# The impact of media on collaborative learning in virtual settings: social construction and social presence perspectives

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## Abstract

Prior work argues that collaborative learning facilitates the construction of individuals' knowledge, because it fosters the information sharing and discussions with other students. This may, in turn, improve learning effectiveness. However, how effective collaborative technologies may facilitate collaborative learning remains to be addressed. To handle this, this study developed a model by drawing on social presence and task closure theories. More specifically, we delineated the relationships between learning environment (the media environment and medium choice) and learning effectiveness. To test the above relationships, we employed laboratory experiment. Most of hypotheses were supported.

## 1    Introduction

Both educators and cognitive psychologists have suggested that learning effectiveness can be improved by learning interactively with learners' peers and in groups [4]. Leidner and Jarvenpaa (1995) confirm this argument by arguing that collaborative learning is superior to other types of learning such as individualistic instruction in terms of increases in individual achievement, positive changes in social attitudes, and general enhancement of motivation to learn [9]. On the other hand, previous research [13] also suggests that employing CT (collaborative technologies such as e-mail and multimedia systems) may facilitate the discussion and knowledge sharing that in turn improves the learning effectiveness of collaborative learning.

While there is little question that collaborative learning is worthwhile, there is less clarity about how best collaborative technologies may facilitate collaborative learning. Interaction of individual learner with other learners and knowledge sharing among them play a key role in influencing collaborative learning. However, research findings regarding the effect of collaborative technologies on the above group information sharing activities are mixed. Some studies [6] [10] found that using collaborative technologies exerts a positive influence on information sharing, whereas such technologies had no effect in other studies [12]. Few studies [8] [11] even noted that collaborative technologies restrain learners from sharing knowledge and experiences. This paradox may due to the specific perspective that an individual study employed to analyze the effect of collaborative learning. To further analyze the above paradox and realize how to use CT to facilitate knowledge sharing efficiently and effectively, this study develops a model drawing on sociological theories—social construction, social presence, and task closure. Specifically, we examined the effects of both media environment and media choice on the effectiveness of collaborative learning.

## 2    Literature review

### 2.1    Collaborative learning and learning effectiveness

According to [1], collaborative learning involves interpersonal processes by which a group of learners work together cooperatively to complete a problem-solving task designed to promote learning. In order to achieve collaborative learning effectively and efficiently, learners are usually involved in a variety of activities such as conversation,

discussion, and debate [14]. Through these activities, participants offer explanations, interpretations, and resolutions to problems, which result in constructing knowledge and gaining insight into a specific problem. Previous studies [9] [10] also noted that collaborative learning entails knowledge sharing and knowledge construction through interactions among participants; an effective collaborative learning not only enhances the learning results (or performance), but promotes the satisfaction of learning process.

Although proponents have recognized the advantages of collaborative learning, how collaborative technology may influence the effectiveness of collaborative learning remains to be addressed. More specifically, as shown in Figure 1, we develop a conceptual model to analyze the impact of media on the effectiveness of collaborative learning. TIP (time, interactions, and performance) theory was used to explain the effectiveness of collaborative learning. To further approach the effect of media, this study used two-part model: media environment and media for a specific communication.

## 2.2 Knowledge construction in the collaborative learning: social construction perspective

In order to explain the role of media environment in facilitating knowledge construction in collaborative learning, this paper used social construction view. "Social construction" derives from [2] research on social institutions. They argue that institutions experienced as objective reality are actually social constructions. Once institutions are socially formulated, members assume an "objective" nature as "facts" in the social world. Applying this concept to knowledge construction, meaning may be socially constructed [13].

To further explain the impact of social setting on knowledge creation, previous research recognized the "subjective" perspective of information—information possesses radically different meanings for different individuals according to their biographies and positions in the social setting [8]. The meaning of information depends on the social setting in which this information is encountered. Intersubjectivity refers to the understanding or meaning that emerges from shared human experience [8]. Miranda and Saunders [13] propose a narrower frame on intersubjectivity than that of Hightower and Sayeed, they argue that meaning derives from the construction of shared understanding or interactive interpretation by a group of participants rather than merely from the cognition of a single individual. In sum, the value of information in decision making or problem-solving is premised on the suitable subjective and social interpretation.

