MEASURING THE COLLABORATIVE PROCESS: THE MISSING INSTRUMENT IN DIGITAL LEARNING

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ABSTRACT

The focus on collaboration is increasing in this age of digital learning. Collaboration, combined with advances in technology, has been argued by researchers and educators as the next big push in enhancement of learning. However, no clear measure of the collaborative process exists. Most studies have viewed collaboration as a dichotomous variable or have used post-hoc analysis to understand the impact of collaboration. In this study, we argue that extent of collaboration needs to be measured as a continuous process variable. Based on previous literature in information systems, management, and education, specific dimensions of collaboration are outlined and an instrument is developed. The instrument is then tested for validity and reliability across seven different criteria in line with existing literature. The paper also outlines how the instrument developed in this article can be used to measure the extent of collaboration in future management research as well as presents guidelines to enhance collaboration between teams.

Keywords: Collaboration process, Instrument development, Measurement, Quasi-experiment.

INTRODUCTION

Information Systems (IS) researchers have spent considerable time trying to understand groups and teams, especially in the context of work systems. Dominant among these have been the work in Group Decision Support Systems (GDSS) & Virtual team's research in Information Systems, and more recently, using a team-based approach in technology training literature as well as e-learning in general. Team based methods have also been used in a lot of different areas such as leadership, decision-making, trust-building, communication, conflict-management, and skill development.

GDSS/virtual teams' research provides considerable evidence that good collaboration improves team performance (Garrison, Wakefield, Xu, & `Kim, 2010). However, much of this research was focused on understanding advanced information technology to improve decision making within groups. The initial research in this area was primarily input-output focused i.e. looking at the use of GDSS in different context to measure outcomes (Fjermestad & Hiltz, 1998). Results of these studies, however, had limited generalizability because of variability in GDSS systems or context. Subsequent research has focused more on the quality of usage of this advanced information technology (Limayem, Banerjee, & Ma, 2006). This quality of usage has been found to be a key determinant of outcome. More recently, though, researchers have argued the focus needs to shift to discussion of the usage process, including a discussion of the collaboration process (Denning & Yaholkovsky, 2008; Helquist, Deokar, Meservy, & Kruse, 2011; Piccoli, Powell, & Ives, 2004).
The use of teams in employee training is a more recent phenomenon, especially with the greater adoption of web 2.0, e-learning, and mobile technologies (Ali-Hassan, Nevo, & Nevo, 2010;

Jokela, 2003). Employee training, by itself, has been found to be one of the most pervasive methods for enhancing individual productivity and communicating organizations' goals to new personnel (Arthur, Bennett, Edens, & Bell, 2003). Teams provide an environment where participants draw on each other for social understanding, observations & reflections, thus, improving training outcomes. Various team-based learning methods have evolved over the years, emphasizing different features ranging from discussions to jigsaw puzzles (for a review of major methods, see Johnson and Johnson (2003)). Benefits of team-based learning have been demonstrated in cognitive domains such as mathematics (Webb, 1982), science (Okada & Simon, 1997), problem solving (Chi, Leeuw, Chiu, & Lavancher, 1994), engineering (Dossett & Hulvershorn, 1983) and technology training (Gupta & Bostrom, 2013). However, given the variance in the learning methods, implementations of the features in them, and interactions among team members, it is not surprising that meta-analysis of team-based learning has shown a great variation in results (Gupta, Bostrom, & Huber, 2010; Lou et al., 1996; Springer, Stanne, & Donovan, 1999).

Various streams of research conclude that greater emphasis is needed on studying the collaborative process. GDSS literature has tried to focus on some aspects of collaboration by researching group sizes (Valacich, Wheeler, Mennecke, & Wachter, 1995), group cohesion (Hiltz, Fjermestad, Ocker, & Twoff, 2006; Yoo & Alavi, 2001) and group development (Chidambaram & Bostrom, 1997). On the other hand, much of the research in training/education literature has been post-hoc and atheoritical in nature (Iverson & Roy, 1994; Johnson, 1981).

This lack of ability in measuring the collaborative process with a solid theoretical conceptualization is a major gap in the current literature; especially with technology tools increasing focus on collaboration. Most researchers have either used post-hoc analysis to understand the process, or have used analysis of discussion text to estimate collaboration (Beise, Carte, Vician, & Chidambaram, 2010). This makes it very difficult to compare across studies as well as collaboration levels across time. The measurement of the collaboration process or the level of collaboration within a team not only opens the black box of collaboration, but also helps us understand the disparity in various studies. In addition, it will help us focus on the extent to which antecedents can be structured to enhance collaboration as well as see the extent to which levels of collaboration impact outcomes. Both of these have immense practical applications (outlined later). Finally, by measuring the collaborative process, we can also see the impact of time on collaboration; an assertion made by many practitioners and researchers.

