Data Flow Diagramming Skills Acquisition: Impact of Cooperative versus Individual Learning

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ABSTRACT

Information systems (IS) process modeling using the technique of Data Flow Diagramming (viz., Systems Analysis) can be defined as a complex task for IS designers. This study draws from the domains of educational psychology and organizational behavior in examining the training of novices in conceptual process modeling. Specifically, an experiment was conducted to determine what effects cooperative, team based participation has on self-efficacy and learning outcomes in dataflow diagramming (DFD) tasks. Results showed novice learners of DFDs performed better when working in cooperative teams rather than learning alone. For those learning in cooperative teams, neither team conflict nor team cohesion had any effect on DFD skill acquisition.

Keywords: Data flow diagrams, Systems analysis and design, Learning style

1. INTRODUCTION

Information systems (IS) process modeling can be considered an ill-structured, complex task that requires higher-order thinking skills. A simple system may require a simple, easy to create process model. However, as systems become more multi-faceted, the complexity of creating process models increases (Millet, 1999). It is difficult for those with minimal training to comprehend the complexity of sophisticated process models (Hungerford and Eierman, 2005).

To facilitate a more rapid progression through the stages of IS design, studies have focused on the similarities and differences between expert and novice designers in constructing conceptual or logical models of systems, the improvement of conceptual design through feedback, and the usage of heuristics in the modeling process. Despite the advances that have been made, there continues to be a call for additional research on the pedagogy of training novices effectively and efficiently (Brown and Klein, 2003). This study draws from the domains of educational psychology and organizational behavior in examining the training of novices in Data Flow Diagramming (i.e., IS process modeling). Specifically, an experiment was conducted to determine what effects cooperative, team based participation had on self-efficacy and learning outcomes in systems analysis tasks.

Data flow diagramming (DFD) is one technique used to document process models and is often a part of Systems Analysis and Design (SA&D) curriculums. In one survey, over half of the respondents (53%) devoted 5-10% of class time to teaching DFDs, and 73% believed it was definitely important to teach DFDs in SA&D courses (Tastle and Russell, 2003). In this research, we examine the factors that may affect the ability of students to learn how to create DFDs.

This paper builds on a cumulative research tradition by extending the research model of Ryan, Bordoloi, and Harrison (2000) that investigated the influence of learning mode (cooperative versus individual learning) and self-efficacy on skill acquisition. Ryan et al., (2000) found that self-efficacy was significantly and positively related to skill acquisition. However, contrary to what was expected, performance for subjects in cooperative teams was not significantly different from subjects working individually. Because of this unexpected result, we were motivated to build on this research in two ways. First, we wanted to see whether team-based cooperative learning is beneficial for other complex tasks in information systems development. Thus, we examine the creation of DFDs rather than ERDs to see if cooperative learning teams lead to higher level performance as theory predicts. Secondly, we include new research questions as suggested by the work of Ryan et al. (2000) that further examine the relationship between cooperative learning teams and performance outcomes. Specifically, we investigate various aspects of intra-group processes that might impact performance by cooperative learning groups as well as the impact of motivation throughout the learning process. By examining these issues, we hope to be able to provide recommendations to instructors on techniques that may enhance process modeling skill acquisition.

2. LITERATURE REVIEW, HYPOTHESES AND RESEARCH MODEL

As recommended for multidisciplinary cumulative research, we selected constructs based on existing MIS studies and prior work in related disciplines (Bandura, 1986; Lee and Bobko, 1994) to guide this empirical investigation. Based on Ryan et al.'s (2000) call for future research to examine the influence that intra-group processes might have on achievement, we include the intra-group process constructs of conflict resolution and team cohesion. In the following few subsections, we discuss these constructs and the related literature, the hypotheses, and our proposed research model.

2.1 Learning Mode

Cooperative learning has been defined by Cohen (1994) as:

> "Students working together in a group small enough that everyone can participate on a collective task that has been clearly assigned. Moreover, students are expected to carry out their task without direct and immediate supervision of the instructor".

Furthermore, the cooperative learning approach incorporates procedures such as communicating a common goal to members and holding group members accountable for their individual performance (Springer, Stanne, and Donovan, 1999). Thus, cooperative learning can assist students in becoming less dependent on teacher instruction and more responsible for their own learning. *Self-directed teams* that exhibit the characteristics of active learning, cooperation in learning, and learning through problem solving can be considered cooperative learning teams (Alavi, Wheeler, and Valacich, 1995).

