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RESEARCH NOTE

MANAGING CLIENT DIALOGUES DURING INFORMATION SYSTEMS DESIGN TO FACILITATE CLIENT LEARNING[1]

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Abstract

It has long been recognized that client learning is an important factor in the successful development of information systems. While there is little question that clients ***should*** *learn, there is less clarity about how best to facilitate client learning during developer-client meetings. In this study, we suggest that a cooperative learning strategy called collaborative elaboration developed by educational psychologists provides a theoretical and practical basis for stimulating client learning during an IS design process. The problem with assessing the effects of collaborative elaboration, however, is in controlling for the many other factors that might affect client learning and outcomes of an IS design phase. In a unique research opportunity, we were able to measure the use of collaborative elaboration among 85 developers and clients involved in 17 projects over a semester-long IS design process. The projects were homogeneous with respect to key contextual variables. Our PLS* *analysis suggested that teams using more collaborative elaboration had more client learning and teams with more client learning achieved better IS design-phase outcomes. This suggests that theories about collaborative elaboration have significant potential for helping IS researchers identify new approaches for stimulating client learning early in the IS design process.*

Keywords: Information systems development, requirements elicitation, learning, client-developer dialogue, cognitive elaboration, user participation

Introduction

It has long been recognized that client learning is an important factor in the successful development of information systems. While there is little question that clients *should* learn, there is less clarity about when and why clients learn or about how best to facilitate client learning (Ciborra and Lanzara 1994; Keil and Carmel 1995; Wastell 1999). By clients, we mean representatives of users and sponsors that are involved in the development effort as sources of adaptive redesign (Ciborra and Lanzara 1994; Urquhart 2001). By client learning, we mean the acquisition of new knowledge that causes changes in requirements that reflect an enhanced understanding of the technology, organizational, and work environment in which the system will operate (Curtis et al. 1988). In this study, we suggest that a cooperative learning strategy developed by educational psychologists called collaborative elaboration provides a theoretical basis for understanding client learning during a design process.

Several case studies in the information systems development (ISD) literature have documented the positive effects of client learning on ISD success, especially during the initial design phases of a project (Curtis et al. 1988; Kirsch and Beath 1996; Newman and Noble 1990; Wastell 1999). Irrespective of these positive effects, if client learning occurs late in a development effort, requirements can fluctuate, leading to design defects, mismanaged client expectations, and budget or schedule overruns (Boehm 1989; Curtis et al. 1988).

Facilitating client learning is difficult, in part because it must occur in the context of a largely emergent design process (Markus et al. 2002). Emergent processes and the learning that is fostered can neither be standardized nor controlled, and thus traditional requirements elicitation modes may suppress rather than foster client learning early in the design process (Beath and Orlikowski 1994; Ciborra and Lanzara 1994; Truex et al. 1999). In this study, we suggest that cooperative learning techniques provide a means to foster early client learning within an emergent process.

While there has been significant research on client learning, most of this research has identified contextual factors that create environments in which client learning can be impeded or fostered without consideration of the specific ways to simulate client learning during the course of the design process. Such contextual factors include power differentials among stakeholders (Hirschheim and Klein 1994; Newman and Noble 1990; Robey and Farrow 1982); an organization's ability to accommodate changes arising from learning (Ciborra and Lanzara 1994); system and organizational complexity (McKeen et al. 1994; Nidomulu 1996), the development methodology used (Beath and Orlikowski 1994; Stein and Vandenbosch 1996), the nature of the client-developer relationship (Urquhart 2001), the experience level of the developer (Cavaye 1995; Curtis et al. 1988), and whether the project is client, analyst, or jointly led (Kirsch and Beath 1996). Together, the extant research alerts us to many contextual factors affecting client learning, but it does not suggest much about why these factors increase or decrease the probability that clients will learn or how client learning can be stimulated.

Some IS researchers have focused on ways of stimulating client learning during IS design by presenting theories and case studies illustrating the value of client-developer dialogues that are dialectic, surfacing and integrating multiple perspectives (Boland 1978; Ciborra and Lanzara 1994; Curtis et al. 1988; Hirschheim and Klein 1994; Salaway 1987; Urquhart 2001; Walz et al.

1993). Most of this IS research, though, is not grounded in extant theory and research about learning (with the exception of Salaway). In this paper, we draw on theories about cooperative learning to propose how client-developer teams could facilitate their dialogue to enhance the type of client learning that leads to improved IS design-phase product and process outcomes. Cooperative learning theories are highly consonant with theories of client-developer dialogue; if empirically demonstrated to have application to the ISD domain, these theories will provide an enriched understanding of how to encourage client learning.

We use an exploratory empirical examination, in which the influences of many contextual factors have been removed through sample selection, to show that cooperative learning strategies merit attention from the IS development research community. Our purpose in this paper, then, is modest: to propose a relationship between the use of theoretically derived cooperative learning techniques, client learning, and outcomes achieved during the IS design phase. Our hope is that by identifying such a relationship, we will succeed at encouraging ISD researchers to consider a new perspective for studying stakeholder participation and learning in ISD projects.

The Role of Collaborative Elaboration in ISD

For decades, educators and cognitive psychologists have suggested that learners benefit from studying interactively with their peers (Cohen 1994; Slavin 1983) and in groups (Vygotsky 1978; Webb and Palincsar 1996). Interactive group learning can be managed through a variety of strategies, typically with more sophisticated strategies leading to enhanced performance (Willoughby et al. 2000). One such strategy that has received a great deal of attention because of its adaptability to a variety of learning situations has been referred to as *elaborative interrogation* (Willoughby et al. 2000), *self-explanations* (Webb and Palincsar 1996), and *cognitive elaboration* (O'Donnell and O'Kelly 1994).[2] We use the term *collaborative elaboration* to emphasize two points: the group context in which learning occurs and the elaboration process that stimulates learning.

