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Editorial

A Measure of Success

Donald G. Perrin

At a recent faculty meeting, ***assessment*** was the topic of discussion. We were presented with a problem of enrollment beyond our capacity, a wonderful but challenging situation. In my mind, I was preparing a speech how the State of California a decade earlier solved the problem with distance learning. The conversation slid to the SAT and standardized tests for college entrance and graduate school. The validity of these tests questioned by many universities and alternative methods of assessment are supporting or even replacing the standardized tests. I began to muse on my dislike of trivia questions and multiple guess responses based on test-methods introduced by Stanford-Binet a century ago. I was jolted to sensibility by a statement: "The Educational Testing Service OWNS education!" quickly followed by "Did you know that the Federal Department of Education under Dr. Spellings is proposing *a uniform exit test for colleges and universities*!" Now I was outraged. In my opinion, the intrusion of politics is the unspoken reason for many failures in education, raising it to the most over-regulated under-funded enterprise in the United States. (I cannot speak for other countries including my native Australia, but I have studied and worked in all levels of U.S. education for over 40 years.) As cannons fired around me, I withdrew to my intellectual cave in an attempt to regain objectivity.

My biggest concern about public education in the United States is that the world is changing more rapidly than education can respond. I compared it with Drucker's *Theory of the Business*. In the early 1990's, major corporations like IBM were failing even though they were doing what made them successful even better than before. The problem, in simple terms, was that the world had changed and they had not. I mused that teacher training and teaching methods are surprisingly similar to those of a century ago, yet the world around us has undergone remarkable changes.

In many disciplines, we start by teaching the history – the part we as teachers are intimately familiar with from our own education. For some reason, this is less interesting to our students. They would rather start with the present, something that modern students may be more intimately familiar with than their teachers. Relating this to Drucker's *Theory of the Business*, education must change to be relevant to the world around us. But how?

Curriculum is based, for the most part, on the past. I drew a Venn diagram with a small overlap between a small circle and a very large circle. The small circle represents the past; the large circle represents the future. The place where they overlap is the present, that thin line we cross as we move from the past into the future. We are attempting to prepare students to live and work in a future using a curriculum that is based on a world that is rapidly changing - so rapidly in many instances that we are preparing students for a world that no longer exists! With the explosion of technology and the diminishing half-life of information, education as we experienced it in past generations, and implement for each new generation of students, has become a dinosaur.

We know a lot about the present and the future that is not yet part of the curriculum. We know how to teach much better than we do. We have yet to implement much of what we have learned in a century of research and innovation in teaching and learning. And when budgets are cut, we return to traditional ways of education: lecture, reading, discussion, and lab and measure results with time honored methods of testing like essays and multiple-choice.

Education is a conservative profession, anchored in the past, and performing like a folk culture in a technology-based world. It requires a level of funding and a quality of leadership not likely to be found in the Department of Education or the Educational Testing Service. Where do we begin?

Editor's Note: In a world where team work and collaboration are increasing productivity in the workplace, successful group activities are an essential component of online learning. This research relates group processes to outcomes, identifies elements that were successful in this study, and raises additional questions for research.

The Perceived Benefits and Difficulties of Online Group Work in a Teacher Education Program

Heejung An, Sang Kyung Kim

Abstract

This study reports on the ways in which online group work was perceived by inservice K-12 teachers participating in a virtual school of education program. Data was drawn from an open-ended online survey distributed at the end of the course. Following Chi's verbal analysis coding method (1997), recurring themes were identified through a quantified qualitative data analysis. Results indicate that the three most prominent benefits which teachers perceived involved 1) their belief that collaborative practices could develop their metacognitive knowledge, 2) recognition of the value of a supportive learning community, and 3) new understanding of how to use online communication technology tools. Besides these benefits, the teachers also perceived difficulties in completing online group tasks, which involved 1) cognitive conflicts, 2) individual differences, 3) group grading challenges, 4) working across different time-zones, and 5) the challenges posed by online communication. Recommendations pertaining to these findings are also provided, with an emphasis on the ways in which online faculty and instructional designers can enhance students' engagement in online group work.