This paper, thus, instead of reviewing the extant literature, presents research on developing an instrument for measuring the extent of collaboration, i.e. the collaborative process. The paper references relevant literature where appropriate. The paper follows the steps suggested in earlier literature to build an instrument (Boudreau, Gefen, & Straub, 2001; Goodhue, 1998; Straub, 1989). These steps are 1) theoretical meaningfulness of constructs 2) observational meaningfulness of concepts 3) discriminant validity 4) convergent validity 5) internal consistency / reliability and 6) nomological validity.

In the next section, we outline the theoretical underpinnings of the collaboration process. Subsequently, the rest of the steps in instrument development are outlined. Next, the paper describes the results of a study conducted to see the convergent validity and reliability of the instrument. The final section summarizes the research and outlines future directions.

THEORETICAL MEANINGFULNESS OF COLLABORATION

The first step in building a valid scale is achieving conceptual clarity on what is to be measured as well as its importance. This is usually rooted in a good theory. The goal of this section to provide conceptual foundation to the concept of collaboration. The paper starts by exploring the accepted definition of collaboration.

Gray (1989) presented one of the most extensive reviews of the theoretical perspectives in behavioral psychology and definitions of collaboration. He defines collaboration as "a process through which parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible" (p. 5). Building on this Wood and Gray (1991), expanded the meaning of collaboration. They stated that collaboration occurs "When a group of autonomous stakeholders of a problem domain engage in an interactive process, using shared rules, norms and structures, to act or decide on issues related to that domain." The definition provides three critical insights into collaboration: 1) Collaboration is a process. 2) Collaboration is based on multiple dimensions such as shared rules, norms and structures and 3) the process of collaboration can be used in multiple domains. This paper adopts this definition and expands on the individual components.

Much of the theoretical basis for work on collaboration comes from early work on social development theory (Vygotskiæi & Cole, 1978). It states:

> Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (inter psychological) and then inside the child (intra psychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals. (p. 57)

Vygotskiæi's theory was an attempt to explain consciousness as the end product of socialization. Most of the original work using this theory was done in the domain of language learning in children (Vygotskiæi & Hanfmann, 1962). Forman and Cazden (1985) extended the framework to collaborative learning. Developmental and Educational psychologists have identified two major categories of peer influence: (a) peers serve as natural teachers and models to simulate cognitive development and (b) peers contribute to task orientation, persistence and motivation to achieve (Rohrbeck, Ginsburg-Block, Fantuzzo, & Miller, 2003). The concepts have been extended in multiple technology training studies with varying results (Bryans & Smith, 2000; Davis & Yi, 2004; Gupta & Bostrom, 2013). Similar variance in results has been observed in meta-studies of GDSS (Dennis, Haley, & Vandenberg, 2001) and virtual teams (Pinsonneault & Caya, 2005) research as well.

A similar construct to collaboration studied extensively in the information systems, and management literature is Group Cohesiveness (Beal, Cohen, Burke, & McLendon, 2003; Gully, Devine, & Whitney, 2012). Group cohesiveness is defined as the extent to which group members feel a part of a group and their desire to remain in the group (Langfred, 1998). While group cohesiveness has a strong relationship to performance, it is argued in a subsequent section, that it is a subset of a larger collaboration construct.

In summary, while social development theory outlines the cognitive reasons for the positive impact of collaboration, it does not provide adequate insight into the concept of collaboration. Additionally, most IS research has looked at collaboration through an input-output lens i.e. studying the causes and consequences of collaboration rather than trying to measure the process; which is where true collaboration exists.

OBSERVATIONAL MEANINGFULNESS OF THE COLLABORATIVE PROCESS

The second major concern in instrument development deals with linking the measures to the theoretical construct defined in the earlier section. Since much of the conceptualization of collaboration is abstract, we use a higher-order framework or meta-theory to develop the specific measure for the collaborative process. The outcome of such a process is an enhanced description of the specific theory involved within a well-defined nomological framework of reference (Utåo, 2005). A meta-theory that fits this purpose is Adaptive Structuration theory (Bostrom, Gupta, & Thomas, 2009). Adaptive Structuration Theory (AST) is formulated as the process through which members' use of rules and resources in interaction in an advanced information technology context. However, in recent years, the concepts from AST has been extended to a variety of contexts (Bostrom et al., 2009).