## 2.3 Social presence theory

To further elaborate on intersubjectivity, this study draws on social presence theory. Social presence is defined as the capability of the medium that fosters the awareness of the other participants and the establishment of interpersonal relationships during the interaction [8]. Prior work operationalized social presence as low to high [16] [13]. Electronic and paper-based, or other noninteractive media represents low in social presence, whereas face-to-face interaction is regarded as high in social presence.

Drawing on social presence theory, the learning and interaction activities in collaborative learning consist of knowledge construction task, which requires intersubjective interpretation—a social activity. Since intersubjective construction of knowledge consists of social activities that necessitate reciprocity, such interaction is noticeably hindered by media low in social presence. In sum, to accomplish intersubjective interpretation effectively, prior study suggests that members of a group either use media high in social presence or avoid receiving too much information simultaneously.

## 2.4 Task closure and information processing in collaborative learning

Beside the social presence of media, this study addresses two other issues that may influence intersubjective interpretation: the capability to handle task closure and process information. Regarding the former, closure refers to the completion of a transmission segment during a communication or interaction activity [18]. Closure theory is premised on the availability of intended recipients. In other words, a communication is considered to be efficient, provided that the intended recipients of a message are physically available to receive it and are capable of attending the interaction. In the light of task closure theory, the presence of others, including (but not limited to) the message sender, affects the recipients' understanding of the message and the success of intersubjective interpretation.

Concerning the capability to process information in a collaborative learning environment, media richness theory

suggests that group task performance (in terms of uncertainty and ambiguity reduction) should improve provided that a fit or match between the task requirements and the media's ability to convey information is satisfied [1]. However, the above fit condition is not feasible if a learner is incapable of dealing with information overload [5]. Thus, although collaborative technologies facilitate message exchange and information acquisition, their use may in turn lead to information overload [5]. The presence of multiple media may even worsen such overload situations, which impede intersubjective interpretation.

In summary, given that task closure (or availability of a communicator) plays a critical role in affecting intersubjective interpretation, when closure is difficult to achieve due to the characteristics of media or information overload, communicators may resort to media with lower social presence to attain closure. Thus, as suggested by [7], the characteristic of media in intersubjective interpretation is not firm; rather individuals may socially construct (or reconstruct) media features to accomplish closure in intersubjective interpretation. From a performance perspective, the use of media low in social presence may paradoxically increase the efficiency of interaction provided that the availability of recipients for communication is low because heavy demands catch their attention.

## 3    Research model, hypotheses, and method preview

As shown in Figure 1, this study develops a research model in the light of the above theories—social presence theory, task closure, and information overload. Some variables of the above model are either not explicitly examined or are tested using surrogates. More precisely, although the hypotheses that examine the impact of media choice (oral vs. written information in multimedia environments) on the effectiveness of collaborative learning were derived from task closure theory, task closure is not explicitly assessed in this paper.

Information is defined as all the content related to a problem-solving task in collaborative learning. Information sharing falls into two categories—learners use oral or written interaction and discussion to achieve group learning. Since information sharing involves the essential and the most explicit part of intersubjective interpretation, information sharing is used as a surrogate for intersubjective interpretation. To further conceptualize information sharing, we employ breadth of interpretation and depth of interpretation. The former refers to the number of discussions posted by learners, whereas the latter represents the detailed responses to the initiated discussions.

### 3.1    The effect of media environment on collaborative learning

To analyze the impact of media environment on information sharing, our study operationalized the experimental treatment as the combination of both an electronic medium and face-to-face (FTF) medium. Thus, learners in this treatment group possess the advantages and challenges of using the above two media. Regarding the features of simultaneity and anonymity in the electronic medium, the former accelerates concurrent information sharing, while anonymity stimulates frank interaction. In addition, the learner may also use FTF to supplement the communication. As a result, using both an electronic medium and face-to-face (FTF) fosters the breadth of information sharing.

