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THEORETICAL AND PEDAGOGICAL ISSUES IN COMPUTER-MEDIATED INTERACTION AND INSTRUCTION: LESSONS FROM THE USE OF A COLLABORATIVE INSTRUCTIONAL TECHNOLOGY

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Abstract. This case study evaluates an innovative piece of software called GroupShare that was used in an undergraduate communication course in the Fall of 1998. GroupShare is a web-based, custom software package that provides students working in anonymous groups with asynchronous communication capabilities and text-based information sharing functions for use in the completion of class assignments. Longitudinal data from this study show that users became highly proficient in the use of the software, found it valuable as a collaborative tool, and formed ties within their groups. Satisfaction with group processes and outcomes, and enjoyment of the process of working together, increased over time, although the difficulty and complexity of assignments was related to lower levels of satisfaction and enjoyment. Results from this study highlight issues in the implementation and use of advanced, computer-based communication and information technologies in the classroom and inform theory on computer-mediated communication, group processes, and the implementation of innovations.

Research on technologies such as electronic mail (Fulk, 1993; Markus, 1994; Rice, 1992; Schmitz & Fulk, 1991), videoconferencing (Finn, Sellen, & Wilbur, 1997), and group support systems (Benbasat & Lim, 1993; Dennis & Gallupe, 1993; Kraemer & Pinsonneault, 1990) suggests the powerful influence that these technologies can have on decision processes and quality, interpersonal and intergroup relations, and organizational structure. With the advent of a reliable and widespread infrastructure in the form of the Internet, the information-carrying capacity of the World Wide Web (WWW), and advances in computer processing speed, storage, dependability, and cost, the capabilities of these types of technologies are now more accessible than ever before. These developments have prompted the migration of electronic technologies into classroom use, for collaboration and knowledge sharing (Sherman, 1998), web page creation and information delivery (Couch, 1997; Schneider, 1998), course content delivery (Couples & Luke, 1998), and custom software designed for information sharing and collaborative tasks (Bentley, Appelt, Busbach, Hinrichs, Kerr, Sikkel, Trevor, and Woetzel, 1997).

Among the proposed advantages of incorporating advanced technologies into instruction are accomplishing new or existing tasks better, performing routine tasks more efficiently, preparing students for competitive job markets, enhancing student/faculty productivity, and reaching students not able to attend classes on campus (Albright & Graf, 1992; Witmer, 1998). Societal pressures are acting to encourage faculty to incorporate advanced technologies into their curricula as well. For example, college-bound students, who have spent the majority of

their lives surrounded by or working with advanced computer technologies, have developed an expectation that these types of technologies will be used for instruction (Albright & Graf, 1992). Speculating about the future of instructional methods, Nickerson (1988) predicts more individualized, adaptive, and interactive instruction, made possible by more powerful and flexible computer-based instructional technologies.

New technologies used for instructional delivery and interaction appear to have primarily positive effects. Hiltz and Wellman (1997) report that in the "virtual classroom," supported by asynchronous, online networks of interaction, mastery of course material was equal to or better than in the traditional classroom. In addition, there was higher satisfaction with the overall quality of the educational experience among students. Gilliver, Randall, and Pok (1998) found that the use of Internet-based, multimedia instructional technologies improved students' understanding of material and performance. Bee and Usip (1998; Usip & Bee, 1998) found that students using web-based instruction technologies (materials placed on the web to supplement traditional classroom lectures) believed that such resources improved their class performance. Meta-analyses of computer-supported instruction generally substantiate these claims, showing that computer-based instruction results in better student performance, faster learning, and more positive subjective evaluations of computer-based courses (Kulik, 1994; Kulik & Kulik, 1991; Willett, Yamashita, & Anderson, 1983).

In spite of these advantages, however, there is resistance to the incorporation of technologies in contemporary curricula, due to a number of challenges in implementing computer-based instructional media. For example, there is wide variation among students' expertise with the technologies involved; esoteric language and terminology oftentimes confound learning and teaching about the technologies; there are discrepancies among students' perceptions of the relevance of the methods involved; and there are different notions among students of when and how to use these technologies effectively (Witmer, 1998). In addition, Bailey and Cotlar (1994) suggest that resistance to pedagogical changes resulting in the increased use of advanced technologies on the part of instructors is perhaps due to reluctance to explore new technologies and the accompanying fear of change. As Vickers and Smalley (1995) point out:

> Many teachers will have to master new subject matter, and most will need to develop different strategies for managing classroom organization and interaction. Some applications (but not all) challenge teachers to reconstruct the practical theories they use for understanding the learning process itself. Teacher's [sic] practical theories, for example, embody all that they "know" on the basis of their stored past experience, about how to teach their subject, manage the classroom, and deal with individual learning problems. The reconstruction of such procedural knowledge is a slow and painful process. (p. 280)

In addition, obstacles in the implementation of Internet-based, interactive instructional methods include substantial infrastructure requirements, requisite technical expertise, the availability of training materials and assistance, financial resources, appropriate student training and support, and differences across countries in the emphasis on and degree to which there exists governmental support for the integration of computers into schools for instructional purposes (Chellappa, Barua, & Whinston, 1997; Dirks, 1997; Hazen, 1992; Vickers & Smalley, 1995). Thus, although evidence suggests that computer- and network-based instructional technologies hold pedagogical value, many challenges exist in the effective implementation of these tools.

In order to explore the use of advanced technologies in instruction, this article presents a case study of an innovative piece of software called GroupShare that was used in an undergraduate communication course in the Fall of 1998. GroupShare is a web-based, custom software package that provides students working in anonymous groups with asynchronous communication capabilities and text-based information sharing functions to use in the completion of a series of several assignments during the course of the class.

The case study detailed here outlines students' experiences with GroupShare in order to examine the following research questions concerning the implementation of instructional technologies: How do students develop proficiencies and skills in the use of these systems and what factors might influence that process? How effective are these technologies, as judged by the patterns of use that emerge? What are the outcomes of system use and what factors might influence these outcomes? The examination of these issues, in turn, is used to inform theory on computer-mediated communication, to highlight strategies that might be appropriate for the implementation of

instructional technologies in the classroom, to examine other important issues implicated by the use of such technologies, and to assess the overall effectiveness of classroom-based instructional media.

This article proceeds by first describing the collaborative software program used and the methods and measures employed in this study. Next, the instructional technology is evaluated, with special emphasis on student outcomes and experiences, particularly as they inform future, related projects. Then, the implications of the findings are considered in terms of extant theory and as they inform the use of computer-aided technologies for instructional purposes. Finally, conclusions and directions for future development and research are suggested.

GroupShare Functionality and Measures

GroupShare Software

This study examines the use of a computer-based instructional technology called "GroupShare." GroupShare is a custom-designed software application that was delivered via the Internet/World Wide Web to students enrolled in an upper-level, undergraduate Communication course at a west coast university in the United States. The course, "Communication, Collaboration, and Organization," was taught in the Fall of 1998 to 58 students.