Keywords: Online learning, collaborative learning, online group learning, online teacher education, metacognition

Introduction

At the current time, most online teacher education programs are adopting a constructivist pedagogical model emphasizing learner-centered collaboration, while at the same time deemphasizing didactic teaching approaches (Bush, 2003; Honebein, 1996; Duffy & Jonassen, 1992; Jonassen, 1994). Within the constructivist framework, knowledge cannot simply be transmitted from teacher to student or individual to individual. Instead, it is built up through the synthesis of social experiences transpiring online (Doolittle, 2001). The question is then whether the plethora of online degree programs in teacher education adequately addresses this collaborative approach in a manner that enables teachers to enhance their pedagogical practices in the classroom. This is an important issue since web-based distance learning is frequently considered as an effective means for meeting the educational needs of busy inservice teachers (Schulz, 2003).

By and large, collaborative learning has been addressed in a growing body of research asserting that such practices lead to improved student learning outcomes and improved social skills development (Johnson & Johnson, 1989; Smith, 1995). In studies on online collaborative activities in teacher education programs, critical thinking skills and multiple perspectives on tasks stand out for having a positive impact on the learning process (Jegede, 2002; Jetton, 2003). Moreover, it is suggested that teachers become more self-reflective through participation in online collaboration, leading to the development of metacognitive skills (Jetton, 2003; Ruhleder & Michael, 2000).

However, while the aforementioned research regarding online collaborative learning processes has been quite positive, this area of study is not without its critics. Some studies investigating students' experiences with collaborative learning methods suggest that students often express little enthusiasm, particularly for group work in online environments. The primary reasons for this are due to "fears of loss of individual voice and identity, and fears of isolation, alienation, and estrangement from the group" (Dirkx & Smith, 2004, p. 134; Smith & Berg, 1997). Coupled with these negative responses, it has been argued that negative experiences with online technologies can intensify students' hesitation toward participating in future collaborative efforts (Bernard, Beatriz, & St. Piere, 2000, as cited in Dirkx & Smith, 2004).

Keeping in mind these two opposing viewpoints about online group work, this study therefore aimed to explore the ways in which inservice teachers perceived their learning experiences while participating in online collaborative group tasks. A guiding assumption of this study was that teachers would not be likely to make a concerted effort in adopting certain instructional approaches unless they could experience such practices firsthand as learners. It was anticipated that this process would subsequently enhance their values and beliefs (Alexander, Schallert, & Hare, 1991; Bird, Anderson, Sullivan, & Swidler, 1992; Florio-Ruane & Lensmire, 1990; Kennedy, 1991). The questions addressed in this study were:

- What are the teachers' perceived benefits while participating in an online group project?
- What are the teachers' perceived difficulties while participating in an online group project?

Conceptual Framework

A growing body of research provides insights regarding the ways in which collaborative work can impact students' learning in face-to-face environments; however, there has been much less exploration of the ways in which teachers perceive this method of learning in online environments. Overall, this literature review was conducted through a combination of both deductive and inductive approaches in order to understand emerging patterns of online collaborative learning in teacher education (Patton, 2002). We first examined the literature focusing on collaborative learning in teacher education. We then reviewed the literature about metacognition and learning communities, which emerged from the participants' answers to the survey questions. This process led us to an understanding of the characteristics of online collaborative group work, thus providing a conceptual framework.

Collaborative Learning[1] in Teacher Education

The constructivist teaching model emphasizes the creation of learning environments that provide students with opportunities for critical thinking, discovery, and collaboration (Duffy & Jonassen, 1992; Lave & Wenger, 1991). A great deal of research indicates that learning through collaborative efforts often results in improved learning outcomes, such as higher levels of academic performance and social competency, as compared to competitive or individual learning (Johnson & Johnson, 1989; Johnson, Johnson, & Smith, 1991; Smith, 1995).

[1] Collaborative and cooperative learning are two different research fields (Dillenbourg, 1999; Dillenbourg, Baker, Blaye, & O'Malley, 1996; McInnerney & Robert, 2004). Dillenbourg (1999), for example, asserts that in collaboration, group members "do the work together," while in cooperation they "split the work, solve sub-tasks individually and then assemble the partial results into the final output" (p. 11). The similarities and differences of these two terms are beyond the scope of this article. Throughout this article, we use the term collaborative learning and define it as a learning method that implies "working in a group of two or more to achieve a common goal, while respecting each individual's contribution to the whole" (McInnerney, & Robert, 203, p. 205).

Within teacher education programs, an emphasis on collaboration is also deemed to be of paramount importance. Faculty is often encouraged to utilize collaborative learning with their preservice and inservice students, primarily because these students are also expected to utilize similar learning approaches during their classroom practice (Kemery, 2000; Kochan, 2000; Schultz, 2003). Schultz (2003) asserts that incorporating well-planned collaborative activities benefits teachers as well as their students, since this usage develops higher order thinking skills[2]. In a similar vein, Jegede (2002) asserts that collaborative online learning in teacher education programs has a positive impact on the learning process, by improving socialization skills as well as enhancing critical thinking. Other benefits of collaborative learning in online environments that have been cited include reflection, peer feedback (Ruhleder & Michael, 2000), and the reduction of anxieties (Gokhale, 1995).