Success of cooperative team learning techniques has been evident in positive student outcomes such as enhanced academic achievement, increased self-esteem, and improved interpersonal relationships (Slavin, 1983). Newmann and Thompson (1987) found that of the 37 studies they reviewed, 68% showed positive student outcomes in the cooperative learning treatment at the .05 significance level over the control group. This indicates that cooperative learning is an effective pedagogical method, at least in some situations.

One question that has arisen in the recent literature is why cooperative learning appears to produce superior results in some cases but not others. Cohen (1994) argues that cooperative learning is especially well suited for "ill-structured problems". The type of interaction that is required for tasks that have clear procedures and "right answers" is different than what is required for conceptual learning and ill-structured problem solving. For conceptual learning to occur in a small group setting, members should mutually exchange ideas, hypotheses, and strategies. Cooperative learning can take advantage of the unique strengths of team learning by selecting tasks that involve abstractions and require and enable representational negotiation (Schwartz, Black, and Strange, 1991).

Ryan, et al. (2000), however, found that there were no significant differences in conceptual database modeling performance between students in cooperative learning groups and students who worked alone. They suggested that because their experiment was only two weeks long, the cooperative learning groups may not have progressed through the group developmental stages (forming, storming and norming) and reached the stage in which the focus was on successful task achievement (performing). They also suggested that intra-group processes might impact novice achievement and that future research should investigate issues such as team cohesion. We examine conflict resolution and team cohesion in the sections which follow.

Consistent with Cohen's assertions, other studies have found that cooperative learning enhances the learning process (e.g., Mehra and Rhee, 2004; Yi, 2005). Studies have provided evidence that cooperative learning, which occurs through participation in small-group activities, contributes to the development of higher-order thinking skills and augments an individual's ability to utilize knowledge and achieve more (Matthews, Cooper, Davidson, and Hawkes, 1995; Noddings, 1989).

Based on Cohen's (1994) assertions and supporting research, we argue that cooperative learning will produce superior results for students learning IS process modeling. IS process modeling (Data Flow Diagramming) is an ill-structured and potentially complex task that requires higher-order thinking skills. Throughout the modeling process, various levels of abstraction must be utilized by the IS designer. Given functional requirements and a description of data flows, various alternative solutions might be proposed. Because there often is not a single "correct answer," IS process modeling could be classified as an ill-structured task.

Hypothesis 1: Those involved in cooperative team learning will have higher Dataflow Diagramming Skill Acquisition than those in the individual treatment.

2.2 Conflict Resolution

Past research in conflict resolution among teams has shown that some conflict is beneficial to team outcomes (DeChurch and Marks, 2001), but different types and amounts of conflict may affect whether conflict is beneficial or detrimental to team outcomes (Chan and Wang, 2005; Jehn and Mannix, 2001). We use the work of Rahim (1983) to distinguish between five types of conflict resolution in teams: accommodation, avoidance, competition, collaboration, and compromise.

Given past research in conflict, we expect accommodation, avoidance, and competition types of conflict resolution to be detrimental to skill acquisition. Accommodation conflict is characterized by an obliging concern for others; passive interaction from one or more members of the team. Avoidance conflict is characterized by apathy by one or more members to team outcomes. Competitive conflict is characterized by one or more team members pursuing his or her own interest, possibly through power or domination, with little or no regard to others' input. These three types of conflict resolution are seen as negative since incomplete information is gathered to make decisions, and information that is gathered is not critically evaluated by all members of the team. Skill acquisition will be diminished if a team member simply acquiesces to another member's ideas without fully understanding or inquiring about alternative solutions.

We expect collaboration and compromise forms of conflict resolution to be beneficial to skill acquisition. Collaborative conflict is characterized by attempts to integrate information from all team members into an optimal solution. Compromise conflict is characterized by considering one's own self as well as other team members and attempting to find a middle ground between different view points. These two types of conflict resolution are seen as positive since everyone's views and input is considered and a cooperative approach to an optimal solution is undertaken.