The topic of the class was the use of advanced communication and information technologies in contemporary organizations. The course emphasized theoretical perspectives and research findings on work and collaboration within organizations, as they are aided by the use of advanced technologies. Topics included technical and infrastructure requirements, research on the technological support of group work, intraorganizational communication issues, and the dynamics of interorganizational relationships and evolving organizational forms.

GroupShare is a custom-designed, computer-based instructional software application that is delivered via the Internet and used by undergraduate students to access course materials and to work together in groups. Informational material, passed one-way from the professor to students, includes the course syllabus, ongoing announcements for the class, and group grades. In addition to this, GroupShare is novel in its ability to support students working together in online groups. It is these group support capabilities that distinguish GroupShare from content delivery tools currently available on the Web and widely used for instructional support.

To support student work online, GroupShare provides asynchronous, text-based communication and information sharing capabilities. Using GroupShare features, students work together in online groups toward the completion of assignments or "modules." To complete module assignments, students can assemble information and then share it with members of their group either (a) by sending messages to any or all other group members as an "individual note" or (b) by placing information in the "group library" where it is available to all group members. Individual notes are sent and received similar to electronic mail messages, placed in an inbox with a hypertext subject line to access them upon receipt. The group library serves as a database for group information, cumulating and archiving messages among users.

In addition to these communication and information sharing functions, GroupShare enables members of groups to work on a shared "working document" that they create jointly. Students collaborate within their groups to draft working documents that address the requirements of 7 module assignments during the academic quarter. Ultimately, working documents are "submitted" as complete prior to each module deadline. Completed working documents are then graded.

Students were randomly assigned to groups of between 5 and 7 people, the members of which remained the same for the duration of the 10-week long class. In all, there were 10 groups. Students were identified to one another only by non gender-specific "user IDs" that were selected by the instructor. Students thus did not know the "real" identity of the other members of their own group, nor did they know the user IDs of members from groups other than their own. Importantly, as Anonymous (1998) points out, the level of "anonymity" experienced by GroupShare users approaches what is more rightly termed "partial anonymity" or that condition where "either a source cannot be individually specified or when there is not a high level of knowledge about a source" (p. 391).

Thus, the pseudonyms provided by user IDs served to mask the true identity of the source, and this use of pseudonyms "functions largely the same as the absence of a source in that the receiver likely perceives the source as an anonymous one" (p. 384). In this manner, students worked with a stable group of people, who remained partially anonymous in terms of identity and its attendant cues (gender, appearance, etc.) for the duration of the class. Working in these groups, students completed seven module assignments, each within a week-long assignment period.[1]

Prior to the use of GroupShare for the completion of modules, students attended a mandatory training session and were allotted time to experiment with GroupShare. Upon completion of each module, students completed a comprehensive online survey that asked them to assess their experiences and perceptions in the completion of the module that they had just completed. They were required to complete the survey before beginning the next module.

GroupShare Assignments. GroupShare module assignments were designed to require widescale participation from group members. Module topics and requirements were related to the current week's class topics and often explicitly asked students to incorporate material from the course readings.

Module 1 asked students to compare collaboration today to collaboration 50 years ago, taking into consideration societal changes, technological changes, any disadvantages of collaboration, and theories of collective action. Module 2 asked students to consider the many possible dimensions along which to organize collaborative technologies and to find and discuss potential problems with the use of group technologies that were identified in the readings. The third module asked students to consider the research findings concerning the various types of group support systems and to consider if these findings fit their own, personal experiences. Module 4 required that students apply Adaptive Structuration Theory (Poole & DeSanctis, 1990) to their own experiences with GroupShare. Module 5 involved an Internet/WWW scavenger hunt where students had to locate specific information on the WWW. Students were asked to answer questions and to supply the specific URLs where these answers could be found. The sixth module asked students to describe what the Internet/WWW might look like 10 years from now by determining and describing the important dimensions of its development, how they believed it would unfold along these dimensions, and why. Each group's response to this module was limited to 1000 words or less. The final module asked students to produce a "top 5" list of what they believed were the most significant issues today that are likely to have an impact on the use of advanced communication and information technologies in the organization of the future.

The nature of two of the modules was different from the other five and requires further clarification. Module 5, the Internet scavenger hunt, did not require composing an essay nor did it require the incorporation of material from class and readings, except as instructions were given in-class on effective use of the Internet/WWW. In these respects, it was unlike other assignments. Module 6 also differed from others in that it was the only module where a word limit was imposed. Instructions for this module indicated that there was a 1000 word maximum limit for the final group response. Due to this added requirement, closer coordination of individual members' efforts was necessary.

Measures

A variety of measures was gathered as part of the GroupShare system. Variables designed to measure (a) the nature of the tasks (modules) completed, (b) individual usage measures, (c) users' subjective assessment of outcomes, and (d) individual user interests and motivations were all included as part of the surveys administered through the GroupShare system.

Nature of Tasks. The *difficulty/complexity* of the module assignments was assessed by asking users to rate the difficulty and the complexity of each of the seven modules. Higher scores on a 7-point Likert-type scale indicate greater difficulty/complexity of a module. As with all measures, Cronbach's alpha was calculated in order to assess the reliability of the measure. Due to autocorrelation among responses (multiple responses from the same individual), the final alpha reliability measure was determined by the mean of seven reliability measures, one calculated for each of the seven modules. The final Cronbach's alpha was .72. This and all other measures are detailed in Appendix A, which contains a list of the variables, the survey items that comprise them, and the

final alpha reliabilities calculated as meass of the seven module alpha measures.

Usage Measures. All usage variables were measured on a 5-point Likert-type scale. Start-up costs were measured by asking users how much time they spent learning to use the GroupShare system, for the module just completed. Choices ranged from "none" to "an enormous amount." *Recurring costs* included items about several personal costs that users might encounter in the use of GroupShare. As part of this measure, users were asked to assess their level of access to GroupShare, the time expended using the system, the speed of the system, and its ease of use. *Personal effectiveness* was measured by the question "How effective are you at completing assignments using GroupShare?" with a scale ranging from "very effective" to "very ineffective." *Visibility of others' contributions* was assessed by a series of items about the extent to which users were able to determine who did what work toward the completion of the latest module. *Proficiency* at using GroupShare was assessed by the question "How proficient do you consider yourself at using GroupShare?" Scale choices ranged from "not at all proficient" to "extremely proficient." *Quality of information acquired* and *quality of information contributed* were each measured by a series of items asking about the accuracy, currency, availability, and relevance of information that people in their group provided using the GroupShare system. *Time spent* per module was assessed by totaling the time reported for several tasks required for the completion of each module. Transformations were performed where necessary such that high values for all usage measures indicate greater degrees of the focal concept. Specific items comprising each variable are listed in Appendix A.

Assessment of Outcomes. *Satisfaction with group outcomes* and *satisfaction with the group process* were each assessed by a series of items measuring various satisfaction dimensions that were based in part on items from Green and Taber (1980). *Enjoyment of the process* was measured by the question "How enjoyable was the process of completing this latest module?" on a 5-point Likert-type scale bounded by "very unenjoyable" and "very enjoyable." High values on outcome assessment measures indicate high satisfaction or enjoyment. Again, the items comprising each variable are listed in Appendix A.

