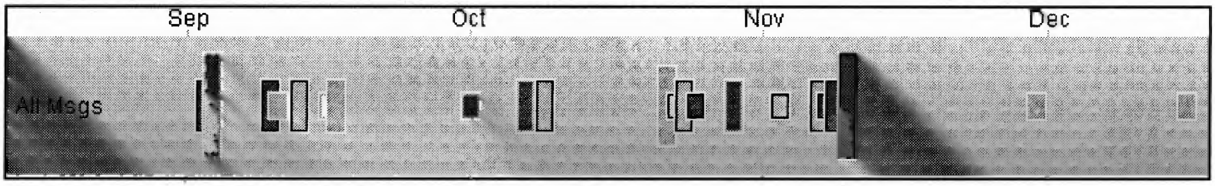


Figure 5.7 MessageTimeline visualization example.

- The *Participant Social Graphs* shows a person centered clique analysis based upon directed reply links (i.e., participant-to-participant interactions). As shown in Figure 5.8, each node (oval) represents a person. The center oval is the selected participant. The size of the oval represents the number of messages written from/to the selected participant; and arrows show direction and magnitude of that participation. See the section in 5.4 (Social Graph Case Study) for a more complete description of participant social graphs.

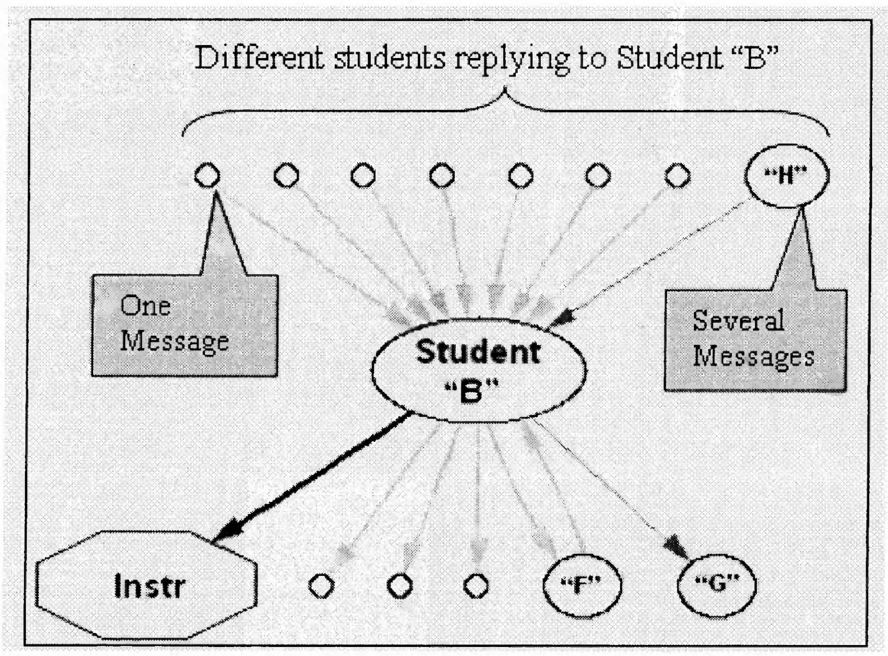


Figure 5.8 Student social graph visualization example.

- The *Weekly Overview* shows a heatmap (color coded grid of numbers), with a row for each conference, and a column for each week in the community. As shown in

Figure 5.9, the number in each cell (and the color of the cell) represents the number of messages for that week/conference (for that particular participant). The student visualization shows weekly participation, for the selected student, for each conference within the web conferencing system.

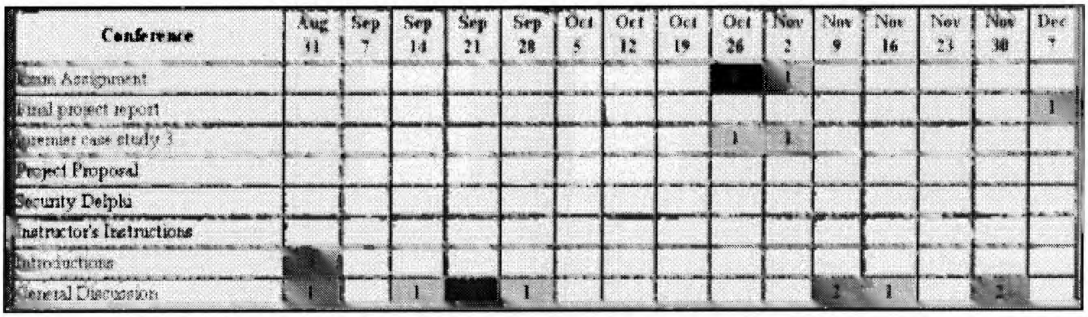


Figure 5.9 Weekly overview by conference student visualization.

Finally, Figure 5.10 shows a view within the full iPET system. The summary bar chart on the left shows total number of messages written by each student (the second bar per student is the total number of messages written by other students as replies to that student). Additional screenshots are shown in Appendix G.

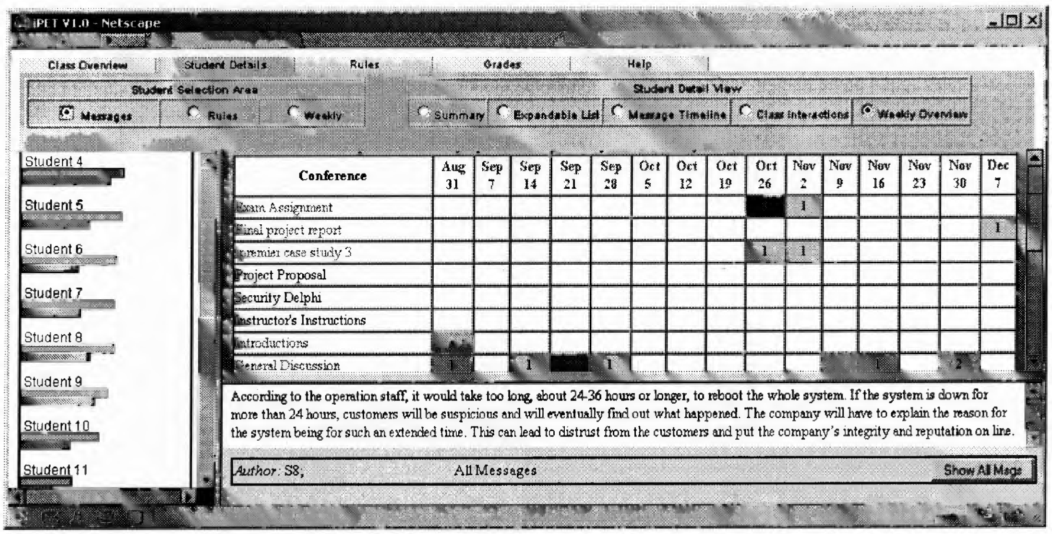


Figure 5.10 An example iPET student view screenshot.

5.3 Message Timeline Case Study

MessageTimelines is one of iPET's participation detail views. The goal of using messageTimelines is to enable a more intuitive understanding of a specific person's participation as compared to a traditional web conference 'list of messages'. In other words, the MessageTimeline visualization attempts to reduce information overload by creating an easy to understand picture of the rhythm of a person's postings. This picture graphically shows all of a person's postings (as opposed to just listing dates next to each posting) and other pertinent information such as the number of replies each of the messages generated.

Specifically, the messageTimeline visualization represents each comment written as a rectangle, known a *message glyph.* The message glyphs (rectangles) are positioned along the x-axis as well as having attributes such as the height, fill color and outline color defined as a function of the following message attributes (the data is collected within iPET):

1. The *date* the comment was written is represented as the position along the x-axis (Figure 5.11) .

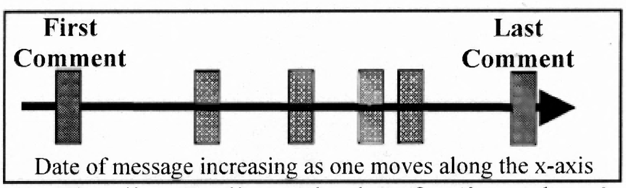


Figure 5.11 MessageTimeline Outline color key for 'in reply to'.

2. The *grade* for a message is represented by the color of the glyph (Figure 5.12)

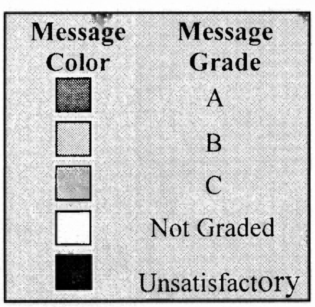


Figure 5.12 MessageTimeline color key for grades.

3. To whom the message was *'In reply to'* is shown by the color of the outline of the message glyph (Figure 5.13)

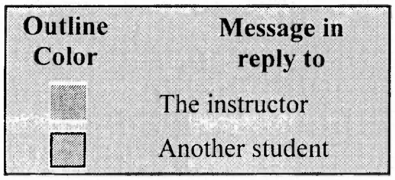


Figure 5.13 MessageTimeline outline key for 'in reply to'.

4. The *number of replies* generated by the posting is represented by the height of the message glyph (Figure 5.14)

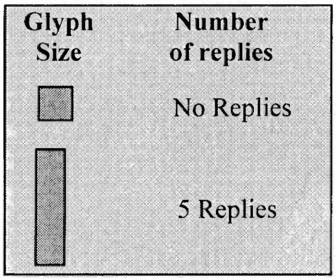


Figure 5.14 MessageTimeline height key.

Message timelines can be used to view all of a partipant's messages, messages within a specific conference, or messages written to satisfy a rule. Figure 5.15 shows the message timeline for all the messages written by a specific person.

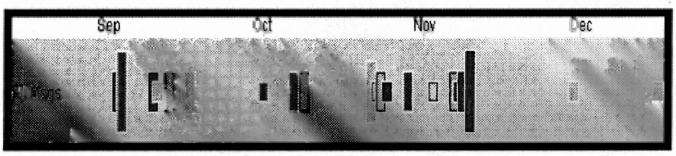


Figure 5.15 Example MessageTimeline.

Figure 5.16 shows a messageTimeline for all the messages written by a specific person for a rule on weekly discussion. The rule specifies that each person needs to post one message per week and respond to two messages from other participants. As previously discussed, iPET has the ability to define this rule, and the messageTimeline shows the results of that rule, where each week is color coded based on how successful the participant was in satisfying the rule.

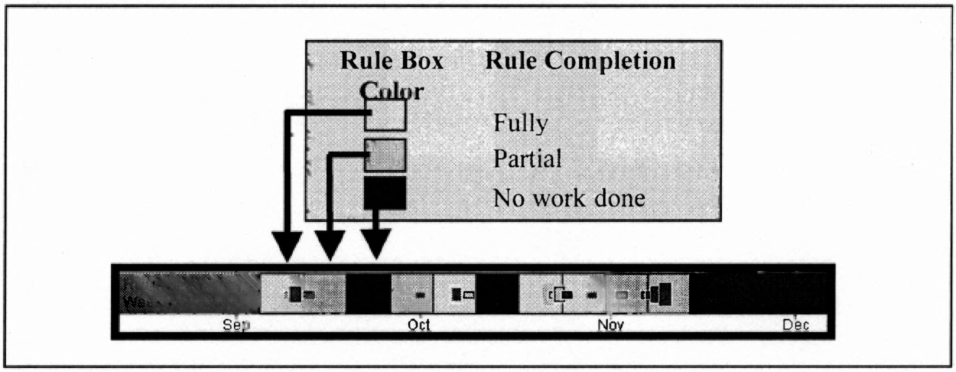


Figure 5.16 MessageTimeline rule example.

5.3.1 Interactivity

In order to better understand the information presented in the timeline visualization, several interactive capabilities are available when using timelines within iPET. These include the ability to:

1. Move the mouse over a message (rectangle) and have a 'mouse-over window' display information such as the date, title, conference, and grade of the message.

2. Move the mouse over the rule name and have a 'mouse-over window' display the rule definition.

3. Click on a message (rectangle) to show the actual message content in the message area (the lower region of the application window, see Figure 5.17).

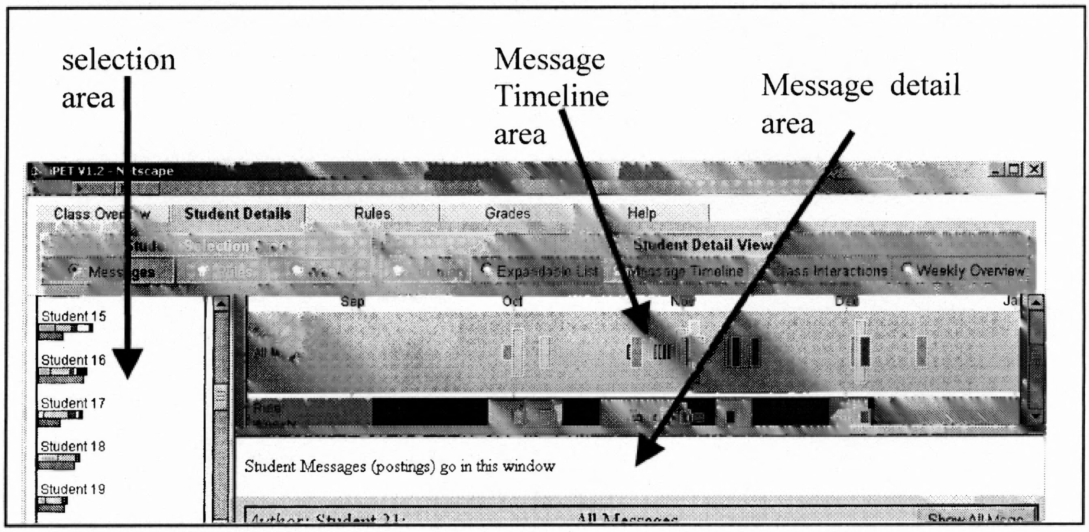


Figure 5.17 iPET screen display.

5.3.2 Comparing Student Timelines

To better understand the applicability of message timelines, Figures 5.18 and Figure 5.19 compares the participation of two students using message timelines. The top student, student "A" contributed 22 messages – one fewer than the lower student, student "B". However, one can quickly see that student "B" did a rush of posts at the end of the semester, and naturally, those postings had little impact on the class. In general, one can see that student "A" had more replies and that student "A" also more frequently satisfied the weekly participation rule. The pattern exhibited by Student "B" is not uncommon – students post messages at the end of the semester to increase their 'message count'. MessageTimelines makes this pattern very easy to identify.

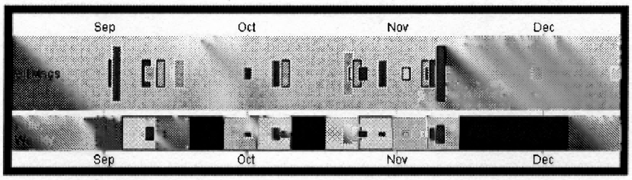


Figure 5.18 MessageTimeline for student A (22 Messages).

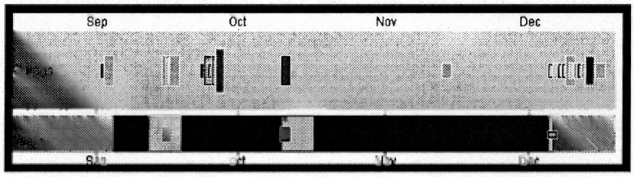


Figure 5.19 MessageTimeline for student B (23 Messages).

5.4 Participant Social Graphs Case Study

Participant-centric network creates a social network for a particular person. In other words, the focus of the network is on a particular person and connectivity analyzed is only between the ego person and the rest of the network (i.e., connections that do not including the ego are eliminated from analysis). *Social Graphs* are visualizations, created by our prototype system, of these person-centered networks.

To better understand the value of Social Graphs, an example is shown within the context of online learning. First, it is often helpful to first analyze student interaction using more traditional techniques. As has been previously stated, a common method to understand class participation is to count the messages written by each student [11]. Table 5.1 shows a small subset of the results for a graduate level information systems class. In this table, the number of messages written by each student is shown. As one can see, Student "A" was not very active, Student "E" was very active, and the other three students were somewhat active. In looking at the outDegree (number of messages written by each student), Student "C" and "D" wrote the same number of messages written to the web conferencing system. Note that it is hard to determine if student "B" is materially different from "C" and "D" with respect to activity in the class.

Table 5.1 OutDegree Results for Five Students

Student Name	Number of messages (outDegree)
"A"	5
"B"	20
"C"	29
"D"	29
"E"	43

5.4.1 Social Network Table Summaries

Using Social Network Analysis, the next logical step to analyze an online class is to show more details of the interaction such as inDegree prestige, which can be either direct (number of replies received by a student), or indirect (number of replies including all replies to each of the replies). With inDegree and outDegree, one can then also compute student degree centrality (inDegree + outDegree). Table 5.2 shows the results for the same students listed in table 5.1. In this table, the total (centrality), outDegree and direct InDegree are shown. The centrality is shown both including the instructor as well as excluding the interaction with the instructor. This can be useful to understand how much of the dialog is between the instructor and the student (as opposed to between two students).

Table 5.2 Direct InDegree and OutDegree for Five Students

	Including Instructor			Not Counting Instructor
	Centrality	outDegree	inDegree	Centrality
Student Name	Total	Messages (to others)	Replies (from others)	Total
"A"	6	5	1	5
"B"	31	20	11	18
"C"	50	29	21	31
"D"	38	29	9	23
"E"	83	43	40	51

One can see in Table 5.2 that student "E" continues to appear very active (however, a sizable number of those messages were from/to the instructor). Student "A" continues to appear as an inactive participant in the class. The other three students were roughly in the middle, with student "C" appearing to be slightly more active with respect to replies from other students. The student social graphs described below help clarify the difference in student interactions for these five students, especially the middle three.

5.4.2 Visualizing Student-Specific Networks

One technique to view a social network is to represent the network as a graph, where nodes represent people, and the edges (or links) connecting the nodes represent the contact between the people. This graph can be directed, where there are arrows on the edges to show the direction of the association. For a distance learning class, the nodes (ovals) can represent students, and edges can represent messages between students. Thus, in Figure 5.20, student 'B' has replied to a message from student 'A'.

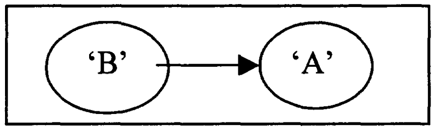


Figure 5.20 Simple graph network.

A student social graph only has edges and nodes for interactions that directly connect to the 'ego' student. This simplifies the network significantly, while at the same time, focuses the analysis on that specific student. In other words, showing a student social graph lets the instructors have a better understanding of one particular student's interaction with the rest of the class. In a student social graph, information is encoded using:

- *Node Shape*: An octagon represents the instructor, ovals are used for all students
- *Node Size*: The student being analyzed (the 'ego') is always represented as a large node. The size of the node for other students that interact with that 'ego' student represents how many messages a student has sent and received between the 'ego' student and the other student.
- *Edge Darkness*: The line darkness/thickness of the edge represents how many messages were sent between the two students (i.e., the darker/thicker the arrow, the more messages sent, in the direction of the arrow, between the two students).

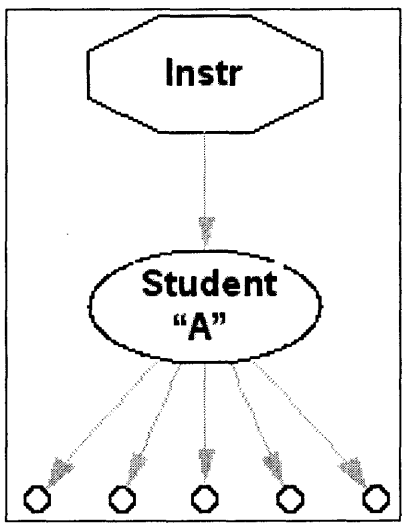


Figure 5.21 Student A's network.

Figure 5.21 shows the network for Student "A" (i.e., Student "A" is the ego student for this network). "A" received one reply from the instructor. In addition, one can see that no student replied to Student "A", and that "A" replied to five other students, but not frequently (the edges are light and the size of the circles are small). Note that there is no two-way conversation (i.e., "A" and a student did not reply to each other). This network confirms that "A" is not active in the online class.

Figure 5.22 shows the network for Student "B". One can notice that many students responded (replied) to "B", but there was no dialog – "B" did not reply to those responses. While there was a bit of two-way 'conversation' with "F", Social Network Analysis would suggest that "B" posted interesting comments, but that "B" could have kept the conversation going when students replied to a post. It is important to note that the two-way conversation (ex. with "F") could have been within one thread or across different postings at different times in the semester – but either way, social network analysis suggests that the two-way interaction helps students be part of a community.

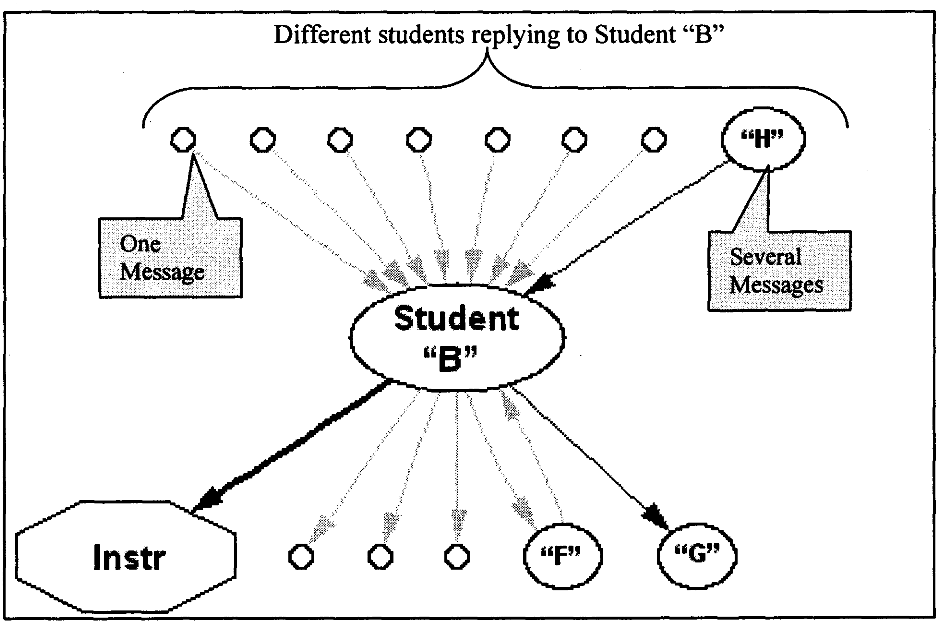


Figure 5.22 Student B's social network.

Figure 5.23 shows that student "C" had more dialog between students (as compared to "B"). Specifically, in Figure 5.23, there are many students that reply to posts from "C" as well as get replies from "C".