Moreover, it has been asserted that online collaborative learning can facilitate metacognition. As Jonassen (1996) points out, those who participate in asynchronous online discussions often "read a posting and decide whether or not to respond, how to respond, and the likely consequences of such a response" (p. 251). Such thought processes not only allow students to engage in self-reflection (Jetton, 2003), but also make it likely to track how their peers' thinking has changed over long periods of time (Ruhleder & Michael, 2000). Oura and Hatano (2001) also emphasized that the process of gaining expertise is assisted by other people, and expertise occurs in socioculturally significant contexts. For example, participation in group decision making can have important cognitive consequences for group members, leading them to adopt the problem-solving strategies that the group has used (Levine, Resnick, & Higgins, 1993). Computer Mediated Discussions (CMD), for example, can serve as a powerful vehicle for understanding the ways in which students share and better understand complex issues pertaining to their schools and surrounding communities (Jetton, 2003).

Collaborative learning activities that are well-suited for online environments include debates, group projects, case study discussions, simulations, role-playing exercises, the sharing of solutions for homework problems, and the collaborative composition of essays, stories, and research plans (Hiltz & Turoff, 2002). Yet, as noted by Schultz (2003), online collaborative work for such courses is usually relegated to discussion board conversations in which participants merely generate a dialogue with their peers about the weekly readings. While this type of activity can certainly be of value, the extent of actual collaboration is usually quite limited. Furthermore, due to the lack of instructional models when implementing online collaborative learning initiatives, there has been a considerable amount of criticism of this learning approach. For example, Dirkx and Smith (2004) assert that learners are usually dissatisfied with group work in online courses because they "struggle with the development of a sense of interdependence and intersubjectivity within their online groups, but end up holding fast to subjective, individualistic conceptions of learning." (p.134). They further suggest that these aspects could also be exacerbated in online environments, due to the difficulty of providing the emotional dynamics deemed to be so critical in the learning process. Other frequent complaints related to online collaboration are found to include the lapse of response time, thus preventing participants from obtaining immediate feedback (Jetton, 2003).

In relation to the aforementioned findings, a substantial amount of research indicates that inservice teachers often feel more comfortable with didactic teaching approaches especially when

[2] The term "higher order thinking skills" is generally used to refer to the cognitive activities that are beyond recall and comprehension, such as analyzing, synthesizing, and evaluation constructing arguments, asking research questions, making comparisons, solving nonalgorithmic complex problems, dealing with controversies, identifying hidden assumptions, classifying, and establishing casual relationships, and most of the classical scientific inquiry strategies (Bloom, 1956; Zohar, 2004; Zohar, 2006).

participating in online environments, primarily because this is the approach they experienced during their own K-12 education (Ball & McDiarmid 1987; Calderhead & Robson, 1991; Duffy & Jonassen, 1992; Sparks & Hirsh, 2000).

Teachers' Beliefs

Researchers who study the behavior of teachers and how they are trained, stress the importance of understanding what teachers think and what their beliefs actually are (Pajares, 1992). This understanding appears significant in that teachers' beliefs play a key role in determining their attitudes and behaviors toward their instructional practices and ways of interacting with students. In turn, student behavior largely mirrors the discourse modeled by and the expectations communicated by teachers when they engage in cooperative learning (Webb, Nemer, & Ing, 2006). In an investigation of teachers' beliefs, Pajares (1992) proposes to consider teachers' beliefs about their confidence to affect students' performance ("teacher efficacy"), about the nature of knowledge ("epistemological beliefs"), about causes of teachers' or students' performance ("attributions, locus of control, motivation, etc."), and about perceptions of self ("self-concept and self-esteem").[3]

Metacognition

Metacognition refers to knowledge about one's own cognition and the ability to monitor the assumptions and implications of one's activities (Cordero-Ponce, 2000; Flavell, 1979; Gagné, Briggs, & Wager, 1992). According to Flavell (1987), metacognitive knowledge is divided into three categories: knowledge of person variables, task variables, and strategy variables**.** Knowledge of person variables is geared for the ways in which people learn and process information, as well as their own awareness of these learning processes. Knowledge of task variables involves an understanding of the nature of the task as well as the type of processing demands it may place upon the individual. Lastly, knowledge of strategy variables encompasses knowledge about both cognitive and metacognitive strategies, as well as conditional knowledge about when and where it is appropriate to use such strategies**.**