User Interests and Motivations. All interest and motivation variables were measured on a 5-point Likert-type scale. *Collectivism/individualism* items were derived from Wagner (1995). *Trust in the system* was assessed by a series of items addressing the degree to which sufficient safeguards were in place to ensure the security of information and the degree to which fellow group members treated information with sufficient levels of care. High values on interest and motivation measures indicate high collectivism or high trust, as shown in Appendix A.

Qualitative Measures. At the completion of each module, students were given the opportunity, as part of the GroupShare survey, to provide additional comments. There was no limit to the length of the response and students were prompted to comment on GroupShare issues, the survey in general, or on any other class-related concerns.

GroupShare Evaluation and Analysis

Evaluation and analysis of users' experiences with the GroupShare system serves to inform pedagogical applications using advanced technologies as well as theoretical perspectives on computer-supported collaborative work. Due to the novelty of the technology, and the exploratory nature of this research, this case study necessarily presents a highly descriptive analysis of the GroupShare technology, focusing on identifying and describing major areas of interest rather than on a predictive model of user behavior. This initial exploration of the GroupShare communication and information system thus provides an important look at computer-based, interactive technologies used for instructional purposes.

GroupShare is evaluated in three, interrelated ways. First, students' proficiency with the system is assessed. Trends are apparent in the degree of facility with the use of the technology and the types of effort users must put forth to become effective users of the system. Second, usage patterns emerging from the data are explored. The nature and dynamics of use offer valuable information for the effective implementation of computer-aided, interactive instructional technologies. Third, outcome measures are evaluated. These measures indicate the relative success of the GroupShare system, students' assessment of the experience using it, and valuable lessons for improvement of future applications.

User Proficiency and Skill

Figure 1 shows the average amount of time, in hours, that each user spent completing module assignments using GroupShare. For the first module, students spent an average of 7.48 hours toward the completion of the module. The amount of time spent per module generally decreased over time, as shown in Figure 1, with a low of 5.44 hours per person spent on Module 6.[2]

In addition to the time spent, several other measures indicate users' proficiency in using the GroupShare system for completing module assignments. Figure 2 shows four such measures over time and indicates that students generally became more competent and effective using GroupShare as the class progressed: Perceived effectiveness and technical proficiency increased while costs associated with using the technology decreased.

Specifically, start-up costs involving learning how to use GroupShare diminished after each module and greatly over time (30%), from 3.62 to 2.53 (on a 5-point scale). Thus, as students used the system more, they needed to spend significantly less time learning how to use it. As one student correctly noted after the first module, it is "always hardest in the beginning." Relatedly, recurring costs such as users' level of access to GroupShare, the time expended using the system, the speed of the system, and its ease of use also tended to decrease over time. At Module 1 users rated these costs at a 2.56 whereas at the completion of the final module these costs were rated as a very low 2.18 on a 5-point scale. Not surprisingly, this suggests that costs incurred by users diminished over time, perhaps as a result of refinements in the technology and more experience with the system.

Several students commented on these recurring costs. After Module 2, one student noted that "The most difficult part for me is the fact that I do not have access to GroupShare from my computer at home, so I can only work on it at school or pay to use the computer at Kinko's." However, costs appear to have decreased over time as students used the system more and found reliable ways to work around their particular problems. After Module 3, one student commented that "It seems that everything is working well the more time is spent using the system" and by Module 5 another noted that "The system is getting easier to use."

In addition to these reduced costs, users generally became more proficient in the use of GroupShare as the class progressed. Self-ratings of proficiency in the use of GroupShare indicate that students felt they became more proficient with each passing module. Proficiency ratings increased from 3.47 on Module 1 to 4.01 (equal to "very proficient") on a 5-point scale for Module 7.

Also, effectiveness at completing modules as a group increased from 3.91 to 4.60 from Module 1 to Module 7, an increase of 18% over that period. Several students predicted this increase, as indicated in comments made after the first module such as "I think that because everyone was getting used to the way GroupShare works, we had a lot of problems. Hopefully as we continue it will become easier" and "I believe as the group finds its niche for communication, we will become more efficient." Indeed, by Module 2 one student noted that "my experience [with] this module was much better than the last" and by Module 3 students noted that "I think we all have everything down pat and it is smooth sailing from here" and "We are improving our efficiency and collaborative skills." By the final module, another user noted that "We have finally figured out how to do this effectively and efficiently after getting half way through."

Effectiveness scores were quite high (ranging from 3.91 to 4.60 on a 5-point scale), indicating that students felt very effective at using GroupShare, perhaps due to its relative ease of use. Indeed, after the first module a student commented "I was very impressed at the relative simplicity of the GroupShare system." In addition, students felt that they were more competent and effective using GroupShare as they used it more. As it turned out, one student's prediction after the first module that "with time our group will become more efficient...it's just a matter of learning from past mistakes since we are all new to the program" was in fact supported by the data.

Figure 2 also indicates that for Module 6 there was a dip in users' self-effectiveness ratings and a spike in users' rating of recurring costs. There was no such indication for either start-up costs or for proficiency ratings. This pattern may have been due to a minor technical error with the system during that module that inconvenienced users (although had no other lasting effects on functionality). Such a technical error would be consistent with the

pattern: It would affect effectiveness and costs but, because they are relatively independent of minor changes in system functionality, would not influence either proficiency or start-up costs in the same way.

Indeed, the qualitative data support this speculation. After Module 6 students commented on the error, noting that "I'm not sure what happened to the system, but it got to the point where I couldn't get on to GroupShare when I wanted to." Other students noted that "because of the programming problems..., I feel that some of the members were not able to complete their work in a timely fashion," and "although [university name] has many locations to access the Net, few places offer both net and Word...And this module, in particular, required, at minimum, a word-counting feature." This suggests that although minor technical errors can have a negative impact on users' notions of self-effectiveness and costs, they do not affect users' overall feelings of individual proficiency nor do users confound these issues with start-up costs such as learning how to properly use the technology. Thus, users seem to be able to appropriately separate task issues from attitudes about their own personal abilities.

System Effectiveness and Usage Patterns

Figure 3 illustrates users' perceptions of the quality of the information contributed and quality of the information acquired from other group members using GroupShare. [3] Both of these measures are relatively high throughout the class, and especially so by Module 7 (4.38 and 4.32, respectively, on a 5-point scale). Thus, students perceive that both the information that they contribute and the information they obtain using GroupShare are of high quality.