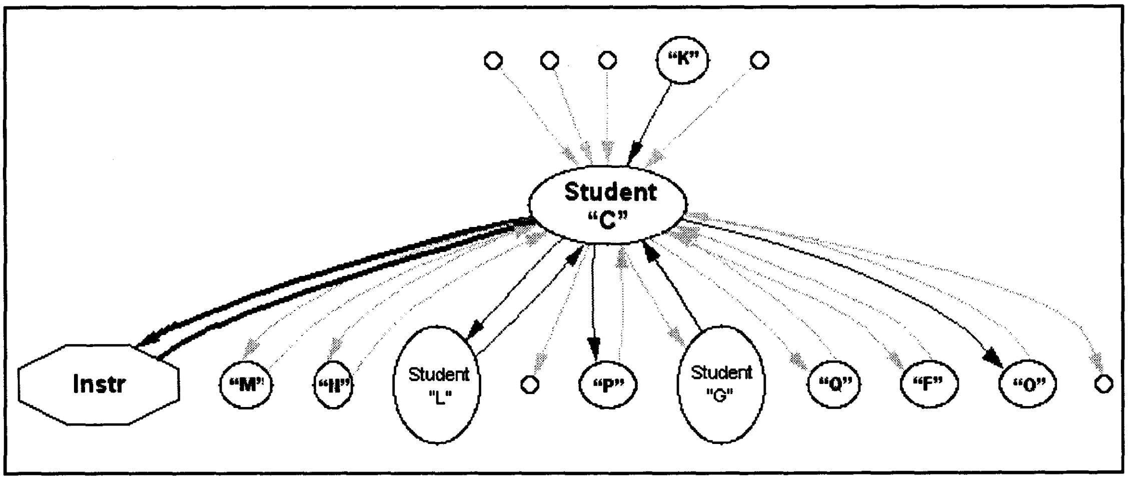


Figure 5.23 Student C's social network.

While the number of messages posted by Student "D" is equal to the number of messages posted by Student "C", Figure 5.24 shows that other students did not respond to messages from "D" as often as they did with student "C" and that one can see many more two-way relationships with the social graph of student "C" (as compared to student "D). While there can be many reasons for this, Social Network Analysis suggests that the posts by "D" were not interesting/relevant to many of the students (except for Student "J").

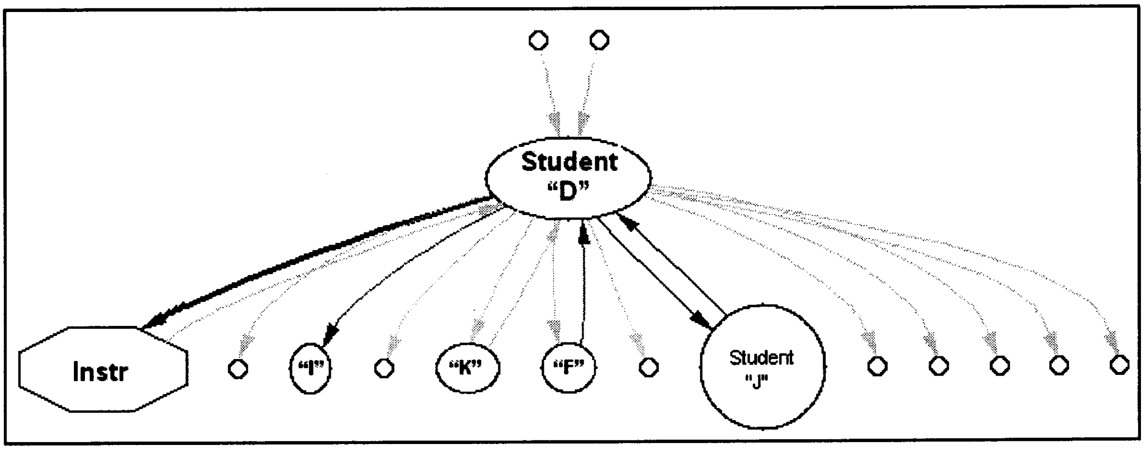


Figure 5.24 Student D's social network.

Finally, as one would expect from someone with such a high inDegree and outDegree, Student "E" (Figure 5.25) shows an interaction that other students should try to emulate.

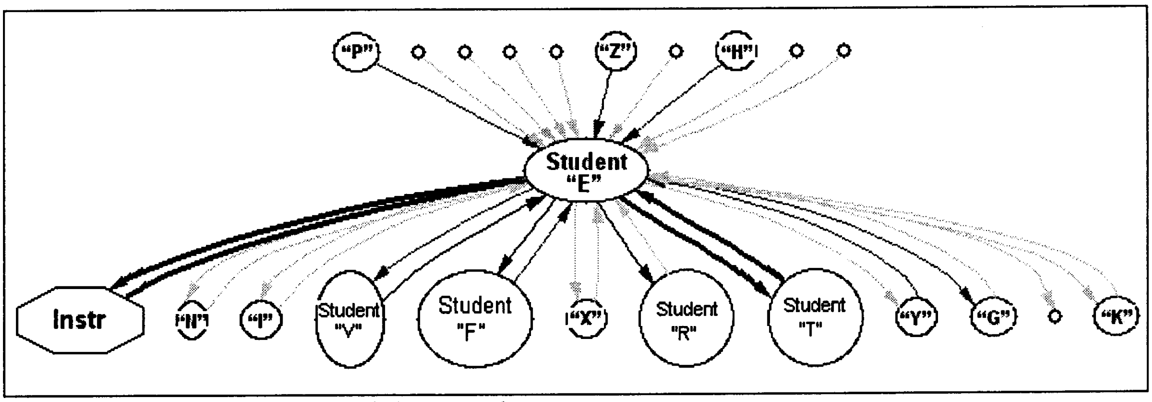


Figure 5.25 Student E's social network.

CHAPTER 6

RESEARCH DESIGN

Dynamic measuring tools for online discourse can be used within many applications of online discussion forums. However, due to the fact that ALNs applied to distance learning are the most common (and hence a strategic research domain to test these hypotheses), the empirical study will focus only on tools applied to online learning.

6.1 Research Model / Framework

The model developed to test the value of dynamic measuring tools for online discourse is based, in part, on the Technology Acceptance Model (TAM) [Davis, 1989], which states that an individual's usage of a system is based on that individual's intention to use a system, which in turn is determined by two key drivers: (1) perceived usefulness and (2) perceived ease of use of that system. Perceived usefulness is the extent to which a person believes that using the system will enhance his or her task performance. Perceived ease of use is the extent to which there will be a small learning curve to know how to use the system and that using the system is "easy". The TAM model is shown in Figure 6.1.

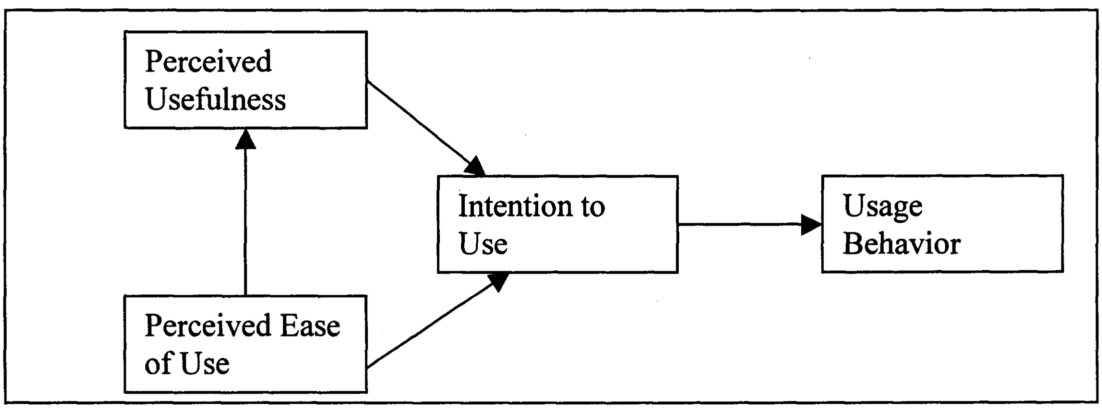


Figure 6.1 Technology Acceptance Model.

In addition to TAM, which can help determine if people (students, instructors) will use a set of tools, the research model also leverages the work done by Wu and Hiltz [2003], which measures, through validated student questionnaires, perceived learning when students use online discussion. In other words, TAM focuses on the use of the tool and Wu and Hiltz, focuses on measuring perceived learning from using the tool, as shown in figure 6.2.

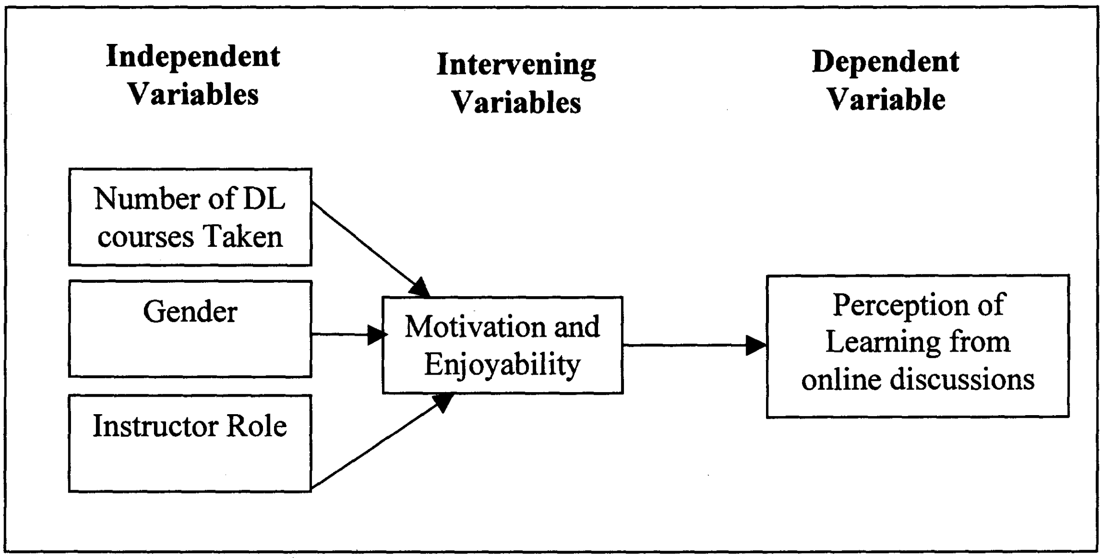


Figure 6.2 Online discussion research model.

As one can see, TAM suggests intervening variables such as perceived ease of use and usefulness, while Wu and Hiltz suggest intervening variables such as motivation and enjoyability. Finally, one additional variable, which was suggested by Rovai [2002], is a student's feeling of being part of part a community (ex. is one encouraged to ask questions?). These variables have been combined to define a research model to test the value of dynamic measuring tools for online discourse, which is described in the following section and summarized in Figures 6.3 and 6.4.

6.1.1 Independent Variables

Because providing students access to the tools, without providing the instructors access to the tools is a scenario that is not desired, those two independent variables are not fully independent. In other words, while one could have created a 2x2 experiment (instructors do/do not have access to the tool, students do/do not have access to the student reports), it was felt that one of those conditions (instructors do not have access to the tools, but students have access to reports) would not be in the instructor's best interest. In addition, student attributes (such as experience taking DL courses) and course attributes (such as the class size or the weight of online participation in a student's final grade) might also have an impact on tool usage and usefulness. Finally, the instructor attribute of the 'number of online classes' previously taught may also be important – but rather than include this attribute within the model, this study will require all instructors to have taught at least one online course prior to being included in this study.

6.1.2 Co-variates and Intervening Variables

Student motivation for class participation is partly based on student attitude as they enter the class (i.e., a co-variate), but also partly based on the ability of the instructor to motivate the students (i.e., an intervening variable). If the instructor participation measurement tools are not used, it will not be possible to realize the toolset's potential benefits. As was previously discussed, according to TAM, perceived ease of use and perceived usefulness drive intention to use, which in turn, drives usage. So, a key set of intervening variables is related to the instructors' and students' perceived usefulness and ease of use of the tools. In addition, Wu and Hiltz's variables of student motivation and enjoyability are both partially an intervening variable, but also partially a co-variate.

Finally, the degree to which a feeling of community is created within the class can drive a student's desire to be part of active dialog within the community. Note that while motivation, enjoyability and being part of a community could easily be thought of as co-variates (ex. community could be more a function of how the instructor interacts with the class), it was thought that if instructors had a better understanding of student participation, they could help student's motivation, enjoyability and building a better community – hence these variables have been categorized as intervening variables.

6.1.3 Dependent Variables

Using these tools, it is expected that instructors will more quickly and more accurately understand student participation. This increase in perceived understanding of student participation will increase an instructor's confidence in the class participation grade given for online discussions. It is further expected that at least some of this extra time will be spent providing more feedback to students within the online discussion forum. Note that it is possible that instructors might just reduce the amount of time spent on a particular class (i.e., no positive impact to students). In this case, the full impact of the tool will only be realized when students have access to the tool (and possibly more willingness of faculty to want to teach online courses).

6.2 Instructor Hypotheses and Research Questions

Figure 6.3 summarizes the research model with respect to instructors. This model shows the research questions and hypotheses associated with the instructor intervening and dependent variables.

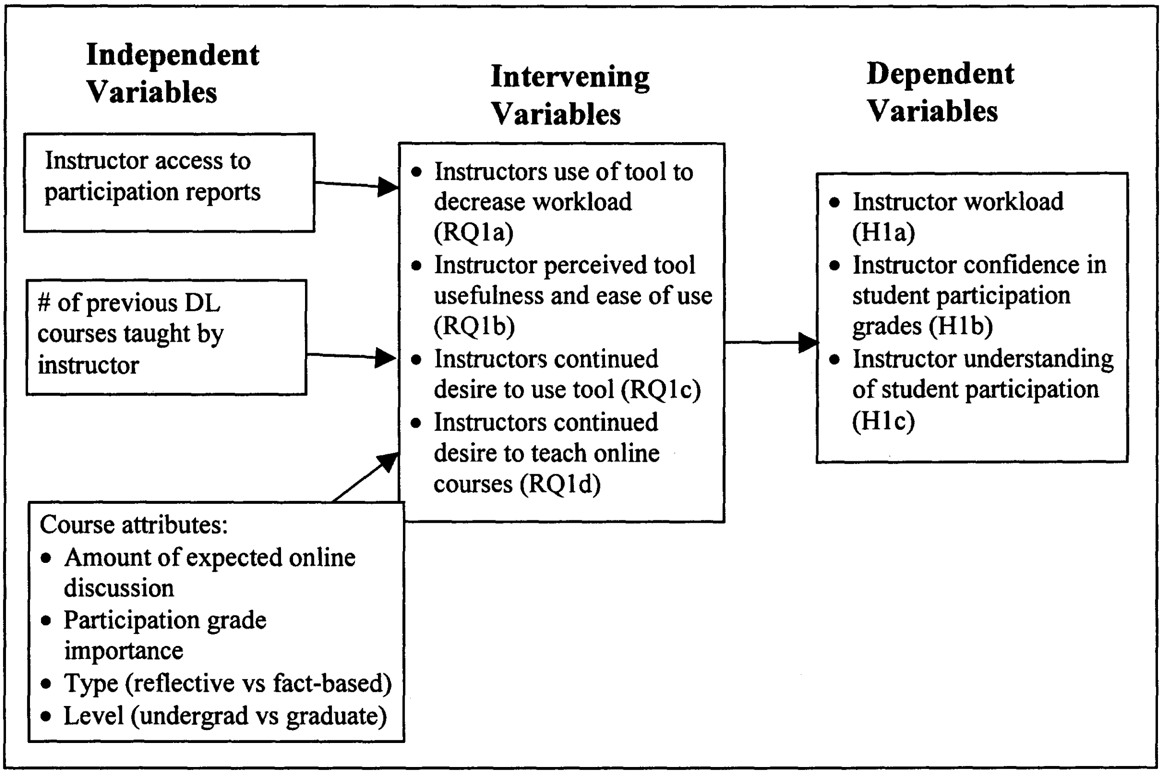


Figure 6.3 Instructor discussion tool research model.

6.2.1 Instructor's User Acceptance / Perceived Usefulness

By providing tools that incorporate simple visualizations and intuitive terminology, it is hypothesized that instructors will perceive iPET to be easy to use and also perceive the tools to be useful. This, according to TAM (Venkatesh, 2000), will lead instructors to use iPET. This is important because if instructors do not use iPET then there is no way for the instructors (and hence the students) to realize the benefits of iPET. The following research questions will be tested to determine if instructors perceived iPET as easy to use and useful.

Perceived usefulness

RQ1a: Will instructors want to use the tools to try to decrease their workload?

Perceived ease of use:

RQ1b: Will instructors perceive iPETas easy to use?

Future use of iPET

RQ1c: Will instructors want to use the tools for future classes?

RQ1d: Will instructors be more willing to teach future online classes (as compared to not having access to iPET)?

6.2.2 Instructor Efficiency and Effectiveness in Course Facilitation

Dynamic measuring tools of online participation can be thought of as part of a distance learning management system. Since it is hypothesized that instructors will use iPET as part of their distance learning management, they will benefit by being able to better monitor/understand student participation, and gain this increase in understanding while at the same time, spending less time evaluating class participation. In other words, it is hypothesized that instructors will spend less time evaluating participation and have a better understanding of student participation. This will lead to instructors having more time to facilitate/encourage class participation. Specifically, it is hypothesized that:

Perceived instructor workload:

H1a: Instructor workload will decrease (as compared to not using the tools).

Perceived Understanding of Student Participation:

H1b: Instructors will have a higher perceived confidence in the participation grade given to each student.

H1c: Instructor perceived understanding of student participation will increase (as compared to not using the tools).

6.3 Student Hypotheses and Research Questions

Figure 6.4 summarizes the research model with respect to students. This model shows the research questions and hypotheses associated with the student intervening and dependent variables.

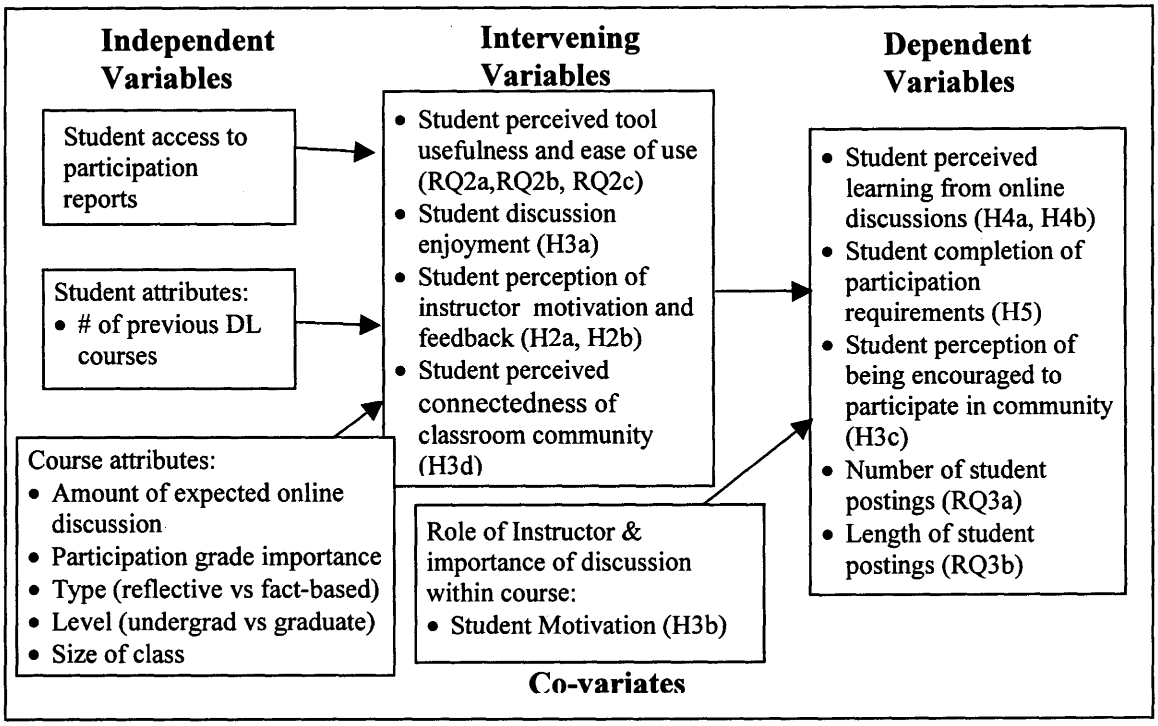


Figure 6.4 Student discussion tool research model.

6.3.1 Student User Acceptance / Perceived Usefulness

By providing tools that incorporate simple visualizations and intuitive terminology, it is hypothesized that students will perceive iPET's student report as easy to use/understand and also perceive the reports as useful. This, according to TAM [Venkatesh, 2000], will lead students to read/use iPET. In addition, it is hypothesized that students will want to continue to have access to the student reports. The following research questions will be tested to determine if students perceived iPET student reports as easy to read and useful.

Perceived usefulness:

RQ2a: Will student reports be perceived as useful ?

Perceived ease of use:

RQ2b: Will students perceive iPET as easy to use?

Use of Reports:

RQ2c: Will students read the iPET generated email/reports and want access to the reports for future classes?

6.3.2 Instructor Role: Providing Feedback and Motivation

Online instructors have often been required to spend significant time grading class participation, [Lazarus, 2003]. Since it is hypothesized that instructors will spend less time understanding/grading class participation, it is hypothesized that they will use some of this 'saved' time in providing more active feedback to students, as well as, in general, motivating the class to participate more within the online discussion. This leads to the following hypotheses:

Providing feedback and motivation:

H2a: Student perception that the "instructor provides discussion feedback" will increase due to the use of iPET.

H2b: Student perception that the instructor motivates class participation will increase due to the use of iPET.

6.3.3 Quality of the Online Community

Active participation is a key driver in the success of online classes [Hiltz & Turoff, 2002]. Since it is expected that instructors will have more time to provide feedback, and in general monitor the class, it is hypothesized that, due to instructors using these online participation measurement tools, students will be more actively engaged in the online community. Specifically, the following are hypothesized with respect to an enhanced community:

Online Discussion Enjoyability:

H3a: Student "Online Enjoyability" will increase due to the use of iPET.

Online Discussion Motivation:

H3b: Student "Online Discussion Motivation" will increase due to the use of iPET.

Encouraged to be part of the online community:

H3c: Students perception of being encouraged to participate in the classroom community will increase due to the use of iPET.

Feel connected to others in the class:

H3d: Students perception of classroom community and being connected to other students in the online community will increase with the use of iPET.

Online Discussion Activity:

RQ3a: Will students post comments more often when the have access to iPET.

RQ3b: Will students post longer comments when they have access to iPET.