Metacognition is also a means to accessing the knowledge of others, which guides learners toward new perspectives on specific aspects of their learning (Davis, 2000). When students compare their thinking with that of others, their understanding deepens due to their spontaneous reflections and exposure to multiple perspectives (Davis, 2000; Levine et al., 1993; Scardmalia & Bereiter, 1991; Vye, Schwartz, Bransford, Barron, & Zech, 1998). For example, Lin and her colleagues (1999) found that when students compared their thinking with peers, their understanding was deepened. Furthermore, Levine, Resnick, and Higgins (1993) argue that people's self-perceptions and evaluations are influenced by comparing themselves to others. Additionally, they argue that "people actively select comparison targets and construct and distort comparison information to serve their goals" (p. 594) when they are engaged in a social comparison.

In teacher education, the notion of engaging teachers in activities calling for development of metacognition has also become a central focus of teacher education programs, as many researchers believe it plays an important role in students' academic performance and cognitive

[3] A change in teachers' pedagogical beliefs can allow teachers to be more willing to challenge didactic pedagogical practices in their classrooms, leading to real educational reform. (Alexandre, Schallert, & Hare, 1991; Bandura, 1986; Fang, 1996; Steinberg, 1998). When teachers make a concerted effort to adopt new instructional strategies that they learned as a learner into their instructional practices, fundamental changes can occur in the processes by which teaching and learning takes place (Jonassen, 1994; Honebein, 1996).

development (Chi, Bassock, Lewis, Reimann, & Glaser, 1989; Jacobson, 1998; Schoenfeld, 1987; Sternberg, 1984). Studies have also found that those who reflect upon their performance and who use that awareness to guide their thoughts and actions are more likely to succeed academically (Alexander, Graham, & Harris, 1998; Lin, 2001). Because of this, Hatano and Inagaki (1992) emphasize that "exploration and reflection" should be incorporated in the learning process in classrooms.

However, metacognition is not an automatic process. Instead, it is the result of the long-term development of a cognitive system (Jacobson, 1998). Merely forcing learners to reflect on various tasks does not guarantee any expected learning outcomes. Learners must be supported by instruction that scaffolds their attention and makes them consciously aware of topics of inquiry, such as explicitly instructing them to compare examples (Brown & Kane, 1988).

Bransford, Brown, and Cocking (2000) posited that in order to develop metacognition, the teaching of metacognitive skills should be integrated into the curriculum in a variety of subject areas**.** While most metacognition intervention initiatives focus on strategy training in which novice learners learn expert strategies to solve complex problems, Lin (2001) and Pramling (1990) highlight the importance of developing a supportive social environment for nurturing metacognition. In such a supportive social learning context, students could work with and listen to others and develop ways of dealing with complex issues that require different kinds of expertise (Bielaczyc & Collins, 1999; Brown, Collins, & Duguid, 1989).

Learning Communities

Vygotsky (1978) notes that learning does not always occur in vacuum, but in a social setting. In other words, learning is influenced by the context in which it takes place: the process of gaining expertise is assisted by other people, and expertise occurs in socioculturally significant contexts (Oura & Hatano, 2001). Furthermore, learners need a supportive learning context in which they can experience multiple perspectives and group feedback on their performance. A community-centered approach that requires the development of classroom and school based norms, as well as connections to the nation and world that support these norms (Bransford, Brown, & Cocking, 2000) could provide this type of learning context. When provided with the chance to practice in an actual in situ environment, students begin to utilize the relevant jargon, imitate behaviors, and gradually start to act in accordance with this norm. (Brown et al., 1989).

Yet, Brown (1994) argues that schools are still inundated with behaviorist principles that are not conducive to bringing about meaningful learning opportunities. Many of her ideas were attempted in the Fostering Communities of Learners project, which was based on Vygotsky's multiple zones of proximal development (1978) and reciprocal teaching (Palincsar & Brown, 1984). This project involved the development of a classroom learning community, with the intent of understanding and interpreting texts. Brown (1997) claimed that through processes like these, reflective activities within the learning community could become internalized, thus fostering self-reflective practices and personal theories of learning. In this learning context, individuals experienced differences in their perceptions of learning (Hogan, 1999), which then became recognized, valued and fostered (Brown, 1994, 1997). According to Brown (1997), encouragement of diversity contributes richness to classroom activities by offering participants opportunities to develop expertise and interests as they work towards a broader, shared goal of understanding. "This interdependence promotes an atmosphere of joint responsibility, mutual respect and a sense of personal and group identity" (Brown, 1994, p. 10), as expertise is distributed in both social and material terms (Roth, 1998).