It is interesting to note that in all seven modules users perceive that the information they contributed is of higher quality than the information that they obtained. This was especially the case in the early stages of GroupShare usage but, by the final module, the difference between these two measures was negligible. One student's comment, following the third module, implies that the decreasing discrepancy between the perceived quality of information contributed and acquired may be due to wider and more complete participation among group members. The student noted that "I enjoyed working on GroupShare for Module 3 because everyone contributed. I did not feel the pressure to complete the document myself. My viewpoint on GroupShare is more positive now." This supports the decreasing difference between the quality of information contributed and acquired to the extent that more information begets a larger pool of information from which to select valuable data. The student's comment also suggests the importance of the degree to which users' believe they can identify which contributions to the final module product came from which of their group members, their perceptions of individualism versus collectivism, and the degree to which they trust the security of the GroupShare system. These variables are represented in Figure 4.[4]

Visibility, or users' perceived ability to discern which of their group members contributed what to the module assignment, increased markedly over the course of the seven modules. At Module 1 students rated visibility at 3.13 and it increased 35% to 4.21 by the final module. Students' comments consistently reflected an inability to identify the source of contributions early in the class. Some comments following the first module about this were that it was "difficult to determine who did what," that users "don't know who contributed what to the project," and it is "hard to assess the contributions of...contributors." Similar, though progressively fewer, comments were made after Modules 2 and 3. Around this time, users began to communicate more explicitly about the nature of contributions and to sometimes "tag" their own contributions with their names in working drafts. Overall, users identified and seemed to overcome this difficulty.

Users' self-ratings of collectivism versus individualism were highly slanted toward feelings that collectivism is an important trait when working in groups. Students rated themselves an average of 4.15 on the individualism/collectivism scale (where 5.0 = highest collectivism) when they began using GroupShare. Interestingly, it appears that working in groups over time using GroupShare may have caused slightly higher collectivism rankings. By Module 7, users rated themselves as 4.44 on the same scale, an increase of 7% from the first use of the system. However, this increase may have been due to group work, use of the system, or other factors as well.

Finally, users tended to have a high degree of trust in the GroupShare system that generally increased marginally over time. On a 5-point scale, trust in the technology was at a low of 3.88 after Module 3 and a high of 4.12 after the final module. Although trust in the system does not seem to have been affected by the technical error noted

earlier that occurred in Module 6, ratings of visibility did drop during that period, but most likely as a function of the nature of the Module 6 assignment (participation was limited by design), as mentioned earlier and as described in more detail in the next section.

Usage Outcomes

Students' satisfaction with group outcomes, satisfaction with the group process, and enjoyment of the process of working on the module all increased markedly from the first module to the last. Increases along these outcome measures were 14%, 24%, and 28%, respectively, from the first module to the last, with each measure ending up after the final module at a rating above 4.0 (4.47, 4.24, and 4.05, respectively, where 5 = either "very satisfied" or "very enjoyable"). Notable, however, is a sharp drop in these measures for Module 6, and their subsequent recovery for Module 7. Examining this trend in conjunction with a measure of the difficulty/complexity of each module suggests a possible explanation, as illustrated in Figure 5.[5]

As Figure 5 shows, satisfaction with group outcomes and processes, and enjoyment of the modules, increased consistently in Modules 1 through 5 (with the exception of a slight decrease in enjoyment from Module 1 to Module 2). After a drop with Module 6, these indicators exceeded their previous Module 5 level in the final module as well. One possible explanation for the drop in Module 6 is the increased difficulty/complexity of that module -- there is a general inverse relation between module difficulty/complexity and the satisfaction and enjoyment measures. This inverse relationship is particularly noticeable with Module 6's sharp increase in difficulty/complexity over the previous module. At the same time that Module 6 became extremely difficult and complex, users were less satisfied with the outcome or product of their group, were less satisfied with the group process, and enjoyed the process of working on the module less. Thus, it appears that the level of difficulty/complexity of the assignment is tied to these outcome measures.

Qualitative data support users' ratings of the difficulty and complexity of Modules 5 and 6. Among the many indicative comments concerning module 5 were "I liked this module the best...fun," "Easy, fun assignment!," "I really enjoyed this module. It was lots of fun for me. It didn't feel like work at all. It's the best module yet...probably because it was the easiest," "I have enjoyed this module the best so far...I think that this module was both fun and challenging," "I enjoyed this assignment a lot more than any of the other ones," and "Loved this module!" By contrast, students said of Module 6 "I don't like the 1000 word limitation...It's hard when there are six people to limit it that much," "I think that this assignment required the most amount of editing so far," "We had a...problem with this one only because of the word limitation," and "I didn't particularly like this module." Clearly, there was a large difference between these two assignments in terms of their difficulty and complexity and this contrast seems to have translated directly into negative ratings of satisfaction and enjoyment.

Viewing this finding in terms of the measures previously explored, it is important to note that other variables appear to be immune to these difficulty/complexity effects. Ratings of time spent working on the module, personal effectiveness using the system, proficiency with GroupShare, start-up costs, collectivism/individualism, and trust in the system do not appear to be influenced greatly, if at all, by the difficulty or complexity of modules. Recurring costs, although increasing with Module 6, were most likely influenced not by module difficulty/complexity, but rather by the minor technical difficulty that occurred in Module 6, as mentioned earlier. Similarly, information acquired and information contributed decrease with Module 6, in all likelihood due to the 1000 word limitation imposed for that assignment. This boundary would, of course, directly limit the amount of information that students could give or receive. This artificial cap on communication for Module 6 may also be responsible for the sharp decrease in users' perceived ability to identify which contributions came from which group members (i.e., visibility).

Thus, it seems that the difficulty or complexity of the task primarily influences the degree to which users were satisfied and enjoyed completing the assignment. Notably, Module 5, although much less difficult and complex than the previous modules, did not prompt a sharp increase in satisfaction and enjoyment and Module 4, although it was rated as very difficult/complex, did not cause a decrease in satisfaction and enjoyment. Instead, only when there was a drastic increase in difficulty/complexity from one module to the next did users' satisfaction and enjoyment vary (decrease) accordingly. This suggests that the contrast between the difficulty/complexity from task to task might be the more important predictor of satisfaction and enjoyment, rather than simply the level of

difficulty or complexity. Further research, however, is necessary to isolate the relationship precisely.

Implications

Findings from this case study of the GroupShare system can inform theory on computer-mediated communication, group processes, and on the implementation of innovations thereby guiding efforts to incorporate innovative, computer-based tools into the classroom. In this section, the development of user norms in GroupShare, strategies for the successful implementation of instructional technologies, workload, hidden costs, and ethical considerations, and the effectiveness of computer-based instructional tools are examined.

Computer-mediated Communication and the Development of User Norms. In order to teach students how to use and understand computer-mediated communication technologies, Witmer (1998) proposes a three-step process by which students first develop conceptual knowledge about the technologies involved, then gain skills using them, and finally incorporate them into their work through experiential learning. Although this process is ideal in theory, it is often difficult to follow in practice. Given the time limitation of an academic semester or quarter, the amount of material to be covered, and the requisite learning time required of new technologies, students are often thrust into developing conceptual knowledge, gaining skills, and developing experiential learning norms in a short period of time, if not simultaneously. But does this necessarily have negative outcomes?