6.3.4 Quality of Discourse

It is important to encourage high quality discourse [Jaffe, 1997]. Since it is expected that instructors will have more time to provide feedback, and in general monitor the class, it is hypothesized that, due to instructors using these online participation measurement tools, the quality and quantity of the discourse will improve. In addition, when students have access to their participation reports, they will feel motivated to be more actively involved in the discourse. Specifically, it is hypothesized that in the online discussions, students will participate more actively and increase their perceived learning.

Perceived learning from peers:

H4a: Student "Perception of Learning from Online Discussion" will increase with the use of iPET.

H4b: Student's perception of learning within the classroom community will increase with the use of iPET.

Student Participation:

H5: Due to the use of iPET, a higher percentage of students will meet all course participation requirements.

CHAPTER 7

RESEARCH METHODS

7.1 Methodology

To explore the impact of using online discourse measuring tools, a 1x2 quasi-experimental study was performed (i.e., a control and an experimental condition). This study, summarized in Table 7.1, evaluated the following two conditions:

a) *Control* – No tools were provided to either the instructors or the students.

b) *Instructor & Students* – Instructors had access to the tools and each student had access to their specific customized student report.

Table 7.1 2x1 Empirical Study

	Control	"Access to iPET"
Condition	WebBoard / WebCT only	Instructor access to participation measuring tools + Student access to customized reports + webBoard / WebCT

Note that in addition to these conditions that were used to analyze student reactions to iPET via student surveys, there were two additional conditions (i.e., beyond control and 'instructor & student") that were used within this research (but not part of the 1x2 student survey analysis).

c) *Log File Analysis* – In order to compare the number and size of student postings with other similar classes, a log file analysis was done on several classes that had completed before this study began. In this condition, the class is a 'control', but analyzed after the class had already completed (hence it was not possible to distribute student surveys). These 'log file' conditions were used to understand differences in class participation via hard data from student postings (between courses that were completed prior to this study, and the same course taught during this study, that had access to the iPET student reports).

d) *Instructor only* – The final condition was an 'instructor only' condition, where the instructor had access to iPET, but the students did not have access to the iPET student reports (and did not get surveys to complete). These classes were not part of the 1x2 student survey study, but were used to gain feedback from instructors on the ease of use and value of iPET.

7.2 Procedures

The dynamic measuring tools (iPET) were made available as a set of web pages (i.e., a web-based application), one logical web site for each online course. The instructors had access to the web site (for their course) that contained reports and visualizations of student participation. Students received access to the tool through an email message that supplied each student with the URL for a customized report (web page) of their participation. The student report was a subset of the tools made available to the instructor.

The key steps during the empirical study included:

1. Identifying courses for "Instructor & Students" and the control condition. At least five courses were identified for each condition.

2. Distributing semi-structured email survey to instructors [one week before the start of semester].

3. Distributing the student questionnaires (as a pre-condition to viewing their student reports). Note this was also done in the control sections [distributed the second week of the semester].

4. Where applicable, interact with each instructor using iPET to define their set of participation rules [completed implementation of the rules by end of week 2 of the semester].

5. Where applicable, updated participation measuring tools for instructors on a weekly basis (as previously described, the instructors accessed the tools via the web)

6. Where applicable, sent Student Reports on a monthly basis – weeks 4, 8 and 12 (as previously described, students accessed the tool via an email message that directed them to a web site)

7. Distributed semi-structured post study email surveys to instructors [distributed the during last week of semester]

8. Distributed post study student questionnaires (and where applicable, as a pre-condition to viewing their final student reports) [distributed during week 12]

9. Distributed a de-brief of the empirical study – to both applicable students and instructors [distributed after the student returns post study student questionnaire].

7.3 Observation / Thinking-out-loud

In the early stages of the development of the tool, there were several sessions of direct observation. In addition, analysis was also done through the review of computer logs. The purpose of these observations was to identify usability issues that needed to be addressed as well as identifying any key features missing from the system. Usability improvements as a result of this effort included a much more detailed help section (and an easier way to 'find' the help descriptions) – the help screens were made available as a 'high-level' tab within the application. In addition, a grading feature (to be able to grade specific student posts) was added during this period of the project.

7.4 Courses in the Study

As shown in Table 7.2, between the fall of 2003 and the spring of 2005, 16 classes participated in a study to evaluate the effectiveness of iPET. An additional three classes were evaluated via log files after the class had completed (hence these 'log file analysis' controls had no student surveys). The first CIS 679 class was used as a pre-pilot study. The purpose of that pre-pilot was to better understand the usability of the system in a real class setting. In the spring 2004, the initial classes got access to the tool. These 'pilot' classes were used to ensure the survey questions were easily understood and also tested the feasibility of distributing student reports. Since no material changes were made to the software and/or the surveys (during or after the 2004 spring semester), those classes were included in the data analysis to follow.

In seven of the classes participating in the study, students were provided access to 'iPET student participation reports'. In three of the classes, instructors were provided access to iPET, but students were not provided access to the 'iPET student participation reports' (one of those was the pilot). Six courses were a control, where students were given pre/post surveys, but neither the instructor nor the students were provided access to iPET. In order to perform 'paired analysis' (i.e.,, a longitudinal study comparing not just means of the group, but the change in individual student responses from the start of the semester to the end of the semester), student surveys were included in the analysis only if they completed both the pre and post survey. Students completed surveys in both the 'access to iPET' and control conditions (except, as previously noted, for the 'log file analysis' and 'instructor only' courses). There were a total of 144 'paired responses' in this study.

Table 7.2 Courses in the Study

Semester	Course	Condition	Pilot / Study / Instructor Impressions
Fall 2001	CIS 732	Control	Post class log file analysis
Fall 2003	CIS 679	Instructor Only	Pre-Pilot (instructor impressions)
	CIS 673	Control	Post class log file analysis
	CIS 675	Control	Post class log file analysis
Spring 2004	CIS 350	Instructor Only	Pilot (instructor impressions)
	CIS 679	Access to iPET	Pilot (used in Study)
	CIS 675	Access to iPET	Pilot (used in Study)
	CIS 673	Access to iPET	Pilot (used in Study)
Fall 2004	ENG 605	Control	Study
	MKT 620	Control	Study
	MGMT 692	Control	Study
Spring 2005	MKT 620	Control	Study
	IT102	Instructor Only	Instructor Impressions
	IT 490	Control	Study
	IT 202	Access to iPET	Study
	MGMT 345	Control	Study
	CIS 735	Access to iPET	Study
	CIS 732	Access to iPET	Study
	CIS 675	Access to iPET	Study

Table 7.3 provides a brief summary of the different courses included within the study. The courses are described by the name of the course, if the course is for graduate or undergraduate students, and the focus of posting (i.e., participation paradigm) within the online course. In terms of the focus (or use) of the web conferencing system, the three categories of courses can be identified via an analysis of each of the courses syllabi. These three categories are:

- *Focus on discussion*: In this category of class, the instructor encourages active participation. This encouragement might be requiring students to post messages on certain topics and reply to other student postings.

- *Focus on Assignments*: In this category of class, the instructor uses the web conferencing system as a means for communicating with students, and as a way for students to 'post' their assignments (often within a 'private' conference between the student and the instructor).

- *Focus on Chunking*: Chunking is the process of summarizing a portion of a lecture or reading – and is a way for an instructor to try to encourage (and measure) if a student is reading (and understanding) specific assignments. A course that focuses the use of the web conferencing system on chunking has each student post their 'chunking exercise' in public folders (for example, each week there is a specific conference for each of the students to post their 'chunk').

Table 7.3 Descriptions of Courses in the Study

Course	Level	Online Posting Focus
CIS 732 Design of Interactive Systems	Graduate	Focus on Discussion
CIS 679 Mgmt of Information Systems	Graduate	Focus on Discussion
CIS 673 Software Design and Production Methodologies	Graduate	Focus on Chunking
CIS 675 Information Systems Evaluation	Graduate	Focus on Discussion
CIS 350 Computer and Society	Undergraduate	Focus on Discussion
ENGLISH 605 Elements of Visual Design	Graduate	Focus on Assignments
MRKT 620 Competing in Global Markets	Graduate	Focus on Assignments
MGMT 692 Strategic Management	Graduate	Focus on Discussion
IT102 Intro to Information Technology	Undergraduate	Focus on Chunking
IT 202 Internet Applications	Undergraduate	Focus on Chunking
IT 490 Systems Integration	Undergraduate	Focus on Chunking
MIS 345 Management information systems	Undergraduate	Focus on Discussion
CIS 735 Computer Mediated Communication Systems	Ph.D. Seminar	Focus on Discussion

7.5 Instructor Semi-Structured Interviews

As was previously mentioned, a set of Pre and Post experiment email questions was distributed to each instructor taking part in the study. These semi-structured questions were used to measure an instructor's perceived workload, perceived understanding of student participation, and if they wanted to continue using the tool. The survey questions, shown in Appendix C, were adapted from previous instructor interview guides [Hiltz, Coppola & Rotter 2000].

Table 7.4 shows the mapping of how the instructor focused research questions and hypotheses were analyzed via the instructor survey questions. Note that, since the instructor surveys were semi-structured, there were multiple opportunities for instructors to provide feedback (i.e. not just the specific questions noted in the table). In addition, many instructors provided feedback throughout the semester (positive and negative). All this information was synthesized when the hypotheses and research questions were analyzed.

Table 7.4 Mapping of Hypotheses and RQs to Instructor Survey Questions

Hypothesis / Research Question	Instructor Survey Question Used
RQ1a: Will instructors want to use the tools to try to decrease their workload?	**Pre-Survey, Q1:** With your basic understanding of the tool, what do you hope/think the key benefits will be (ex. save time, more accurate grading) **Pre-survey, Q8**: What is more important (use of time, improved understanding)
RQ1b: Will instructors perceive iPET as easy to use?	**Post-survey, Q7**: Did you find the tools easy to use?
RQ1c: Will instructors want to use the tools for future classes?	**Post-survey, Q9**: Do you want to use this tool when teaching future classes? **Post-survey, Q5 & Q6**: Did you find the tools useful? Did you find any of the tools not useful?
RQ1d: Will instructors be more willing to teach future online classes (as compared to not having access to iPET)?	**Post-survey, Q9**: Do you want to use this tool when teaching future classes?
H1a: Instructor workload will decrease (as compared to not using the tools).	**Pre-survey, Q6&Q7**: Time spent on distance learning classes, **Post survey, Q3& Q4:** Time spent on this distance learning class
H1b: Instructors will have a higher perceived confidence in the participation grade given to each student.	**Post survey, Q8**: Do you think the tools made you more accurate in understanding / grading participation
H1c: Instructor perceived understanding of student participation will increase (as compared to not using the tools).	**Post survey, Q8**: Do you think the tools made you more accurate in understanding / grading participation
H5: Due to the use of iPET, a higher percentage of students will meet all course participation requirements	**Post survey, Q2**: What percentage of the students satisfied the participation requirement? Was this different from pervious classes you have taught?

7.6 Student Surveys

As was previously mentioned, a pre and post questionnaire was used to measure each student's "perception of learning from online discussion", "online discussion enjoyability", "online discussion motivation" and students belief that the "instructor plays a crucial role in motivating effective online discussions". The electronic survey used a likert-type scale for each item and is shown in Appendix C. The survey needed to have been completed by the student before the student could view their student participation report. In other words, to help increase response rates, students had to answer the survey before they could view their student reports. The survey questions were adapted from validated surveys described by Wu & Hiltz [2003] and Rovai [2002]. The five measures, the list of questions comprising the measures, as well as the abbreviations used to describe the questions, are shown in Table 7.5.

Table 7.5 Measures and Questions

Question	Short Name
Student Perceived Learning from Online Discussion	
Q4: Via online discussions, I learn a great deal from my peers	Learn from Peers
Q5: Online discussion is useful to my learning	Online discussion useful
Q6: Learning quality is improved by online discussions	Improved learning
Q7: Peer comments are very valuable in online discussions	Valuable peer comments
Online Discussion Motivation	
Q8: Reading online discussions motivated me to learn more	Motivated to learn more
Q9: Online discussion motivated me to do my best work	Motivated to do best work
Q10: My learning interest was improved by online discussion	Increased learning interest
Q11: Online discussions increased my desire to learn	Increased desire to learn
Q12: I feel that I have useful insights for other students in this course.	Insights for others
Q13: I feel that other students have useful insight for me in this course.	Others have insights for me
Q14: I hesitate to participate because I feel that I am not as knowledgeable as most of the other students.	Hesitate to participate
Learning in the Community	
Q15: I am encouraged to ask questions	Encouraged to ask questions
Q16: I feel that it is easy to get help when I have a question	Easy to get help
Q17: I receive timely feedback	Received timely feedback
Q18: I feel that other students do help me learn	Others help me learn
Online Discussion Enjoyability	
Q19: I enjoy online discussions	Enjoy online discussions
Q20: I enjoyed reading online messages	Enjoy reading messages
Q21: I enjoy posting online discussion items	Enjoy posting messages
Q22: Online discussion is a good use of my time	Good use of time
Instructor's role in motivating class participation	
Q23: The instructor encouraged active online participation	Instructor encouraged participation
Q24: The instructor provided constructive feedback (regarding online discussion postings)	Received instructor feedback
Q25: The instructor was helpful in guiding the online discussion	Instructor guided discussions

Table 7.6 shows the mapping of how the student focused research questions and hypotheses were analyzed via the student surveys. Other survey questions, not specifically mentioned in Table 7.6, were also evaluated to identify any other significant results (as well as interactions with other independent variables such as the size of the class).

Table 7.6 Mapping of Hypotheses / RQs to Student Survey Questions

Hypothesis / Research Question	Student Survey Question Used
RQ2a: Will student reports be perceived as useful?	**Q2**: The participation reports were useful
RQ2b: Will students perceive iPET as easy to use?	**Q1**: The participation reports were easy to understand
RQ2c: Will students read the iPET generated email/reports and want access to the reports for future classes?	**Q3**: I want to have participation reports for future classes
H2a: Student perception that the "instructor provides discussion feedback" will increase due to the use of iPET.	**Q17**. Receive timely feedback **Q24**: Received instructor feedback
H2b: Students perception that the instructor motivates class participation will increase due to the use of iPET	**Q23**: Instructor encouraged participation
H3a: Student "Online Enjoyability" will increase due to the use of iPET.	**M5**: Online discussion enjoyability **Q19**: Enjoy online discussions
H3b: Student "Online Discussion Motivation" will increase due to the use of iPET.	**M3**: Online discussion motivation **Q8**: Motivated to learn more
H3c: Students perception of being encouraged to participate in the classroom community will increase due to the use of iPET.	**Q15**: Encouraged to ask questions
H3d: Students perception of classroom community and being connected to other students in the online community will increase with the use of iPET.	**Q12**: Insights for others **Q18**: Others help me learn
RQ3a: Will students post comments more often when the have access to iPET.	Log file analysis
RQ3b: Will students post longer comments when the have access to iPET.	Log file analysis
H4a: Student "Perception of Learning from Online Discussion" will increase with the use of iPET.	**M2**: Student perceived learning from online discussion **Q5**: Online discussion useful
H4b: Student's perception of learning within the classroom community will increase with the use of iPET.	**M2**: Student perceived learning from online discussion **Q6**: Improved learning

7.7 Distribution of Students Across the Independent Variables

The main focus of this study was to understand the value of iPET (i.e. access to iPET was a key independent variable). However, two other independent variables were also investigated (as covariates). To summarize, the three independent variables investigated were:

- Access to iPET: A binary value differentiating between students having access to iPET (the condition) and students not having access to iPET (the control).
- PreviousDL: A variable noting the number of distance-based (ex. Web-based) classes a student has previously taken.
- ClassSize: The number of students in the class being evaluated.

Table 7.7 shows the distribution of students across each of the independent variables. For example, 60 students had access to iPET and 84 were in the control.

Table 7.7 Distribution of Students Across Independent Variables

	Category	Number of Students (completing pre & post surveys)
Access to iPET: If class is in the condition or the control	Condition	60
	Control	84
Class Size: Number of students in the class	Less than 13	11
	13-19	43
	20-25	51
	26 or more	39
PreviousDL: Number of previous distance learning classes taken by the student	0 classes	28
	1 class	27
	2-3 classes	35
	4 or more classes	54

7.8 Student Survey Validity

A study is valid if its measures actually measure what they claim to, and if there are no logical errors in drawing conclusions from the data. Validity, and how to assess survey validity, has been discussed in numerous text books, papers and web sites. One such example is [Rosenthal & Rosnow, 1991], which discusses validity as a first step in data analysis. In fact, there are a great many descriptions for different types of validity, but in general, validity has to do with threats and biases which could undermine the value of the research. Below, different aspects of validity are discussed.

7.8.1 Internal Validity

Internal validity ensures that variables, other than the independent variables being studied, are not responsible for a significant part of the observed effect on the dependent variables. Internal validity was reviewed with respect to:

- *Hawthorne effect* – Did the actions in the study contaminate the outcomes? For example, when Hawthorn investigated productivity improvements, the productivity improvements were found to reflect researcher attention, not the interventions being studied. In this study, students in both the control and the experimental condition completed pre/post course surveys. Student interactions with instructors were no different in the two conditions (the student reports in the experimental condition were not distributed by the instructor). Hence, there was no 'raised awareness' that might have caused students to participate more actively or change their perceptions of call dynamics.

- *Mortality bias* – Since the study was just for one semester (~12 weeks), it is not surprising that there were no known mortalities during the study and hence. However, another more realistic dimension of mortality bias was the number of students that completed the first survey, but did not complete the second survey. These students were not included in the analysis (since the analysis focused on the differences between the post survey from the pre survey results). The number of students that had this 'mortality' was 17. Specifically, there were 161 who completed the first study, and 144 that completed both surveys. This equates to a 10.5% mortality rate (with no class having a significantly higher mortality rate). Some of these students 'dropped the class', while others just did not complete the final survey.

- *Order effect* – The survey used randomization of survey questions to eliminate order effects of the instrument

- *Selection bias* – Did the subject selection approach constitute a random sample? Classes were assigned to the control (and experimental condition) on a random basis. However, it did turn out that there were more IT focused classes in the iPET condition (as opposed to the control). This was not a bias, in that all the courses in the study required intensive student participation and the percentage of the grade allocated to online participation was similar across the classes. In addition, the classes in the study were selected with some bias with respect to the instructor, in that the instructor volunteered to be part of the study. In addition, while students did not know (when registering for the class) that class was part of the study, they did had the option of not completing the surveys. Hence for both instructors and students, there might be a slight bias in that there were no results from instructors/students that did not want to participate in the study. This is a common bias for studies when subjects are being 'recruited'.

- *Evaluation apprehension* – There was no bias due to evaluation apprehension in that the students knew that their instructors did not see their individual results of the surveys (so students did not answer the survey to make the instructor 'look good'). In addition, the phrases in the survey were worded in both positive and negative wording (so there no attempt to change the belief of the students as they were responding to the surveys).

- *Control awareness* – the control group was not aware (until after the study) that they were within a control.

- *Before-After study concerns*: In comparing before-after results, the study ensured that there was no instrumentation change (i.e. same survey questions, delivered through same web interface) and minimal maturation of the subjects (in that the study, for a specific participant was approximately 3 months).

7.8.2 Construct Validity

Construct validity reviews the logic of items which comprise a measure in the study.

Construct validity was reviewed with respect to:

- *Convergent validity* – ensures that the indicators for a given construct should be at least moderately correlated among themselves. Cronbach's alpha is commonly used to establish convergent validity. In computing Cronbach's alpha, all 144 'pre-surveys' were used (across both the condition and control). Cronbach's alpha was computed for the 5 multi-item measures (ex. online discussion motivation) and shown in Table 7.8 (calculated in SPSS under Analyze, Scale, Reliability Analysis). While there is no agreed upon 'cut-off', it has been stated, that a value of 0.7 and above is an acceptable alpha [Nunnally, 1978]. Using this cut-offs, the following three measures clearly have convergent validity:

- Student Perceived Learning from online Discussion
- Online Discussion Motivation
- Online discussion Enjoyability

But, two measures have borderline convergent validity.

- Learning in the Community
- Instructor's role in motivating class participation

For these two measures, care must be taken in reporting the results of these measures, and a stronger focus will be placed on the individual questions within the measure.

Table 7.8 Cronbach Alpha for the Five Multi-Item Measures

Measure	Cronbach Alpha	Convergent Validity
Student Perceived Learning from online Discussion	0.84	Strong
Online Discussion Motivation	0.77	Moderate
Learning in the Community	0.61	Weak
Online discussion Enjoyability	0.78	Moderate
Instructor's role in motivating class participation	0.66	Weak

- *Content validity* – ensures the items measure what they claim to measure. This was validated by first adapting the measures from previously published (and validated) measures. In addition, the measures were reviewed by experts in the field of asynchronous learning networks.

- *Criterion validity* – focuses on the correlation between instrument measurement items and the actual measure. In other words, was what was being measured a good indication of the actual measure. In this study, criterion validated was ensured by the measures being reviewed by experts in the field of asynchronous learning networks.

- *External validity* – focuses on the possible bias of generalizing conclusions from a sample to a population, to other subject populations, to other settings, and/or to other time periods. Since the all the subjects (and all but one of the instructors) were associated with NJIT, care must be taken in generalizing the results of this study. While one might extrapolate to other technically focused universities that have a history of teaching a significant number of distance classes, it might not be valid to extrapolate to other universities or to extrapolate for other uses of ALNs (ex. within industry). To understand if these results are applicable across a broader audience is a topic of future potential research.

- *Discriminant validity* – ensures that the indicators for different constructs (ex. questions in a study) should not be so highly correlated as to lead one to conclude that they measure the same thing. Discriminant validity can be determined by examining the correlation across the different constructs. Toward this end, two correlation matrices were evaluated. One for each of the five multi-item measures (Table 7.9).

Table 7.9 Correlation Matrix Across the Five Measures

	Student Learning from Discussion	Online Discussion Motivation	Learning in the Community	Online Discussion Enjoyability	Instructor's Role in Motivating Participation
Student Perceived Learning from Discussion	1.0	0.58	0.57	0.61	0.51
Online Discussion Motivation	0.58	1.0	0.46	0.82	0.54
Learning in the Community	0.57	0.46	1.0	0.44	0.64
Online Discussion Enjoyability	0.61	0.82	0.44	1.0	0.46
Instructor's Role in Motivating Participation	0.51	0.54	0.64	0.46	1.0

This correlation matrix shows that the cross correlations are not high, with the exception of online discussion enjoyability and online discussion motivation, which had a correlation of 0.8. The fact that discussion motivation and enjoyability might be related is not surprising. For example, if a student knows they are supposed to be active with respect to online discussion, and they enjoy reading/writing online postings, then they will be more motivated to participate as compared to a student that does not enjoy posting / reading comments. So, to summarize, all five measures have discriminant validity, although future research might show that two of the measures should be combined (Online Discussion Motivation and Online Discussion Enjoyability).