AST describes 'shared rules, norms and structures' (outlined in the definition of collaboration) in three ways: spirit, features and dimensions (DeSanctis & Jackson, 1994) – see Table 1. AST states that in a 'problem domain', the participants interpret the structures provided, i.e. the intended spirit. The spirit is the "*official line*" which the structures present to the participants regarding how to act, interpret the features, and fill in the gaps in the procedures that are not explicitly specified (DeSanctis & Jackson, 1994). Depending on the interpretation, the levels of collaboration can be vastly different between groups.

Table 1. Structural Descriptors in AST

Structural Descriptor	Definition
Spirit	The general intent of the work system as it is presented to the user. It is reflected in the design and implementation.
Features	Specific type of capabilities, rules and resources offered by or associated with the structures.
Dimensions	An aspect or characteristic of a structure that reflects a bundled set of features implemented in a particular context.

Features are options and capabilities offered by (explicitly) or associated (implicitly) with a structure (DeSanctis & Jackson, 1994). IS researchers, while examining the impact of collaboration and technology, have researched a considerable number of structural features, including individual characteristics, situational factors, group structure and task characteristics (Pinsonneault & Caya, 2005). However, the problem with structures and spirit is that they can differ in implementation and interpretation. For example, case studies have been broadly classified as McAleer Interactive Case Analysis (MICA) and Harvard Case Method (HCM) depending on the following features: role of the instructor, participant and the case guidelines (Desiraju & Gopinath, 2001). Although useful in understanding the two different case study methods, the study comparing MICA and HCM has failed to attribute learning variance to the different features

offered by each method because of the difference in implementation (Desiraju & Gopinath, 2001). Thus, spirit and features are not enough to explain structural influences on results.

The AST answer to this problem is to describe structures in terms of structural dimensions. A dimension describes an aspect of structure as a resource or constraint in work (DeSanctis & Jackson, 1994; Gupta, 2008). Dimensions are scalable, reflecting the amount of a given characteristic manifested in the structure. Sets of features are used to create a particular level of a dimension. For example, researchers have used the dimension of restrictiveness to differentiate between decision support systems (Silver, 1991). Restrictiveness measures the degree to which the features of a system limit the decision-making process. Features such as the ability to show a spreadsheet, implement functions and executive programming codes were used to measure restrictiveness of a decision support system. Features can positively or negatively influence existing dimensions of the work system, or provide dimensions that would not otherwise exist.

Drawing on team research in Education (Johnson & Johnson, 1999) and Management (Franklin, Wissler, & Spencer, 1976), six important structural dimensions of teams that influence learning were identified: Coordination, accountability, support, cohesion, goal emphasis, and team feedback. These are outlined in Table 2 and discussed next. The research and theory associated with each of these dimensions represents the little 't' needed to use AST as a meta-theory (Bostrom et al., 2009; Watson, 2007). These are also cited in subsequent paragraphs.

Table 2. Team dimensions

Team Dimensions	Definition	Example of features
Coordination (Johnson & Johnson, 1999)	Perception of the degree to which participants are linked in a way that some benefit is accrued to the collaborating individual.	Role, resource, reward or goal interdependence
Accountability (Franklin, Wissler, & Spencer, 1976)	Individual accountability is the degree to which the performance of each individual participant can be assessed, and feedback is seen by the team as well as the individual.	Using an average score to reflect the score of each individual in the team; random selection of an individual assignment to represent the team
Support (Vygotskiæi & Cole, 1978)	Degree to which participants offer useful help to fellow team members, or provide information that may be useful in understanding a concept.	Shared goals, rewards
Cohesion / Identity (Vygotskiæi & Cole, 1978)	Salience of one's self-definition as a team member	Ground rules (e.g. conflict management, roles, shared goals).
Goal Emphasis (Franklin et al., 1976)	Degree to which participant behavior is focused on accomplishing team goals.	Goal-setting procedures, tracking the extent of achievement of goal
Team feedback (Johnson & Johnson, 1999)	Degree to which team members discuss how well they are achieving their goals and maintaining effective working relationships.	Team performance assessments in weekly meetings, online discussion forum