H2: The type of conflict resolution will moderate the relationship between Learning Mode and Dataflow Diagramming Skill Acquisition.
H2a: Avoidance, accommodation, and competitive conflict resolution will have a negative impact on skill acquisition.
H2b: Collaborative and compromise conflict resolution will have a positive impact on skill acquisition.

2.3 Team Cohesion

Team cohesion can be defined as "the degree of unification that enables a group or organization to survive, reach its maximum productivity, and command commitment, loyalty, team spirit, team work, and solidarity from its members" (Mbaatyo, 2001, p. 29). The relationship between team cohesiveness and performance of the team is one of the most widely studied in cohesion literature. Results have supported a small but significant positive relationship between the two variables (Mullen and Copper, 1994).

Studies on the impact of team cohesiveness to individual factors such as performance or learning are rarer. Cohesive teams have been found to enhance individual performance (Williams and Widmeyer, 1992) and productivity (Knutson, 1998). There is also evidence that good teamwork (defined as communication, coordination, balance of member contributions, mutual support, effort and cohesion), has a strong, positive effect on individual member's learning (Hoegl and Gemuenden, 2001). Similarly, Mbaatyo (2001) argues that team cohesiveness is essential to knowledge acquisition for the individual.

H3: The degree of team cohesion will moderate the relationship between Learning Mode and Dataflow Diagramming Skill Acquisition.

2.4 Self-Efficacy

Self-efficacy is concerned with an individual's perception of how well he or she can perform some required action needed to deal with a perspective situation. An efficacy expectation is the conviction that one can successfully execute the behavior required to produce the outcomes. Prior research has provided evidence that self-efficacy is related to an individual's task performance in many different contexts, including educational contexts in which individuals are learning new concepts, skills, and/or abilities (Stajkovic and Luthans, 1998; Zusho, Pintrich, and Goppola (2003). The sparse research on how a team-based cooperative learning environment affects self-efficacy, however, has had mixed results (Griffin and Griffin, 1998).

Self-efficacy is developed through four principal sources: performance accomplishments, vicarious experience, verbal persuasion and emotional arousal (Bandura, 1977). These sources have been empirically confirmed by numerous researchers (e.g., Luzzo, Hasper, Albert, Bibbi, and Martinelli, 1999; Usher and Pajares. 2006). However, the importance of self-efficacy's different sources have varied depending on the context (Fencl and Scheel, 2004). We hypothesize that self-efficacy will be higher for those working in cooperative teams on a complex task, such as developing DFD, as a result of team work facilitating more opportunities for vicarious experience and verbal persuasion. For example, the team setting gives individuals the chance to discuss and formulate how to approach dataflow diagramming problems. It provides members the opportunity, not only to think through their own strategies, but to experience the strategies of others. In addition, team members can verbally encourage others in the process of discovery and learning. This is consistent with other research that found that members with high-self-efficacy encourage others in their team to continue working, (Baker and Campbell, 2005).

H4: Self-efficacy will be higher for those who participated in team-based work groups rather than worked individually.

We propose that self-efficacy has a direct influence on task performance. Quinones (1995) found that pre-training self-efficacy was positively related to motivation to learn, as well as to post-training knowledge and behavior. Compeau and Higgins (1995), in a study of computer training methods, found that self-efficacy had a significant impact both on outcome expectations and on actual performance. Other studies have also found a significant direct relationship between self-efficacy and performance (Gist, Stevens, and Bavetta, 1991; Eyring, Steele, and Francis, 1993; Mathieu, Martineao, and Tannenbaum, 1993).

H5: There is a direct positive relationship between self-efficacy and Dataflow Diagramming Skill Acquisition.

2.5 Research Model

The proposed model, shown below in Figure 1, indicates that Dataflow Diagramming Skill Acquisition (DFDSA) is a function of Learning Mode (either team or individual) and Self-Efficacy. While this model is similar to the work of Ryan et al. (2000), our proposed model additionally suggests that DFDSA in the team learning mode will be moderated by the degree of team cohesion and the level of conflict resolution. An individual's motivation level can impact his/her learning outcome, therefore it was included as a *control* variable for the purpose of statistical analysis in the present study. As opposed to the Ryan et al. (2000) study, motivation is used as a control variable throughout this experiment. In the original study, only pre-training motivation was measured.