The second correlation matrix shows the correlation of all of the actual survey questions (Table 7.10). As can be seen, there was no correlation above 0.75. These low to moderate cross correlations re-enforce the individual survey questions as having high discriminant validity.

Table 7.10 Correlation Matrix for Each Individual Item

	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25
Q4: Via online discussions, I learn a great deal from my peers	1.00	0.59	0.69	0.38	0.65	0.42	0.48	0.36	0.32	0.33	-0.06	0.29	0.32	0.45	0.26	0.49	0.44	0.34	0.56	0.27	0.52	0.31
Q5: Online discussion is useful to my learning*	0.59	1.00	0.57	0.68	0.59	0.42	0.42	0.38	0.31	0.24	0.10	0.26	0.41	0.38	0.42	0.45	0.33	0.37	0.73	0.34	0.37	0.29
Q6: Learning quality is improved by online discussions	0.69	0.57	1.00	0.48	0.56	0.39	0.44	0.36	0.37	0.38	0.02	0.23	0.31	0.41	0.22	0.33	0.24	0.24	0.49	0.27	0.42	0.31
Q7: Peer comments are very valuable in online discussions*	0.38	0.68	0.48	1.00	0.40	0.21	0.13	0.23	0.15	0.20	0.00	0.18	0.34	0.30	0.38	0.17	0.07	0.14	0.64	0.27	0.28	0.15
Q8: Reading online discussions motivated me to learn more	0.65	0.59	0.56	0.40	1.00	0.56	0.50	0.36	0.25	0.32	0.00	0.18	0.33	0.30	0.27	0.56	0.46	0.48	0.50	0.30	0.41	0.43
Q9: Online discussion motivated me to do my best work	0.42	0.42	0.39	0.21	0.56	1.00	0.67	0.42	0.51	0.42	0.07	0.08	0.28	0.27	0.37	0.62	0.54	0.57	0.38	0.36	0.16	0.43
Q10: My learning interest was improved by online discussion	0.48	0.42	0.44	0.13	0.50	0.67	1.00	0.49	0.51	0.45	0.13	0.15	0.23	0.25	0.29	0.63	0.63	0.65	0.36	0.29	0.21	0.41
Q11: Online discussions increased my desire to learn*	0.36	0.38	0.36	0.23	0.36	0.42	0.49	1.00	0.26	0.13	0.29	0.28	0.33	0.24	0.34	0.52	0.55	0.48	0.44	0.37	0.29	0.32
Q12: I feel that I have useful insights for other students in this course	0.32	0.31	0.37	0.15	0.25	0.51	0.51	0.26	1.00	0.49	0.12	-0.07	0.07	0.22	0.14	0.46	0.40	0.49	0.20	0.31	0.07	0.20
Q13: I feel that other students have useful insight for me in this course.	0.33	0.24	0.38	0.20	0.32	0.42	0.45	0.13	0.49	1.00	0.01	0.03	0.03	0.10	0.24	0.42	0.24	0.29	0.21	0.36	0.04	0.36
Q14: I hesitate to participate because I feel that I am not as knowledgeable as most of the other	-0.06	0.10	0.02	0.00	0.00	0.07	0.13	0.29	0.12	0.01	1.00	0.17	0.18	0.07	0.21	0.12	0.16	0.21	0.07	0.20	0.06	0.19
Q15: I am encouraged to ask questions*	0.29	0.26	0.23	0.18	0.18	0.08	0.15	0.28	-0.07	0.03	0.17	1.00	0.52	0.31	0.15	0.14	0.11	0.01	0.36	0.39	0.40	0.32
Q16: I feel that it is easy to get help when I have a question*	0.32	0.41	0.31	0.34	0.33	0.28	0.23	0.33	0.07	0.03	0.18	0.52	1.00	0.43	0.28	0.31	0.20	0.08	0.50	0.36	0.48	0.41
Q17: I receive timely feedback	0.45	0.38	0.41	0.30	0.30	0.27	0.25	0.24	0.22	0.10	0.07	0.31	0.43	1.00	-0.04	0.21	0.20	0.17	0.26	0.32	0.55	0.37
Q18: I feel that other students do help me learn*	0.26	0.42	0.22	0.38	0.27	0.37	0.29	0.34	0.14	0.24	0.21	0.15	0.28	-0.04	1.00	0.30	0.26	0.13	0.48	0.25	-0.06	0.18
Q19: I enjoy online discussions	0.49	0.45	0.33	0.17	0.56	0.62	0.63	0.52	0.46	0.42	0.12	0.14	0.31	0.21	0.30	1.00	0.65	0.60	0.47	0.47	0.22	0.46
Q20: I enjoyed reading online messages	0.44	0.33	0.24	0.07	0.46	0.54	0.63	0.55	0.40	0.24	0.16	0.11	0.20	0.20	0.26	0.65	1.00	0.65	0.32	0.21	0.20	0.22
Q21: I enjoy posting online discussion items	0.34	0.37	0.24	0.14	0.48	0.57	0.65	0.48	0.49	0.29	0.21	0.01	0.08	0.17	0.13	0.60	0.65	1.00	0.25	0.20	0.15	0.25
Q22: Online discussion is a good use of my time*	0.56	0.73	0.49	0.64	0.50	0.38	0.36	0.44	0.20	0.21	0.07	0.36	0.50	0.26	0.48	0.47	0.32	0.25	1.00	0.34	0.41	0.24
Q23: The instructor encouraged active online participation	0.27	0.34	0.27	0.27	0.30	0.36	0.29	0.37	0.31	0.36	0.20	0.39	0.36	0.32	0.25	0.47	0.21	0.20	0.34	1.00	0.31	0.50
Q24: The instructor provided constructive feedback (regarding online discussion postings)	0.52	0.37	0.42	0.28	0.41	0.16	0.21	0.29	0.07	0.04	0.06	0.40	0.48	0.55	-0.06	0.22	0.20	0.15	0.41	0.31	1.00	0.42
Q25: The instructor was helpful in guiding the online discussion	0.31	0.29	0.31	0.15	0.43	0.43	0.41	0.32	0.20	0.36	0.19	0.32	0.41	0.37	0.18	0.46	0.22	0.25	0.24	0.50	0.42	1.00

*Questions that were worded negatively on the student survey

7.8.3 Reliability

Another aspect of survey validity is to ensure that the surveys are reliable. Reliability is the accuracy of an item, scale, or instrument as compared to the hypothetical (true) measure of what is being observed. A survey can not be valid without being reliable. That is, reliability is a necessary but not sufficient condition for validity. Two aspects of reliability are discussed:

- *Test-retest reliability* – The extent to which each item or instrument yields the same score when administered in different times, locations, or populations and measures the stability over time. Since the surveys were administered via the web, there are no inter-rater reliability concerns. However, it is possible that different teachers and teaching styles might impact the results of the surveys. Due to this reliability concern, when comparing class participation across multiple semesters (ex. log file analysis), the only courses that were included in the type of analysis were either taught by the same instructor or had a consistent and well defined set of class participation guidelines. Finally, it is possible that different subjects (ex. students at different universities) would generate different results. This potential test-retest reliability (across different schools, or within industry) is noted in Chapter 10 with respect to limitations and potential areas for future research.

- *Cronbach's alpha* – when a scale is comprised of multiple items, cronbach's alpha is the most common form of reliability coefficient. Cronbach's alpha can be interpreted as the percent of variance the observed scale would explain in the hypothetical true scale. The results of the cronbach alpha analysis were presented in the previous discussion on construct validity/convergent validity. To summarize those results the following three measures clearly have convert validity:

    - Student Perceived Learning from online Discussion
    - Online Discussion Motivation
    - Online Discussion Enjoyability

  But, two measures had borderline convergent validity.

    - Learning in the Community
    - Instructor's Role in Motivating Class Participation

7.9 Normal Distribution

A normal distribution is required to use significance tests such as 't-tests'. If a normal distribution is not present, then cross tabulation and PRE tests such as Chi-Squared / Lamda need to be used. While it has been stated that likert-type responses can be treated as normally distributed [Sisson & Stocker,1989)], the actual distribution of the surveys (for the pre-survey questions across both conditions) was analyzed to determine if the answers to the questions were normally distributed. The Shapiro-Wilk test [Shapiro & Wilk, 1965], calculates a *W* statistic that tests if a random sample, $x_1, x_2, \ldots, x_n$ comes from a normal distribution. W may be thought of as the correlation between given data and their corresponding normal scores, with W = 1 when the given data are perfectly normal in distribution. When W is significantly smaller than 1, the assumption of normality is not met. That is, a significant W statistic rejects the assumption that the distribution is normal. As can be seen in tables 7.11 & 7.12, while the 'W' statistic was fairly close to 1 (between 0.9 and 0.96 for the multi question measures and between 0.85 and 0.91 when analyzing each question individually), the results were significantly different from 1, which rejects the assumption that the distribution in normally distributed. This suggests that while the results were close to being normally distributed, there was not a true normal distribution (note that a larger sample size might have been normally distributed). Hence, in contrast to Sisson & Stocker, these survey responses were not assumed to be normally distributed.

Table 7.11 Shapiro-Wilk Test for Normality for Each Individual Question

Measure	W - Statistic	Sig.
Q4: I learn a great deal from my peers	.890	.000
Q5: Online discussion is useful to my learning	.880	.000
Q6: Learning quality is improved by online discussions	.910	.000
Q7: Peer comments are very valuable in online discussions	.905	.000
Q8: Reading online discussions motivated me to learn more	.912	.000
Q9: Online discussion motivated me to do my best work	.896	.000
Q10: My learning interest was improved by online discussion	.907	.000
Q11: Online discussions increased my desire to learn	.864	.000
Q12: I feel that I have useful insights for other students in this course.	.868	.000
Q13: I feel that other students have useful insight for me in this course.	.876	.000
Q14: I hesitate to participate because I feel that I am not as knowledgeable as most of the other students.	.845	.000
Q15: I am encouraged to ask questions	.897	.000
Q16: I feel that it is easy to get help when I have a question	.912	.000
Q17: I receive timely feedback	.885	.000
Q18: I feel that other students do help me learn	.891	.000
Q19: I enjoy online discussions	.893	.000
Q20: I enjoyed reading online messages	.908	.000
Q21: I enjoy posting online discussion items	.900	.000
Q22: Online discussion is a good use of my time	.884	.000
Q23: The instructor encouraged active online participation	.846	.000
Q24: The instructor provided constructive feedback	.849	.000
Q25: The instructor was helpful in guiding the discussion	.880	.000

Table 7.12 Shapiro-Wilk Test for Normality for the Multi-Question Measures

Measure	W - Statistic	Sig.
Student Perceived Learning from online Discussion	.943	.000
Online Discussion Motivation	.956	.000
Learning in the Community	.932	.000
Online discussion Enjoyability	.943	.000
Instructor's role in motivating class participation	.901	.000

7.10 Association and Significance Testing

Association refers to the strength of a relationship. Significance on the other hand, is the percent chance that a relationship found in the data is just due to an unlucky sample, such that if we took another sample we might find nothing. For significance testing, Social scientists often use the .05 level as a cutoff: if there is 5% or less chance that a relationship is just due to chance, it will be concluded that the relationship is real. A relationship can be strongly significant even when the association of variables is very weak (this may happen in large samples, where even weak associations may be found significant). Also, two variables may be strongly but not significantly associated (this may happen in small samples). The selection of the test for association depends on two key factors:

- *Normal Distribution* – Since, as was discussed in the previous section, a normal distribution can not be assumed, cross tabular tests such as Gamma and Lamda can be used, but parametric 't-tests' can not be used.
- *Data Level* – Some of the variables in the analysis were ordinal (ex. response to survey questions), but some were nominal (ex. control vs experimental condition).

Taken together, the appropriate association test is Lamda, also known as *Goodman-Kruskal lambda*. Lamda was designed for use with nominal data that might not be normally distributed. Lambda is a popular measure because of its easily-understood interpretation in terms of proportionate reduction in error (PRE) varying from 0 to 1, which means that its value reflects the percentage reduction in errors in predicting the dependent variable outcome, when given knowledge of the independent variable. Specifically, a Lambda of 0 indicates that knowing the distribution of the independent variable is of no help in estimating the value of the dependent variable.

SPSS generates three versions: a symmetric version, and two asymmetric versions, one with each of the two variables considered as dependent. Since it was known which variables were independent (i.e. access to iPET), this asymmetric capability was leveraged in the calculations to follow. In addition, SPSS also computes the significance of the Lambda calculation (which was used to determine which results were significant). Finally, in SPSS, to compute Lamda one selects Analyze, Descriptive Statistics, Crosstabs; enter row and column variables; selected Statistics; select Lambda.

CHAPTER 8

INSTRUCTOR SURVEY ANLAYSIS & RESEARCH RESULTS

8.1 General Participation Requirements

Replies to **Post Survey Q1** ("Please describe participation requirement for this class, and in general, how student participation was graded") enables one to get an understanding of how different instructors encouraged/required class participation. In response to Q1, it was observed that many instructors had class participation rules. Sometimes it was a certain number of comments/week. For other instructors, it included a certain number of replies to other students. One typical response was "Students were required to participate every week about their lecture viewing and article reading. Their participation was due every Sunday midnight. Every Monday or Tuesday their participation was graded for lectures and articles." Finally, there was no clear & consistent method for grading participation. In fact, if answered, most instructors just noted the percentage of grade attributed to class (online) participation. The participation requirements were similar in other classes (i.e. in the control as well as other courses, in general, at NJIT).

8.2 Instructor's Perceived Usefulness

RQ1a: Will instructors want to use the tools to try to decrease their workload?

Result: *Yes*

In general, instructors wanted to both decrease their workload and improve their understanding of student participation. Hence it is not surprising to find that instructors wanted to use iPET to both decrease their workload and improve their understanding of student participation. However, while instructors wanted to use the tool for both workload reduction and improvement in understanding participation, the latter was typically slightly more important (i.e. better understanding in the same amount of time). To answer **RQ1a**, **Pre-Survey Q1** ("What do you hope/think the key benefits of the tool?") and **Pre-survey, Q8** ("What is more important – use of time, understanding participation") were analyzed. In reviewing the answers to Q1, there was one instructor whose initial focus was to save time (using the grading module). However, many other instructors had a slightly higher focus on an increased understanding of participation. This view was very consistent (in both written and verbal responses). The second question, Q8**,** focused not on iPET, but in general, the importance of decreasing instructor workload verses improved understanding of class participation. Just as for the answers to the iPET focused question, instructors wanted to spend less time understanding participation and also gain a better understanding of student participation. This view was very consistent (in both written and verbal responses) across both the control and test conditions (the written question was only given to the instructors in the experimental condition).

8.3 Instructor's Perceived Ease of Use

RQ1b: Will instructors perceive iPET as easy to use?

Result: *Yes*

Instructors were able to quickly understand how to use iPET without needing to become an SNA expert. To answer **RQ1b**, the **Post Survey Q7 (**"Did you find the tools easy to use?") was reviewed. For most instructors, a 30 minute one-on-one discussion was sufficient to enable those instructors to understand and use the key iPET concepts.

For others, the online help was all that was required (i.e. a couple of instructors did not even require the 30 minute one-on-one discussion). However, the 'grading' module was the most difficult for instructors to understand and use. This difficulty was due to several compounding reasons. First, there were some browser compatibility problems (bugs) in trying to get the grading feature to work across multiple browsers. In addition, it was not possible to integrate the grading feature into WebCT (just WebBoard). Finally, the grading feature was added late in the tool development, after the 'thinking out load' usability analysis, and so, the system might benefit from additional analysis on the best way to support a grading capability within an integrated suite of tools such as iPET. These reasons might explain why this feature was not used as much as the other components of the tool, and in fact, one suggestion has been to remove the grading capability, and add a 'quick email' capability – to easily send comments directly to the student.

8.4 Instructor's Desire to Continue to Use iPET

RQ1c: Will instructors want to use the tools for future classes?

Result: *Yes*

All instructors valued the tools and wanted to continue using iPET for future classes. As further evidence of the value of iPET, while this study was being conducted, several instructors asked for 'iPET views' of other classes they were teaching that were not included in the study. To answer this question, **Post Survey Q9** ("Do you want to use this tool when teaching future classes?") was evaluated. The answer was consistently positive and in fact, at this time, work is underway to try to investigate the feasibility of establishing a support structure so that iPET can continue to be used beyond this research project.

The reason instructors wanted to use the tools in the future can be better understood by examining which (if any) parts of iPET instructors found useful. If instructors found the tool useful, there would be a greater chance of them wanting to use the tool for future classes. So, two related survey questions – **Post Survey Q5 ("**Did you find any of the tools useful?") and **Post Survey Q6** ("Did you find any of the tools NOT useful?") can help understand which aspects of iPET caused the instructors to want to continue to have access to iPET for future classes. In examining the results of these survey questions, different instructors found different tools to be useful. Several instructors noted their favorite as messageTimelines. Others liked the summary view of each student ("I found them [the tools] useful to give me a flavor of the outliers"), and one mentioned the social graphs ("tool helped me to see the interactions of students easily"). Many instructors like the capability to easily view all of a particular student's messages within a single window. Finally, the following statement shows the general enthusiasm for the tool, "[liked it] very much, it is extremely helpful. Sell it!". As for the aspects of iPET that were NOT useful, while no instructor answered this question explicitly (except to state 'no – everything was useful'), it became clear that the grading tool was not being used (and hence not useful in its current form). Only one instructor used the grading tool for an extended period of time. Potential reasons for this lack of use were discussed in section 8.3 (Instructor's Perceived Ease of Use).

RQ1d: Will instructors be more willing to teach future online classes (as compared to not having access to iPET)?

Result: No (but instructors were already positively included to teach online courses)

This research question links an instructor's desire to use iPET to an instructor's desire to teach future online classes. However, there was no stated increase in desire to use iPET did not translate into being 'more willing to teach future online classes'. This is likely due to the fact that most instructors in the experimental condition had previously taught several online courses, and already had a positive view on teaching online courses.

8.5 Instructor Perceived Workload

H1a: Instructor workload will decrease – as compared to not using iPET.

Result: *Accepted*

In general, instructors reported increased efficiency in understanding student participation. However, some instructors did not actually reduce their workload, but rather, seemed to have used their "extra time" to gain more insight into student participation. This is likely due to the fact that some instructors have a 'mental clock' of how much time they should spend grading class participation – when the tool makes them more efficient, they spend the additional time obtaining additional insight.

The hypothesis **H1a** was investigated through analysis of **Post Survey Q3 / Pre survey Q6** ("How much time/week did you spend teaching the class?") and **Post Survey Q4 / Pre survey Q7** ("How much time/week did you spend sending/receiving/grading student participation?"). For instructors that did not have access to iPET, there was no reported difference in time spent for the class or with respect to sending/receiving/grading student participation. Instructors spent between five-twenty hours per week to teach the class (this was the same across both the control and experimental condition). However, for instructors that had access to iPET, there was one instructor who reported spending noticeably less time during the semester when they had access to iPET. Others reported no change. A typical view by the instructor was that it took approximately four to five hours per week and that it was slightly less than in previous semesters (when they did not have access to iPET). In terms of sending/receiving/grading student participation, instructors spent between one to five hours/week. For instructors that had access to iPET, one reported significantly reduced time performing these activities (a 33% reduction in the time required to grade participation.). Another, more typical instructor reported "I used to spend about three hours a week – with the tool I spent about two and half hours per week".

8.6 Instructor perceived Understanding of Student Participation

H1b: Instructors will have a higher perceived confidence in the participation grade given to each student.

Result: *Accepted*

H1b: Instructor perceived understanding of student participation will increase.

Result: *Accepted*

There was a significant positive result in that instructors reported an increase in their confidence in understanding student participation, and hence, increased their confidence in the accuracy of the participation grade given to each student. The hypothesis **H1b** and **H1c** were investigated through analysis of **Post Survey Q8** ("Do you think the tools made you more accurate in understanding student participation?"). Most instructors noted that they had a significantly better understanding of student participation after using iPET. The "tool helped me to see the interactions of students easily", "it gave overall performance in one glance", "I thought it made the participation grades more accurate," "I had much more confidence in the awarding of points for participation" and "I found them [the tools] useful to give me a flavor of the outliers" are examples of how instructors' valued iPET in gaining a more accurate understanding of student participation.

8.7 Instructor Perception of Student Participation Requirements

H5: Due to the use of iPET, a higher percentage of students will meet all course participation requirements.

Result: *Rejected, but not conclusive*

There was no reported difference in the number of students that met the course participation requirements. The hypothesis **H5** was analyzed via **Post Survey Q2** ("What percentage of the students satisfied the participation requirements?"). This lack of improvement might be attributable to the fact that many instructors used iPET to understand class participation (ex. grading), but might not have used it to encourage participation. For example, there were no known occurrences where an instructor saw a student not participating at an expected level, and then reached out to that student (ex. sent the student an email message). Student reports were supposed to be proxies for this behavior, but there are several potential reasons the student reports did not raise student participation completion percentages. First, there was a lot of information within the report, so a student not meeting a participation rule might not have quickly understood that fact. Second, the participation reports were not emailed to the student from the instructor (the reports were distributed via the researcher's email account). Finally, the change in the completion of participation requirement was reported as perceived by instructors – based on memory of previous courses – not actual completion percentages (a limitation which has been noted in Chapter 10). Hence, while no positive results were identified within this study, these results are not conclusive.

CHAPTER 9

STUDENT SURVEY ANLAYSIS & RESEARCH RESULTS

9.1 Data Analysis

Appendix D shows, for each individual and multi-item measures with convergent validity, the Lamda and significance calculations. The distribution for each survey question is also presented. The results in that appendix were used to answer the following research questions and hypotheses.

In addition, to compare (in Sections 9.3, 9.4 and 9.6) how the two conditions of 'access to iPET' and 'control' changed from the beginning of the class (pre survey) to the end of the class (post survey), a 'change' calculation is computed by subtracting the average pre response (to the survey question) from the average post-survey response (this is done separately for each condition). Since each question was scored using a Likert five point scale, calibrated such that an answer of (1) strongly agrees with a positively worded statement, a 'change' calculation with a negative result implies a lower (better) response in the post survey as compared to the pre survey.

9.2 Student User Acceptance / Perceived Usefulness

9.2.1 Perceived Usefulness

RQ2a: Will student reports be perceived as useful?

Result: *Yes*

Question two in the student survey, which is shown in Table 9.1 and was only given in the post survey for students that had access to iPET, directly asks this question (Q2: Participation reports were useful). Students did think the reports were useful (at the 0.01 level of significance) and on average, 'agreed' with the statement 'the participation reports were useful' (an average of 2.1 on the one to five Likert-scale). Hence, RQ2a can be answered that students did perceive the reports to be useful.