Coordination is the perception that participants are linked in a way that some benefit is accrued to the collaborating individual. Such interdependence has been shown to have a positive effect on attitude and performance of the group (Shaw, Duffy, & Stark, 2000; Tait & Billinghurst, 2015). Group features used to implement this dimension are role or reward interdependence, resource scarcity, and shared goals. Role interdependence is structured by assigning each student a role. Reward interdependence is structured by providing a team reward to the team if for successful individual performance of all participants. Resource interdependence is created by giving each member a scare resource for problem solving. Finally, goal interdependence is structured by

providing the team with a mutually shared team goal. Higher level's coordination structural dimension has also been found to eliminate negative consequences of virtual teams (Pinsonneault & Caya, 2005).

Accountability is the degree to which performance of each individual student can be assessed and feedback on individual performance seen by the team as well as the individual. It is important that team members know who needs more assistance, and that they cannot '*hitch-hike*' on the work of others or lurk in the shadows (Baumer, Sueyoshi, & Tomlinson, 2011). The extent of accountability outlines the extent to which there is equity of information and participation across the group (Huang, Wei, Watson, & Tan, 2003). A common way of implementing this in a learning context is by giving an individual test for each student and randomly selecting one student's work to represent the efforts of the entire team.

The rest of the dimensions are usually associated with the internal team norms. The support dimension reflects the degree to team members support of each other. Since individuals are working together on tasks, they have many opportunities to supplement each other's efforts. When team norms favor support, individuals more readily offer the help that fellow team members can use, or provide information that may be helpful in understanding a concept (Chidambaram & Tung, 2005). These norms also help manage conflict within a group (Mortensen & Hinds, 2001), making group members more approachable (O'Connor, Gruenfeld, & McGrath, 1993). Considerable support for this dimension can also be found in the social media literature (Purohit et al., 2014).

One of the most extensively studied constructs in team literature is group cohesion or identity – the degree to which members of a group are attracted to another member and are motivated to stay in the group (Bettenhausen, 1991). Researchers have shown that higher level of cohesion plays an additive role in improving group outcomes (Gully et al., 2012; Langfred, 1998; Yoo & Alavi, 2001). Features influencing this dimension focus on formation of convergent values and expectations.

Goal emphasis directly relates to the task and its accomplishment. A higher level of this structural dimension stimulates an enthusiasm among participants for setting and achieving goals contributing to high-quality outcomes. Features that promote this dimension include goal-setting procedures and tracking the learning goals achieved by the team (Poole & DeSanctis, 1992).

Table 3. Team dimensions

Team dimension	Cooperation	Competition	Individualistic
Coordination	Mutual	Relative	Self
Accountability	Mutual	Opposite	Individual
Support	High	Low	None
Identity/ Cohesion	Shared	Relative	Individual
Goal Emphasis	Mutual	Differential	Self
Team feedback	Enhance	Oppose	Oppose

Team feedback is the degree to which team members discuss how well they are achieving their goals and maintaining effective working relationships (Hess, Fuller, & Mathew, 2006; Hiltz et al., 2006). Performance appraisal and feedback are among the features that are commonly used to

implement this dimension. These features are designed to enhance the collaboration level within groups.

An alternate way of conceptualizing the importance of the above mentioned structural dimensions is to map them to the three commonly outlined orientations of a team in the literature: i.e. Collaborative, Competitive, and Individualistic (Denning & Yaholkovsky, 2008; Iverson & Roy, 1994; Johnson, Maruyama, Johnson, Nelson, & Skon, 1981). It has also been suggested that collaborative groups perform better than competing groups (Johnson & Johnson, 1975; Lou et al., 1996). The paper uses the discussion above regarding structural dimensions to see the differences across team orientations that result in performance differences (see Table 3). The table also implies that while the orientation types provide a broad classification of teams, the actual team orientation is a continuous scale varying for low levels of collaboration to high levels of collaboration, changing over time.

FACE VALIDITY AND RELIABILITY

Reliability concerns the extent to which measurements are repeatable (Nunnally, Durham, Struening, & Guttentag, 1975), or have a relatively high component of true score and relatively low component of random error (Carmines & Zeller, 1979).