3. RESEARCH METHODOLOGY

Four sections of students enrolled in an undergraduate Systems Analysis and Design course at a midsized U.S. university participated in an experiment to test our hypotheses. Participation in the experiment was optional. Students who chose not to participate were not required to do additional work; students who did participate did not receive any additional credit for doing so. Of the 177 students enrolled in the four sections, 166 students (93.7%) participated in the experiment. All four sections of the class had the same instructor. Questions asked in one section were provided to all sections, along with answers, through email.

Two sections of the class were randomly assigned to the cooperative learning mode and the other two sections were assigned to the individual learning mode. Sections were assigned so the approximate number of students assigned to each condition would be equal. Of the 166 students, 84 were assigned to the individual learning mode condition, and 82 were assigned to the cooperative learning mode condition. Students in the cooperative learning mode were assigned to teams of four. These teams had been in place in the class for approximately five weeks, so team members were known to each other.

3.1 Sample Demographics

The 166 students participating were somewhat older than typical undergraduate students. The average age was 23.8. Participants had, on average, four months of work experience in the IT field, although 78% had none. Gender breakdown of the students was 66% male, 34% female.

3.2 Procedures

At the beginning of the experiment, the instructor provided students with an overview of the experiment. They were told the purpose of the experiment was to determine the best method of teaching data flow diagrams to undergraduates with little or no experience in constructing them. Willing participants filled out the consent form as well as an initial survey asking for demographic information.

The experiment lasted three weeks. During this three-week phase, students were taught the basics of data flow diagrams and were given examples of data flow diagrams with increasing difficulty. No CASE tools to assist with the creation of the DFDs were used. At the end of each week, students were assigned a data flow diagram to complete either on their own, or within their team (depending on the condition they were assigned). All sections received the same amount of time to complete the assigned DFD in class.

Students then completed a survey to determine their perceptions of their own self-efficacy and motivation when creating the data flow diagram assigned that week. Students in the cooperative learning mode were also asked to answer questions on cohesion and conflict within their teams. At the end of three weeks, an assignment was given to test the students' mastery of data flow diagrams. This assignment was completed individually by all students.

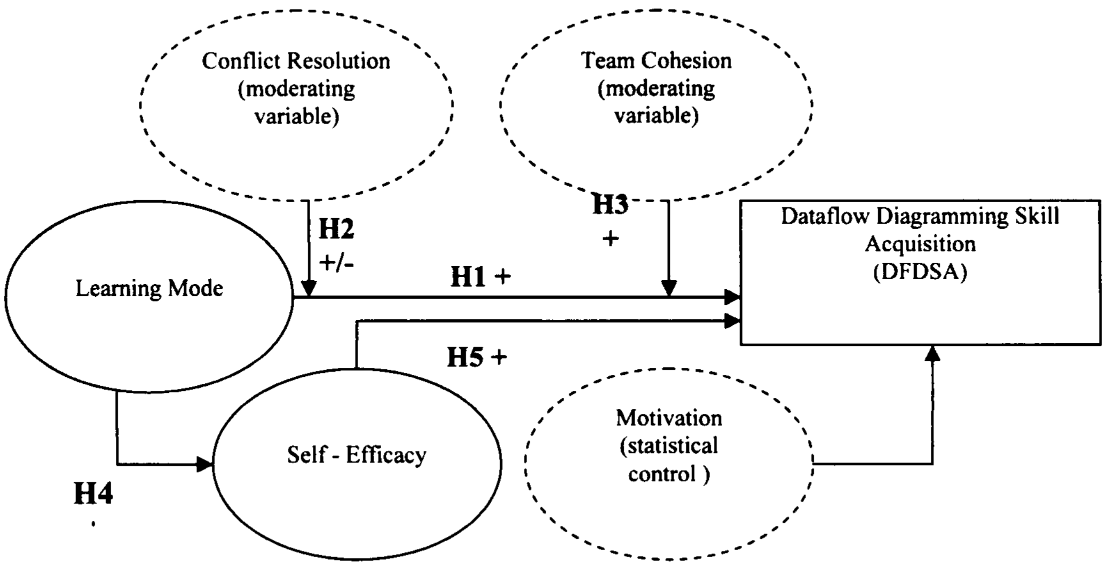

Figure 1: Research Model

3.3 Measures
Measures of all constructs used previously validated instruments. All items were measured using a seven-point Likert scale with anchors of strongly disagree and strongly agree.