However, an electronic medium is not a suitable alternative to explore complex ideas or to pursue the depth of information sharing, being media low in social presence. The above phenomenon is elaborated further as follows. First, recipients are overloaded with information due to the simultaneity and anonymity, which in turn makes the focus of information for recipients difficult, if not impossible [7]. Second, to achieve depth of information sharing, interactions among participants become critical. As suggested by prior work [13], to gain deep insights from group interactions, it is necessary that individuals are capable of analyzing and synthesizing feedback from participants based on differences in experiences, values, and views of their cognitions. Media high in social presence fosters the above interactions or reciprocity more efficient and effective than does media low in social presence. Third, in terms of the written information conveyed by electronic medium, a reader draws meaning from a text subjectively, whereas the meaning of speech is gained intersubjectively and references social context [16]. Therefore, the added availability of an electronic medium will occasion individually subjective interpretations rather than facilitating intersubjective interpretations, which impedes the depth of information interpretation. Finally, using both FTF and electronic media indicates that a learner may employ either written or spoken communications. Under such conditions, since the participants need to attend to multiple media, as noted by [17], a large amount of information and interaction diminishes recipients' capability to respond to the communications of others. Based on the above argument, this study hypothesizes that:

*H1: The breadth of information sharing will be more in environments that use both electronic medium and FTF than in FTF environments.*
*H2: The depth of information sharing will be less in environments that use both electronic medium and FTF than in FTF environments.*

In the light of the subjective perspective of information, knowledge construction depends on the social setting in which the information is encountered. Extending this concept in a group setting, intersubjective interpretation refers to the sharing of experience or idea that leads to the consensus on information meaning or interactive interpretation by a group of people [13]. Intersubjective interpretation fosters the formulation of a shared social reality. In addition, intersubjective interpretation stimulates the provision of comprehensive information concerning a problem-solving task because of the diverse interpretation (breadth of interpretation) and insights (depth of interpretation) provided by group members. As a result, due to the acquisition and interpretation of a large number of viewpoints, members are able to reduce the uncertainty and ambiguity in terms of knowledge construction to a certain extent. This study therefore proposes that:

*H3.a: The breadth of information sharing has a positive effect on learning achievement.*
*H3.b: The breadth of information sharing has a positive effect on students' satisfaction.*
*H3.c: The breadth of information sharing has a positive effect on students' perceptions of the emotional learning climate.*
*H4.a: The depth of information sharing has a positive effect on learning achievement.*
*H4.b: The depth of information sharing has a positive effect on students' satisfaction.*
*H4.c: The depth of information sharing has a positive effect on students' perceptions of the emotional learning climate.*

## 3.2 The effect of medium choice on collaborative learning

The selection of media is premised on communicators' tendency towards task closure. Although using media facilitate information sharing, the negative effect of information overload on learning effectiveness cannot be neglected. By using additional medium tends to worsen information overload because communicators usually need relatively high levels of cognitive demands to deal with fuzzy tasks [19]. The availability of group members lessens when they are confronted by information overload. Under such conditions, adopting low social presence medium such as an electronic medium facilitates closure in group's interaction. We therefore propose the following hypotheses.

*H5.a: In environments with both FTF and electronic media, written discussion of information among group members will have a positive effect on learning achievement.*
*H5.b: In environments with both FTF and electronic media, written discussion of information among group members will have a positive effect on students' satisfaction.*
*H5.c: In environments with both FTF and electronic media, written discussion of information among group members will have a positive effect on students' perceptions of the emotional learning climate.*
*H6.a: In environments with both FTF and electronic media, oral discussion of information among group members will have a negative effect on learning achievement.*
*H6.b: In environments with both FTF and electronic media, oral discussion of information among group members will have a negative effect on students' satisfaction.*
*H6.c: In environments with both FTF and electronic media, oral discussion of information among group members will have a negative effect on students' perceptions of the emotional learning climate.*
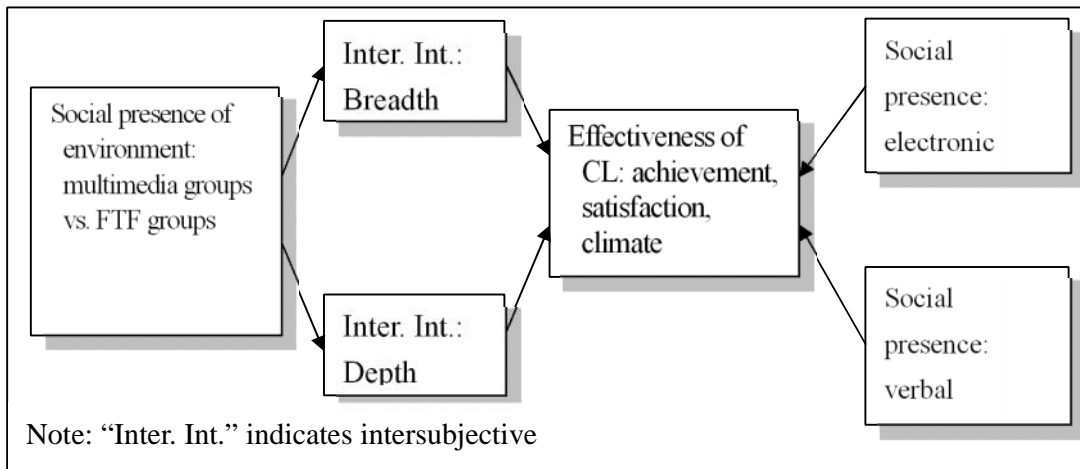
**Fig. 1　Research model**