Table 9.1 Chi-Square Calculations for Q2

Chi-Square	Mean		Chi-Square	Significance
	Control	Condition		
Q2: Participation reports were useful	N/A	2.1	39	0.001

9.2.2 Perceived Ease of Use

RQ2b: Will students perceive iPET as easy to use?

Result: *Yes*

Question one in the student survey, which is shown in Table 9.2 and was only given in the post survey for students that had access to iPET, directly asks this question (Q1: The participation reports were easy to understand). Students did think the reports were easy to use (at the 0.01 level of significance) and on average, 'agreed' with the statement 'The participation reports were easy to understand' (an average of 1.8 on the one to five Likert-scale). Hence, RQ2b can be answered that students did perceive the reports to be useful.

Table 9.2 Chi-Square Calculations for Q1

Chi-Square	Mean		Chi-Square	Significance
	Control	Condition		
Q1: The participation reports were easy to understand	NA	1.8	31	0.001

9.2.3 Use of Reports

RQ2c: Will students read the iPET generated email/reports and want access to the reports for future classes?

Result: *Yes*

Question three in the student survey, which is shown in Table 9.3 and was only given in the post survey for students that had access to iPET, directly asks this question (Q3: I want to have participation reports for future classes). Students did think the reports were easy to use (at the 0.01 level of significance) and on average, 'agreed' with the statement 'I want to have participation reports for future classes' (an average of 1.7 on the one to five Likert-scale). Hence, RQ2c can be answered that students did perceive the reports to be useful. To further support this answer, for the classes that had access to student reports, the percentage of students that read at least one of the student reports was: 75%, 80%, 82%, 89%, 100%.

Table 9.3 Chi-Square Calculations for Q3

Chi-Square	**Mean** Control	Condition	**Chi-Square**	**Significance**
Q3: I want to have participation reports for future classes	NA	1.7	32	0.001

9.3 Instructor Role: Providing Feedback and Motivation

9.3.1 Instructor Feedback

H2a: Student perception that the "instructor provides discussion feedback" will increase due to the use of iPET.

Result: *Accepted*

Question twenty-four in the student survey directly asks this question (Q24: The instructor provided constructive feedback). In addition, question seventeen (Q17: I receive timely feedback) also is strongly tied to hypothesis 2a. As shown in Table 9.4, students did think the instructor provided more timely feedback when the students (and instructors) had access to iPET (at the 0.01 level of significance). The change in response was 0.64 better for students that had access to iPET as compared to those in the control (i.e. an average lower post response of 0.37 in the access to iPET condition combined an average higher post response of 0.27 in the control). Furthermore, students did perceive more timely feedback (at the 0.01 significance level), with the change in response 0.48 better for students in the experimental condition as compared to those in the control (i.e. an average lower post response of 0.42 in the access to iPET condition combined an average higher post response of 0.06 in the control). Hence, H2a is accepted.

Table 9.4 Mean and Lamda Calculations for Q17 & Q24

Lambda (Control as Dependent)	**Change in Mean** Control	Condition	**Lamda**	**Significance**
Q17: I receive timely feedback	0.06	-0.42	.33	0.001
Q24: Instructor provided constructive feedback	0.27	-0.37	.27	0.005

Note: change in mean is average post results – average pre results

9.3.2 Instructor Motivation of Class Participation

H2b: Student's perception that the instructor motivates class participation will increase due to the use of iPET.

Result: *Rejected*

Question twenty-three in the student survey addresses this question (Q23. The instructor encouraged active online participation). As shown in Table 9.5, with a level of significance of 0.07, one can not assume that students thought that the instructors encouraged active online participation. In addition, the actual change in response was not noticeably different in the control verses the students that had access to iPET. Hence, H2b is not accepted.

Table 9.5 Mean and Lamda Calculations for Q23

Lambda (Control as Dependent)	**Change in Mean** Control	Condition	**Lamda**	**Significance**
Q23: instructor encouraged participation	0.19	0.18	.22	0.07

Note: change in mean is average post results – average pre results

9.4 Quality of the Online Community

9.4.1 Online Discussion Enjoyability

H3a: Student "Online Enjoyability" will increase due to the use of iPET.

Result: *Accepted*

This hypothesis is addressed by M5 (online discussion enjoyability) and also from the specific item within that measure (Q19: I enjoy online discussions). As shown in Table 9.6, both Q19 and M5 were significant at the 0.01 level. The change in responses were also both noticeable (ex. Q19 was 0.37 better – an average lower post response of 0.25 in the access to iPET condition combined an average higher post response of 0.12 in the control). Hence, this hypothesis was accepted.

Table 9.6 Mean and Lamda Calculations for Q19 &M5

Lambda (Control as Dependent)	Change in Mean Control	Change in Mean Condition	Lamda	Significance
Q19: I enjoy online discussions	0.12	-0.25	.317	.002
M5: Online Discussion enjoyability	0.45	-0.83	.417	.002

Note: change in mean is average post results – average pre results

9.4.2 Online Discussion Motivation

H3b: Student "Online Discussion Motivation" will increase due to the use of iPET.

Result: *Accepted*

This hypothesis is addressed by M3 (online discussion motivation), and also the specific item within that measure (Q8: Reading online discussions motivated me to learn more). As shown in Table 9.7, measure 3 was significant at the 0.05 level, and in addition, the results for Q8 were significant at the 0.01 level. Furthermore, the change in responses for Q8 was 0.37 better for students that had access to iPET as compared to those in the control (i.e., an average lower post response of 0.22 in the access to iPET condition combined an average higher post response of 0.15 in the control). Hence, this hypothesis is accepted.

Table 9.7 Mean and Lamda Calculations for Q8 & M3

Lambda (Control as Dependent)	Change in Mean Control	Change in Mean Condition	Lamda	Significance
Q8: Motivated to learn	0.15	-0.22	.300	0.008
M3: Online Discussion motivation	1.04	-0.62	.313	0.05

Note: change in mean is average post results – average pre results

9.4.3 Encouraged to be Part of the Online Community

H3c: Students perception of being encouraged to participate in the classroom community will increase due to the use of iPET.

Result: *Rejected*

This hypothesis is addressed by the specific item within that measure (Q15: I am encouraged to ask questions). As shown in Table 9.8, this question did not produce any significant results. In addition, there was basically no change in response (i.e., pre survey verses post survey) .Hence, this hypothesis is rejected.

Table 9.8 Mean and Lamda Calculations for Q15

Lambda (Control as Dependent)	**Change in Mean**		**Lamda**	**Significance**
	Control	Condition		
Q15: Encouraged to ask questions	0.007	-0.002	.167	.194

Note: change in mean is average post results – average pre results

9.4.4 Connection to Others

H3d: Student perception of classroom community and being connected to other students in the online community will increase with the use of iPET.

Result: *Accepted*

This hypothesis is addressed by two specific items, Q18 (I feel that other students help me learn) and Q12 (I have insight for others). As shown in Table 9.9, the results for Q18 were significant at the 0.05 level and Q12 was significant at the 0.01 level. So, students that had access to iPET increased both the feeling that they had useful insights for others, and also increased their perception that others had useful information for them. The actual change (from pre survey to post survey) was especially noticeable in Q12 (an improvement of 0.59 – an average lower post response of 0.42 in the access to iPET condition combined an average higher post response of 0.17 in the control). Hence, this hypothesis was accepted.

Table 9.9 Mean and Lamda Calculations for Q12 & Q18

Lambda (Control as Dependent)	Change in Mean Control	Condition	Lamda	Significance
Q12: Insights for others	0.17	-0.42	.317	0.001
Q18: Other students help me learn	0.02	0.17	.283	0.029

Note: change in mean is average post results – average pre results

9.5 Online Discussion Activity

In order to understand if the use of iPET increases activity within an online community, 'similar classes' were identified. This is because one can not just compare the participation of students in the control condition to the participation of students in the experimental condition in that there are many factors (such as the participation requirements for the specific classes being analyzed) that can influence the activity of the class. Three courses (CIS673, CIS675 and CIS732) where identified, where a semester had access to iPET, and a previous semester did not have access to iPET. For all three courses, the analysis of the previous control class was done after the class completed, via log file analysis. For CIS 732 and CIS 673, the class that had access to iPET and the control class were taught by the same professor. For CIS675, the classes were taught by different instructors, but the course had a well-defined and consistent syllabus as well as consistent set of class participation requirements.

9.5.1 Exchange Ratios

Before exploring the results of the log file analysis, it is helpful to first review the focus of the online posting within each course. As was discussed in section 7.2 (and shown in Table 7.2a), both CIS675 and CIS732 were focused on discussion – posting and answering questions. However, CIS673 had a chunking focus – students summarizing chapters. The impact of this difference in focus can be better understood by examining the exchange ratio for these courses. The exchange ratio was originally discussed within an ALN context twenty-five years ago [Hiltz & Turoff, 1981]. Specifically, three values can be computed when analyzing a class's exchange ratio:

- *Direct Exchange Ratio*: The number of replies received by a student (directly to their postings) divided by the number of postings by that student.
- *Direct and Nested Exchange Ratio*: The total number of replies received by a student (including all replies to replies of the students posting) divided by the number of postings by that student.
- *Nested Only Exchange Ratio*: The number replies generated by replies to the student (i.e. only count replies to replies of the students posting) divided by the number of postings by that student.

To show the exchange ratio in an example, if a student posts a message, two students reply to that message and three students reply to each of the replies of the message:

- *Direct Exchange Ratio*: Uses the two direct replies to calculate the ratio
- *Direct and Nested Exchange Ratio*: Uses all eight replies to calculate the ratio
- *Nested Only Exchange Ratio*: Uses the six indirect replies to calculate the ratio

With this background in mind, Table 9.10 shows the exchange ratios for all the classes analyzed with respect to log file analysis.

Table 9.10 Exchange Ratios for Courses in the Log File Analysis

Course	Semester	Condition	Direct Exchange Ratio	Direct and Nested Exchange Ratio	Nested Only Exchange Ratio
CIS 732	Spring 2005	Access to iPET	0.72	1.50	0.78
	Fall 2001	Control	0.69	1.48	0.79
CIS 675	Spring 2005	Access to iPET	0.75	1.26	0.51
	Spring 2004	Access to iPET	0.61	1.33	0.72
	Fall 2003	Control	0.89	2.15	1.26
CIS 673	Spring 2004	Access to iPET	0.50	0.63	0.13
	Fall 2003	Control	0.56	0.68	0.12

As one can see, for the courses that focused on online discussion (CIS732 and CIS675), there was a noticeably higher 'Direct and Nested' and 'Nested only' exchange ratios (as compared to CIS673). This demonstrates a different pattern of online posting communication and makes intuitive sense. That is, if a student is focusing on posting a message that summarizes a chapter or lecture (as in CIS673), there might be a response from the instructor (or other student) stating either 'nice summary' or pointing out key points missed in the summary. In contrast, when the focus is on discussion, an interesting discussion thread can generate many replies and replies to replies. Finally, note these exchange ratios are fairly constant across both the 'access to iPET' and 'control' condition (especially for CIS732 and CIS673, which had the same instructor across both classes).

9.5.2 Number of Messages per Participant

RQ3a: Will students post comments more often when they have access to iPET?

Result: *Yes, for classes that focus on discussion.*

Table 9.11 summarizes the results of three courses that were analyzed in terms of the number of postings per student. One can see that the answer to the question "Will students post comments more often when they have access to iPET", is yes for classes with a focus on online discussion (but not for classes with a focus on chunking). The reason for this is that for 'chunking focused classes', the participation paradigm was very clearly defined, without an expectation for many responses to the student postings. Hence, feedback from iPET on participation did not generate additional postings. Conversely, for courses where additional replies were encouraged, the iPET student reports seemed to have motivated students to post and reply more often (between 23% and 57% more often).

Table 9.11 Percent Change in the Number of Student Postings

Course	Semester	Condition	num students	notes per student	% increase in notes per student	Number of instructor notes
CIS 732	Spring 2005	Access to iPET	22	47	57%	261
	Fall 2001	Control	26	30		265
CIS 675	Spring 2005	Access to iPET	17	32	23% (vs 2003)	213
	Spring 2004	Access to iPET	19	35	42% (vs 2003)	262
	Fall 2003	Control	32	26		231
CIS 673	Spring 2004	Access to iPET	21	33	0%	76
	Fall 2003	Control	21	33		93

9.5.3 Messages Size

RQ3b: Will students post longer comments when they have access to iPET?

Result: *Possible, but further study is required to confirm*

In Table 9.12, one can see that the answer the question "Will students post longer comments when they have access to iPET" is not clear. Two classes (CIS 673 and CIS

675) did have an increase the average length per message but CIS 732 had an average message size that was 23% smaller than the previous control CIS 732 class. In reviewing the actual postings, one possible reason for CIS 732 not having an increase in message size was observed. For the more recent class (the class that had access to iPET), many more students posted attachments (as compared with the earlier class, which was several years earlier, and posted many more answers 'in the message being posted'). This change in 'posting behavior' might have significantly influenced these results.

Table 9.12 Percent Change in Message Size

Course	Semester	Condition	Num Students	Bytes / message	% increase in message size
CIS 732	spring 2005	Access to iPET	22	1,450	-23%
	Fall 2001	Control	26	1,897	
CIS 675	Spring 2005	Access to iPET	17	2,499	68% (compared to control)
	Spring 2004	Access to iPET	19	1,844	24% (compared to control)
	Fall 2003	Control	32	1,481	
CIS 673	Spring 2004	Access to iPET	22	1,894	40%
	Fall 2003	Control	23	1,350	

Note: Message size includes HTML formatting

9.6 Quality of Discourse

9.6.1 Learning from Peers

H4a: Student "Perception of Learning from Online Discussion" will increase with the use of iPET.

Result: *Possible, but not conclusive*

This hypothesis is addressed by M2 (student perceived learning from online discussion), and also a specific item within that measure (Q5: online discussion is useful to my learning). As shown in Table 9.13, measure 2 was significant at the 0.05 level, but the result for Q5 was not significant. Hence, this hypothesis is rejected. However, further research could be conducted to understand why students felt online discussions were not more useful when they had access to iPET, but did feel that they had insights for others and gained insights from others (see H3d: Students perception of classroom community and being connected to other students in the online community will increase with the use of iPET).

Table 9.13 Mean and Lamda Calculations for Q5 & M2

Lambda (Control as Dependent)	Change in Mean Control	Change in Mean Condition	Lamda	Significance
Q5: online discussion are useful	0.17	-0.23	.100	0.255
M2: perceived learning	0.48	0.22	.217	0.039

Note: change in mean is average post results – average pre results

9.6.2 Learning within the Community

H4b: Student's perception of learning within the classroom community will increase with the use of iPET.

Result: *Possible, but not conclusive*

This hypothesis is addressed by M2 (student perceived learning from online discussion), and also a specific item within that measure (Q6: learning quality is improved by online discussions). As shown in Table 9.14, measure 2 was significant at the 0.05 level, but the results for Q6 were not significant. Hence, while additional research might prove conclusive, based on current results, this hypothesis is rejected.

Table 9.14 Mean and Lamda Calculations for Q6 & M2

Lambda (Control as Dependent)	Change in Mean Control	Change in Mean Condition	Lamda	Significance
Q6: Learning quality is improved	0.17	0.15	.15	0.177
M2: Perceived learning	0.48	0.22	.217	0.039

Note: change in mean is average post results – average pre results

9.7 Qualitative Student Feedback

Students that had access to the iPET reports were given the opportunity to provide informal feedback (to the researcher) via email. In brief, students thought the reports were helpful, but worried that instructors might just use the message counts (i.e., not focus on the quality of messages). Many of the students were also focused on the report accuracy. This focus on the quality of the report re-enforces the fact that student's had a heightened awareness of their participation and the importance of that participation.

9.8 Interaction of the use of iPET and Class Size

To explore the interaction of iPET and class size, an analysis was done to compute the association and significance (i.e. Lamda and Sigma) as a function of class size for the 'access to iPET' and control conditions separately (i.e. two sets of calculations). If the pattern of association / significance changed between the two cases (access to iPET and control), there was an interaction effect between the access to iPET condition and class size. As Table E.1 (in Appendix E) shows, this is the case for two of the individual items, but none of the multi-item measures:

- **Q6 (Improved learning quality)** – produced significant results at the 0.01 level in the 'access to iPET' condition but not in the control condition. The association (Lamda) was 0.23. As one can see in the distribution of change in responses (post – pre survey), as shown in Table 9.15, there is a negative relation between large class sizes and access to iPET with respect to a student's impression of improved learning.

Table 9.15 Distribution of Counts for Change in Response for Q6

	Change	Class Size <13	13-19	20-25	> 26
Access to iPET	-2.0	0	2	2	0
	-1.0	2	3	4	0
	0.0	6	14	5	0
	1.0	2	4	12	0
	2.0	1	0	3	0
Control	-2.0	0	1	0	4
	-1.0	0	3	2	1
	0.0	0	12	16	25
	1.0	0	3	5	4
	2.0	0	2	1	1

- **Q18 (Others help me learn)** – produced significant results at the 0.01 level in the control condition but not in the 'access to iPET condition'. However, in this case, the level of association was only 0.15. Hence, even though the results were significant, there is not enough of an association to be of interest. This is re-enforced in Table 9.16, which shows the distribution of change in responses (post – pre survey). Across all levels of previous DL, there is no change in the control condition (between pre and post survey results), but there appears to be a possible negative relation between larger class sizes and access to iPET with respect to a student's impression of other helping the student learn. Note however, that the results for the 'Access to iPET' condition were not significant.

Table 9.16 Distribution of Counts for Change in Response for Q18

	Change	Class Size <13	13-19	20-25	> 26
Access to iPET	-2.0	0	1	2	0
	-1.0	3	6	4	0
	0.0	4	10	6	0
	1.0	4	5	10	0
	2.0	0	1	4	0
Control	-2.0	0	0	0	3
	-1.0	0	4	2	2
	0.0	0	13	15	33
	1.0	0	1	7	0
	2.0	0	2	1	1

Hence, based on this data, there is an interaction effect between class size and access to iPET with respect to a student's perception that learning quality is improved by online discussions. This interaction effect might be due to the fact that with more students in the class, there might be less of a feeling of connecting to others in the class, and this is compounded by the fact that the student reports are longer (a student is being compared with a larger number of other students). Furthermore, for discussion-intensive classes (such as these courses) with a large number of students, postings grow at an exponential rate and students can not keep up with all the other student postings. To compensate for this, students typically selectively choose to focus on a few discussion topics. This behavior of selectively reading postings might have contributed to the negative interaction of class size and access to iPET, in that iPET reminded students of the fact that they (might have been) selectively reading posts.

9.9 Interaction of the use of iPET and Previous DL Courses

To explore the interaction of iPET and class size, an analysis was done to compute the association and significance (i.e. Lamda and Sigma) as a function of the number of previous distance learning courses taken by the student for both the 'access to iPET' and control conditions separately (i.e. two sets of calculations). If the pattern of association / significance changed between the two cases (access to iPET and control), there was an interaction effect between the access to iPET condition and class size. As Table C.1 and Table F.2 (in Appendix F) shows, this is the case for three of the individual items, but none of the multi-item measures:

- **Q5** (Online discussion useful) – produced significant results at the 0.01 level in the control condition (with a level of association at 0.10), but not in the 'access to iPET condition'. The distribution of change in responses (post – pre survey) is shown in Table C.3

- **Q19** (Enjoy online discussions) – produced significant results at the 0.05 level in the control condition but not in the 'access to iPET condition'. However, the level of association was very small (0.06). The distribution of change in responses (post – pre survey) is shown in Table C.4.

- **Q25** (Instructor guided discussions) – produced significant results at the 0.05 level in the control condition (with the level of association again being only 0.10). There were no significant results in the 'access to iPET condition'. The distribution of change in responses (post – pre survey) is shown in Table C.5

Based on the low levels of association, it is not surprising to find that, as one looks at the average change in response as a function of the number of previous DL courses across both the control and access to iPET condition (Table 9.17), there is no meaningful pattern between access to iPET and previousDL courses. Based on this view of the data, there is no compelling data showing that there is an interaction between use of iPET and the number of previous distance learning courses taken by a student. However, since the same size was fairly small, this could a topic for future research.

Table 9.17 Change in Response as a Function of Previous DL Courses

		Number of Previous DL Courses			
		0	**1**	**2-3**	**>3**
Q5	Access to iPET	-0.20	0.40	0.28	0.04
	Control	0.50	0.57	0.21	-0.07
Q19	Access to iPET	-0.40	-0.30	-0.33	-0.15
	Control	-0.04	0.18	0.06	0.26
Q25	Access to iPET	-0.60	0.50	-0.06	0.37
	Control	0.26	0.18	0.12	0.07

CHAPTER 10

CONCLUSION

10.1 Summary of Instructor Findings

Instructors wanted to use the tools for future classes because instructors had an increased understanding of student participation (as compared to not using the tools) and also had a higher confidence in the participation grade given to each student. Table 10.1 summarizes the results with respect to instructors.

Table 10.1 Summary of Results for Instructor Questions / Hypothesis

Hypothesis / Research Question	Result / Strength of Response	Summary
RQ1a: Will instructors want to use the tools to try to decrease their workload?	Yes / Weak	While instructors wanted to use the tool for workload reduction they also wanted to use the tool for improvement in understanding participation, the latter was typically more important (i.e. better understanding in the same amount of time).
RQ1b: Will instructors perceive iPET as easy to use?	Yes / Weak	Online help and 30 minute 'tutorials' were typically what was required. Grading module was difficult and required more one-on-one instruction.
RQ1c: Will instructors want to use the tools for future classes?	Yes / Strong	All instructors valued the tools and wanted to continue using iPET for future classes. Furthermore, while the study was being conducted, several instructors asked for 'iPET views' of other classes that were not included in the study.
RQ1d: Will instructors be more willing to teach future online classes (as compared to not having access to iPET)?	No / Weak	Teachers in the study were already willing /liked to teach online courses.
H1a: Instructor workload will decrease (as compared to not using the tools).	Yes / Weak	One instructor reported that he reduced the time required to grade participation by 33%. Other instructors used the extra time to gain a better understanding of student participation.
H1b: Instructors will have a higher perceived confidence in the participation grade given to each student.	Yes / Strong	"I had much more confidence in the awarding of points for participation".
H1c: Instructor perceived understanding of student participation will increase (as compared to not using the tools).	Yes / Strong	"I thought it made the participation grades more accurate," and the "tool helped me to see the interactions of students easily".
H5: Due to the use of iPET, a higher percentage of students will meet all course participation requirements	No / Weak	Many instructors used iPET to understand class participation (ex. Grading), not to encourage participation.