Elaboration is a strategy in which individuals verbally expand, or embellish, on a concept, domain, or knowledge that is new to them. Thus, a client might describe her view of a technology that might work for her even though she may know relatively little about it, and a developer might describe whatever she knows about a client's work process. To ensure that these discussions create genuine learning, learners will (1) apply their initial understanding of the domain or concept to concrete examples (or analogies) with which they have had experience, (2) explain their own assumptions underlying their view of the target concept, (3) identify alternative assumptions that could apply, and (4) explain the concept using multiple interpretations, different formats, and varied perspectives (Webb and Palincsar 1996). It is through this self-paced, in-depth examination and exploration of new concepts and domains that the learner observes for herself inconsistencies among her assumptions, and inconsistencies between her assumptions and those of others (Woloshyn et al. 1993).

By exploring these inconsistencies, the learner's understanding or mental model of the domain is changed. Norman (1982) identified three forms of learning, of which only one—*structuring*—involves significant changes to one's existing mental model. Vandenbosch and Higgins (1996), in a review of the mental model learning literature to explain learning from executive information systems, explain that Norman's structuring is equivalent to other cognitive psychologists' perspectives of learning, referring to this class of learning as

[2] There are alternative strategies that have also been found to be successful, such as the Vygotskian approach of reciprocal teaching (Vygotsky 1978; see also Palinscar and Brown 1984), but the Vygotskian approach assumes a student-teacher relationship that is not appropriate in the ISD context, since clients are learning in part about their own contexts, not just the developer's context.

model building. Since learning was defined as ***changes*** in preexisting requirements reflective of a new understanding of the situation, model-building learning should be facilitated during an ISD effort. As such, elaboration as a stimulant for model-building learning may provide a strategy for facilitating client learning about requirements.

Collaborative elaboration (CE) extends this notion of elaboration to suggest that a learner is unlikely to find these inconsistencies by herself. Collaborators surrounding the learner take on the role of encouraging this elaboration process by probing with *why* questions, reminding the learner of additional analogies or previous experiences that might help to make the concept more concrete, and, in general, guiding the learner to use the CE techniques when formulating her explanations. It is this guidance and gentle probing by others that makes the learning process a collaborative one. When several people are trying to learn at the same time (as is common in requirements analysis), they will need to variously switch between generating their own elaborations and helping others to self-elaborate. Educational research has repeatedly demonstrated that cooperative group learning strategies such as CE, when compared to non-cooperative strategies of self-study and lecturing, lead to more efficient and higher quality learning (Bruffee 1999; Dillenbourg 1999; O'Donnell and O'Kelly 1994; Slavin 1983; Webb and Palincsar 1996; Willoughby et al. 2000).

For an IS design team, the use of CE may imply different behaviors and information-sharing practices than are common practice today. For example, instead of quickly seeking consensus on a single set of requirements, the use of CE might yield an initial set of highly divergent problem definitions, distinct solutions, and contrasting interpretations of information as learners work their way through multiple alternative possible assumptions, interpretations, and perspectives. Instead of clients lecturing developers about the client work context and developers lecturing clients about possible technology options, each would proceed through the design process sharing their knowledge about the other's domain, with the intention of unearthing information gaps, misunderstandings, and incorrect assumptions so that these could be appreciated. As the process continues and developers and clients learn about each other's domain as well as their own domains, new conceptual models of the system design may emerge.

Although CE has been identified as valuable for educational-based learning, the relevance of CE to the ISD context has not been demonstrated. If the use of CE can be shown to be related to client learning and outcomes in an IS design context, this would suggest that client-developer dialogue might be managed in ways that foster enhanced levels of learning. It would also suggest that the user participation literature might benefit from the study of design processes that leverage cooperative learning opportunities. Therefore, our intent is to conduct an initial exploratory empirical investigation into the role of CE in contributing to the type of client learning that is likely to lead to outcomes indicative of a superior IS design-phase process. Our basic proposition was simple:

> *The more CE experienced during the IS design phase of an IS development project, the greater the client learning, and the greater the client learning, the more positive the IS design-phase outcomes.*

Study Context

Cooperative learning is contingent on the presence of cooperative interdependence (Johnson and Johnson 1989, 1998). A defining characteristic of cooperative groups is that members hold themselves and each other accountable for contributing their share of the work to achieve the group's goals. In groups that are genuinely cooperative, individuals are willing to invest the psychological energy in each other's collective action and are open to influence by other group members. Consequently, we assess, as a control on client learning, the degree to which members of an ISD group demonstrate cooperative interdependence.

Many contextual variables (as noted in the "Introduction") have been shown to affect client learning in ISD. These may also affect the relationships among CE and cooperative interdependence, client learning, and IS design-phase outcomes. For example, project complexity (Nidomulu 1996) may discourage participants from using CE, or if they use CE, complexity may hinder client learning. Similarly, some development methodologies may discourage both CE and client learning in favor of moving a project inexorably forward (Beath and Orlikowski 1994). Therefore, to determine if CE affects client learning which in turn affects IS design-phase outcomes, either the effect of CE needs to be assessed taking these contextual factors into account (requiring a very large sample of ISD projects that vary on each contextual variable), or these contextual factors need to be used in the selection criteria for the sample, so as to create homogeneity with respect to the contextual factors. We adopted the latter approach since our intention was to rule out plausible alternative explanations for a relationship between CE, client learning, and design-phase outcomes, not to demonstrate that CE contributes to client learning and design-phase outcomes above and beyond the effect of contextual factors.