Table 4. Collaboration Measurement Items

Code	Dimension	Measurement item / Question
Collab1	Coordination	The instructor would view our interpretation of the collaborative guidelines as inappropriate.
Collab2	Coordination	We did not use the collaboration guidelines in the most appropriate fashion.
Collab3	Individual Accountability	I am not in favor of having a partner, because I did not learn anything from my partner.
Collab4	Support	My partner was friendly and easy to approach.
Collab5	Support	My partner paid attention to what I was saying.
Collab6	Cohesion	Working with a partner in the learning process seems like a good idea to me.
Collab7	Cohesion	Having a partner during the learning process was fun
Collab8	Cohesion	I enjoyed working with a partner during the learning process.
Collab9	Goal Emphasis	My partner emphasized learning.
Collab10	Goal Emphasis	My partner encouraged me to give my best effort.
Collab11	Team Feedback	My partner encouraged us to work together.
Collab12	Team Feedback	My partner helped me enhance my learning.

Since the above dimensions are scalable, the following items in Table 4 were developed to measure them. These scales were built by modifying existing scales in cohesion (Yoo & Alavi, 2001), attitude (Kinzie & Delcourt, 1991), consensus (Salisbury, Chin, Gopal, & Newsted, 2002) and faithfulness (Chin, Gopal, & Salisbury, 1997). These items were, initially, vetted with the 45 part-time MBA students from a large southeastern university for face validity tests. These participants were asked to work on a small Microsoft Access project for one hour before doing a card sorting exercise (to provide some context) with multiple constructs. Measurement items (described in Table 4) were listed on the cards, and participants were asked to sort the cards in relevant pre-defined categories (listed as dimensions in Table 4). Overall, this exercise found good face validity,

with over 80% agreement between participants on the collaboration items. Together, they measure the level/extent of collaboration in a team, i.e. collaboration process.

A second, larger, study was done to perform further reliability and validity tests. The context of the study was technology training, a context that provided the ability to compare data with existing literature. The study also used previously developed, and used e-learning methods based on social cognitive theory. This ensured consistent exposure of material across all teams. The study used introduction to MIS undergraduate students from the same university. The students were paired randomly and were tested for history. Only zero-history groups were used for further analysis. These students already had knowledge of basic Excel and thus, were trained in advanced Microsoft Excel (graphs and formulas) in pairs. Questions were noted down for evidence. Teams were given specific guidelines on collaboration i.e. discuss at least three questions with each other. Teams also shared one computer to ensure resource interdependence. Outcome variables were self-efficacy regarding Excel and Satisfaction from the learning process. Self-efficacy has been shown to be the single most important attribute in information systems literature affecting usage while satisfaction from the learning process was captured to evaluate the learning method.

All items were measured on a 7-point scale. Self-efficacy and Satisfaction for the learning process came from existing instruments. Data was collected using web-based instrument, at an individual level. The instrument is shown in Appendix 1. After removing for incomplete data, and other irrelevant data (non-paired data, etc.), the final sample size was 120. Other basic biographical information is presented in Appendix II. As can be seen from that, the sample represents a good cross-section of genders and business majors.

Table 5. Construct reliability (N=120)

Construct	Cronbach's Alpha
Collaboration	0.914
Satisfaction	0.860
Self-efficacy	0.815

Reliability, as measured by multi-item measures, is often estimated by Cronbach's alpha. In this case, SPSS was used to measure Cronbach's alpha. Table 5 the alpha values for the above-mentioned constructs using bootstrapping. Bootstrapping is a random sample – resample method of estimating reliability, reducing the need to have multiple samples. In this case, the reliability values are constantly >.70, showing good internal consistency of constructs.

DISCRIMINANT & CONVERGENT VALIDITY

The discussion of discriminant validity and convergent validity requires a new analysis, i.e. factor analysis. There are two kinds of factor analysis: exploratory factor analysis (EFA) or confirmatory factor analysis (CFA). CFA is generally used for well-formed constructs, coming from existing measures. EFA is better suited for newly developed constructs, especially in the case of similar psychological measures (Thompson, 2004). Thus, EFA was used in this analysis.
Discriminant validity is concerned with the extent to which participants respond similarly to different constructs. Convergent validity is the degree to which multiple attempts to measure the same concepts are in agreement (Bagozzi, Yi, & Phillips, 1991). It can be assessed by inspecting

the estimates of item variance, i.e., is there agreement among the measures of the same trait. This is usually assessed by looking at the factor loading of the measures (Bagozzi et al., 1991). As mentioned earlier, satisfaction and self-efficacy were the other constructs used in this study. Thus, discriminant and convergent validity were assessed by verifying item factor loading on the factor it is measuring is maximally different from other constructs and maximally similar to the construct it is measuring. Table 6 shows the factor matrix using maximum likelihood with varimax rotation for independent variables and dependent variables.