3.3.1 Conflict: Five conflict management behaviors (Rahim, 1983) - collaboration, competition, accommodating, compromise, avoidance - were assessed. The team conflict scale used nineteen items to measure the five conflict management behaviors (Montoya-Weiss, Massey, and Song, 2001). Sample questions included "I collaborated with my teammates to come up with decisions acceptable to us," "I used my power to win in a competitive situation," "I accommodate to the wishes of my teammates," "I proposed a middle ground for breaking deadlocks," and "I tried to keep my disagreement with my teammates to myself in order to avoid hard feelings."

3.3.2 Cohesion: Cohesion was measured using a validated six-item scale (Wech, Mossholder, Steel, Bennett, 1998). Sample questions include "There is a high spirit of teamwork among my teammates," and "People in my team are never afraid to speak their minds about issues and problems that affect them."

3.3.3 Self-efficacy: Self-efficacy was measured using the Compeau and Higgins (1995) computer self-efficacy measurement adapted for data flow diagrams. Nine items were used and included such questions as I could create a DFD (similar to the one just given) effectively… "if I had never created a DFD like the one being requested," "if I had only the textbook for reference."

3.3.4 Motivation: Motivation was assessed using a two-item measure from Hicks and Klimoski (1987). Questions included "I am motivated to learn how to create data flow diagrams," and "I tried to learn as much as I could about data flow diagrams." While others have measured motivation prior to instruction (i.e., pre-training motivation, see Ryan et al., 2000), consistent with our research design of multiple data collection points, we measured motivation each time we gathered data (once each week) throughout the experiment. This allowed us to track motivation levels throughout the experiment rather than relying solely on motivation at the onset of the experiment.

3.3.5 Data flow diagram skill acquisition (DFDSA): To assess final performance on the individual assignment given to all students, two graders graded each DFD. There were eight processes that students should have identified; students received deductions for each process they missed. In addition, a set amount of points were deducted for other types of errors (for example, data flow line arrow in wrong direction, incorrect data flow labeling). Each assignment was given a score of 0 to 30.

3.4 Reliability and Validity
Reliability for all constructs was sufficient. Table 1 provides reliability scores for each construct at each of the three time periods.

Construct validity was assessed using factor analyses. Factor analyses at all three time periods was done, with results showing that items loaded as expected with one exception. Avoidance and accommodating conflict types loaded together on a single construct. Since our hypotheses treat these two forms of conflict similarly (as negative types of conflict), we treat the two as one construct. Table 2 provides results of factor analysis at Time 3 only.

4. RESULTS

To test hypothesis 1, whether individuals working in cooperative teams would have higher DFDSA than those individuals working alone, ANOVA was used to compare performance between the two groups. ANOVA is a proper statistical technique to use to compare variance in outcomes between two groups, and has been used in past collaborative learning research (Bernstein, Rieber, Stoltz, Shapiro, onnors, 2004). Results indicated a significant difference in DFDSA based on learning mode ($F=10.734$, $p=.001$), with participants in the cooperative learning teams scoring significantly higher than participants in the individual group condition.

Hypotheses 2 and 3 were tested using multiple regression. Results for hypothesis 2 are presented at each of the three time periods. Hypothesis 2a indicated negative forms of conflict (avoidance, accommodation, competitive) would have a negative impact on DFDSA while controlling for motivation. Results indicate that while the direction of the forms of conflict were as expected, negative conflict did not significantly affect DFDSA. Table 3 provides results of the two forms of negative conflict at each of the three time periods.