Identifying a set of ISD projects that are homogeneous with respect to the range of possible contextual factors can be challenging since each IS design effort tends to be unique (in size, complexity, organizational context, characteristics of participants, developer experience, development methodology, length of time, etc.). Nevertheless, after much searching, we were able to identify a reasonably homogeneous set of 17 IS design projects. Each project involved four developers (graduate students in Computer Science) and one client from their university's library services department (for a total of 85 participants), and used an analyst-led iterative development methodology with standardized milestones and a 12-week design phase ending in the development of a prototype. Each library client represented a slightly different customer base, but all clients required the development of a Website connected to a database. Clients participated because they were promised development support for full-scale implementation (during the second semester) of those prototypes they wanted to see carried through to implementation. Moreover, library clients were informed by their CIO that he would use these prototypes to help determine his IT budgeting for the year; thus, clients were motivated to see the projects succeed. The authors were not involved in managing or coordinating the projects; the Computer Science class was taught by Dr. Barry Boehm. A colleague of Dr. Boehm's, an individual who had served in this capacity for many years, served as a project coordinator. This coordinator screened candidate projects so that each one had a similar number of risk factors. All of the developers had a similar low level of experience in ISD as well as in participation in client-focused design efforts, and all of the clients were library staff inexperienced in being ISD clients and unfamiliar to the developers. All developers had used the library system and thus had some familiarity with the client's work process.

With this sample, then, we were able to hold relatively constant the effects of many contextual variables on the relationships between CE, client learning, and outcomes of the IS design phase including (as noted in the "Introduction") power differentials among stakeholders, organizational ability to accommodate changes, system complexity, development process, nature of client-developer relationship, developer's experience, and how the project was led. While such a sample removes the effect of many exogenous factors, it introduces the problem of generalizability to industry-based nonstudent projects as well as to projects where these exogenous factors vary. Since our purpose was only to establish first that a relationship exists between CE, client learning, and the outcomes of a design-phase project, generalizability was of less concern than was removing the effect of as many exogenous factors as possible. We return to the issue of generalizability in the "Limitations" section of the paper.

Although the impact of many contextual factors was removed by the selection of our sample, there was one additional variable, developer communication quality, that has been shown to affect outcomes of IS design projects (Guinan 1998; Guinan and Bostrom 1986), which we did not believe we could control through homogeneous sample selec-

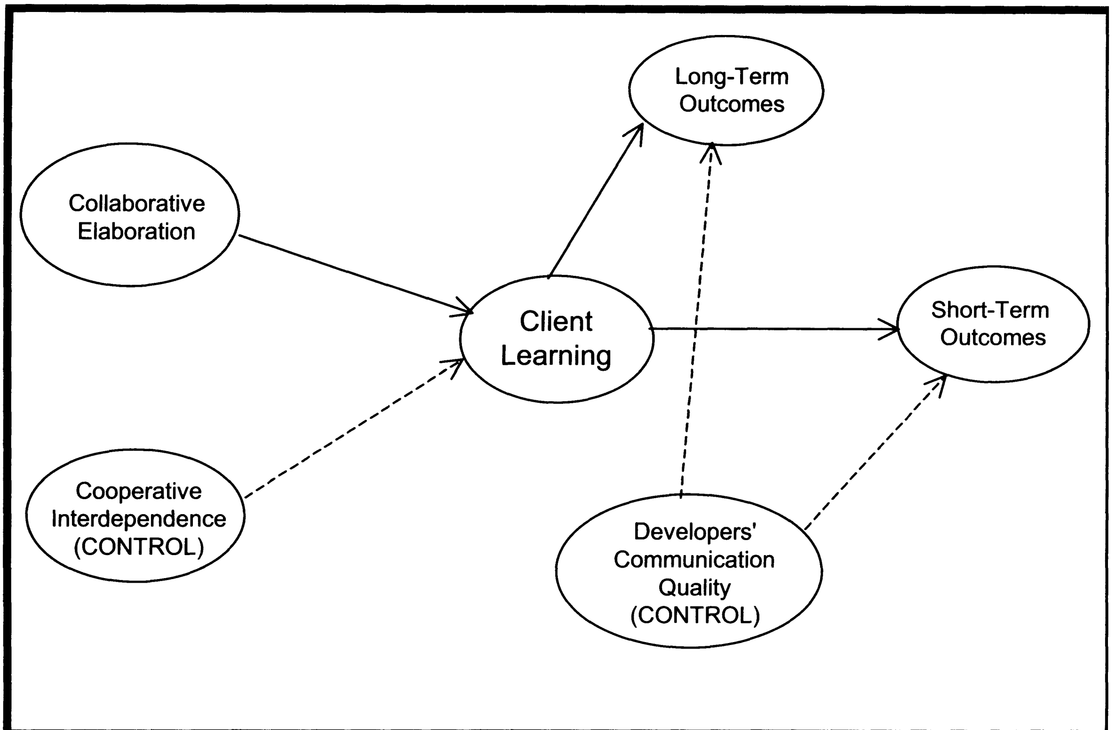

Figure 1. Hypothesized Model

tion. It seemed likely that developer communication quality would not only vary across projects, but would affect design-phase outcomes. Therefore, we have included this variable in our analysis.

Summary

In sum, we hypothesized that a team's use of CE would be related to increased client learning, after controlling for cooperative interdependence, and that client learning would be related to superior IS design outcomes, after controlling for developers' communication quality. We examined the impact of client learning and developers' communication quality on both short-term and long-term outcomes. Our hypothesis is summarized in the model depicted in Figure 1 with dashed lines indicating the role of the two control variables.