## 4　Methodology

### 4.1　Course and subjects

This study used field experiment to test the hypotheses. We examined the information sharing and discussion in collaborative learning. One hundred fifty-six senior college students (the third year of a four-year undergraduate program) participated in the experiment. The students were divided up into twenty-three, six to eight-member groups. The groups were drawn from at a southern university in Taiwan, R. O. C.. The average age of the subjects participating in the experiment was 21.2 years. Students received course credit for joining this experiment. Rewards are given for those teams that embark on the discussion and group interactions enthusiastically. Subjects are randomly assigned to the groups.

The title of the course is "management of information systems," which emphasizes the organizational foundations and technical foundations of information systems (IS). The course is required for the enrolled senior students of MIS (management of information systems) department in the College of Business.

The subjects were well represented among the traditional business undergraduate population. They were young and the gender had even distribution reasonably (56.4% males, 43.6% females). In the first week of class, this study conducted a preliminary survey that measured demographics, attitudes toward collaborative learning, previous experience with collaborative learning and computers, and self-reported knowledge of course material. In addition, we also administered a quiz that evaluated the subjects' background knowledge regarding the core case material. The average typing speed of the subjects was about 15 words (in Chinese) per minute. A series of t-tests demonstrated that no significant difference between the treatment (multimedia) and control (FTF) groups on the above dimensions. Given the results of t-test, it is reasonable to assume that our subjects possessed the homogeneity of pre-treatment skills, attitudes, and experience. On an average, the FTF groups made 62 total comments during the collaborative learning, while multimedia groups made an average of 93 total comments.

### 4.2　Experimental manipulation and learning task

This study investigated the effectiveness of collaborative learning for two treatments—multimedia groups and FTF groups. While the subjects in the first treatment use both electronic medium and FTF to achieve a collaborative learning assignment (multimedia groups), subjects in the second treatment employed FTF to fulfill the assigned task collaboratively (FTF groups). The multimedia groups involved 12 teams (76 students), whereas FTF groups involved 11 teams (80 students). The subjects in both of the two groups received the same level of task. Two case studies were assigned for both teams. The first task was assigned before midterm, while the second task was given before the final exam.

The assistant of the class gave out the case materials (in hard copy) to each subject on week in advance of his/her

scheduled sessions. Before participating in the scheduled sessions, subjects were asked to analyze the cases, research a lot of background material that may facilitate the realization of the assigned cases. Subjects were also told that they would be examined on the case materials at the beginning of each collaborative learning session. Doing this, subjects were assured of thorough preparation and understanding of the cases, which is also the pedagogical assumption of a collaborative learning [9].

### 4.3   Measures

Since this study focuses on the effectiveness of collaborative learning in terms of social presence and task closure theories, two issues have to be measured—information shared and effectiveness of collaborative learning. Regarding the former, information shared during collaborative learning was measured by coding videotaped discussions of all groups, while coding electronic transcripts of multimedia groups. The breadth of information sharing referred to the total number of distinct discussion sequences contributed by the learners during a session. Depth of information sharing was the number of rounds concerning a specific issue during group interactions. For multimedia groups, both verbal and electronic scores were added together to form the total of breadth and depth scores. Four raters (assistants) helped to measure the breadth and depth of information-sharing. To adjust for group size, the scores of group information-sharing were divided by the number of group members. In terms of the learning effectiveness, this study used three sets of variables based on TIP theory—learning achievement, satisfaction with the learning process and outcome, and the emotional climate of the learning environment [1].