Table 6. Convergent and Discriminant Validity (N=120)

Item	Self-efficacy	Collaboration	Satisfaction	Coordination
Collab1	-0.054	-0.244	-0.058	0.812
Collab2	-0.154	-0.161	-0.111	0.694
Collab3	-0.029	-0.808	-0.062	0.196
Collab4	0.135	0.684	-0.003	-0.152
Collab5	0.111	0.741	0.112	-0.112
Collab6	0.077	0.875	0.051	-0.007
Collab7	0.101	0.885	0.031	-0.002
Collab8	0.045	0.567	0.095	0.008
Collab9	0.092	0.889	0.03	-0.095
Collab10	0.094	0.851	0.05	0.019
Collab11	0.063	0.869	0.076	-0.016
Collab12	0.083	0.829	0.094	-0.035
Satis1	-0.185	-0.146	-0.846	0.05
Satis2	-0.182	-0.18	-0.843	0.068
Satis3	0.304	0.082	0.686	-0.123
Satis4	-0.261	-0.237	-0.809	0.032
SSET1	0.839	0.114	0.127	-0.065
SSET2	0.741	0.09	0.086	0.044
SSET3	0.645	0.038	0.087	-0.061
SSET4	0.665	0.165	0.087	-0.145
SSET5	0.842	0.118	0.167	-0.067
SSET6	0.783	0.028	0.122	-0.098
SSET7	0.84	0.074	0.099	0
SSET8	0.786	0.08	0.098	-0.081
SSET9	0.818	0.058	0.18	-0.029
SSET10	0.819	0.141	0.128	-0.103
SSET11	0.855	0.102	0.082	-0.037

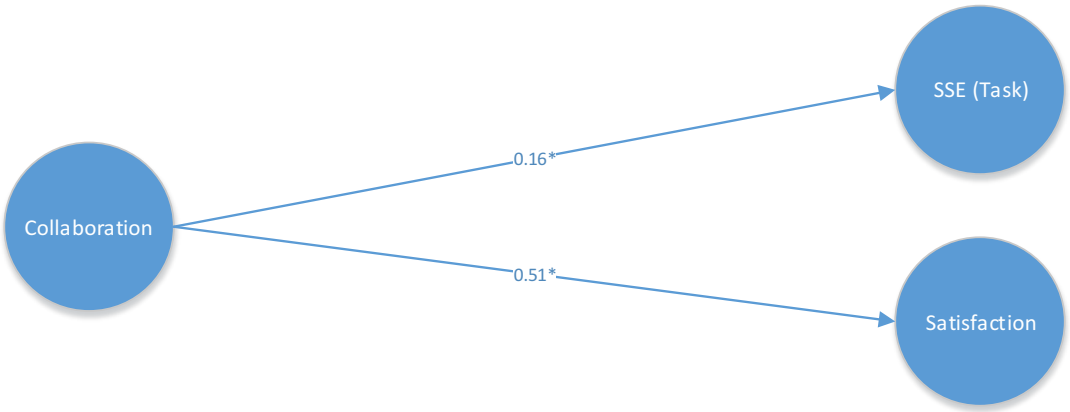
An in-depth review of the feedback based on the instrument, and literature provided insight into the lack of convergence of the two items. Both, as defined, are structures in the form of artifacts, i.e. in a learning context, these are overarching rules imposed on the group by the designer while the other structures are developed by the group themselves. Similarly, in a decision making situation, these structures would be defined by the goals and the mechanism in which appraisal is done. Thus, it is incorrect to include these in the instrument. Overall, however, it can be concluded that sufficient discriminant and convergent validity were achieved. The two items in question were dropped from further analysis. N future studies should continue to include them since non-learning context might not have imposed rules to the extent that this study did.

NOMOLOGICAL VALIDITY

Nomological validity addresses the concern regarding the construct making sense in a larger theoretical framework. If newly measured constructs "behave" in expected ways in an accepted theoretical framework, it increases our confidence in the new measure.

As mentioned earlier, the data set presented here was based on an technology training context & e-learning context. The core hypothesis, drawn from concepts of paired program and collaborative learning, was that the greater the levels of collaboration in a team, the greater the learning outcomes as measured by self-efficacy and satisfaction. The general research model is shown in Figure 1.