10.2 Summary of Student Findings

By analyzing the results of the student surveys, it can be seen that students thought that the reports were useful and easy to understand. Students also reported that they wanted access to student reports for future classes. Furthermore, students felt strongly that, when they had access to iPET student reports, their instructors provided increased discussion feedback. In addition, the student's online enjoyability and discussion motivation increased. These results are also supported via unstructured comments sent from some of the students to the researcher (via email). Finally, in classes that had a focus of online discussion, the use of iPET resulted in students posting more comments. These results are summarized in Table 10.2.

Table 10.2 Summary of Results for Student Questions / Hypothesis

Hypothesis / Research Question	Result	Student Survey Question Used	Level of Sig.	Total Change of means (change condition - change control)
RQ2a: Will student reports be perceived as useful?	Yes	Q2	0.01	NA
RQ2b: Will students perceive iPET as easy to use?	Yes	Q1	0.01	NA
RQ2c: Will students read the iPET generated email/reports and want access to the reports for future classes?	Yes	Q3	0.01	NA
H2a: Student perception that the "instructor provides discussion feedback" will increase due to the use of iPET.	Accepted	Q17 Q24	0.01 0.01	-0.48 -0.64
H2b: Students perception that the instructor motivates class participation will increase due to the use of iPET	Rejected	Q23	0.07	NA
H3a: Student "Online Enjoyability" will increase due to the use of iPET.	Accepted	M5 Q19	0.01 0.01	-1.29 -0.37
H3b: Student "Online Discussion Motivation" will increase due to the use of iPET.	Accepted	M3 Q8	0.01 0.05	-1.85 -0.37
H3c: Students perception of being encouraged to participate in the classroom community will increase due to the use of iPET.	Rejected	Q15	0.19	NA
H3d: Students perception of classroom community and being connected to other students in the online community will increase with the use of iPET.	Accepted	Q12 Q18	0.01 0.05	-0.59 0.15
RQ3a: Will students post comments more often when the have access to iPET.	Yes (discussion focused courses)	NA	NA	23% to 57% posting increase
RQ3b: Will students post longer comments when the have access to iPET.	Possible	NA	NA	No definitive pattern
H4a: Student "Perception of Learning from Online Discussion" will increase with the use of iPET.	Possible (but not conclusive)	M2 Q5	0.05 0.25	-1.28 NA
H4b: Student's perception of learning within the classroom community will increase with the use of iPET.	Rejected	Q6 M2	0.18 0.05	NA -1.86

10.3 Limitations

There were several limitations in this study, many of which were discussed in Section 7.8 (which describes the study's internal and external validity). Below, some of the key limitations are discussed in more detail.

10.3.1 Size of Study

In this study, the number of classes (and number of students) was fairly small. Specifically, there were 144 students (in 13 classes) that participated in this study. There was an additional four classes that used the iPET tool, but only by the instructor (i.e., students in these additional classes did not participate student surveys). While one instructor used the tool at a University in France, the other instructors and all of the student feedback was obtained from within one technically focused university.

10.3.2 Instructor Attitude

The instructors that participated in this study were all experienced (and liked) teaching online courses. It is possible that instructors that were new to teaching online courses would have produced different results. It is also possible that instructors that do not like teaching online courses would also have reacted differently to a tool such as iPET. This difference might also impact the perceived ease of use of the iPET set of tools.

10.3.3 Type of ALN

Another limitation of this study was the fact that the only ALN studied were ALNs used for online learning. Other ALNs (ex. corporate knowledge repositories) might have different needs for dynamic measure tools of online discourse. Finally, while some of the information was 'hard data' from log file analysis, there were many instances of 'self-reported perceptions' (ex. instructor's confidence in providing an accurate class participation grade).

10.3.4 Researcher Interaction with Students

In this study, the researcher distributed the student reports generated by iPET (via email). It is possible that results would have been different if the instructor of the class distributed the reports. For example, students might have spent more time reviewing the reports had they been distributed by the instructor.

10.4 Contributions

The main contribution of this work was to demonstrate that using dynamic measurement tools within an ALN increases participation without increasing facilitator workload. Due to the fact that active online discussion is a key factor in the success of an ALN, this research demonstrates that dynamic measuring tools for online discourse can help ensure a positive outcome within an online learning environment.

10.4.1 Increased Participation within an ALN

Since, to get the most out of online learning, students needs to be active participants within the ALN [Hiltz & Turoff, 2002], tools such as iPET can help ensure a positive outcome within an online learning environment. This is because, for classes with a focus on discussion, the use of iPET has been shown to increase the number of posted messages, This is, at least in part, due to the introduction of iPET participation reports – proactively sending individuals information to let them understand their current level of participation and how that compares with the facilitator's expectations for participation.

10.4.2 Increased Facilitator Understanding of Participation within an ALN

In addition to increasing student participation, iPET has been shown to increase an instructor's understanding of student participation without increasing their workload. Understanding online discussions, and in particular, teaching an online course, is currently seen as a time consuming task – typically requiring more time than teaching a face-to-face class. This study demonstrated that when instructors had access to the iPET suite of tools, they had an increase in confidence of their understanding of student participation without having an increase in their workload. When students have access to iPET student reports, they felt that instructors provided more feedback and that they had an increased motivation for online discussion which results in more messages being posted within the class. Taken together, iPET established an environment of increased focus on participation, without increasing instructor workload.

10.4.3 Visualization Techniques for Discourse within an ALN

This work introduced, in a real-world environment, new and useful views of an ALN that were based on both Social Network Analysis and Information Visualization. While some of these views were graphical in nature, others were simply a re-ordering of the list of messages. So, for example, rather than forcing the ALN conferencing system to 'hard-code' a view of 'list by date' or 'list by conference', this system introduced the idea of letting the users select between many of these simple list views (as well as the more advanced visualization views).

10.5 Potential Future Research

10.5.1 Addressing Perceived and Self-Reported Results

Many of the variables reported in this study were self-reported impressions. For example, time spent by instructors was a self-reported number that might not be accurate. In addition, many questions focused on perceived as opposed to actual data (ex. "I learn a great deal from my peers"). These self-reported results might be error prone. So, one area of investigation would be to do a detailed field study of the impact of iPET on actual participation patterns. While there were positive results with respect to the number of messages (analyzed via log files), additional longitudinal studies could be done to verify the results and investigate other questions (such as changes in student grades or a longitudinal study that exposes students to iPET halfway through the semester).

10.5.2 Addressing Limitations in the Validity of the Study

An area of investigation that could be studied is the variability in the value of tools such as iPET as a function of the 'technology comfort' of the class (the majority of classes in this study were IT focused courses). For example, one could study the impact of a tool such as iPET on ALNs within other universities (this study focused on distance learning within a university that had a high familiarity and acceptance with distance learning). Furthermore, since almost all of the instructors in this study were experienced and liked teaching online courses, further study with instructors (or facilitators) new to using ALNs could be investigated. Finally, more investigation needs to be done to better understand the potential interaction of access to tools such as iPET and the number of previous DL courses taken by a student.

10.5.3 Improved Student Reports

There are several potential reasons that the student reports did not raise student participation completion percentages. One reason might be that there was a lot of information within the report, so a student not meeting a participation rule might not have quickly understood that fact. Another reason might be that the participation reports were not emailed to the student from the instructor (the reports were distributed via the researcher's email account). So, a future area of study could be to study the impact of shortening the student reports (perhaps the students had information overload from the student reports) and/or having the reports emailed from the instructors account.

10.5.4 Improved Grading Module

The grading module within iPET was the one feature that was often considered difficult to use (which is one likely reason it was not used extensively). Additional research could be done to determine a better way to capture an instructor's thoughts (grades/comments). An avenue to explore is that rather than providing a mechanism to grade each message, the system could enable the instructor to easily send an email message to the student (referencing any specific message) – this would enable more direct feedback that is applicable for industry as well as within courses. Another possibility would be to note that instructors typically read several messages by a student, and then determine that student's grade. Hence, it might be best to allow an instructor to enter grades for a student, as opposed to grades for a specific message.

10.5.5 Relationship of Enjoyability and Motivation

Future research could investigate the online discussion enjoyability and motivation. This research would focus on trying to determine if these two measures are related, and if so, the relationship between these two concepts. This research might lead to additional tools that could be created to help drive enjoyability (if that leads to motivation), or motivation (if that leads to enjoyability).

10.5.6 Additional Data and Metrics

There are multiple areas of research suggested as a result of this work with respect to examining additional information. Once example would be exchange ratios. One could investigate the use of exchange ratio calculations as a way to measure instructor's ability to generate student dialog. In addition to exchange ratios, one could also investigate other metrics such as equality of participation (as opposed to activity of participation) or Social Network Analysis metrics such as centrality (determining which student was more central within the student body).

10.5.7 Course Categorization

This research introduced the categorization of courses with respect to the use of the web-based conferencing system within the course. An open area of research is to try to systematically determine the categorization of a class. In addition, one could define specific tools that would be more applicable for a specific category of courses. For example, metrics such as exchange ratios can be used to categorize class participation paradigms. This, in turn, can be used to help determine/select tools that are more appropriate for different participation paradigms.

10.5.8 Applicability within Industry

While this study was focused on the use of an ALN within an academic environment, the use of these tools should be applicable across a wide range of ALNs. One such use would be within industry, where ALNs are used as knowledge repositories. One area of study would be on the impact of dynamic measurement of participation within a corporate knowledge repository. For example, one could determine if a tool such as iPET significantly increases knowledge sharing and/or access to knowledge that has been stored within the ALN.

APPENDIX A

CONSENT FORM

Before a survey is completed by a participant, an "electronic consent" is obtained by each participant. This is achieved with the following sentence being included before the start of the survey.

> "By answering these questions, you are accepting to be a participant in the "Student participation evaluation study" (more details are available in the consent form.)"

The consent form is shown below

****

Name of Project Director or Principal Investigator: **Jeffrey Saltz**
Thesis Advisors: **Prof. Roxanne Hiltz, Prof. Murray Turoff, Prof. Katia Passerini**

Title of Project: **Student Interaction Browser**

I acknowledge that I was informed by **Jeffrey Saltz** (Investigator) of NJIT of a project concerning or having to do with the following: ***Studying the effectiveness of tools to improve an instructor's knowledge of distance-based student participation.***

PURPOSE:

The purpose of this experiment/survey is to find out, in a scientific manner, instructors and students' opinions of the web-based tools supplied to the instructor.

DURATION:

My participation in this study will last until the end of the semester (until I submit the questionnaire, or until I decide not to submit it).

PROCEDURES:

I have been told that, during the course of this study, I will be asked to voluntarily:

- *Complete a pre-experiment questionnaire*
- *Receive a demo of the tool (only for instructors, through using an interactive web site).*
- *Use the tool as needed during the semester*

- Complete a post-experiment questionnaire

PARTICIPANTS:

There will be several sections participating in this study.

EXCLUSIONS:

I will inform the researcher if any of the following apply to me:

- I do not wish to complete the study for any reason.

RISK/DISCOMFORTS:

I have been told that the study described above may involve the following risks and/or discomforts: *none known or anticipated*

There also may be risks and discomforts that are not yet known.

CONFIDENTIALITY:

Every effort will be made to maintain the confidentiality of my study records. Officials of NJIT will be allowed to inspect sections of my research records related to this study. If the findings from the study are published, I will not be identified by name. My identity will remain confidential unless disclosure is required by law.

PAYMENT FOR PARTICIPATION:

I have been told that I will receive no monetary compensation for my participation.

CONSENT AND RELEASE:

I fully recognize that there are risks that I might be exposed to by volunteering in this study which are inherent in participating in any study, I understand that I am not covered by NJIT's insurance policy for any injury or loss I might sustain in the course of participating in the study.

RIGHT TO REFUSE OR WITHDRAW:

I understand that my participation is voluntary and I may refuse to participate, or may discontinue my participation at any time with no adverse consequence. I also understand that the investigator has the right to withdraw me from the study at any time.

INDIVIDUAL TO CONTACT:

If I have any questions about my treatment or research procedures that I discuss them with the princpal investigator. If I have any additional questions about my rights as a research subject, I may contact:

Richard Greene, M.D., Ph.D., Chair, IRB (973) 596-3281

**** Technical Note: people who fill in questionnaires are officially called "subjects"*

APPENDIX B

SURVEYS AND SEMI-STRUCTURED INTERVIEWS

The following sections display the surveys (distributed to students) and semi-structured interviews (to guide discussions with instructors) that were used to collect data within this study.

B.1 Semi-Structured Pre-Experiment Instructor Interview

Review Introduction/Demo/Tutorial:

A walk through of the basic capabilities of the software, using an older/pre-populated class discussion, will be provided, and questions on functionality will be answered. Then, the following questions should be answered.

1. **With your basic understanding of the tool, what do you hope/think the key benefits will be?**(ex. save instructor time?, better understand "at-risk" students, more accurate grading?)

2. **With your basic understanding of the tool, what problems/shortcomings do you forsee?**

3. **Overall, how would you describe your expectations for this tool:**
   (a) Very enthusiastic
   (b) Enthusiastic
   (c) Neutral
   (d) skeptical
   (e) Very doubtful

4. **Have you previously taught DL/ALN courses?**
   If so, how many courses? For how many years?

5. **This semester, which courses are you going to teach fully or partially online?**
   How many students are in each course?

6. **How much time/week did you typically spend (on average) teaching previous classes (including reading webBoard, preparing/grading assignments/tests, facilitating discussions, coaching individuals/groups on assignments, ...)?**

Please provide an approximate breakdown for each of these. Do you expect the time you spend on this class to differ significantly from other DL courses you have taught?

7. **How much time/week do you spend (on average) PER STUDENT sending/receiving/grading student participation (i.e. using webBoard)?** Do you expect the time you spend on this class sending/receiving/grading student participation to differ significantly from other DL courses you have taught?

What is more important to you:

(a) More effective use of time (ex. faster grading of class participation)
(b) Better understand / improved encouragement of student participation
(c) Roughly equal combination of (a) and (b)
(d) Neither (please explain: ____________________________)

B.2 Semi-Structured Post Experiment Instructor Interview

The following survey questions were adapted from previous instructor interview guides [Hiltz, Coppala & Rotter 2000].

Introduction

Please be assured that what you share in this survey/interview will be kept confidential. You might be identified in a report as a "computer science full time faculty member", or a "school of management adjunct faculty member", but not in any way that would reveal your identify as an individual. So, please feel free to tell what you really think and feel; this will be the most helpful in trying to find out if these tools are useful and how they might be improved in the future.

Instructors view of student participation

1. **Please describe participation requirement for this class, and in general, how student participation was graded.** (Was there required postings in a specific conference? If so, for each required participation, how many posts/replies and how often).

2. **What percentage of the students satisfied the participation requirement for the class?** Was this percentage different from other DL classes you have taught? If so, why?

Instructor time required

3. **How much time/week did you spend (on average) teaching the class (including reading webBoard, preparing/grading assignments/tests, ...)?** Did the time you spend on this class differ significantly from other DL courses you have taught?

4. **How much time/week did you spend (on average) sending/receiving/grading student participation (i.e. using webBoard)?** Did the time you spend on this class sending/receiving/grading student participation differ significantly from other DL courses you have taught?

Instructor perceived tool usefulness

5. **Did you find any of the tools useful?**
   If yes, which features did you find most valuable and how did you use them?
   If no, why not? (software problem, too slow, wanted different features, I'm fine just using webBoard).

6. **Did you find any of the tools NOT useful?**
   If yes, which features did you find least valuable?
   Should they be removed from the system, or can you suggest ways to improve their usefulness.

7. **Did you find the tools easy to use?**

Instructor usage / value

8. **Do you think the tools made you more accurate in understanding/grading student participation?**
   If so, how?
   If not, are there changes to the software that would have allowed you to be more productive?

9. **Do you want to use this tool when teaching future classes?**
   If so, how would you use the tool? Are there features you would like to see added?
   If not, are there features that if added, would cause you to want to use the software?

10. **Did providing summary report to students change student behavior/participation (if applicable)?**
    If so, can you describe the changes?

11. **Is there anything else you would like to add to this discussion?**

B.3 Semi-Structured Instructor Interview (Control Survey)

The following survey questions were adapted from previous instructor interview guides [Hiltz, Coppala & Rotter 2000].

Introduction

Please be assured that what you share in this survey/interview will be kept confidential. You might be identified in a report as a "computer science full time faculty member", or a "school of management adjunct faculty member", but not in any way that would reveal your identify as an individual. So, please feel free to tell what you really think and feel; this will be the most helpful in trying to find out if these tools are useful and how they might be improved in the future.

Instructors view of student participation

1. **Please describe participation requirement for this class, and in general, how student participation was graded.** (Was there required postings in a specific conference? If so, for each required participation, how many posts/replies and how often).

2. **What percentage of the students satisfied the participation requirement for the class?** Was this percentage different from other DL classes you have taught? If so, why?

Instructor time required

3. **How much time/week did you spend (on average) teaching the class (including reading webBoard, preparing/grading assignments/tests, ...)?** Did the time you spend on this class differ significantly from other DL courses you have taught?

4. **How much time/week did you spend (on average) sending/receiving/grading student participation (i.e. using webBoard)?** Did the time you spend on this class sending/receiving/grading student participation differ significantly from other DL courses you have taught?

B.4 Student Pre Survey (and control sections)

Note that the actual survey will not label the measures and intermix the questions.

For each of the questions below, please note if you:

Strongly Agree (SA)
Agree (A)
Neither agree nor disagree (N)
Disagree (D)
Strongly Disagree (SD)

Students Perception of Learning from Online Discussion (Wu & Hiltz, 2003):

1. Via online discussions, I learn a great deal from my peers.....SA A N D SD
2. Online discussion is NOT useful to my learning. .... SA A N D SD
3. Learning quality is improved by online discussions........... SA A N D SD
4. Peer comments are NOT very valuable in online discussions..SA A N D SD

Online Discussion Motivation (Wu & Hiltz, 2003) :

1. Reading online discussions motivated me to learn more....... SA A N D SD
2. Online discussion motivated me to do my best work.......... SA A N D SD
3. My learning interest was improved by online discussion...... SA A N D SD
4. Online discussions DECREASED my desire to learn.......... SA A N D SD
5. I feel that I have useful insights for other students in this course

   SA A N D SD
6. I feel that other students have useful insights for me in this course

   SA A N D SD
7. I hesitate to participate because I feel that I am not as knowledgeable as most of the other students SA A N D SD

Online Discussion Enjoyability (Wu & Hiltz, 2003):

1. I enjoy online discussions... SA A N D SD
2. I enjoyed reading online messages.............................. SA A N D SD
3. I enjoy posting online discussion items.......................... SA A N D SD
4. Online discussion wastes my time...................................SA A N D SD

Instructor's Role in motivating class participation (adapted from Wu & Hiltz, 2003)

1. The instructor encouraged active online participation.......... SA A N D SD
2. The instructor provided constructive feedback................. SA A N D SD
   (regarding online discussion postings)
3. The instructor was helpful in guiding the online discussion.. SA A N D SD

Learning within the classroom community (adapted from Rovai, 2002)

1. I am NOT encouraged to ask questions .... SA A N D SD
2. I feel that it is hard to get help when I have a question .... SA A N D SD
3. I feel that I receive timely feedback... SA A N D SD
4. I feel that other students do NOT help me learn .... SA A N D SD

Previous Online Course Experience

1. How many online courses have you taken
   (before this course)? 0 1 2 3 >3

B.5 Student Post Experiment Survey (and control)

Note that the actual survey will not label the measures and intermix the questions.

For each of the questions below, please note if you:
Strongly Agree (SA), Agree (A), Neither agree nor disagree (N), Disagree (D), or Strongly Disagree (SD)

Students Perception of Learning from Online Discussion (Wu & Hiltz, 2003):

1. Via online discussions, I learn a great deal from my peers.... SA A N D SD
2. Online discussion is NOT useful to my learning. .... SA A N D SD
3. Learning quality is improved by online discussions........... SA A N D SD
4. Peer comments are NOT very valuable in online discussions. SA A N D SD

Online Discussion Motivation (wu & Hiltz, 2003) :

5. Reading online discussions motivated me to learn more....... SA A N D SD
6. Online discussion motivated me to do my best work........... SA A N D SD
7. My learning interest was improved by online discussion...... SA A N D SD
8. Online discussions DECREASED my desire to learn.......... SA A N D SD
9. I feel that I have useful insights for other students in this course SA A N D SD
10. I feel that other students have useful insights for me in this course SA A N D SD
11. I hesitate to participate because I feel that I am not as knowledgeable as most of the other students SA A N D SD

***Online Discussion Enjoyability (Wu & Hiltz, 2003)*:**

12. I enjoy online discussions.. SA A N D SD
13. I enjoyed reading online messages................................ SA A N D SD
14. I enjoy posting online discussion items.......................... SA A N D SD
15. Online discussion wastes my time.................................SA A N D SD

Instructor's Role in motivating class participation (adapted from Shea 2002; Wu & Hiltz, 2003)

16. The instructor encouraged active online participation.......... SA A N D SD

17. The instructor provided constructive feedback.................... SA A N D SD
(regarding online discussion postings)

18. The instructor was helpful in guiding the online discussion.. SA A N D SD

19. My grade for online discussion was fair........................ SA A N D SD

Learning within the classroom community (adapted from Rovai, 2002)

20. I am NOT encouraged to ask questions .... SA A N D SD

21. I feel that it is hard to get help when I have a question .... SA A N D SD

22. I feel that I receive timely feedback....................................... SA A N D SD

23. I feel that other students do NOT help me learn .... SA A N D SD

Value of Student Participation Reports (Not asked if in the control)

24. The participation reports were easy to understand .... SA A N D SD

25. The participation report were NOT useful.......................... SA A N D SD

26. I would want to have participation reports for future classes..SA A N D SD

APPENDIX C

IRB NOTICE OF APPROVAL

Written approval by NJIT Review Board to conduct the empirical study.

NJIT NEW JERSEY INSTITUTE OF TECHNOLOGY

Institutional Review Board: HHS FWA 00003246
Notice of Approval
IRB Protocol Number: E6-04

Principal Investigator/Dept: Jeffrey Saltz/Information Systems

Title: Student interaction browser
Performance Site(s): NJIT

Sponsor Protocol Number:

Type of Review: FULL [ ] EXPEDITED [X]

Type of Approval: NEW [X] RENEWAL [ ] MINOR REVISION [ ]

Approval Date: March 4, 2004 Expiration Date: March 3, 2005

1. **ADVERSE EVENTS:** Any adverse event(s) or unexpected event(s) that occur in conjunction with this study must be reported to the IRB Office immediately (x3281).
2. **RENEWAL:** Approval is valid until the expiration date on the protocol. You are required to apply to the IRB for a renewal prior to your expiration date for as long as the study is active. Renewal forms will be sent to you; but it is your responsibility to ensure that you receive and submit the renewal in a timely manner.
3. **Consent Form:** All subjects must receive a copy of the consent form; the original signed copy must be kept in a secure place by the principal investigator.
4. **Subjects:** Number of subjects approved: 60.
5. The investigator(s) did not participate in the review, discussion, or vote of this protocol.
6. **APPROVAL IS GRANTED ON THE CONDITION THAT ANY DEVIATION FROM THE PROTOCOL WILL BE SUBMITTED, IN WRITING, TO THE IRB FOR SEPARATE REVIEW AND APPROVAL.**

________________________ March 4, 2004
Richard Greene, M.D., Ph.D., Chair IRB Date

APPENDIX D

STUDENT SURVEY DISTRIBUTION RESULTS

The distribution for the change (post survey – pre survey) in student answers to the survey questions as well as the level of association (Lamda) and significance (sigma) calculations for those distributions.