Data from students' experience with GroupShare indicate that users developed both technical proficiency and appropriate norms of use rather quickly. As already discussed, user effectiveness, proficiency, and the amount of information acquired and contributed all increased, in most cases rapidly, with ongoing use of GroupShare. In addition, the amount of time spent on each module, start-up costs, and recurring costs diminished with experience. Perhaps as a result, satisfaction with the process and outcome and enjoyment of the process increased over time as well. Overall, these variables indicate that a high level of technical proficiency with the GroupShare system was achieved with some alacrity. Of course, a number of factors can contribute to the quick development of users' technical proficiency, and should be designed into the implementation process to the extent possible. Among such facilitators are the ease of use of the specific innovation, the intuitiveness of its design or its similarity to other technologies with which users already have experience, and the degree of training and reference materials available through peer interaction or other means.

In addition to developing technical proficiency, students readily established norms of use and group behavior. Further, their online conversations and specific comments to the instructor suggest that they formed satisfying emotional bonds and feelings of group identity and cohesiveness within the GroupShare system, in spite of a body of research that claims that computer-mediated communication exhibits a diminished capacity to convey rich social cues. This belief has been dubbed "systems rationalism" (Lea, 1991), the "cues filtered out" approach (Culnan & Markus, 1987; Walther, 1992), and the "social cues perspective" (Spears & Lea, 1992). In all cases it refers to the view that computer-mediated, as compared to face-to-face communication, lacks the capacity to incorporate rich contextual and nonverbal cues into communication, filtering out such things as gesticulation, facial expressions, tone of voice, and external environmental signals.

This environment of reduced social cues has been said to lead to a correspondingly reduced social constraint and reduced impact of social norms. The disinhibition characteristic of such environments is said to increase "flaming," or the hostile expression of strong feelings (Kiesler, Siegel, & McGuire, 1984; Siegel, Dubrovsky, Kiesler, & McGuire, 1986; Sproull & Kiesler, 1991) and to encourage a greater equality of participation (Siegel et al., 1986), a reduction in status differentials (Dubrovsky, Kiesler, & Sethna, 1991), and group decisions that are more polarized and risky than those arrived via face-to-face communication (Kiesler et al., 1984). Spears and Lea (1992) sum up these views as painting a picture of an environment with a lack of social cues, difficulties of coordination and feedback, deindividuation, and depersonalization.

However, such "liberation" claims and flaming results have been challenged by others on several levels (Culnan & Markus, 1987; Lea, O'Shea, Fung, & Spears, 1992; Postmes, Spears, & Lea, 1998; Spears & Lea, 1994; Walther, Anderson, & Park, 1994; Walther, 1992). Indeed, recent accounts suggest that newer media such as electronic mail and other forms of computer-mediated communication are used often and effectively for socioemotional tasks

(Markus, 1994; Rheingold, 1993; Rice & Love, 1987; Walther, 1992, 1996). Computer-mediated communication demonstrates the ability to provide deep and meaningful interpersonal interaction, particularly given anticipated future interaction (Walther, 1994) or sufficient time (Walther et al., 1994) and it has been proposed that communication mediated by the computer can be even more interpersonally involving than communication that takes place face-to-face (Walther, 1996).

In fact, students using the GroupShare system seem to have established usage norms quickly that enabled them to distinguish among one another well, although they were always only identified by non-gender-specific pseudonyms. For example, the marked and early increase in the degree to which users perceived that they could identify which group members contributed what information toward the module assignment (i.e., "visibility") indicates that students quickly attached identities to the user IDs and began to assign some degree of "personality" to each individual. In addition, examination of the notes users posted to one another provides ample evidence of rich, social, and personal communication on a regular basis, occurring very early on in the process. Overall, students were able to overcome the limitations of working in an environment of reduced social cues and to interact effectively and, at times, develop what appeared to be strong ties.

Successful Implementation of Instructional Technologies. Goodman and Griffith (1991) outline the critical processes of the implementation of new technologies. According to them, these are socialization about a technology and its usage, commitment and reward allocation for its use, methods of feedback and redesign, and diffusion within the social system in question. In this process, gaining commitment is crucial, as it increases the probability of performing behaviors consistent with the utilization of the technology, stimulates the development of positive attitudes about the technology, and influences how individuals process discrepant information about the technology.

In spite of the importance of gaining user commitment to new technologies, implementation research has shown that a "paradox of value" is often created that serves to dampen commitment rather than secure it. The paradox of value is created by enthusiasm to institute innovations such as new technologies, policies, or practices (Sproull & Hofmeister, 1986): By creating unrealistically high expectations for innovations, users are often disinclined to work toward a successful implementation, due to the misalignment between their initial, high expectations and subsequent experiences with innovations that rarely live up to their promise (Cohen & Axelrod, 1984; Sproull & Hofmeister, 1986). The negative effect of a misfit between preview and experience implies that a realistic preview of an innovation's capabilities, even if it includes negative information, is often a more effective implementation strategy (Goodman, 1993).

Providing a realistic preview seems to be particularly important in the context of implementing new technologies in the classroom. Because students do not have the same obligations to a course as organizational members might to the company that employs them, they can be especially harsh critics of implementation efforts. In addition, although the use of instructional technologies might be the focus of students' attention in any one class, it is unlikely that they have widespread experience with such technologies across classes or that these technologies require the same skills, knowledge, and effort. These factors combine to suggest that the implementation of instructional technologies in a student population might be especially problematic. One way to inoculate against these forces is to make a concerted effort to provide students with a realistic preview of the innovation in use, including the many potential problems that might occur with the innovation. In the implementation of GroupShare, this was accomplished by sharing openly with students potential problems that might occur with the system and by previewing "worst case" scenarios in an effort to encourage students to plan accordingly.

Not only is a realistic preview important, but an active "alignment process" between the new technology and its users must be accommodated in the implementation process. Alignment is a continuous process that can take many forms, ranging from total system redesign to minor technological and user adjustments. These adjustments are what constitute the "re-invention" of the innovation by users (Rice & Rogers, 1980; Rogers, 1993) and may take place in either the technology or in the organization or class (Leonard-Barton, 1988).

Users play a central role in the alignment of the technology and the group. Rogers (1993) acknowledges the individual's role in this part of the implementation process while also pointing out the flexibility of the technology:

> The individual plays an active, creative role in the innovation process by matching the innovation with a perceived organizational problem, and perhaps in re-inventing the innovation. An innovation should not be conceived as a fixed, invariant, and static element in the innovation process, but as a flexible and adaptable idea that is consecutively defined and redefined as the innovation process gradually unfolds, often leading to re-invention. (pp. 19-20)

Alignment is thus typically arrived at through an interactive process of negotiation or "mutual adaptation" whereby reinvention of the technology and adaptation of the organization create a new version of the technology in the course of its implementation (Leonard-Barton, 1988). According to Leonard-Barton (1988) this occurs through a recursive process of small and large adaptive cycles wherein changes ranging from minor adjustments to major overhauls in technology and organization take place. Therefore, a "successful new technology implementation...is an interactive process of incrementally altering the technology to fit the organization and simultaneously shaping the user environment to exploit the potential of the technology" (Leonard-Barton, 1987, p. 7).