Figure 1. Research Model (* P<0.10)



A Structural Equation Model (SEM) based on the above constructs, and paths were done using LISREL. Based on the cutoff values in previous research (Hu & Bentler, 1999; Tanaka, 1993; Vandenberg, 2002), the model showed good fit (NFI > 0.93, CFI > 0.94, RMSEA < 0.065).

Figure 1 also shows the path coefficients, which are significant at P<0.10 level. It implies that changes in the extent of collaboration were found to have a significant effect on satisfaction and specific self-efficacy. Thus, the measures also 'behave' as expected in a greater theoretical setting, providing good nomological validity.

In summary, the instrument developed in this study has been shown to be theoretically grounded. It faithfully represents the underlying theory, and the process of dimensionality assures that the right concept is measured. Empirical study confirmed that what is measured is statistically valid and reliable. The next two sections discuss the limitations of the study, followed by implications and conclusions. The last section also contains a discussion on future research using this instrument and study.

LIMITATIONS

The limitations of the study arise from the context and method of the study. While the development of the collaboration instrument is well conceptualized, the actual instrument is studied in an technology training context. This choice of the context helps in explaining results of previous technology training studies; however, other contexts need to be evaluated. Furthermore, the measurement of the collaboration scale is done with face-to-face groups. Although the scale can be extended to virtual teams, and it should be studied in that context.

The data used for the study was collected using a laboratory quasi-experiment. Thus, it suffers from the generalizability associated with a laboratory experiment. However, since the focus here was on development of a new instrument, the focus was on internal validity instead of external. Secondly, the students were used as a proxy for general business personnel. This is consistent with prior studies as well as with studies that have shown that business students are indeed a good approximation of organization employees (Santhanam, Sasidharan, & Webster, 2008). The third limitation of the study stems from using dyads for collaboration. While dyads have been shown to provide the greatest impact on outcomes in a learning environment, they can be considered as a special class of groups because certain patterns of interaction are dictated by the size of the group. However, while the study results might not be generalizable across larger groups, the instrument itself should be group size neutral. Instead, it could actually be used to see how the collaborative process differs across groups of different sizes.

IMPLICATIONS AND CONCLUSION

The development of a collaboration has implications across a number of different disciplines like management, computer supported collaborative learning, group decision support systems (including research on wikis), project management, human resources and computer science (peer programming). Each of these areas uses teams, and has found a positive effect of using teams, but with high variability in outcomes.

The development of a well validated instrument itself has a lot of benefits. Researchers suggest that using validated instruments in repeated studies allows for great generalizability and comparability (Boudreau et al., 2001). The instrument presented and validated in this research now offers a clear way of measuring the collaborative process, opening the black box in a theoretically grounded manner. This helps researchers to more accurately predict performance.

Theoretically, development of a collaboration instrument also enriches the discipline by going beyond the input-output framework, to an input-process-output framework. The development of the instrument itself is grounded in Adaptive Structuration theory as well as other literature, providing future researchers clear and well defined dimensions on which the instrument is based. This allows researchers to tweak the instrument depending on the context.

The study also enriches AST literature by expanding its tenants beyond advanced information technology. Information systems has generally been viewed as a discipline that borrows theories rather than contributing theories. However, the application of AST to a broader context suggests

that information systems disciplines can borrow a theory (Structuration theory), refine it, and contribute it back to the larger discipline.

More specifically, in the context of the study used to develop the instrument, the results explain the disparity between studies using collaboration. For example, this study explains the variance between education and technology training results in collaborative learning as well as the variance in education studies. Education literature has consistently argued and found a positive impact of teams in learning, but technology training literature within information systems has not been consistent. According to this study, this can be explained by the lack of focus on the development of structural dimension in technology training studies. The variation in education literature can also be explained similarly i.e. the variance in extant literature can be explained by the possible variance in the levels of collaboration dimensions. Similar studies need to be done using this instrument to explain variance in the literature between GDSS / virtual teams.

The study also has important practitioner implications. The collaboration instrument not only outlines the important dimensions of collaboration, but also provides examples of structural features that can enhance these dimensions. Given that the paper outlines the key structural dimensions that go into making a good collaborative process, practitioners can focus on the structural features to externally scaffold the context/domain, to achieve high collaboration and consequently, outcome.

