

# GroupSpace as Support for Collaborative Learning

## Research Design

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### 1. Introduction

#### 1.1. Collaborative Learning

Collaborative learning evolved from the work of psychologists such as Johnson and Johnson (1975) and Slavin (1987). It involves social processes by which a small group of students work together to complete an academic problem-solving task designed to promote learning. The collaborative learning concept is based on the three premises of effective learning: (1) active learning and construction of knowledge; (2) cooperative and teamwork in learning; and (3) learning via problem solving (Maryam 1994).

Collaborative learning has been advocated as the primary means of operationalizing the three attributes of effective learning. Regarding collaborative learning, there are primarily three lines of research in literature, namely, “effect” research, “conditions” research, and “interaction” research.

##### 1.1.1. Whether collaborative learning was more effective than learning alone?

This line of research is conducted to answer the question “Is collaborative learning more efficient than learning alone.” This type of research studies are referred as the “effect” paradigm. There is ample empirical evidence for the positive outcomes. Many studies conducted with all age groups over the past forty years provide evidence that participants who study together often learn more than those who study alone. This has proven true for diverse subject area and a wide range of tasks and for learners working in small groups as

well as in pairs (Johnson and Johnson, 1990). Studies show that collaborative learning increased student involvement in courses (Collier, 1980; Cooper, et al., 1990) and increased student involvement in the learning process promotes problem solving and critical thinking skills (Bligh, 1972; Kulik and Kulik 1979; McKeachie 1980; McKeachie, et al., 1987; Smith, 1986). Collaborative learning procedures have also been found to be more effective than traditional instructional methods in promoting student learning and academic achievement (Johnson, et al., 1981; Slavin, et al., 1985). Collaborative learning procedures have also been shown to enhance student satisfaction with the learning and classroom experience (Bligh, 1972; Kulik and Kulik, 1979)

Although the positive outcomes largely dominate this line of research, there is also a body of contradictory results (Slavin, 1983; Webb, 1991). Some negative effects are stable and well documented. For example, low achievers progressively become passive when collaborating with high achievers (Salomon and Globerson, 1989; Mulryan, 1992). This contradiction leads researchers to believe that collaboration is in itself neither efficient nor inefficient and collaboration works under some conditions (Dillenbourg, et al., 1996). This brings the researchers to the second line of research.

1.1.2. Under what circumstances collaborative learning was more effective than learning alone?

The line of research is also referred as “conditions” paradigm. Numerous condition (independent) variables have been studied, including the composition of the group, the features of the task, the context of collaboration and the medium available for communication. Studies show that groups of three are less effective because they tend to be competitive, while pairs tend to be more cooperative (Trowbridge, 1998). Azmitia

(1998) found that when novices were paired with experts on a model building task they improved significantly, while equal ability did not.

In a large-scale review, Johnson and Johnson (1990) concluded: “Simply placing students in groups and telling them to work together does not in itself promote higher achievement.” Similarly, in another review, most studies reported no positive effect for collaborative learning when students studied together but were tested individually or when they studied together and created a group product (Slavin, 1983). However, most studies reported a positive learning effect when students studied together and were given a group reward based on the individual progress of all learners in the group (Slavin, 1983).

Under this line of research, numerous studies have been conducted to see if computer-supported collaborative learning (CSCL) is more effective than collaborative learning without CSCL. Maryam (1994) found that GDSS (Group Decision Support System)-supported collaborative learning leads to higher levels of perceived skill development, self-reported learning, and evaluation of classroom experience and also significantly higher final test grades in comparison with non-GDSS supported collaborative learning. Hiltz, Coppola, Rotter, and Turoff (2000) conducted a three-year longitudinal field study that compared the process and outcomes of learning using an on-line anytime/anywhere environment to those for comparison sections taught in the traditional classroom. The results show that when students are actively involved in collaborative (group) learning on-line, the outcomes can be as good as or better than those for traditional classes, but when individuals are simply receiving posted material and sending back individual work, the results are poorer than in traditional classrooms. A recent analysis of many research

studies found that when learning from computer-delivered training in classroom settings, small groups learned significantly more than individuals learned under optimal conditions that included previous group work experience and use of cooperative group learning strategies (Lou, Abrami, and d'Apollonia, 2001)

A more recent study conducted by Crone (2006) investigates how interactive computer-supported workspaces can support co-located synchronous collaborative work. They compared situations where all work surfaces are shared, to situations where the shared work surfaces are combined with private laptops. Results show that the shared work surfaces combined with private laptops offers a good support for the dynamic shifting between collaborative and individual work activities, and lets the users take more advantage of the interactive workspace technology and that the laptops served both as work surfaces for individual work activities, and as private interaction tools in the interactive workspace. They also account for a survey study with groups engaged in the same kind of collaborative activities without CSCW. Results from the survey study show that both shared and private work surfaces are considered important by a majority of the subjects, and that there is a need to easily transfer information between work surfaces.

Researchers discovered that not all forms of collaborative learning are equally effective and the independent variables do not have simple effects on learning outcomes but interact with each other in a complex way. This leads to the third line of research.