With the implementation of instructional technologies for classes, realistic previews and alignment processes are crucial for successful use of the system. A realistic preview of the technology might alert students to such potential system problems as slowness, lack of access, errors in functionality, and system errors. As the findings of this study demonstrate, technical errors hurt effectiveness ratings and increase recurring costs but do not change users' ratings of their own proficiency. To some degree, this may be due to a realistic preview of potential system malfunctions, and users' preparedness to cope with them accordingly (i.e., not to blame themselves). In order to accommodate alignment processes, the instructor should build a certain amount of flexibility into instructional technologies and then solicit feedback from students and use that information to effectively redesign the innovation to meet students' needs and desires. By addressing these two implementation strategies, a smoother and more effective implementation may be achieved.

Workload, Hidden Cost, and Ethical Considerations. As Sherman (1998) points out, time spent in preparation for courses using web-based, instructional technologies can be a great deal longer than with more traditional means of course delivery, particularly in initial deployments. This was the case with GroupShare. A conservative estimate is that the preparation, instruction, and support of this course took three to four times longer than its counterpart with the same content, previously taught without the use of GroupShare. Of course, this cost would presumably decrease over time and there are a number of options that could defray the costs of the effort, such as technical staff or instructional support.

Among some of the hidden costs with the development and use of new, computer-aided instructional technologies are issues of student productivity, a balance between course content and delivery tools, and increased expectations of reachability. Students using the GroupShare system were incredibly productive. With seven module assignments and 10 groups, students produced 70 assignments over the course of the quarter, each of which had to be graded, with feedback given in a timely fashion. On average, discounting Modules 5 and 6 which were atypical, each of the 10 groups produced a document of approximately 3000 words per week (the equivalent of a 10-page paper), well beyond even high expectations. Although on the one hand this is a remarkable achievement in terms of student productivity, it comes with a high cost borne by the instructor in terms of time expended grading and providing feedback.

In addition, there is a tendency for new instructional technologies to overshadow course content (Sherman, 1998), even if the technology can be considered to be an object of study itself. At times, particularly in the early stages of implementation, it did seem as if the class was about GroupShare and not about collaborative processes and organizations. However, as users became more proficient and comfortable with the technology, this was less and less the case. Still, it should be noted that this kind of cost is entirely absent in a more traditional class that does not employ novel and/or highly technical tools.

Also, there is the hidden cost of student expectations of greater reachability that was prompted by the use of GroupShare. Because all communication among students was online, and assignments and all other materials were incorporated into the system, the instructor was held to a higher standard of availability and responsiveness than might otherwise have been the case. Too, because student grades were fundamentally tied to the reliability and operability of the system, technical or user errors needed to be dealt with promptly and efficiently. These

factors combined to instill higher than normal expectations of availability for the instructor. In addition, the ease of use of electronic mail (the use of which was highly encouraged in this particular class) as well as its low threat to students (as compared, perhaps, to face-to-face communication) likely prompted increased communication demands as well.

Finally, there are subtle ethical issues to be considered when using an instructional tool that is capable of capturing, storing, and reproducing literally every interaction that students have with one another. Even though students are made aware of the capabilities of advanced technologies to capture and manipulate this information, it is easy for them to forget that this capacity exists. For example, in notes to one another over GroupShare, students often spoke openly about the their personal lives (drug use, sex, and other personal facts) and their feelings about the instructor and the class, in ways they likely would not have otherwise. On several occasions, they also asked whether or not the instructor read the individual notes between group members that were exchanged over the system. Even with reinforcement that the instructor did indeed have access to their communications, the exchange of what might be viewed as private communication between group members persisted.

Effectiveness of Computer-based Instructional Tools. Overall, students' reactions to the use of GroupShare in the class were overwhelmingly positive. Comments received from students after the final module bring to light some of the specific advantages of this type of system. Several students noted the hands-on nature of the use of GroupShare, as in this comment: "I just wanted to say, I got a lot more out of this class than most classes I have taken in the Comm department. Hands on experience should be a part of more curriculum." Others enjoyed the practical experience the technology provided: "I really think that this class prepared us for what our jobs are going to look like. It prepared us to work with people who we don't know and attempt to accomplish tasks" and "Because of the nature of the class, I feel that I learned a lot more than I would have without the direct and applied structure of GroupShare. I learned practical and useful skills for my future, and I enjoyed the process of doing so." Finally, several students enjoyed the innovativeness of the system saying that "I hope in the future more classes will offer innovative and creative ways to stimulate students' minds" and that "This has been a really great experience for me. I would choose to use GroupShare in my other classes over face-to-face group meetings."

One key to this success is perhaps due to the fact that GroupShare was explicitly concerned with the formation and support of cooperative learning groups. Although the web is often used as a delivery tool, instructional technologies utilizing network capabilities often do not "directly support more collaborative forms of information sharing, where widely dispersed working groups work together to jointly author, comment and annotate documents, and engage in other forms of collaboration such as group discussions " (Bentley et al., 1997, p. 1071). The nature of student groups, however, is an important factor in this regard. Higher achievement and more positive relationships occur where "cooperative learning" takes place. According to Bailey and Cotlar (1994), cooperative learning "is the use of small groups of students working together to maximize their own and each others' education" where "meaningful cooperation is goal-driven, with students responsible for the planning necessary to accomplish the goals" (p. 186). Consistent with this, Hiltz and Wellman (1997) report that perceptions of "group learning," versus "individual learning" make assessment of outcomes more positive in the virtual classroom.

Students using GroupShare seemed to respond positively to this type of cooperative learning. Several of them commented on the fact that they learned from one another as much as from lectures or from readings. This is, perhaps more than the quantitative measures of satisfaction and enjoyment and students' comments about the system, indicative of the relative success of the technology. Fortunately, it seems that in spite of legitimate fears to the contrary (Sherman, 1998), GroupShare as a tool or novelty took a back seat to GroupShare as a facilitator of learning.

Conclusion

The value of this case study is threefold. First, by providing in-depth data on student experiences with this type of web-based system, insights into future, related implementation efforts can be gained. In the relatively new arena of web-based instruction, such information can be particularly valuable to others seeking to implement advanced

technological aids in the classroom. Second, the nature of the over-time data from this case study provides a unique insight into the unfolding processes by which students appropriate instructional technologies (Poole & DeSanctis, 1990). These data suggest effective implementation methods for instructional technologies as well as means of improving subjective results such as satisfaction with group processes and outcomes. Third, the findings of this case study inform theory on computer-mediated communication, group processes, and on the implementation of innovations. Findings add to existing theory in these areas, suggest modifications in some cases, and areas for further research as well.

Consistent with past research (Bee & Usip, 1998; Gilliver et al., 1998; Hiltz & Wellman, 1997; Kulik, 1994; Kulik & Kulik, 1991; Usip & Bee, 1998; Willett et al., 1983), data from students' use of GroupShare demonstrate that computer-based technologies are viable tools that can be used effectively for instructional purposes. In a relatively short time students became highly proficient in the use of the software, found it valuable as a collaborative tool, and formed ties within their groups. GroupShare users experienced few problems with the relatively "lean" text-based communication environment and reported that high quality information was being shared over the system. Satisfaction with group processes and outcomes and enjoyment of the process of working together increased over time, although the difficulty and complexity of assignments was related to lower levels of satisfaction and enjoyment, under certain circumstances. Overall, students indicated that they enjoyed the experience of using a technology like GroupShare as part of the class.