### 4.4   Procedure

To facilitate the process of the experiments, two professors and four assistants were involved. The assistants distributed the task (case study) and instructions, verbally explained the characteristics of collaborative learning and JoinNet (for multimedia groups only). The collaborative learning sessions for each team in both treatments (multimedia and FTF groups) were scheduled three weeks apart, and each session lasted two hours. Doing so enables subjects to stabilize their IT appropriation pattern and to form established (versus ad hoc) teams with both a history and future of working together [1].

## 5    Data analysis and results

Table 1 illustrates the descriptive statistics of the research variables. Regarding the effect of media environment on information sharing, while the total number of breadth of information sharing for multimedia group is greater than that of FTF group (Mean 22.39 > 6.46), the total number of depth of information sharing for multimedia group is less than that of FTF group (Mean 4.4 < 5.71). The results of t-test indicate that the above differences are significant. Thus, as expected, both hypothesis 1 and 2 are supported.

**Table 1. Descriptive statistics**

| | All groups （23） | | | | Multimedia treatment (12) | | | |
|---|---|---|---|---|---|---|---|---|
| | FTF groups: （11） | | Multimedia groups: （12） | | Verbal information sharing | | Electronic Information- sharing | |
| Variable | Mean SD | Max. Min. | Mean SD | Max Min | Mean SD | Max Min | Mean SD | Max Min |
| Breadth of information sharing | 6.46 1.37 | 8.75 4.67 | 22.39 7.36 | 34.10 11.30 | 8.61 4.81 | 21.00 2.50 | 13.77 7.25 | 26.96 3.29 |
| Depth of information sharing | 5.71 1.19 | 7.63 4.50 | 4.40 1.38 | 6.80 2.00 | 0.96 0.50 | 1.86 0.27 | 3.43 1.33 | 6.00 1.20 |

In order to test the effect of media environment (H3 and H4) and media choice (H5 and H6) on intersubjective interpretation, this study used PLS (partial square least).   PLS has been widely employed for two main reasons [3]. This study examined two structural models: the effects of media environment and the effects of media choice.

We used PLS-Graph Version 3.0 in this paper. Following recommended two-stage analytical procedures [3], this study conducted confirmatory factor analysis to evaluate the measurement model; then, the structural relationships were assessed. To validate the structural models, this study performed three types of validity assessment—content validity,

convergent validity, and discriminant validity. As indicated in Table 2, our measures of both reliability and AVE are above the acceptable value. The weights and loadings of the constructs in our research model are calculated. After deleting those measures that have insignificant loadings at the level of 0.01, the path loadings of the remaining items are significant at the level of 0.01. Finally, we investigated the discriminant validity of our instrument by looking at the square root of AVE as suggested by previous work [3]. This finding is consistent with the discriminant validity shown in Table 3—the square root of AVE for each construct is greater than the levels of correlation involving the construct. The measures of inter-construct correlations in this table also suggest that each construct shares larger variance with its own measures than with other measures.

**Table 2. Reliability, AVE, CR of confirmatory factor analysis**

| Measures | Items | Composite Reliability | Average variance extracted (AVE) | Cronbach's $\alpha$ |
|---|---|---|---|---|
| Satisfaction | 7 | 0.972 | 0.832 | 0.963 |
| Learning climate | 8 | 0.960 | 0.751 | 0.951 |

**Table 3. Correlation between constructs**

| | Breadth | Depth | Grades (Learning achievement) | Satisfaction | Learning climate |
|---|---|---|---|---|---|
| Breadth | 1.00 | | | | |
| Depth | -0.25 | 1.00 | | | |
| Grades | -0.05 | -0.26 | 1.00 | | |
| Satisfaction | 0.39 | 0.15 | -0.31 | 0.91 | |
| Learning climate | 0.42 | 0.13 | -0.24 | 0.51 | 0.87 |
| The shaded numbers in the diagonal row are square roots of the average variance extracted (AVE). | | | | | |

Given the acceptable validity and multicollinearity, hypotheses (H3 to H6) were tested by PLS. The results are shown in Figure 2 and 3 to represent the media environment effects and medium choice effects respectively. Numbers in the model represent beta weights that are similar to standardized regression coefficient in multiple regression. Both multiple $R^2$ values (for endogenous variable) and the significance of the beta are shown in Figure 2 and 3.