Method

The group-based nature of CE use (i.e., that CE needs to be used during group dialogues, not simply by an individual working alone) required that the unit of analysis be teams. Therefore, we collected data from 17 project teams, comprising the 68 developers and 17 clients participating in the study.[3] The four developers and one client for

[3]In this study, 80 percent of the students formed their own teams, and the remaining students were assigned to teams by the project coordinator. Two-thirds of the teams selected a project (based on a one-paragraph description), and the remaining teams were assigned to a project by the project coordinator. All teams met their clients for the first time at an all-class session one week before the start of the design effort. The results were almost identical when we included an additional control variable for self-selected versus randomly assigned groups. Bootstrapped test results showed this control variable had a nonsignificant effect on all endogenous constructs.

each of the 17 project groups met in three 90-minute meetings during the 12-week design phase: in the third, sixth, and ninth weeks of the project. Immediately following each of the three meetings, clients were surveyed about the use of CE by both developers and themselves, the degree of cooperative interdependence exhibited during the meeting, and the extent of client learning that occurred. Only clients were asked about CE usage since the classroom environment created the possibility of a reporting bias by the students. By measuring these constructs after each of the three meetings rather than once at the end of the project, bias in reporting of CE, cooperative interdependence, and client learning was reduced. We collected data at all three meetings since we expected the effects of CE to be cumulative. Since we did not have specific expectations about when CE might occur, whether CE and client learning should occur early or late in a project, or even whether CE and client learning would necessarily occur at the same time, we averaged the assessments of CE, cooperative interdependence, and client learning across the three meetings. By averaging the measures across the three meetings, our intention was to obtain a richer and more stable measure of the CE and client learning variables than we would have obtained from a single assessment at a single point in time. In addition to the meeting assessments, at the end of the 12 weeks we collected data on the outcomes of the IS design phase. Finally, at the end of the project, clients were asked to provide an overall assessment of developer communication quality (communication quality has been traditionally measured at the conclusion of the project, when respondents are best positioned to make that judgment).

Measures

CE Used During Client-Developer Meetings. Six items were developed to measure the extent to which CE techniques were used in each meeting. The six items were tailored to the ISD context The clients were asked: During this meeting, to what extent did both clients and developers (1) ask about the other party's unstated reactions to ideas, (2) use multiple ways to describe an idea, (3) identify differences that were not immediately obvious to participants, (4) focus on understanding or achieving others' personal goals, aside from program specifications, (5) generate several alternatives that accomplished at least one shared goal, and (6) compare alternatives to fallback positions? These items were designed to assess the degree to which the client-developer dialog included CE techniques such as assumptions surfacing, examining alternative perspectives, and understanding alternative cause-effect links (Webb and Palincsar 1996).

Cooperative Interdependence. After each meeting, clients were asked to indicate the extent to which the tasks that (1) clients and (2) developers were expected to complete in preparation for the meeting had in fact been completed. We took this evidence of responsible behavior to be a key indicator that members held themselves and others in the project accountable for contributing their share of the work to achieve project goals.

Client Learning. We adapted Vandenbosch and Higgins' (1996) index of model-building learning to measure client learning. While CE researchers typically measure learning by testing for specific changes in content knowledge obtained (e.g., Willoughby et al. 2000), we had no preconceived idea of what each client might learn. Like others (e.g., Vandenbosch and Higgins 1996), we expected clients to be sufficiently self-reflective as to be able to report when they had "changed their minds." Therefore, we asked clients three questions:

(1) To what extent did the dialogue in the meeting reorient your thinking about requirements?

(2) To what extent did the dialogue in the meeting question your preconceptions about requirements?

(3) To what extent did the dialogue in the meeting expand your scope of thinking about the requirements?

Clients responded to these three items after each of the three meetings. To assess the reliability of our respondents' quantitative ratings, we looked for examples of client model-building learning in observations of a randomly selected set of meetings. Two examples were a client cutting the project scope after the developers verified the feasibility of purchasing an off-the-shelf software component and a client changing his or her perspective when the developers discovered a new software package that might be helpful.

IS Design Phase Outcomes. Two outcomes of the IS design phase were assessed: (1) short-term and (2) long-term outcomes. Our measure of short-term design-phase outcomes focused mainly on the quality of the prototype that the developers generated. Our measure of the long-term design-phase outcomes focused on the degree to which the design phase helped the client to build a capability for effectively participating in future IS design efforts (Ross et al. 1996; Stein and Vandenbosch 1996). Four items were used to measure short-term outcomes: (1) number of points assigned to the prototype and accompanying design documents based on evaluations made by a panel of software engineering industry experts invited by the course professor, (2) client response to a question as to whether they were sufficiently pleased with the prototype to commit resources to carry the prototype forward into development (only about one-third of the projects were expected to be carried forward), (3) client rating of the extent to which requirements were met by the prototype, and (4) client rating of the extent to which expectations for the design process had been met. Long-term design-phase outcomes were assessed using four items asking about the degree to which the design effort had increased the client's understanding of their and their end-users' work needs, business problems, characteristics of particular information technologies, and project management.

Developer Communication Quality. A seven-item scale developed by Guinan (1988) and validated by McKeen et al. (1994) was used to assess the quality of the developers' command of the language, sensitivity to others' needs, attentiveness, and listening. Consistent with the manner in which this scale has been used in previous studies (McKeen et al. 1994), clients were asked to assess developer communication quality at the end of the design phase.

Appendix A shows the individual items used to measure each construct along with means and standard deviations for each item.

Analysis Strategy

Our hypothesized model suggested that CE and cooperative interdependence would be positively related to client learning, and that client learning and developer communication quality would be positively related to the two design-phase outcomes. To test this model, partial least squares (PLS), a latent structural equation modeling technique that utilizes a correlational, principle component-based approach to estimation (Chin 1997), was used. Each multi-item construct was modeled as reflective (vs. formative) of the latent variable (Chin 1998a). Limiting our model to no more than two structural paths to any one construct allowed us to meet Chin's (1997) sample size recommendation of 5 to 10 times the largest number of structural paths to any one construct given the construct is measured with reflective indicators.[4] To estimate the significance of the path coefficients, we used bootstrapping with a sample size of 500, as recommended by Chin (1998b).