Hypothesis 2b indicated positive forms of conflict (collaborative, compromise) would have a positive impact on DFDSA while controlling for motivation. Results show that not only did these forms of conflict not significantly impact DFDSA, but that they were also in the opposite direction as expected. While not significant, results indicate a negative

	Time 1	Time 2	Time 3
Conflict	.80	.74	.83
Cohesion	.84	.90	.91
Self-efficacy	.88	.93	.93
Motivation	.63	.71	.86

Table 1. Reliability Results

	Self-efficacy	Cohesion	Motivation	Collaborative Conflict	Competitive Conflict	Avoidance/ Accomodation Conflict	Compromise Conflict
SE1	**.529**	.200	.590	-.057	.161	.144	.154
SE2	**.670**	.150	.279	.033	.273	-.060	.210
SE3	**.834**	.152	.248	-.109	.094	-.012	.203
SE4	**.844**	.150	.051	.016	.034	-.043	-.032
SE5	**.813**	.197	.140	-.030	.112	.028	-.052
SE6	**.778**	-.023	-.137	.174	.250	-.122	-.099
SE7	**.782**	-.011	.173	.201	.078	-.122	-.248
SE8	**.726**	.084	.118	-.060	-.128	.042	.171
SE9	**.764**	-.039	.166	.187	.124	-.281	-.139
COH1	.074	**.853**	-.062	.303	.109	.012	.027
COH2	.064	**.779**	-.003	.172	.065	.046	.174
COH3	.144	**.744**	.036	.089	.091	-.026	-.076
COH4	.120	**.687**	.016	.451	.062	-.096	-.029
COH5	.059	**.809**	-.005	.261	.086	.000	-.051
COH6	.133	**.863**	.026	.150	.030	-.014	.017
M1	.306	-.043	**.791**	.166	.002	.014	-.087
M2	.377	.029	**.681**	.189	-.121	-.016	-.009
COLL1	-.003	.207	-.111	**.708**	-.138	.111	.026
COLL2	.067	.108	.122	**.746**	-.053	.081	.144
COLL3	.043	.165	.099	**.849**	-.135	.074	.093
COLL4	.026	.168	.059	**.809**	.075	.195	-.079
COLL5	.083	.301	.003	**.817**	-.177	-.043	.066
COLL6	.093	.255	.078	**.735**	-.025	-.048	.226
COMP1	.193	.046	-.009	-.112	**.885**	.035	.092
COMP2	.127	-.046	-.128	-.131	**.896**	.071	.138
COMP3	.074	.014	-.157	-.025	**.901**	.052	.059
COMP4	.057	.205	.165	-.075	**.787**	-.097	.072
COMP5	.142	.265	.094	-.067	**.731**	.132	.204
AVOID1	-.033	-.036	.331	-.063	-.135	**.816**	-.059
AVOID2	.085	-.274	.154	.116	-.145	**.767**	.067
ACCOM1	-.085	.089	-.251	.130	.298	**.735**	.064
ACCOM2	-.171	.020	-.267	.037	.296	**.781**	.124
ACCOM3	-.114	.277	-.461	.415	.073	**.380**	.061
ACCOM4	-.319	.149	-.030	.418	.009	**.656**	-.004
COMPR1	-.047	.014	-.004	.197	.267	.067	**.865**
COMPR2	.040	-.001	-.052	.229	.267	.073	**.893**

Table 2. Factor Analysis of Items

	Time 1 t / Sig.	Time 2 t / Sig.	Time 3 t / Sig
Accomodation / Avoidance Conflict	-1.191 / .238	-1.386 / .170	-1.732 / .088
Competitive Conflict	-.022 / .983	-1.079 / .285	-.111 / .912

Table 3. Results of Hypothesis 2a

	Time 1 t / Sig.	Time 2 t / Sig.	Time 3 t / Sig
Collaborative Conflict	-.232 / .818	-.185 / .854	-.782 / .437
Compromise Conflict	-.180 / .858	-.833 / .408	-.571 / .570

Table 4. Results of Hypothesis 2b

relationship with DFDSA rather than a positive relationship. Table 4 provides results of the positive conflict at the three time periods.

Hypothesis 3 determined whether team cohesion could moderate the effect of learning mode to DFDSA. Similar to conflict, team cohesion was not found to significantly impact DFDSA (Time 1: t=.337 p=.737; Time 2: t=.054 p=.957; Time 3: t=1.608 p=.113).

Hypothesis 4, examining self-efficacy between those working in teams with those working individually, was tested using ANOVA over the three time periods. We expected to find participants in the cooperative teams to have higher self-efficacy. Results were mixed. Results at times one and three were not significant (Time 1: F=.055 p=.815; Time 3: F= .387, p=.535). However at time 2, the hypothesis was supported (F=14.398 p=.000). Figure 2 shows a graph of self- efficacy between the two groups.