From Figure 2, as anticipated, information sharing—both breadth (H3.b and H3.c) and depth (H4.b and H4.c) of information sharing—facilitates the effectiveness of collaborative learning in terms of satisfaction and emotional learning climate. However, neither breadth (H3.a) nor depth (H3.b) of information sharing has a significant influence on learning achievement—grades of quizzes.

Regarding medium choice, drawing on closure theory, group members tend to adopt medium low in social presence (written discussion of information) to achieve a closure (or to avoid information overload) in group communication provided that the target recipients are unable to pay attention to the interaction immediately. This indicates that using appropriate medium may foster the effectiveness of CL to a certain extent. As expected, using electronic medium (or written discussion) exerted a positive effect on satisfaction (H5.b) and on climate (H5.c). However, the impact of electronic medium on learning achievement is insignificant (H5.a). On the other hand, surprisingly, the findings regarding using medium high in social presence such as verbal communication contradicted our hypotheses (H6.a, H6.b, and H6.c).
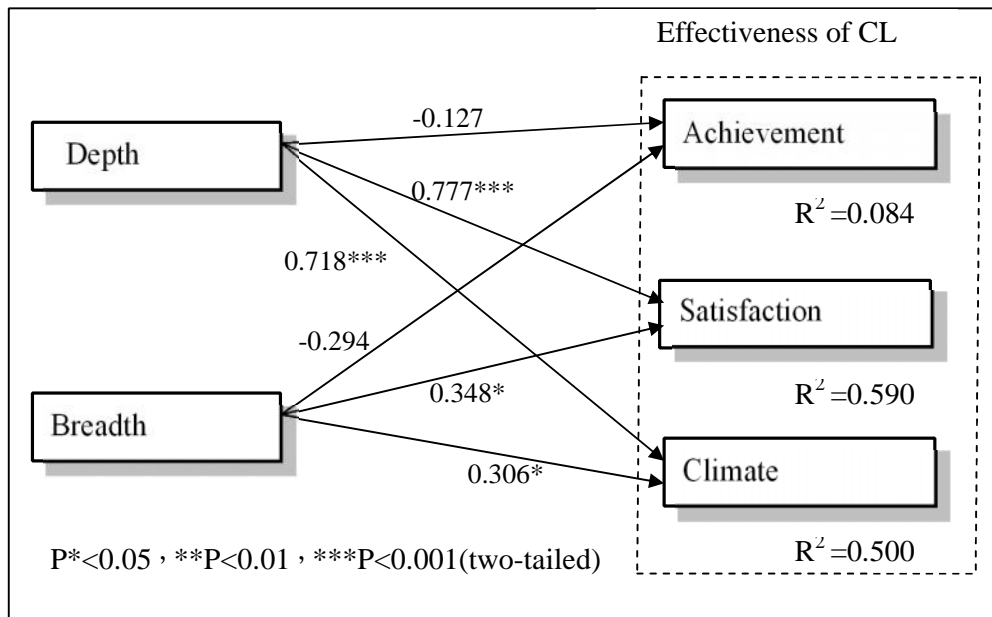
**Fig. 2   Results of media environment effects (H3 and H4)**
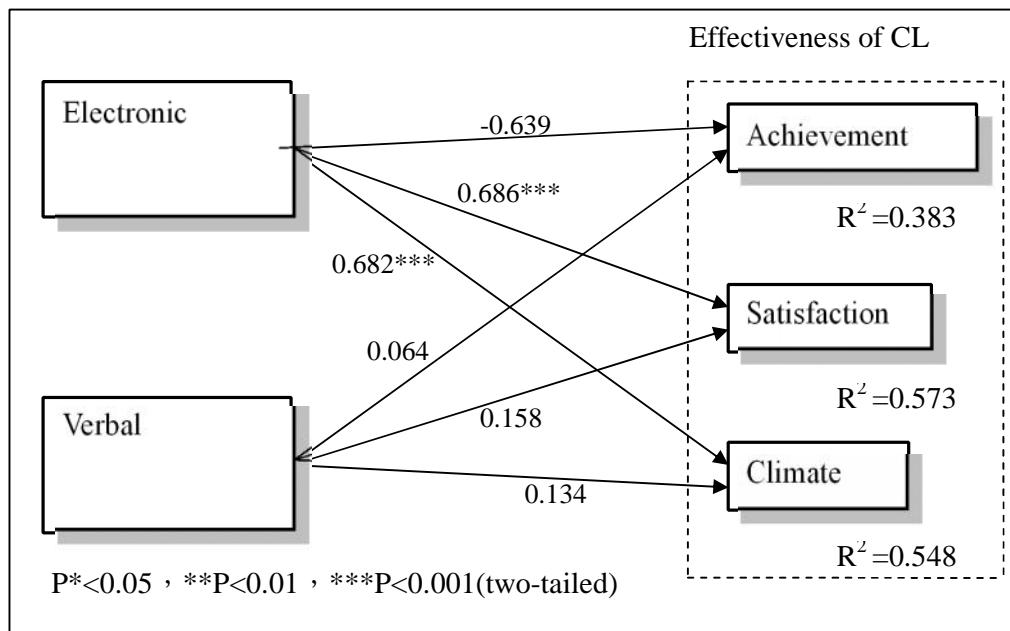