[4]In order to test the adequacy of our sample size, we simulated data that conforms to the estimates obtained in this study to determine the frequency (i.e., the power) with which PLS was able to detect each structural path for different samples. Following this procedure we generated 1,000 samples of size 17 that modeled the parameter results to be presented. The power estimates from this simulation were reassuring, with one path having a power of .776 and all others above .980. Moreover, the Type I error was found to be .074 for only one path with the rest at .05 or less. These results suggest, as others have shown (Chin and Newsted 1999; Gopal et al. 1993) that PLS is able to obtain robust estimates even with small sample sizes.

Results

Measurement Model

Results of the PLS component-based analysis, correlations among the constructs, alpha coefficients, reliability tests, PLS-computed variability for each construct, and inter-construct correlations are presented in Tables 1 and 2. Table 1 provides the correlations of each item to its intended construct (i.e., loadings) and to all other constructs (i.e., cross loadings). Although there is some cross-loading, all items load more highly on their own construct than on other constructs and all constructs share more variance with their measures than with other constructs. Table 2 shows that the alpha coefficients for the items within each construct are sufficiently high (greater than .70, per Nunnally 1978). The more accurate composite reliabilities, which avoid the assumption of equal weighting of items, were even higher with only the 0.88 estimate for short-term outcomes below the 0.90 level. Table 2 also presents average variance extracted as well as correlations between constructs. Comparing the square root of the average variance extracted (AVE) (i.e., the diagonals in Table 2, representing the average association of each construct to its measures) with the correlations among constructs (i.e., the off-diagonal elements in Table 2, representing the overlap association among constructs) indicates that each construct is more closely related to its own measures than to those of other constructs. Moreover, all AVEs were well above the 0.50 recommended level (Fornell and Larcker 1981; see also Chin 1998b). In sum, these results support the convergent and discriminant validity of our constructs.

Structural Model

Figure 2 presents a graphical depiction of the PLS results and Table 3 contains the outer-model loadings of the items on each construct. All paths are significant with the model accounting for 55 percent of the variance in client learning, 56 percent of the variance in the long-term outcome of client capability building, and 57 percent of the variance in short-term outcomes.[5]

The results in Figure 2 support the proposition that both CE and cooperative interdependence contribute to client learning, and client learning in turn contributes to short-term outcomes of the design process. Client learning, however, did not significantly contribute to the long-term outcome of client capability building. Although models that included a path between developer communication quality and CE and a path between developer communication quality and client learning were estimated, these paths were not significant, suggesting that, as expected, client learning is affected not by the developer's communication abilities but by collaborative elaboration. In addition, these tests suggest that CE is not enhanced by—nor does it enhance—perceptions of developer communication ability. Instead, it is the self-elaboration process by client and developer together, rather than simply listening to or communicating, that helps clients to learn.

Limitations

Before discussing these results, it is important to keep in mind some aspects of the design that should cause us to be cautious in their interpretation and reluctant to generalize from them without further study. By using a sample of 17 projects in which the impact of many extraneous factors has been removed, we have eliminated several threats to internal validity. However, some threats remain. Several of our measures were newly developed and require further validation. No standardized measures for CE or cooperative interdependence exist. Because we assessed CE

[5]One alternate model we tried, at the request of a reviewer, was to treat cooperative interdependence as a moderator of the CE-to-learning relationship, rather than a control. The interaction of CE and cooperative interdependence was nonsignificant as expected with a mean standardized path of -0.035. The test was accomplished using the procedure outlined by Chin et al. (2003).

Table 1. PLS Component-Based Analysis: Cross-Loadings

Construct/Items	CI	CE	CL	DCOM	ST OUT	LT OUT
CI1	**0.964**	–0.002	0.452	0.501	0.515	0.284
CI2	**0.974**	0.021	0.533	0.385	0.373	0.359
CE1	–0.020	**0.897**	0.426	0.045	0.532	0.348
CE2	–0.109	**0.862**	0.259	0.034	0.385	0.356
CE3	–0.062	**0.903**	0.462	–0.123	0.367	0.269
CE4	–0.303	**0.830**	0.451	–0.040	0.252	0.255
CE5	0.099	**0.881**	0.410	0.051	0.395	0.309
CE6	0.281	**0.893**	0.663	0.203	0.625	0.421
CL1	0.467	0.529	**0.818**	0.384	0.506	0.488
CL2	0.369	0.482	**0.915**	0.067	0.431	0.365
CL3	0.493	0.418	**0.903**	0.315	0.589	0.586
DCOM1	0.343	–0.036	0.199	**0.889**	0.588	0.516
DCOM2	0.513	–0.032	0.231	**0.933**	0.552	0.672
DCOM3	0.365	0.196	0.317	**0.787**	0.539	0.464
DCOM4	0.582	–0.010	0.355	**0.891**	0.549	0.638
DCOM5	0.331	0.175	0.024	**0.785**	0.413	0.438
COM6	0.422	–0.065	0.277	**0.932**	0.569	0.577
DCOM7	0.095	0.111	0.381	**0.739**	0.541	0.516
ST OUT1	0.270	0.573	0.461	0.636	**0.774**	0.727
ST OUT2	0.128	0.466	0.509	0.439	**0.801**	0.550
ST OUT3	0.608	0.290	0.464	0.439	**0.830**	0.386
ST OUT4	0.474	0.261	0.459	0.492	**0.821**	0.483
LT OUT1	0.222	0.414	0.490	0.540	0.746	**0.788**
LT OUT2	0.248	0.416	0.469	0.632	0.645	**0.965**
LT OUT3	0.316	0.244	0.474	0.561	0.477	**0.867**
LT OUT4	0.406	0.276	0.560	0.579	0.565	**0.951**

Note: Boldface numbers are loadings (correlations) of indicators to their own construct; other numbers are cross-loadings. To calculate cross-loadings, a factor score for each construct was calculated based on the weighted sum, provided by PLS-Graph, of that factor's standardized and normalized indicators. Factor scores were correlated with individual items to calculate cross loadings. Boldface item loadings should be greater than cross-loadings. See Appendix A for actual item wording in the surveys.