1.1.3. Which interactions occur under which conditions and what effects do these interactions have?

This line of research is also referred as “interactions” paradigm. Under this paradigm, the question “under what circumstances collaborative learning was more effective than learning alone” is split into two sub-questions: which interactions occur under which conditions and what effects do these interactions have. Webb (1991) found that collaborative learning was better when the group is moderately heterogeneous with high ability and medium ability students or medium ability and low ability students or the group is homogenous with medium ability students than homogeneous high ability students, homogeneous low ability students, or heterogeneous groups comprising high, medium, and low ability. Verba and Winnykammen (1992) found that in pairs where the high ability child was the novice and the low ability child the expert, the interaction involved more collaboration and joint construction.

## 1.2. GroupSpace as support for collaborative learning

GroupSpace is a server-driven laptop workspace – computer-supported collaboration involving large shared displays. It is an integrated set of hardware, software, and communication capabilities aimed at improving group interactions and task performance during face-face meetings.

GroupSpace typically supports groups through the following two mechanisms:

PointRight and MultiBrowse. PointRight refers to moving a mouse pointer across different displays in the interactive workspace. This enables connected laptops to control the mouse pointer of the public computer. Individuals can gain control of the group screen by moving their laptop mouse pointers beyond the top of their laptop screens.

Keystrokes go to where the mouse pointer is currently positioned. Copying and pasting between different work surfaces is also possible. MultiBrowse refers to sending files or

URLs between different displays in the workspace by drag-and-drop operations.

Dragging and dropping file or URL icons into the GroupSpace window will cause them to be multi-browsed to the corresponding destination machine, which may be one of laptops connected to the space or the public desktop itself. These two mechanisms are the primary means by which GroupSpace may increase the effectiveness or efficiency of face-to-face interacting groups.

In the past, research examining educational use of GroupSpace focused on which activities can be supported, how users were using GroupSpace, and how GroupSpace should be designed to support activities of synchronous co-located collaborative work in a good way. Crone's study on GroupSpace is mainly a user study on how different configurations of the interactive workspace affect how, and for what purpose, the provided hardware and software tools are used by the groups, to inform the design and configurations of the GroupSpace. The research did not answer the question "whether using GroupSpace in collaboration leads a better learning outcome compared to the collaboration without using GroupSpace." Many educators, students, and employers intuitively feel that the integration of GroupSpace into group work will enhance the effectiveness and efficiency of the collaboration. Despite this belief, there is no study conducted to prove it. Research is needed to provide information and insight into the impact of GroupSpace on the collaborative process.

To justify the use of GroupSpace in collaborative learning under certain conditions, we do have to prove conclusively that there is a significant difference between using GroupSpace and not using GroupSpace in terms of learning outcomes. In other words, in

addition to how the features and functions of GroupSpace are used, we also need to find out how its capacity and features influence the collaborative process.

## **2. Purpose of the Study**

Based on the “condition” line research in general and Crone’s study in particular, we believe that the next logical step on GroupSpace study is to investigate if there is any difference between the collaborative learning under the condition using GroupSpace and the condition without using GroupSpace (if other conditions are kept same), specifically whether the use of a computer-supported face-face collaboration system (GroupSpace) in a collaborative learning process enhances student learning and evaluation of collaboration experiences compared to not using the system.

In addition, we will also investigate what is user’s experience when interacting with GroupSpace to inform the possible improvement of software design, the physical space design, and the documentation design.

## **3. Theoretical Framework and Hypothesis**

Group work or collaboration has potential process gains and process losses. Process gains refer to the synergistic aspects of the group interaction that improve group performance relative to the individual member performance. Process losses, on the other hand, refer to certain aspects of the group interactions that impair group performance relative to the efforts of individual members working alone. Increasing process gains and reducing process losses can facilitate group interactions and improve the effectiveness and efficiency of the collaboration, and thus group performance (Maryam,1994).

| <b>Group Process Gains</b>  | <b>Group Process Losses</b>   |
|---|---|
| <ul style="list-style-type: none"> <li>◆ A group as a whole generates more information and alternatives compared to the average group member</li> <li>◆ Groups are more effective and objective in evaluation and error detection tasks</li> <li>◆ Working in a group may motivate the individual member to perform better</li> <li>◆ Interactions among the group members lead to synergies</li> </ul> | <ul style="list-style-type: none"> <li>◆ Member participation in the group is fragmented (i.e., group members should take turns in speaking/controlling the public display)</li> <li>◆ One or a few individual members may dominate group discussions and monopolize the group's time (control)</li> <li>◆ Fear of negative evaluation (evaluation apprehension) causes members to withdraw and avoid participating in the group discussions</li> <li>◆ Higher volumes of information generated during the group process creates a condition of information overload for individual member</li> </ul> |

Adapted from Nunamaker, et al. (1991).