**Fig. 3   Results of medium choice effects (H5 and H6)**

## 6   Discussion

Our findings support our hypotheses that media environments have positive effect on both depth and breadth of information sharing. However, following influences of the above aspects on the effectiveness of CL are slightly surprised. In the light of intersubjective interpretation, either breadth or depth of information sharing facilitates knowledge construction, which in turn has positive effect on learning performance. Our data suggests that while information sharing has significantly positive effect on learning satisfaction and climate, the above impact on learning achievement (grades of quizzes) is insignificant.

The implications and possible explanations for the above phenomena are as follows. First, the findings regarding H1 and H2 indicate that medium plays a key role in facilitating information sharing—breadth or depth. In a CL context, more information sharing indicates a learner has more opportunity to receive diverse viewpoints, and to discuss these

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viewpoints more fully. However, as indicated by H3.a and H4.a, these viewpoints do not guarantee the development of correct or appropriate solutions for a problem, since the information sharing did not exert a positive influence on learning achievement significantly. In sum, although reaching agreement is not a requirement for achieving intersubjective interpretation, it does demand a common reference point. Doing so not only solves members' divergent perspectives efficiently, but facilitates the obtaining of shared meaning effectively. Therefore, prolonged discussions and information sharing do not have a positive effect on learning achievement, not because they are ineffectively in themselves. Rather, this is because the students lacked the capability of integrating divergent views.

The second issue that has been addressed is medium choice effects. According to the task closure theory [18], due to the anonymity and simultaneity, using electronic media enforced greater demands on group attention. Besides, the availability of two media in multimedia environments tempted learners with increased cognitive demands of having to attend to interaction. This is likely to decrease learners' attention to others' interpretative overtures. To facilitate the closure of communication under multimedia environment coupled with fuzzy task, learners resorted to medium low in social presence for information sharing such as written discussion.

## 7    Limitations

The involvement of instructors is limited in this study. They did not either facilitate information sharing or provide feedback that reconciles different perspectives proposed by students [9]. This is, to a certain extent, why some of the extended discussions ended without consensus. Future research may assess the role for instructor in stimulating intersubjective interpretation.

## 8    Conclusions

The data of this study provides substantial evidence regarding the perspective of information sharing. In a CL context, the effectiveness of learning depends on learners' capability of sharing information efficiently and effectively, from which a learner may construct knowledge. Intersubjective interpretation plays a key role in facilitating the above activities. Our findings also shed light on the social presence of knowledge, i.e. insight or interactive interpretation is socially established during information sharing. Regarding medium choice, the learning performance, in aggregate, for using written discussion is better than that of oral discussion. Thus, we have evidence to support task closure theory.

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