Table 2. Inter-Construct Correlations: Consistency and Reliability Tests

Construct (# items)	Cronbach's Alpha	Composite Reliability	AVE	min[2]	max	CI	CE	CL	DCOM	LT OUT	ST OUT
Cooperative Interdependence (2)	0.969	0.969	0.940	1.301	–1.568	**0.969**[1]					
Collaborative Elaboration (6)	0.953	0.953	0.771	2.231	–1.890	0.01	**0.878**				
Client Learning (3)	0.911	0.911	0.774	2.380	–1.732	0.511*	0.542*	**0.879**			
Developers' Communication Quality (7)	0.949	0.949	0.729	1.145	–2.632	0.334	0.377	0.557*	**0.854**		
Long Term Outcomes (4)	0.915	0.942	0.802	1.443	–1.666	0.452	0.046	0.305	0.647**	**0.896**	
Short Term Outcomes (4)	0.822	0.882	0.651	1.280	–1.961	0.452	0.504*	0.587*	0.679**	0.631*	**0.807**

*Significant at 0.05 level; **Significant at 0.01 level.

[1]The shaded numbers on the diagonal are the square root of the variance shared between the constructs and their measures. Off diagonal elements are correlations among constructs. For discriminant validity, diagonal elements should be larger than off-diagonal elements (see Agarwal and Karahanna 2000; Compeau et al. 1999). Diagonal = square root of $(\Sigma\lambda_i^2)/(\Sigma\lambda_i^2 + \Sigma\theta_{ii})$; Composite reliability = $(\Sigma\lambda_i)^2/\{(\Sigma\lambda_i)^2 + \Sigma\theta_{ii}\}$. In both cases, λ_i are factor loadings and Θ_{ii} are unique error variance = $1 - \lambda_i^2$.

[2]Construct values are standardized and normalized by PLS-Graph by default. Means and variances are therefore 0 and 1 for all constructs.

Table 3. Outer Model Loadings				
	Entire Sample Estimate	**Mean of Subsamples**	**Standard T-Statistic Error**	**T-Statistic**
COOPERATIVE INTERDEPENDENCE (CI)				
CI1	0.964	0.980	0.058	17.200
CI2	0.974	0.981	0.036	27.288
COLLABORATIVE LEARNING (CE)				
CE1	0.898	0.896	0.102	9.197
CE2	0.862	0.870	0.099	8.846
CE3	0.903	0.906	0.078	12.044
CE4	0.830	0.844	0.107	6.535
CE5	0.881	0.888	0.084	11.037
CE6	0.893	0.897	0.086	10.649
CLIENT LEARNING (CL)				
CL1	0.818	0.886	0.088	10.766
CL2	0.915	0.931	0.070	12.523
CL3	0.903	0.924	0.072	12.869
DEVELOPER COMMUNICATION QUALITY (DCOM)				
DCOM1	0.889	0.897	0.079	11.293
DCOM2	0.933	0.927	0.072	12.104
DCOM3	0.787	0.808	0.128	5.536
DCOM4	0.891	0.897	0.080	11.092
DCOM5	0.785	0.810	0.116	6.501
DCOM6	0.932	0.928	0.072	12.601
DCOM7	0.740	0.772	0.127	5.836
SHORT-TERM OUTCOMES				
ST OUT1	0.774	0.827	0.128	6.864
ST OUT2	0.801	0.842	0.100	9.175
ST OUT3	0.830	0.855	0.113	8.162
ST OUT4	0.821	0.854	0.101	8.816
LONG-TERM OUTCOMES				
LT OUT1	0.788	0.837	0.113	6.209
LT OUT2	0.965	0.953	0.067	14.152
LT OUT3	0.867	0.902	0.078	11.694
LT OUT4	0.951	0.946	0.067	14.182