Hypothesis 5 tested whether a direct relationship exists between self-efficacy and DFDSA while controlling for motivation and was tested using multiple regression. This hypothesis was also tested at three time periods. Results indicate that the relationship between self-efficacy and DFDSA was not significant. Interestingly, the results show that while not significant, the direction of the relationship was in the opposite direction as expected in times 2 and 3. (Time 1: t=.344 p=.731; Time 2: t=-.560 p=.577; Time 3: t=-.574 p=.567). Table 5 provides summary of the results of the hypotheses.

5. DISCUSSION

Our study shows clearly that novice learners of data flow diagrams learn best by working in cooperative teams. Students who learned in cooperative teams performed significantly better on a DFD assignment than did those working independently. Interesting, final grades for the entire course for those in the individual sections (whose DFD grades were significantly lower than the cooperative teams groups) were *higher* than those sections whose members worked on the DFDs in teams. Although the difference in final course grades was not significant, it does reinforce our finding that for novices, learning DFDs in cooperative teams will enhance their skill acquisition.

Our results are consistent with much other research on cooperative learning, but are different than one IT-related study in which subjects in the cooperative learning treatment did not perform significantly better on a conceptual data modeling task than those assigned to an individual-work treatment (Ryan et al. 2000). Ryan et al. expressed the concern that because their experiment lasted only two weeks, the cooperative learning groups may not have adequately progressed through the group developmental stages and thus, could not focus solely on task performance. To avoid this problem in the present experiment, the teams were formed at the beginning of the semester (five weeks prior to the beginning of the experiment) and the experiment lasted an additional three weeks. Future research could manipulate the length of time in which groups are in existence to determine the impact on performance outcomes. Another difference between our work and the Ryan et al. (2000) study was the group task: process modeling rather than conceptual database modeling. Process modeling involves modeling functionality whereas conceptual database modeling involves modeling static data structures. Brown and Klein (2003) suggest that outcomes in cooperative learning may result from the type of knowledge being conveyed and/or reinforced.

While we hypothesized that negative forms of conflict would be detrimental to DFDSA, and positive forms of conflict would be beneficial to DFDSA, this did not prove to be true. Neither form of conflict was significant with regard to DFDSA, and positive conflict actually had a negative relationship with DFDSA (although not significant). It could be that our teams did not spend enough time working on the DFDs for conflict to arise, even though they were pre-existing teams. An alternative explanation may be that since they were already formed teams, they had already passed the "storming" phase of team work processing, and being in the "norming" stage, knew how to deal with any conflict issues as they arose.

Team cohesion among the cooperative team members also was not found to be significantly related to DFDSA. Eighty five percent of the individuals in the cooperative work teams felt their team was cohesive. This high percent of members who felt their team was cohesive may not have given us enough variance to actually test the moderating effect of team cohesiveness. Or, perhaps, in teams like this, the team tends to be cohesive in the short-term to work and learn together. While team cohesion may be a positive aspect for some things, it was not important for DFDSA. Future researchers may want to examine if learning other types of tasks are affected by team cohesion.

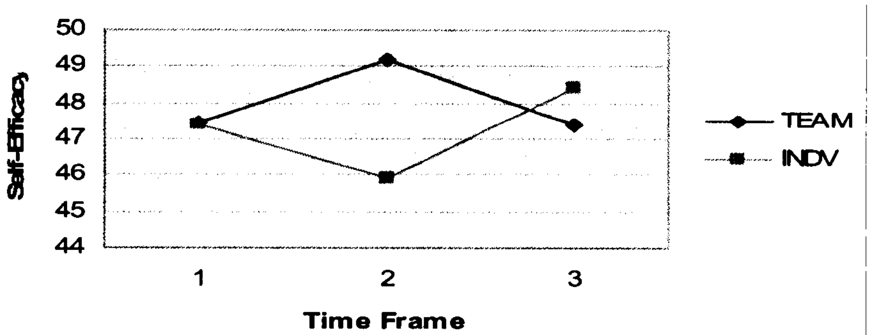

Figure 2: Changes in self-efficacy between two groups over three time periods.