There are several keys to the successful implementation of tools like GroupShare in the classroom. It is important to offer students a realistic preview of their experiences, including negative effects, when introducing the innovation. Realistic previews guard against discrepancies between expectations and experiences that can lead to negative attitudes, misuse, or even sabotage of innovations. In addition, it is important to gain students' commitment to the technology. One means by which to do so is to actively involve users in processes of feedback and redesign. Doing so helps to achieve an alignment between technology and goals that helps to make technological educational aids more effective. Finally, it is important to consider the appropriateness of the technology being implemented. Instructional tools should be selected on the basis of what they might potentially add to the educational experience and not simply in order to invoke the latest technological gadgets (Hantula, 1997). With these guidelines, smooth implementation of computer-based instructional technologies can be achieved, to the benefit of both students and instructors.

Endnotes

1. Students were not formally limited in their interactions with one another in class or outside of it. However, they were instructed not to reveal their identities to other group members for the duration of the class. Post-class surveys, as well as informal feedback, showed that students generally honored this request, although at least one instance of accidental identify revelation was uncovered (students saw one another working on the same assignment in a campus computer lab, thus discovering a fellow group member). In addition, at least two other pairs of students discovered others' identities; one pair was in the same group (and were actually engaged to be married) and members of the other pair were in different groups. All in all, students seemed to like the notion of working anonymously and looked forward to the in-class "revelation" session that was promised and occurred following the final module.

In terms of demographics, age of students was never solicited, but it is believed that all but 2 students were in the typical range of college juniors and seniors (21-22 years of age). 17 students (29%) were male and 41 (71%) were female.

2. It should be noted that factors such as student courseload (that may vary by student) or workload (that may vary over the duration of the academic quarter) were not measured and could have affected variables such as the time spent on each module. This type of workload consideration could also influence other relations in this case study. In addition, as discussed later, a technical difficulty that occurred in Module 6 may have influenced the amount of time spent on that particular module.

3. The range of values in Figure 3 has been constrained for illustrative purposes. The possible range of values in Figure 3 is from 1-5.

4. As with Figure 3, the range of values represented in Figure 4 has been constrained for illustrative purposes. The variables represented have a possible range from 1-5.

5. In Figure 5 note that the variable Difficulty and Complexity of Module has a possible range of 1-7 while the other variables all have a potential range from 1-5. In order to better enable a visual comparison, however, the Difficulty/Complexity variable has not been normalized to a 5-point scale. As with preceding Figures, the range of values represented in Figure 5 has been constrained to the range depicted.

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Appendix A. Variable Operationalization Summary

Variable	Items	Alpha
Start-up Costs	Including all training, reading, and talking with others, how much time did you spend between the last Module and the one you just completed learning how to use GroupShare?	n/a
Visibility	It is clear to me which group member contributed which information to the Module Group members are *not* aware of which contributions toward the Modules come from which person * Others can tell what work I did on the Module It is obvious who did what work toward the completion of the Module	.88
Recurring Costs	I could not gain access to GroupShare when I wanted to Using GroupShare was extremely time consuming GroupShare was easy to use * I could not use GroupShare as much as I wanted to because the system was very slow Giving and getting Module information using GroupShare was simple * I could hardly afford the time needed to put my information into GroupShare Exchanging information through GroupShare was very difficult Locating information using GroupShare was *not* too time-consuming *	.84
Quality of Information Contributed	The information I *provided* using GroupShare was accurate The information I *provided* using GroupShare was always current The information I *provided* using GroupShare was entered in a timely fashion The information I *provided* using GroupShare was relevant for completing the Module assignment	.88

Quality of Information Acquired	The information I *obtained* using GroupShare was accurate The information I *obtained* using GroupShare was always current The information I *obtained* using GroupShare was available in a timely fashion The information I *obtained* using GroupShare was relevant for completing the Module assignment	.84
Satisfaction with the Outcome	How satisfied are you with the results of your work? How satisfied are you with the quality of your group's decisions? In general, how satisfied are you with your work?	.83
Satisfaction with the Group Process	The decisions in my group were very fair In general, work with my group was satisfying Decisions and choices made in my group were well-coordinated The choices made in my group were often confusing *	.80
Collectivism / Individualism	People in a group should be willing to make sacrifices for the sake of the group's well-being People should be made aware that if they are going to be a part of a group then they are sometimes going to have to do things they don't want to do People who belong to a group should realize that they're not always going to get what they personally want People in a group should realize that they sometimes are going to have to make sacrifices for the sake of the group as a whole	.91
Trust in System	GroupShare has sufficient safeguards to prevent outsiders from breaking into it I trust my group members to use information appropriately when it is made available on GroupShare I am worried about how the information will be used after I place it on GroupShare * Members of groups other than my own will not receive information published on GroupShare The GroupShare site is a threat to my privacy *	.70

NOTE: Items marked with an asterisk are reverse-coded.

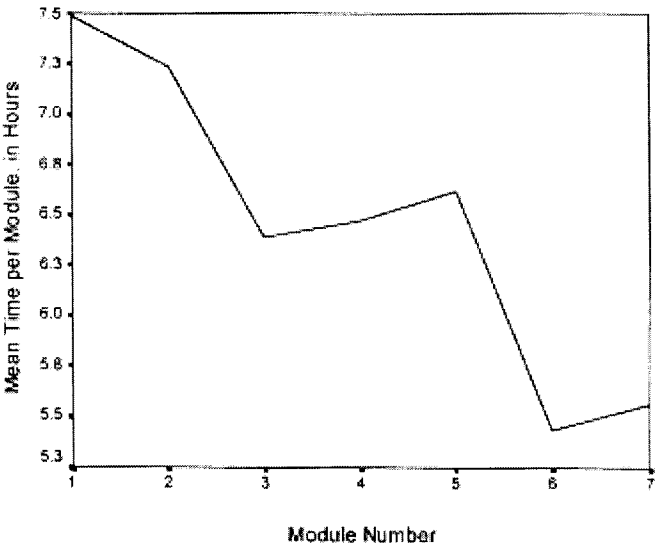

Figure 1. Average time spent per module.