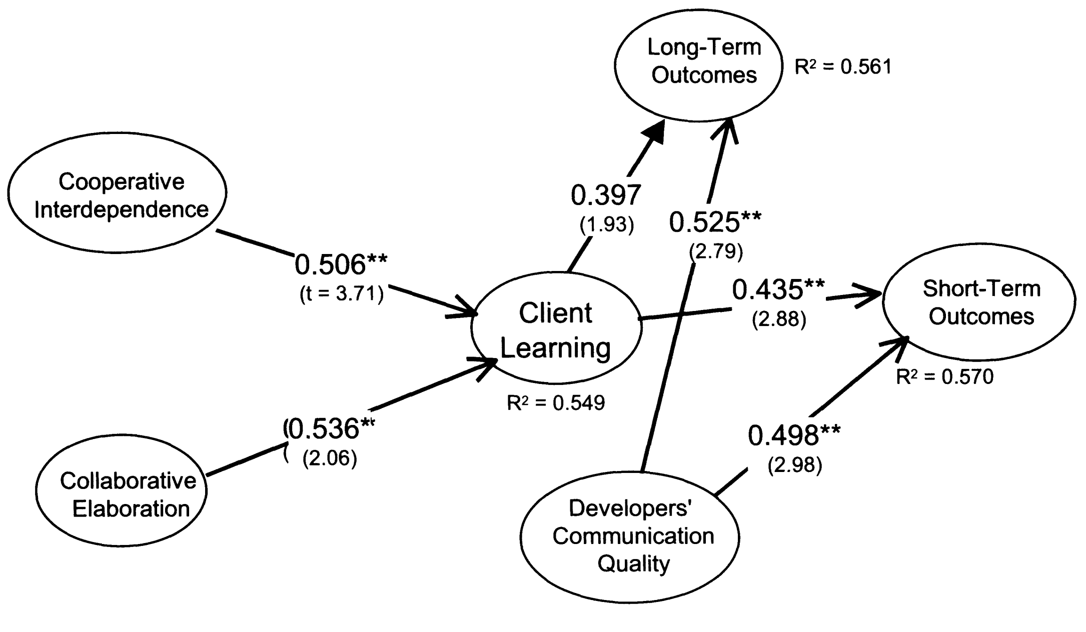

Figure 2. Results

exclusively from the client point of view, an alternate interpretation of our results is possible: it may not actually be CE that is driving client learning but some other aspect of the team's performance during the three meetings, which was captured in the client's reports of CE behaviors. By asking the client to report CE behavior three times, we expect to have reduced the frequency with which this error might have occurred. Another threat is that there may be systematic differences between clients or project teams that account for the relationship between CE, learning, and design outcomes. One possible systematic difference that we controlled for was communication quality. However, there may be other systematic differences such as client participation level (for which cooperative interdependence is in part controlled) or client openness to change. Moreover, students largely self-selected into the teams and projects. While this self-selection may account for differences in design outcomes, it seems unlikely to present an alternative interpretation for the observed relationship between CE, client learning, and design outcomes. Nevertheless, the lack of random assignment raises the possibility that contingency or moderator variables such as group cohesiveness or previous shared experiences may have enhanced the effect of CE on learning in some teams. However, whether this type of effect could masquerade as CE and thus undermine our interpretation of our results is an open question needing further study.

In addition to the above internal validity threats, this highly constrained sample of 17 teams of student developers and university library clients raises several threats to external validity, as noted earlier. The clients in our sample may have had low expectations for the prototypes the students generated, which may have allowed CE and learning to play a more prominent role in design outcomes than when client expectations and pressures are high. Similarly, developers who have professional reputations at stake and development experience may find such interactive group learning strategies as CE of less value for engendering client learning. Finally, there is a need to study whether CE still has a positive effect on learning and design outcomes when different organizational, technological, and management contexts are taken into account.

Since it would seem difficult to replicate the level of control achieved in this design with projects in business contexts, future research might need to use samples of a very large number of projects so that extraneous variables can be statistically controlled. Alternatively, CE could be studied intensively, so that the way in which these other factors play a role is examined in more depth. When this follow-on research is conducted, the effects of development methodology, developer expertise, client role, project complexity, and organizational culture on the relationship between CE, client learning, and outcomes of the IS design phase can be explored.

Discussion

Our results indicate that teams using more CE will engender more client learning and teams with more client learning will achieve better IS design-phase outcomes. This suggests that theories about collaborative elaboration may have significant potential for helping IS researchers identify new approaches for efficiently stimulating client learning early in the design process. For example, Ciborra and Lanzara (1994) argue that actor learning is limited when contextual practices remain unquestioned and cognitive frames unexplored. The use of CE strategies may provide a natural means by which such factors are considered during the design process. As such, CE may provide a means to "break powerful imageries and institutional bonds at a deeper level" (Ciborra and Lanzara 1994, p. 79).

Given this initial evidence that cooperative learning strategies have applicability to the ISD domain, ISD research can benefit from the rich educational research stream upon which CE is based. For example, educational research has found that cooperative learning (vs. competitive or individualistic efforts) tends to result in greater retention of what was learned, increased willingness to take on difficult tasks and persist despite difficulties, higher-level reasoning, creative thinking, superior transfer to new situations, and more positive attitudes toward the task (Johnson and Johnson 1998). For ISD research, this suggests that the use of CE may engender not just learning but commitment, not just high-quality designs but innovative designs, not just acquisition but transfer of knowledge, and not just satisfaction with the group but with the task. If so, CE may provide a unified framework for understanding the formation of commitment, innovativeness, learning, and satisfaction in ISD. Moreover, cooperative learning research may provide a theoretical frame for characterizing user participation not in terms of the quantity of participation episodes, but as a process—a cooperative learning process (Newman and Noble 1990). The behaviors associated with CE require that client-developer dialogues be managed to allow participants to discuss what they know least in order to enhance their learning. Such a dialogue is closer to what Salaway (1987), drawing on the work of Argyris and Schon (1974) on organizational learning, refers to as "Model II" information systems development. Salaway's research indicates that few developers manage their dialogue with clients in this way. Given our findings indicating the value of CE for client learning and design outcomes, future research should focus on when and where CE occurs instinctively and how the use of CE can be enhanced. CE may arise only in situations of great perceived need (such as with teams in which the need for learning is recognized and shared) or when previous requirements definition methods have not worked. Much research is needed on what gives rise to CE in ISD teams.

Except for developer communication quality, the measures used in this study were tailored to this context and need to undergo further rigorous development. By adapting our measures to our context, their face validity was dramatically improved. Reasonable discriminant and convergent validity assessments on such a small sample provide evidence that our approach resulted in reliable measures. However, extensions to this work in other settings will require newly developed measures. Research is needed to develop scales for CE, cooperative interdependence, and ISD learning (by clients and/or developers) so that findings across settings can begin to accumulate.