Table D.1 Q4: Learn from Peers

Lamda: 0.23 Sig: 0.02		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	5	2	7
	-1.0	20	9	29
	0.0	22	54	76
	1.0	9	13	22
	2.0	4	6	10
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.2 Q5: Online Discussion Useful

Lamda: 0.19 Sig: 0.25		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	1	3	4
	-1.0	12	8	20
	0.0	29	54	83
	1.0	13	16	29
	2.0	5	3	8
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.3 Q6: Improved Learning

Lamda: 0.15 Sig: 0.18		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	4	5	9
	-1.0	9	6	15
	0.0	25	53	78
	1.0	18	12	30
	2.0	4	8	12
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.4 Q7: Valuable Peer Comments

Lamda: 0.22 Sig: 0.06		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	4	5	9
	-1.0	12	6	18
	0.0	21	56	77
	1.0	19	12	31
	2.0	4	5	9
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.5 Q8: Motivated to Learn More

Lamda: 0.30 Sig: 0.01		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	8	2	10
	-1.0	18	9	27
	0.0	21	50	71
	1.0	6	19	25
	2.0	7	4	11
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.6 Q9: Motivated to do Best Work

Lamda: 0.30 Sig: 0.01		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	5	2	7
	-1.0	21	6	27
	0.0	23	54	77
	1.0	10	18	28
	2.0	1	4	5
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.7 Q10: Increase Learning Interest

Lamda: 0.20 Sig: 0.05		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	9	3	12
	-1.0	14	8	22
	0.0	25	51	76
	1.0	10	20	30
	2.0	2	2	4
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.8 Q11: Increased Desire to Learn

Lamda: 0.13 Sig: 0.27		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	6	3	9
	-1.0	12	8	20
	0.0	26	56	82
	1.0	12	11	23
	2.0	4	6	10
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.9 Q12: Insights for Others

Lamda: 0.30 Sig: 0.001		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	6	3	9
	-1.0	20	5	25
	0.0	28	55	83
	1.0	5	17	22
	2.0	1	4	5
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.10 Q13: Others Have Insights

Lamda: 0.12 Sig: 0.18		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	4	3	7
	-1.0	7	3	10
	0.0	26	56	82
	1.0	17	18	35
	2.0	6	4	10
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.11 Q14: Hesitate to Participate

Lamda: 0.25 Sig: 0.002		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	4	2	6
	-1.0	8	10	18
	0.0	17	60	77
	1.0	23	7	30
	2.0	8	5	13
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.12 Q15: Encouraged to Ask Questions

Lamda: 0.13 Sig: 0.32		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	6	4	10
	-1.0	15	10	25
	0.0	23	55	78
	1.0	7	7	14
	2.0	9	8	17
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.13 Q16: Easy to Get Help

Lamda: 0.25 Sig: 0.06		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	10	3	13
	-1.0	17	11	28
	0.0	20	59	79
	1.0	9	8	17
	2.0	4	3	7
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.14 Q17: Received Timely Feedback

Lamda: 0.33 Sig: 0.001		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-2.0	6	3	9
	-1.0	25	8	33
	0.0	18	58	76
	1.0	8	11	19
	2.0	3	4	7
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.15 Q18: Others Help Me Learn

Lamda: 0.28 **Sig: 0.03**		**Condition**		**Total**
		iPET	Control	
Change in answer (post-pre)	-2.0	3	3	6
	-1.0	13	8	21
	0.0	20	61	81
	1.0	19	8	27
	2.0	5	4	9
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.16 Q19: Enjoy Online Discussions

Lamda: 0.32 **Sig: 0.002**		**Condition**		**Total**
		iPET	Control	
Change in answer (post-pre)	-2.0	1	1	2
	-1.0	25	6	31
	0.0	25	62	87
	1.0	6	12	18
	2.0	3	3	6
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.17 Q20: Enjoy Reading Messages

Lamda: 0.20 **Sig: 0.03**		**Condition**		**Total**
		iPET	Control	
Change in answer (post-pre)	-2.0	8	2	10
	-1.0	13	7	20
	0.0	28	57	85
	1.0	9	14	23
	2.0	2	4	6
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.18 Q21: Enjoy Posting Messages

Lamda: 0.37 **Sig: 0.00**		**Condition**		**Total**
		iPET	Control	
Change in answer (post-pre)	-2.0	4	4	8
	-1.0	26	4	30
	0.0	22	56	78
	1.0	6	14	20
	2.0	2	6	8
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.19 Q22: Good Use of Time

Lamda: 0.17 **Sig: 0.17**		**Condition**		**Total**
		iPET	Control	
Change in answer (post-pre)	-2.0	4	5	9
	-1.0	10	6	16
	0.0	24	57	81
	1.0	18	12	30
	2.0	4	4	8
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.20 Q23: Encouraged Participation

Lamda: 0.22 **Sig: 0.07**		**Condition**		**Total**
		iPET	Control	
Change in answer (post-pre)	-2.0	1	3	4
	-1.0	15	8	23
	0.0	21	53	74
	1.0	18	12	30
	2.0	5	8	13
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.21 Q24: Received Feedback

Lamda: 0.27 **Sig: 0.005**		**Condition**		**Total**
		iPET	Control	
Change in answer (post-pre)	-2.0	6	3	9
	-1.0	19	6	25
	0.0	28	53	81
	1.0	5	11	16
	2.0	2	11	13
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.22 Q25: Discussions were Guided

Lamda: 0.18 **Sig: 0.16**		**Condition**		**Total**
		iPET	Control	
Change in answer (post-pre)	-2.0	1	3	4
	-1.0	15	6	21
	0.0	22	55	77
	1.0	16	15	31
	2.0	6	5	11
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.23 Student Learning From Discussion

Lamda: 0.22 Sig: 0.04		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-7.0	1	0	1
	-6.0	2	2	4
	-4.0	2	0	2
	-3.0	2	4	6
	-2.0	4	7	11
	-1.0	8	5	13
	.0	15	39	54
	1.0	7	4	11
	2.0	8	10	18
	3.0	7	3	10
	4.0	3	5	8
	5.0	0	2	2
	6.0	1	2	3
	8.0	0	1	1
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.24 Online Discussion Motivation

Lamda: 0.38 Sig: 0.005		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-10	1	0	1
	-9.0	1	1	2
	-6.0	2	1	3
	-5.0	4	1	5
	-4.0	4	0	4
	-3.0	9	1	10
	-2.0	6	3	9
	-1.0	9	7	16
	.00	4	35	39
	1.0	6	10	16
	2.0	5	5	10
	3.0	3	3	6
	4.0	2	8	10
	5.0	0	2	2
	6.0	1	3	4
	7.0	1	1	2
	8.0	0	1	1
	9.0	1	1	2
	10.0	0	1	1
	11.0	1	0	1
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.25 Learning in the Community

Lamda: 0.37 Sig: 0.003		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-8.0	1	0	1
	-6.0	1	1	2
	-5.0	4	0	4
	-4.0	5	4	9
	-3.0	4	2	6
	-2.0	5	2	7
	-1.0	12	7	19
	.0	7	49	56
	1.0	7	8	15
	2.0	5	1	6
	3.0	3	5	8
	4.0	4	2	6
	5.0	2	3	5
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.26 Online Discussion Enjoyability

Lamda: 0.42 Sig: 0.002		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-6.0	0	1	1
	-5.0	4	2	6
	-4.0	8	1	9
	-3.0	4	2	6
	-2.0	7	4	11
	-1.0	11	3	14
	.0	8	46	54
	1.0	8	7	15
	2.0	3	3	6
	3.0	5	8	13
	4.0	0	3	3
	5.0	2	0	2
	6.0	0	2	2
	7.0	0	2	2
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

Table D.27 Instructor Motivating Participation

Lamda: 0.23 Sig: 0.03		Condition		Total
		iPET	Control	
Change in answer (post-pre)	-4.0	0	1	1
	-3.0	5	2	7
	-2.0	6	4	10
	-1.0	10	12	22
	.0	17	40	57
	1.0	11	6	17
	2.0	7	3	10
	3.0	4	6	10
	4.0	0	2	2
	5.0	0	3	3
	6.0	0	5	5
Total		60	84	144

Note: Cell counts are for change (post-pre) in student response

APPENDIX E

INTERACTION OF CLASS SIZE AND ACCESS TO IPET

The results of calculations for the level of association and significance for the answers to the student survey questions with respect to class size. The control and 'access to iPET' conditions were treated as two separate populations.

Table E.1 Class Size Interaction with Access to iPET

Question	Control		Access to iPET	
	Lamda	Sigma	Lamda	Sigma
Student Learning from Discussion				
Q4: Learn from Peers	0.01	0.78	0.06	0.60
Q5: Online discussion useful	0.04	0.44	0.0	1.0
Q6: Improved learning	0.04	0.83	0.23	0.01
Q7: Valuable peer comments	0.08	0.15	0.15	0.14
Online Discussion Motivation				
Q8: Motivated to learn more	0.0	1.0	0.09	0.36
Q9: Motivated to do best work	0.05	0.39	0.04	0.61
Q10: Increased learning interest	0.0	1.0	0.15	0.06
Q11: Increased desire to learn	0.03	0.52	0.08	0.17
Q12: Insights for others	0.01	0.81	0.10	0.38
Q13: Others have insights for me	0.07	0.09	0.03	0.72
Q14: Hesitate to participate	0.06	0.20	0.06	0.48
Learning in the Community				
Q15: Encouraged to ask questions	0.05	0.10	0.03	0.78
Q16: Easy to get help	0.03	0.56	0.19	0.10
Q17: Received timely feedback	0.03	0.48	0.06	0.37
Q18: Others help me learn	0.15	0.01	0.13	0.16
Online Discussion Enjoyability				
Q19: Enjoy online discussions	0	1	0.05	0.55
Q20: Enjoy reading messages	0.01	0.78	0.05	0.55
Q21: Enjoy posting messages	0	1	0.11	0.31
Q22: Good use of time	0.04	0.46	0.17	0.10
Instructor motivating participation				
Q23: Instructor encouraged participation	0.04	0.18	0.07	0.55
Q24: Received instructor feedback	0.07	0.27	0.08	0.51
Q25: Instructor guided discussions	0.03	0.59	0.01	0.28

Table E.2 Class Size Interaction with Access to iPET for Multi-Item Measures

Measure	Control		Access to iPET	
	Lamda	Sigma	Lamda	Sigma
Student Learning from online Discussion	0.06	0.25	0.15	0.10
Online Discussion Motivation	0.09	0.05	0.17	0.03
Online discussion Enjoyability	0.08	0.08	0.19	0.06

Note: Only multi-item measures that can be used are displayed

To see if the small sample size impacted the association and significance testing, the calculations were also done grouping the change into three groups (-1,0,1) as opposed to five groups (-2,-1,0,1,2) . In other words, an additional analysis was done just looking at 'improved post survey results', 'the same results' and 'lower results'. The results were largely the same except that Q18 (Others help me learn) did not have significant results with this grouping in change in responses.

APPENDIX F

INTERACTION OF PREVIOUS DL CLASSES AND ACCESS TO IPET

The results of calculations for the level of association and significance for the answers to the student survey questions with respect to number of previous DL courses taken by the student. The control and 'access to iPET' conditions were treated as two separate populations.

Table F.1 The Interaction of Previous DL Experience with Access to iPET

Question	Control		Access to iPET	
	Lamda	Sigma	Lamda	Sigma
Student Learning from Discussion				
Q4: Learn from Peers	0.05	0.37	0.07	0.27
Q5: Online discussion useful	0.10	0.01	0.05	0.36
Q6: Improved learning	0.06	0.20	0	1.0
Q7: Valuable peer comments	0.08	0.10	0.06	0.50
Online Discussion Motivation				
Q8: Motivated to learn more	0.05	0.09	0.03	0.79
Q9: Motivated to do best work	0.06	0.25	0.06	0.48
Q10: Increased learning interest	0.05	0.27	0.03	0.65
Q11: Increased desire to learn	0.07	0.19	0.02	0.71
Q12: Insights for others	0.05	0.31	0.05	0.44
Q13: Others have insights for me	0.07	0.15	0.10	0.18
Q14: Hesitate to participate	0.04	0.46	0.08	0.40
Learning in the Community				
Q15: Encouraged to ask questions	0.04	0.53	0.04	0.51
Q16: Easy to get help	0.09	0.08	0.04	0.68
Q17: Received timely feedback	0.07	0.13	0.03	0.62
Q18: Others help me learn	0.04	0.63	0.02	0.82
Online Discussion Enjoyability				
Q19: Enjoy online discussions	0.06	0.05	0.06	0.36
Q20: Enjoy reading messages	0.06	0.22	0.06	0.61
Q21: Enjoy posting messages	0.06	0.25	0.03	0.65
Q22: Good use of time	0.07	0.17	0.14	0.15
Instructor motivating participation				
Q23: Instructor encouraged participation	0.05	0.24	0.08	0.10
Q24: Received instructor feedback	0.15	0.01	0.09	0.07
Q25: Instructor guided discussions	0.10	0.03	0.03	0.75

Table F.2: Previous DL Interaction with Access to iPET for Multi-Item Measures

Measure	Control		Access to iPET	
	Lamda	Sigma	Lamda	Sigma
Student Learning from online Discussion	.0.07	0.22	0.04	0.59
Online Discussion Motivation	0.13	0.01	0.19	0.04
Online discussion Enjoyability	0.07	0.10	0.16	0.07

For the questions that had significant results (Q5, Q19 and Q25), Tables C.5, C.6 and C.7 show the distribution for the change in student response (pre survey – post survey).

Table F.3 Distribution of Counts for Change in Response for Q5 (Online Discussion Useful)

	Change	PrevDLNew			
		0	1	2-3	> 3
Access to iPET	-2.0	0	0	0	1
	-1.0	1	2	3	6
	0.0	4	3	10	12
	1.0	0	4	2	7
	2.0	0	1	3	1
Control	-2.0	2	0	0	2
	-1.0	2	0	1	0
	0.0	6	13	21	23
	1.0	4	4	5	2
	2.0	6	4	1	0

Table F.4 Distribution of Counts for Change in Response for Q19 (Enjoy Online Discussion)

	Change	PrevDLNew			
		0	1	2-3	> 3
Access to iPET	-2.0	0	0	0	1
	-1.0	2	6	7	10
	0.0	3	2	10	10
	1.0	0	1	1	4
	2.0	0	1	0	2
Control	-2.0	1	0	0	0
	-1.0	2	3	1	0
	0.0	17	10	14	21
	1.0	3	2	2	5
	2.0	0	2	0	1

Table F.5 Distribution of Counts for Change in Response for Q25 (Instructor Guided Discussions)

	Change	PrevDLNew			
		0	1	2-3	> 3
Access to iPET	-2.0	0	0	1	0
	-1.0	3	0	6	6
	0.0	2	5	6	9
	1.0	0	5	3	8
	2.0	0	0	2	4
Control	-2.0	0	2	1	0
	-1.0	3	2	0	1
	0.0	13	7	12	23
	1.0	5	3	4	3
	2.0	2	1	0	0

To see if the small sample size impacted the association and significance testing, the calculations were also done grouping the change into three groups (-1,0,1) as opposed to five groups (-2,-1,0,1,2) . In other words, an additional analysis was done just looking at 'improved post survey results', 'the same results' and 'lower results'. The results were not materially different.

APPENDIX G

IPET SCREENS

To provide a better understanding of the iPET integrated set of tools, the following images are example screens within iPET.

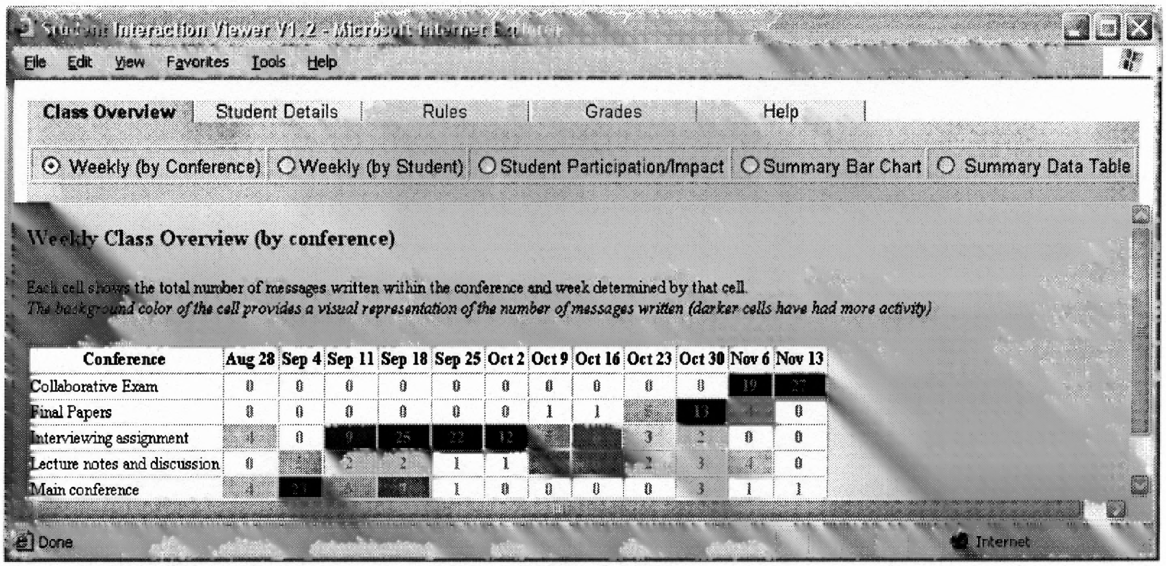


Figure G.1 Class overview – weekly (by conference).

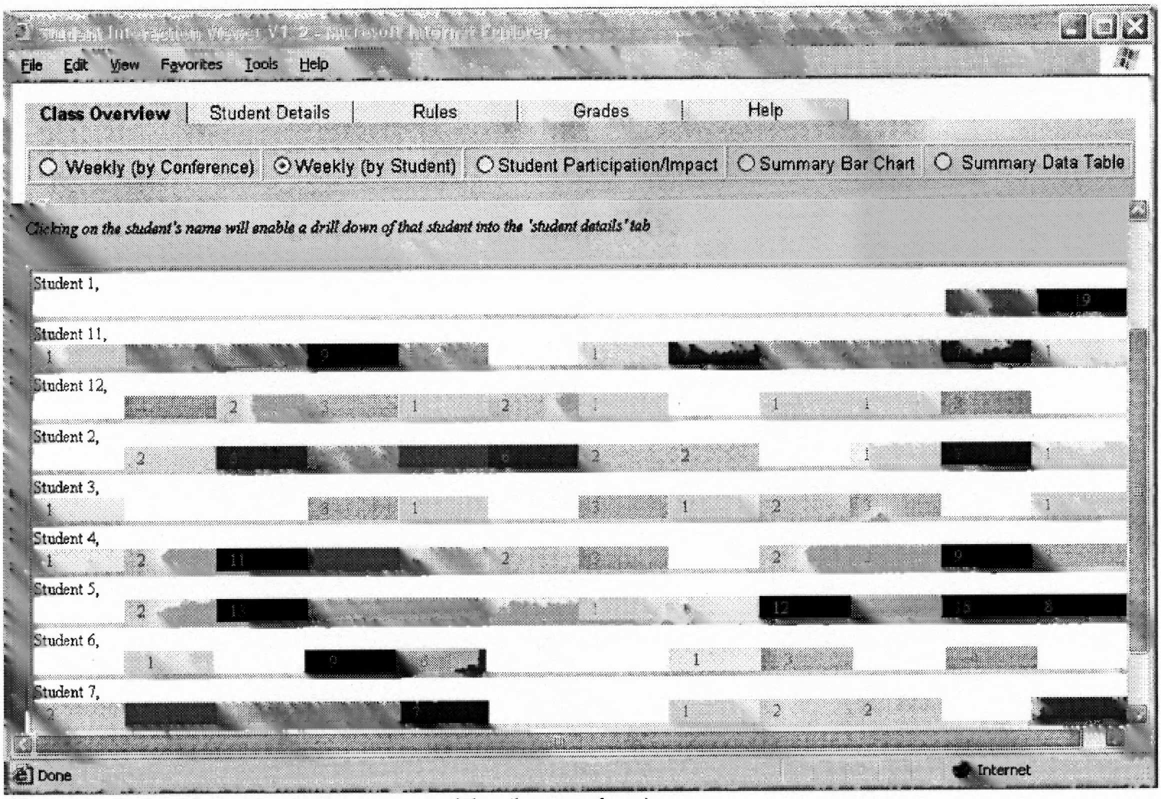


Figure G.2 Class overview – weekly (by student).