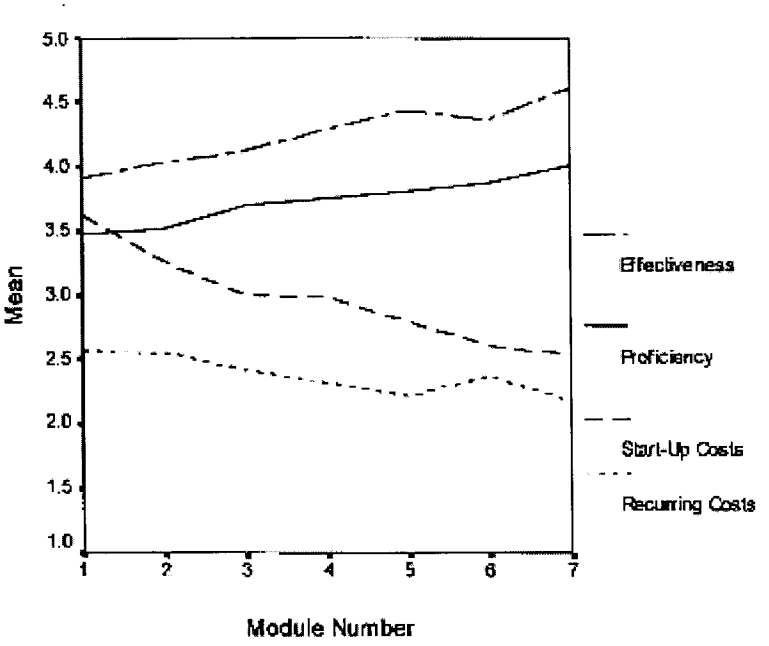

Figure 2. User proficiency and skill measures, over time. <\center>

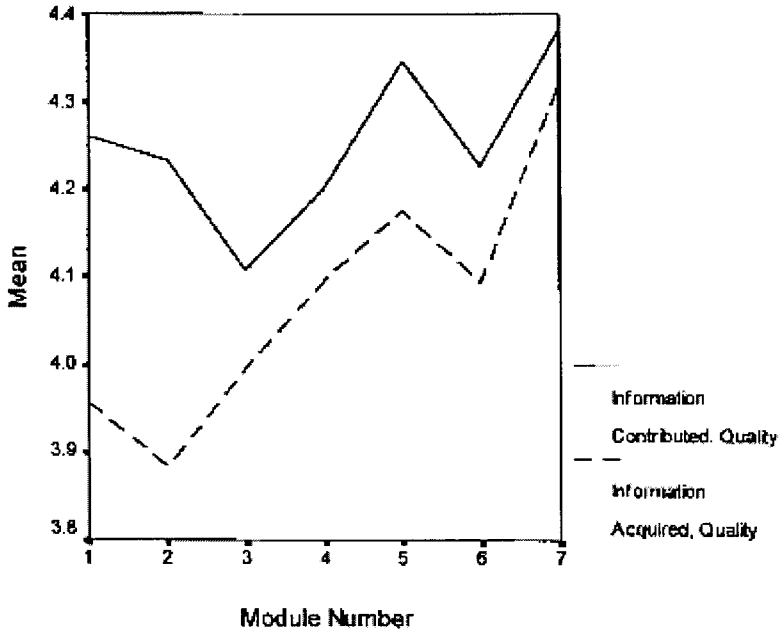

Figure 3. Quality of information contributed and acquired, over time.

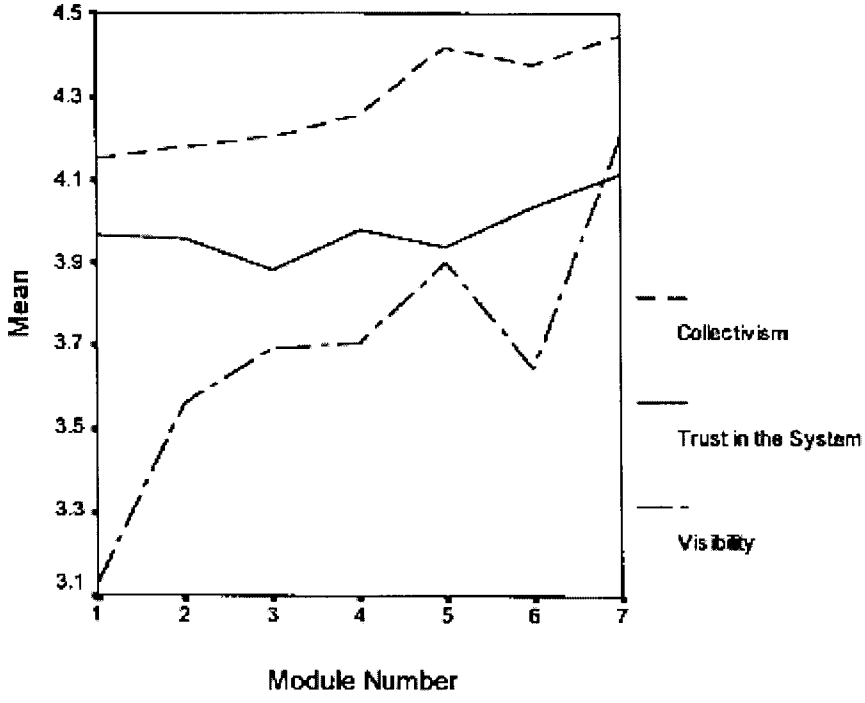

Figure 4. Collectivism, trust, and visibility measures, over time.

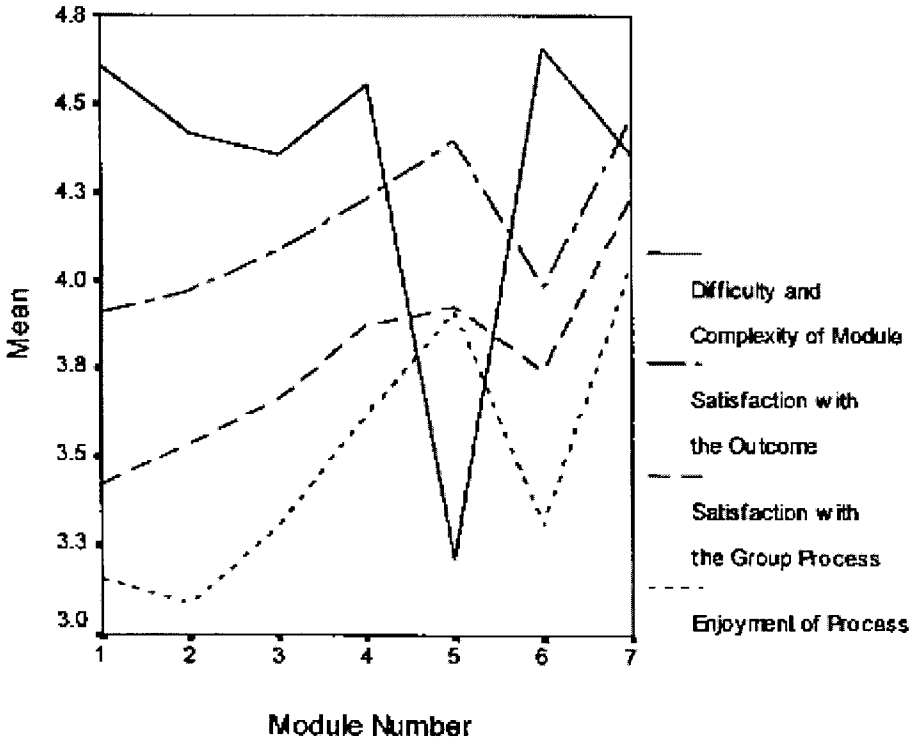

Figure 5. Usage outcome measures, over time.

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