To increase the reliability of our measures, we aggregated across assessments of separate CE behaviors and, as a result, we do not know which kinds of CE behaviors are more or less important for client learning in an ISD context. We also aggregated across meetings and as such do not know the ideal trajectory of CE or client learning or if the relationship between CE and client learning is lagged or changes over time. Research is needed on the role of specific CE behaviors over time in affecting client learning.

Our results did not find a relationship between client learning and the long-term outcome of increased client capability. This may be a result of using a newly developed measure. Alternatively, it may be that changes to a client's long-term capability are more affected by individual-level factors (for example, openness to change), or that client learning in individual projects must accumulate over time and across projects before the learning changes the client's capability to effectively participate in future IS design projects. More research is needed on the relationship between within-project client learning and the development of a client capability to participate in future projects.

In conclusion, cooperative learning theory and our preliminary findings offer a modest recommendation: future research on ISD should incorporate the educational psychology perspective on cooperative learning when developing further theory on how stakeholders in a complex ISD process should interact. We argue that, by incorporating learning theory into ISD theories, we can achieve a deeper understanding of stakeholder dialogue. For example, there is much current ISD theorizing suggesting stakeholder participation and control is a determinant of design outcomes (Hartwick and Barki 1994; Hunton and Beeler 1997; Kirsch 1997). Cooperative learning theory provides an alternative perspective: learning is affected not simply by stakeholder participation or control, but by the inclusion of CE during stakeholder dialogues. That is, according to collaborative learning theory, giving stakeholders responsibility to review a client interface will not affect stakeholder learning unless the stakeholder engages in CE when doing the review. This suggests that research on stakeholder participation would need to examine not just the activities in which the stakeholder participates, or the amount of control the stakeholder exerts, but how the dialogue between stakeholders is carried out. Thus we hope that this paper provides a catalyst to ISD researchers to consider the way in which client-developer meetings are managed and to bring extant collaborative learning theory to bear.

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Appendix A

Individual Items for Construct Measurement

Label	Item	Mean (sd)
Immediate Post-Meeting Measures (means across 3 meetings)		
COOPERATIVE INTERDEPENDENCE **During this meeting, to what extent did**		
CI1	You meet obligations for this meeting?	3.0 (1.4)
CI2	The developers meet obligations for this meeting?	3.3 (1.4)
COLLABORATIVE ELABORATION **During this meeting, to what extent did both clients and developers:**		
CE1	Ask about the other party's unstated reactions to ideas?	2.7 (0.9)
CE2	Use multiple ways to describe an idea?	3.1 (1.0)
CE3	Identify differences that were not immediately obvious to participants?	3.1 (1.0)
CE4	Focus on understanding or achieving others' personal goals, aside from program specifications?	2.5 (1.1)
CE5	Generate several alternatives that accomplished at least one shared goal?	2.9 (1.3)
CE6	Compare alternatives to fallback positions	2.7 (1.3)
CLIENT LEARNING **To what extent did the dialogue in the meeting:**		
CL1	Reorient your thinking about requirements?	2.9 (0.9)
Cl2	Question your preconceptions about requirements?	2.7 (0.9)
CL3	Expand your scope of thinking about the requirements?	3.0 (1.1)
Measures Obtained at End of Design Phase		
DEVELOPER COMMUNICATION QUALITY (COMM) **Over the course of the semester, the students:**		
DCOM1	Had good command of the language.	4.1 (0.9)
DCOM2	Were sensitive to others' needs of the moment.	4.0 (1.0)
DCOM3	Typically got right to the point.	4.2 (0.8)
DCOM4	Paid attention to what other people said.	4.2 (1.3)
DCOM5	Dealt with others effectively.	3.9 (0.9)
DCOM6	Were good listener(s).	4.0 (1.1)
DCOM7	Generally said the right thing at the right time.	3.7 (0.9)

Label	Item	Mean (sd)
SHORT-TERM OUTCOMES OF IS DESIGN PHASE		
ST OUT1	Now that the semester has ended, what is your current assessment of the probability (0%-100%) that the prototype will be carried forward to implementation in the Spring?	60.6 (36.4)
ST OUT2	To what extent did the team meet your original requirements? (For this item, respondents selected from a 7-point anchored scale, from 1 = not at all to 7 = a great extent)	3.4 (0.9)
ST OUT3	To what extent did the team provide you with all the client-requested features, functions, and capabilities that were expected early in the project? (For this item, respondents selected from a 7-point anchored scale, from 1 = not at all to 7 = a great extent)	3.3(1.1)
ST OUT4	Number of points given to team based on ratings of the quality of the prototype and life cycle deliverables by a panel of software engineering experts from (max = 524, min = 361.)	456 (42.8)
LONG-TERM OUTCOMES OF IS DESIGN PHASE **As a result of this last semester's interactions with the students (joint meetings, prototype showings, and presentations) to what extent did these combined experiences**		
LT OUT1	Allow you to learn specific ways in which users perform their work?	2.7 (1.3)
LT OUT2	Give you new understanding, insights, and knowledge about business processes in general, which you can apply to future contexts (e.g. how to improve customer service, how business-to-business web functions ought to work, etc.)?	2.9 (1.2)
LT OUT3	Broaden your overall knowledge about how technologies can be used in different contexts in the real world (e.g. handheld devices, web tools, platforms and databases and their compatibilities)?	2.7 (1.2)
LT OUT4	Add constructively to your general inventory of project management skills (e.g. how to manage a project team, how to negotiate, changes of scope, etc.)?	3.2 (1.3)

Note: Except for ST OUT4, all items were collected from the clients then standardized prior to analysis. DCOM and LT OUT items used a five-point scale of 1 = strong disagree and 5 = strongly agree. CI, CE, and CL items and ST OUT2 and ST OUT3 used a five-point scale of 1 = no extent and 5 = great extent.