GroupSpace capabilities and features can facilitate group interactions and improve group performance by increasing process gains and reducing process losses when compared to teamwork not using GroupSpace:

- GroupSpace increases effectiveness of collaborative learning by supporting cooperation and teamwork among the students through facilitating information sharing and “common ground” annotation through MultiBrowse and “Copy and Paste” functions (a process gain).
- GroupSpace increases effectiveness of collaborative learning by facilitating evaluation and modification of student’s mental models through working simultaneously on the same document and therefore rapid feedback from group members (group gains).

- GroupSpace increases effectiveness of collaborative learning by increasing student participation and active involvement in knowledge construction by facilitating generation, exchange, and analysis of information during the learning group interactions.
- PointRight and MultiBrowse eliminate or reduce fragmentation of member participation (a process loss) and thus, increasing the amount of information and alternatives generated by groups per time unit (a process gain).

Therefore, our **hypothesis** is: GroupSpace enhances the effectiveness of collaborative learning in terms of self-reported learning and evaluation of collaboration experience by increasing group process gains and decreasing group process losses when compared to the teamwork not using GroupSpace as a collaborative learning tool.

The impact of GroupSpace on collaborative learning will be evaluated in an empirical study involving Stanford STEP students (if Prof. Jennifer is still considering using GroupSpace in her class)

### **3. Study Design**

#### 3.1. The subjects

Half of subjects using GroupSpace in their team project and the other half not using GroupSpace

#### 3.2. Procedure

Quarter-long course, once a week, 1 hour and 50 minutes. For all subjects, everything is same except that half of the students will use GroupSpace for their team project and the other half will not. During the first two weeks, The experimental groups were instructed on how to use the software. A small project and test follow to test if they have learned how to use GroupSpace. From the third week, students (3-4 students in each group) are required to regularly meet to collaborate for their group project. The experimental groups use GroupSpace, while the control groups do not use. The independent variable is the condition using computer-supported face-face collaboration system vs. not using the system

### 3.3. Dependent measures

Consistent with the research literature in the area, collaborative learning effectiveness (the dependent variable of the study) was measured in terms of students' perceptions of their learning and their evaluation of their classroom and group work experience. 23 items were used in the post-course questionnaire adapted from Hiltz (1988). Hiltz' questionnaire was developed to assess the relative effectiveness of an online course with collaborative learning feature and was in turn based on a thorough review of the literature on learning effectiveness, particular Centra's (1982) summary. Five-point Likert-type scales were used to measure all items. The questionnaire also contained some demographic questions such as: age, gender, grade, major, computer skills, pre-knowledge about GroupSpace, etc and an open-ended question eliciting the subjects' comments on aspects of the group work that they liked or disliked. It was administered anonymously.

### Items Associated With the Learning and Evaluation Scales

| Learning Scales  | Evaluation Scales  |
|--|--|
| <p>Perceived Skill Development</p> <ul style="list-style-type: none"> <li>◆ Increase in skill in critical thinking</li> <li>◆ Increase in ability to integrate facts</li> <li>◆ Ability to critically analyze issues</li> <li>◆ More confident in expressing ideas</li> <li>◆ Learning to value other points of view</li> <li>◆ Learning to interrelate important topics and ideas</li> </ul> <p>Self-Reported Learning</p> <ul style="list-style-type: none"> <li>◆ Increase understanding of basic concepts</li> <li>◆ Learned factual material</li> <li>◆ Learned to identify central issues</li> </ul> <p>Learning interest</p> <ul style="list-style-type: none"> <li>◆ Discussed topics outside the class</li> <li>◆ Did additional reading</li> <li>◆ Did some thinking for myself</li> </ul> | <p>Class Evaluation</p> <ul style="list-style-type: none"> <li>◆ Found the course a good learning experience</li> <li>◆ Learned more because of class format</li> <li>◆ Course was boring</li> <li>◆ Student comments are useful to me</li> </ul> <p>Group Work Evaluation</p> <ul style="list-style-type: none"> <li>◆ Group work contributed to course quality</li> <li>◆ Group work contributed to learning</li> <li>◆ Group work is productive because of the collaboration format – a group gain</li> <li>◆ Group work contributed to the increased efficiency of your work (the quantity of work that you can complete in given time) because of collaborative format – a process gain</li> <li>◆ Achieved more as a group – a process gain</li> <li>◆ Group work was engaging – a process gain)</li> <li>◆ format is time wasting (a process loss)</li> </ul> |

In addition to the above questionnaire for investigating the effectiveness of GroupSpace on the collaborative process, we will also ask the experimental groups the following questions to explore the user's experience when interacting with GroupSpace:

- ◆ Documentation looked inadequate or difficult
- ◆ Trouble with wireless connection
- ◆ The system is too complicated

- ◆ Had some bad experience (system crashed or did not seem to work properly)
- ◆ Can you think of any suggestions for improvement of the GroupSpace

Their responses to these questions will be combined with observations and the structured interviews to find out a fuller and more accurate picture for how users are interacting with GroupSpace to inform: How should GroupSpace be designed and implemented to support activities of synchronous co-located collaborative work in a good way and how the software design, the physical space design, and the documentation design can be improved.

According to Nass' approach, it is better to limit independent variables but measure as many dependent variables as you can.

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