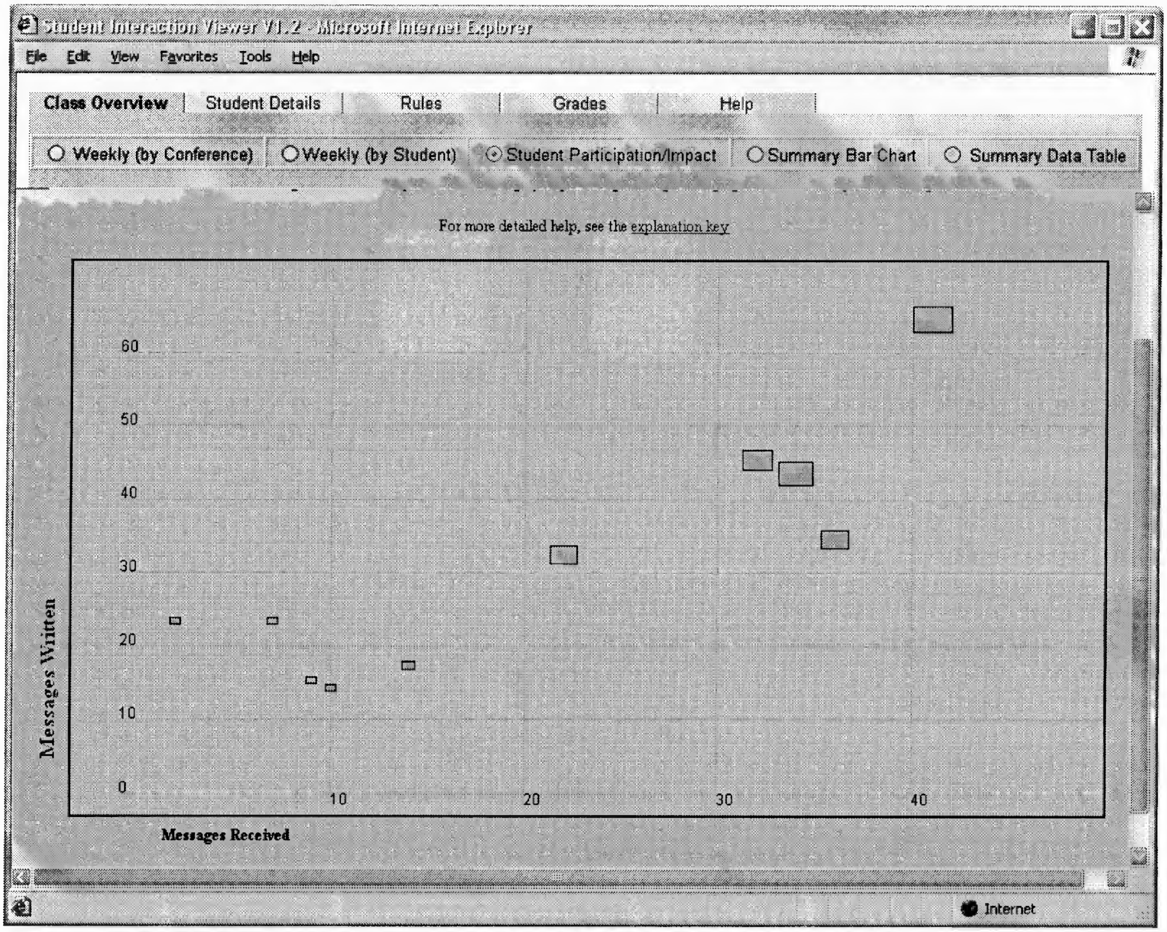


Figure G.3 Class overview – student participation plot.

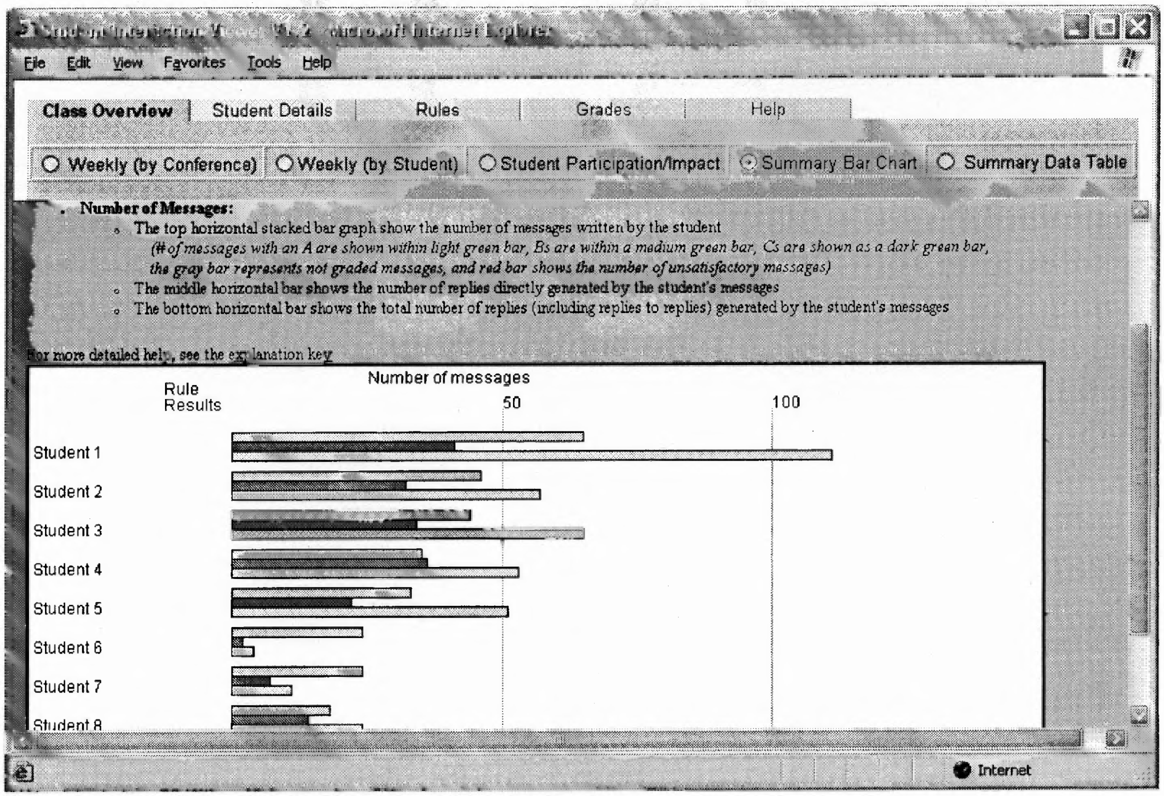
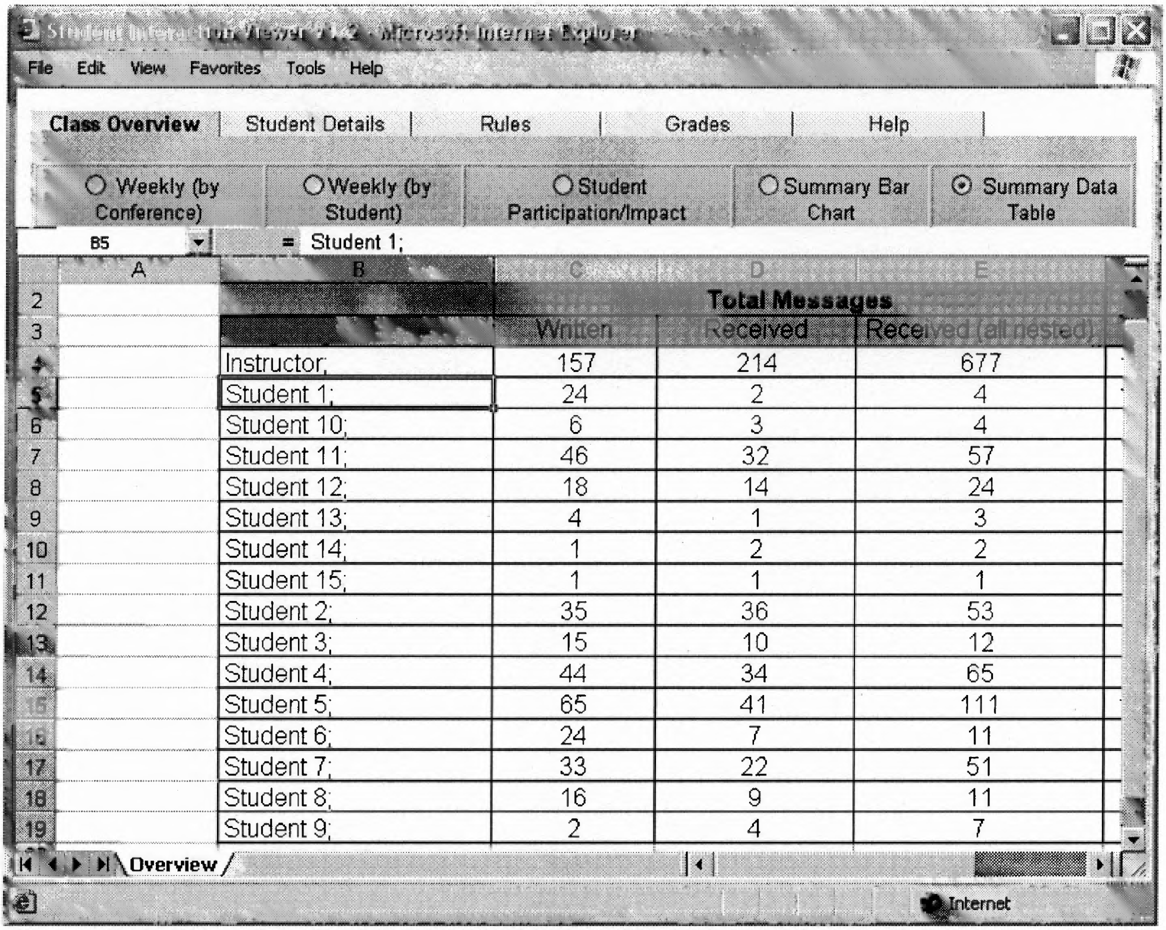


Figure G.4 Class overview – summary bar chart.



	Total Messages		
	Written	Received	Received (all nested)
Instructor;	157	214	677
Student 1;	24	2	4
Student 10;	6	3	4
Student 11;	46	32	57
Student 12;	18	14	24
Student 13;	4	1	3
Student 14;	1	2	2
Student 15;	1	1	1
Student 2;	35	36	53
Student 3;	15	10	12
Student 4;	44	34	65
Student 5;	65	41	111
Student 6;	24	7	11
Student 7;	33	22	51
Student 8;	16	9	11
Student 9;	2	4	7

Figure G.5 Class overview – summary data table.

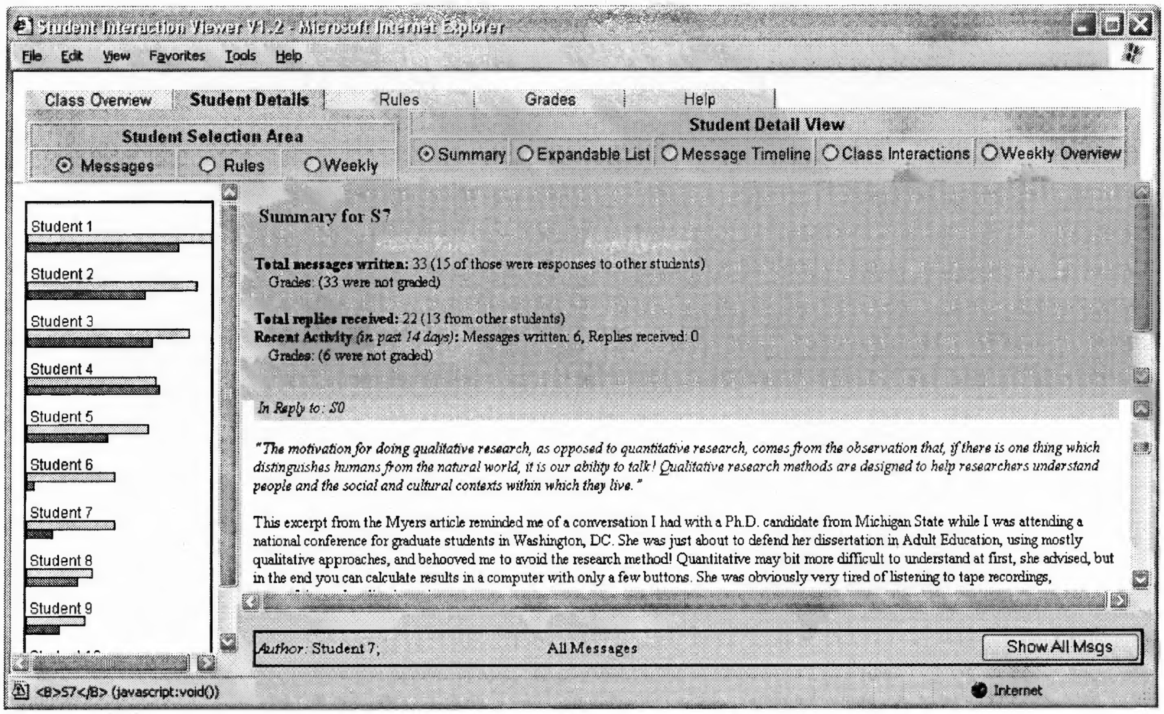


Figure G.6 Student view – summary.

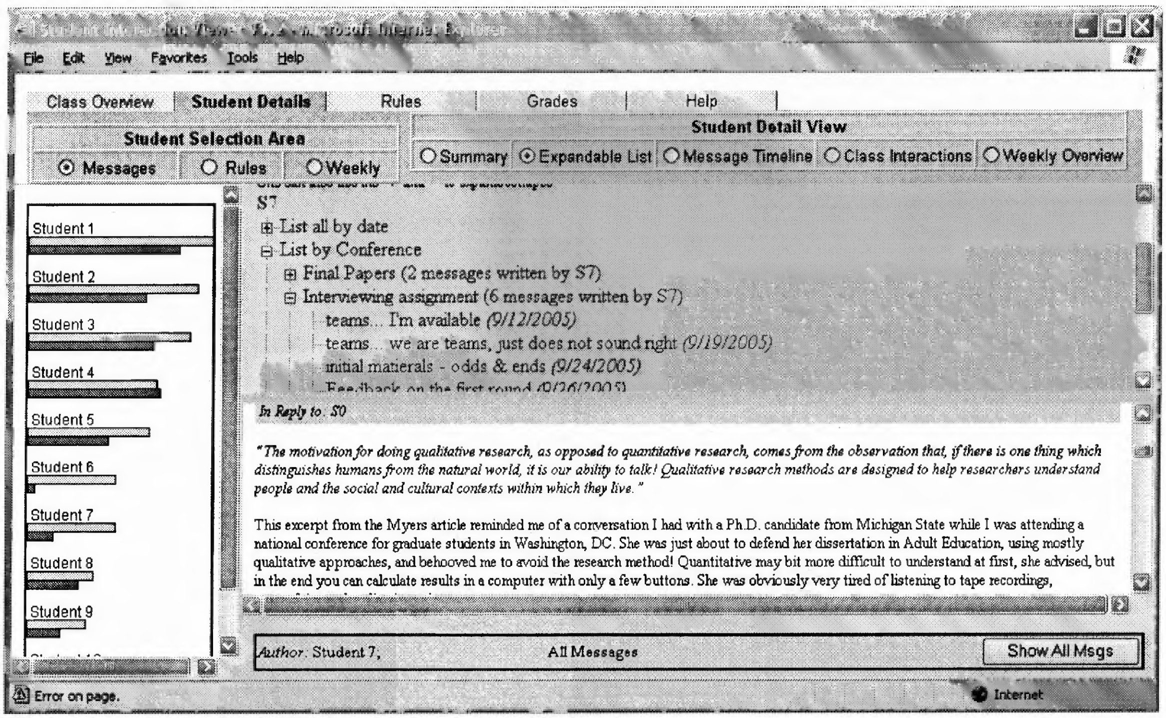


Figure G.7 Student view – expandable list.

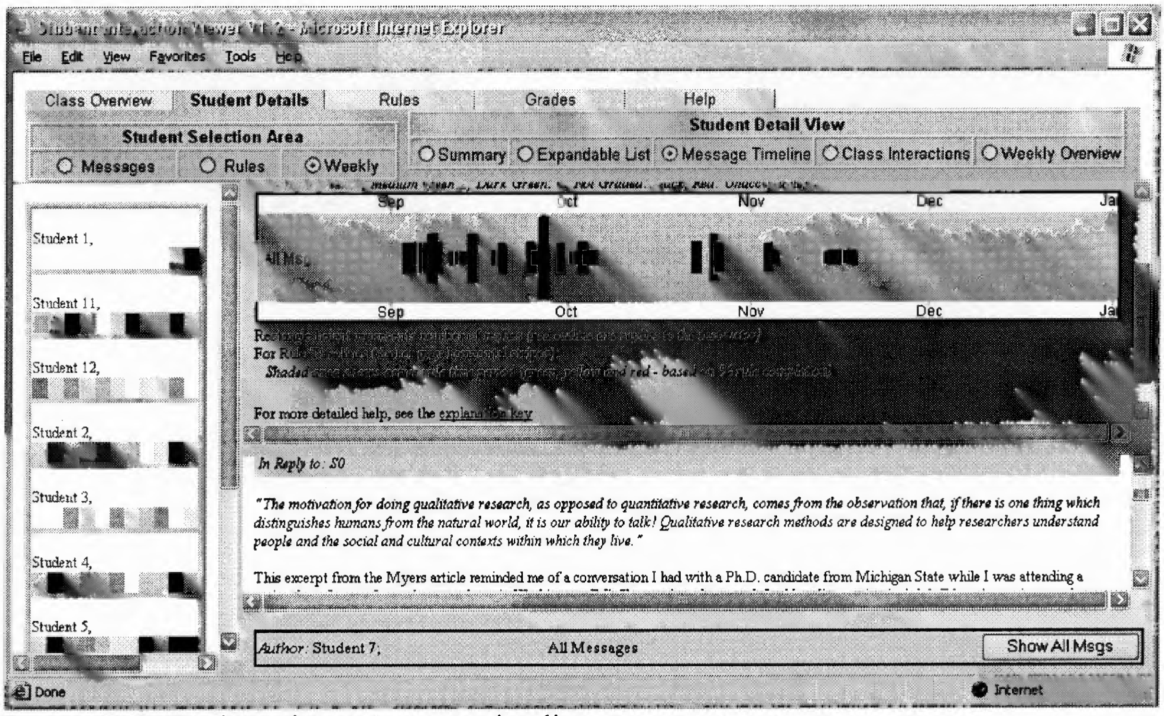


Figure G.8 Student view – message timeline.

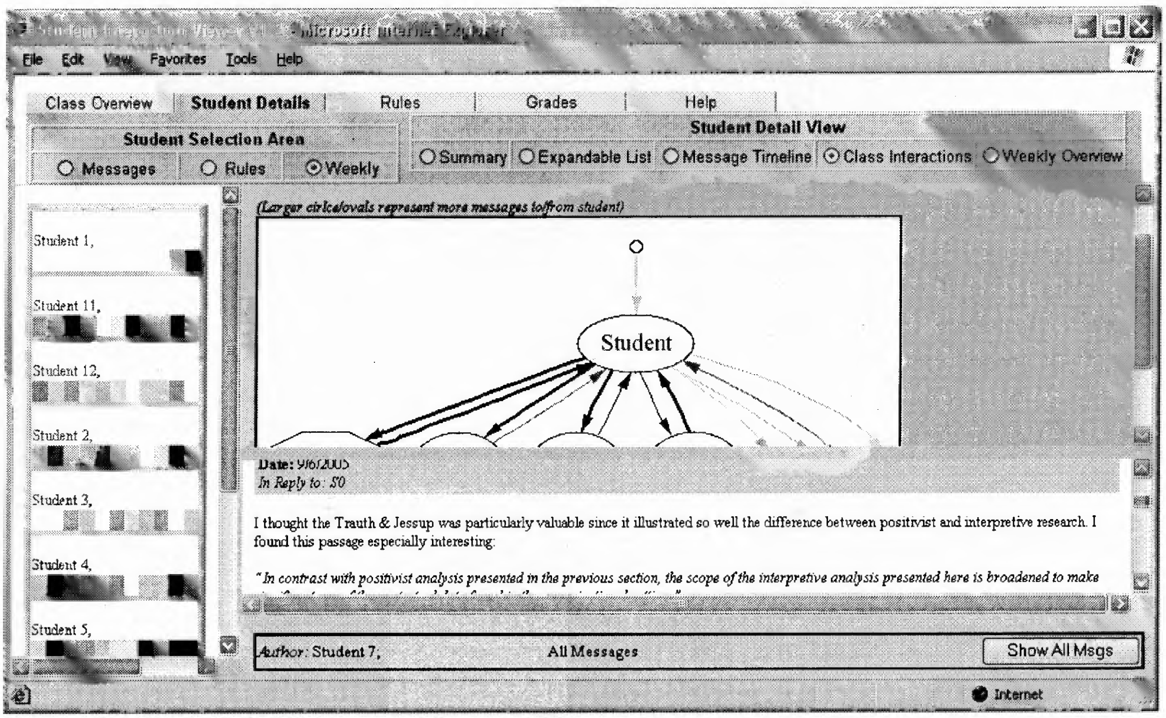


Figure G.9 Student view – class interactions.

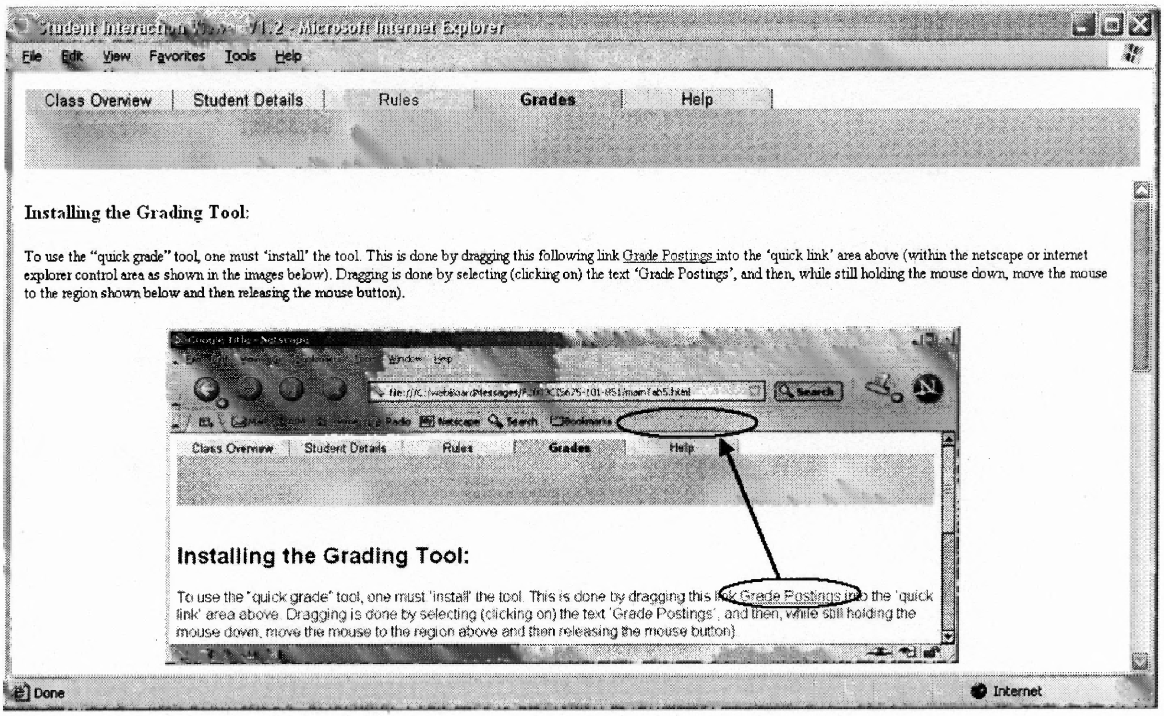


Figure G.10 Grade plug-in.

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