For example, the context of study used for data collection implies that practitioners and developers of e-learning suites can enhance learner self-efficacy and satisfaction using collaboration. Practitioners can also figure out more structural features that can directly contribute to the structural dimensions that contribute to collaboration. The structural features outlined in this paper provide some initial examples. Future developers can also work on how the structural features mentioned earlier can be built directly into the information technology system, whether collaborating with a real or virtual person. An early example of this work can be found in English tutoring (http://callmom.pandorabots.com/static/callmom/tutor.html).

This research opens up multiple opportunities for future research. Future research needs to focus on early development team structures through mechanisms outlined earlier. Another important area for future research is a micro level analysis of the possible self-feeding aspect or reciprocal causation phenomenon regarding collaboration. Such an analysis would focus on the embedded and emergent structures. Such a study would provide a significant contribution to the long term understanding of collaboration.

In conclusion, this research also opens up the black box of the collaborative process not studied by earlier researchers. The findings presented in this paper confirm that appropriation of collaboration structural dimensions play an important role in determining the learning outcomes. The instrument outlined needs to be evaluated in more contexts for it to become more generalizable. Additionally, an important implication of this is that future researchers need to account for the level of appropriation in their studies.

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Appendix A: Scales Used

Table 1. Items for measuring Satisfaction from Process Reliability in (Chin et al., 1997)= 0.82, (Green & Hughes, 1986) = 0.88

How would you describe your learning process on the scale below? The two ends of the scale represents the two ends of a continuum.		
Question	Agreement Scale	
Efficient	1(Strongly Agree) – 7(Strongly Disagree)	Inefficient
Coordinated	1(Strongly Agree) – 7(Strongly Disagree)	Uncoordinated
Fair	1(Strongly Agree) – 7(Strongly Disagree)	Unfair
Confusing	1(Strongly Agree) – 7(Strongly Disagree)	Understandable
Satisfying	1(Strongly Agree) – 7(Strongly Disagree)	dissatisfying

Table 2. Items for measuring self-efficacy (Reliability in (Hollenbeck & Brief, 1987) = 0.89)

The following questions ask you to rate your CURRENT ability regarding using Excel. Please rate your level of agreement with the following statements		
Code	Questions	Agreement Scale
SE1	I have mastered Excel use	1(Strongly agree) – 7(Strongly disagree)
SE2	I cannot yet use Excel as well as I would like	1(Strongly agree) – 7(Strongly disagree)
SE3	I am able to perform tasks using Excel well	1(Strongly agree) – 7(Strongly disagree)
SE4	It is not yet possible for me to use Excel at the level I like	1(Strongly agree) – 7(Strongly disagree)

Appendix B: Population demographics

Table 1. Population Demographics

Sample size	120
CGPA	3.33
Gender (%)	
Girls	51.7
Boys	48.3
Major (%)	
Accounting	11.67
Economics	0.83
Finance	16.67
Int' Business	7.50
Management	8.33
MIS	1.67
Marketing	21.67
Real Estate	6.67
Risk Management	2.50
Other	22.50

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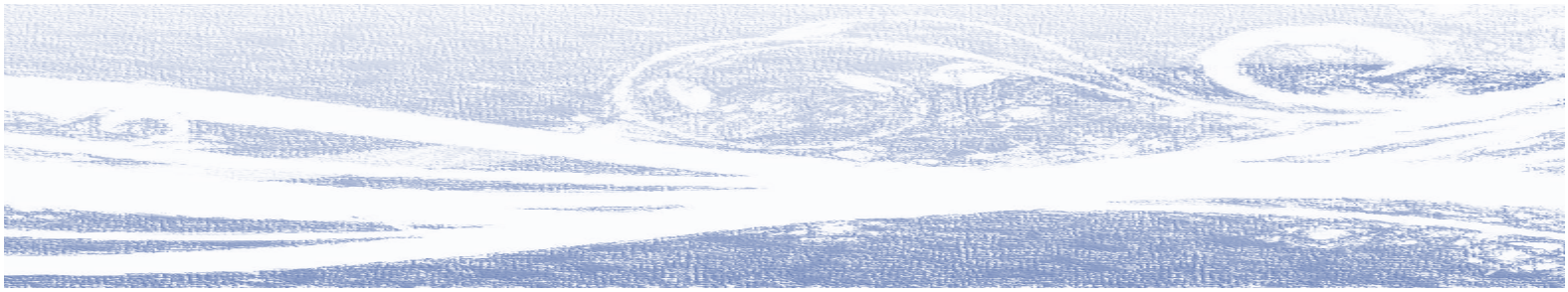

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