	Results	Comments
H1: Condition → DFDSA	Supported	Those in cooperative team condition had higher DFDSA.
H2a: Negative conflict negatively moderates cooperating team condition → DFDSA	Not supported	Not significant, direction as expected.
H2b: Positive conflict positively moderates cooperating team condition → DFDSA	Not supported	Not significant, direction opposite what was expected (more positive conflict, lower DFDSA)
H3: Cohesion positively moderates cooperating team condition → DFDSA	Not supported	
H4: Condition → self-efficacy	Partially supported	Higher self-efficacy was significantly higher for cooperating team members at time 2 only.
H5: Self-efficacy → DFDSA	Not supported	Not significant, direction opposite what was expected at times 2 and 3 (greater self-efficacy, lower DFDSA).

Table 5. Results of hypotheses

When comparing self-efficacy between the two samples, self-efficacy was higher for those who worked in the cooperative teams, but only at time 2. It could be that at time 1, all participants felt as lost (or as clued in) as all others, so self-efficacy did not differ between the two groups. At time 2, with teammates to help them work out problems or questions, cooperative team members felt more confident they could create DFDs on their own. At the same time, self-efficacy among individuals dropped significantly. Complexity of the DFD at time 2 was increased to such a degree that individuals realized the basics learned at time 1 would not get them through. Having to struggle through the development of the DFD on their own, lowered their self-efficacy. At time 3, as DFDs became more complex, self-efficacy of individuals working alone increased as they realized their knowledge base to create a DFD was increasing, and they realized they could create complex DFDs. Those in the cooperative team group may have started to realize they had relied too much on their teammates in time 2, and, when given more difficult DFDs, may have begun realizing that they didn't know as much as they originally thought. As such, self-efficacy at time 3 for the individuals rose, while self-efficacy for the cooperative team members lowered. Ultimately, the fact that individuals' self-efficacy was not significantly different from cooperative team members' self-efficacy at time 3 did not matter. Although the individuals' self-efficacy was not significantly different from the cooperative team members, the individuals' skill acquisition proved lower. Thus, there was not a significant relationship between self-efficacy and DFDSA.

Motivation was used as a statistical control variable so that varying levels of motivation among individuals would not confound results of DFDSA. In this study, participants were relatively motivated throughout the experiment. Average scores of motivation were 5.49, 5.29, and 5.32 for times 1, 2, and 3 respectively. Overall, motivation level scores varied between a low of one to a high of seven for all students. Because of this variation in motivation, it was necessary to control for motivation. However, there are likely direct effects of motivation to DFDSA. Motivation as a future research area will be discussed in more detail in the next section.

6. CONCLUSION

We have shown that learning mode is a primary determinant of DFD skill acquisition. In this study, for those in a cooperative team learning environment, neither team conflict (negative or positive) nor team cohesion played a part in DFDSA. Instructors of Systems Analysis and Design courses who teach data flow diagramming techniques may find it beneficial for students to be placed in small teams to enhance their skill acquisition. While DFDs are taught widely and are considered an important skill to be learned in many Systems Analysis and Design courses (Tastle and Russell, 2003), other methods of process modeling are also used. We posit that these results can be generalized to other process modeling methods, but empirical testing should confirm this. We see these results as being an important contribution to the teaching of data flow diagrams.

Future researchers should examine cooperative learning using different types of teams. For example, one limitation of this study is that all teams had been in place for the same length of time – approximately five weeks. As a result, the first two stages of team formation (forming and storming) had likely already occurred. Cooperative learning, and the effect of conflict on cooperative learning may differ if teams have been in place for a shorter duration. Another limitation, and area for future research, is the role of team cohesion. In this study, the majority of students (85%) felt their teams were cohesive. The effect of cooperative learning on skill acquisition may differ if teams have greater variation of cohesion, including studying teams that are highly un-cohesive. Finally, motivation should be examined more fully. Some students prefer learning in teams, others may prefer to learn alone. Some studentsare serious students, others more lackadaisical. How motivated the student is to learn the topic, and his/her preferred learning mode, may have a direct affect on skill acquisition In addition, future researchers could examine what techniques work best to keep motivation for learning SA&D skills, and in particular, DFD skills, high.

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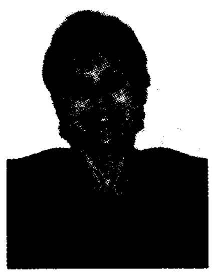

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