Thomas (2002) noted that a supportive learning context can be formed within web-based learning environments in which learners process information, increase their knowledge, and conduct reflective thinking about their own and others' teaching practices. While pursuing their own

group's goal in an online environment, students have the opportunity to participate in asynchronous online discussions, which can serve as personally meaningful and spontaneous tasks. When engaged in online discussions, participants are sometimes urged to role-play with the audience, which enables them to "get inside the skin" of the audience and to experience the message as the audience would (Hays, 1996). By forming one's own ideas to persuade their readers and replying to others' messages through critical analysis, students can practice real-world interactions of the given topics (Brown et al., 1989; Horwitz, 2000).

Methods

Context and Participants

This study was conducted with two online classes (the same course with different sections) in an instructional technology program during the Spring 2005 semester, at an online graduate school of education located in the southwestern U.S. Two sections were held at the same time, and taught by the same instructor (the first author of this article) via the Blackboard Learning System™. The course sequences, materials, and learning activities were exactly the same in both classes. This course was 8-weeks long, and was required for students who had just entered the program during their first year. This course was intended to orient students to the program, through exposure to basic instructional design approaches, national technology standards and the development of an electronic portfolio.

Data was drawn from twenty-six participants (Female: 17 and Male: 9) who were enrolled in these two classes. All of the participants were K-12 teachers, except for five (3: technology coordinators/specialists, 1: military officer; 1: science coach). Students were participating in this course from different areas of the U.S., in states such as Alaska, California, Florida, Georgia, Illinois, Massachusetts, New Jersey, North Carolina, Ohio, South Carolina, and Texas). Participant ages ranged were 25 – 56 years old and their teaching experience was also very diverse, ranging from 1 to more than 25 years of experience. Only 3 of the participants had ever taken an online course before.

Participants' reasons for enrolling in this online program included furthering their own education, becoming a proficient / highly qualified teacher, and interest in enhancing their students' knowledge and skills. Secondary reasons included upgrading their professional status, seeking a promotion, and obtaining a higher level of compensation. Participants also indicated that this online Masters Degree program enabled them to accomplish their aforementioned goals more easily. The program allowed for a more flexible schedule that enabled them to meet work and family commitments more easily than in face-to-face classes.

Description of the Group Project

The instructor randomly formed groups of 3-4 students and initiated the online collaborative group project by posting a message indicating the project specifications as well as some successful tips for communicating within the groups. Each group was provided with a group discussion board on the Blackboard Learning System™. All participants were required to rely on each other, while also being held accountable for their own portion of the work. Participants communicated primarily via group discussion boards, because this was considered to be the most convenient and conducive method for collaboration. In addition, some participants indicated that they made numerous phone calls to clarify group objectives and some students used email to make comments geared for a specific individual within their group.

The instructor did not intervene in any group processes except to answer student questions in relation to the project. Group members were advised to choose their own role regarding portions of work they expected to complete. Note that student assessment was based on the group's work,

rather than the efforts of any particular individual. Students had three weeks to complete it. The actual assignment description is listed as follows:

> *With your learning community, write an 8-10 page APA formatted paper that compares and contrasts the five different design approaches described in your text. Explain how each supports problem-solving skills, literacy, building of learning environments, and a community of learners. Does one design lend itself to one particular goal more than the others? Is anything missing from these designs? Include within your discussion particular National Educational Technology Standards that might be met through this approach. You should refer to the Standards designed for your students, rather than those geared for teachers.***"**

Data Resources and Analysis

The data was collected through an online questionnaire that was distributed on the last day of the 8-week course. Student involvement was entirely voluntary. Participants were first asked to indicate their reasons for enrolling in the program and to provide information about their group's communication methods. The participants were then asked to answer two open-ended questions regarding what they perceived to be the benefits and difficulties of working on the online group papers. These two written protocols were expected to capture students' beliefs and perceptions on their experiences in online collaborative learning. In response to these two primary research questions, we used Chi's verbal analysis coding method (1997), which blends qualitative and quantitative analyses. A great deal of literature suggests that the combination of these two types of data analysis is necessary in order to remove each method's shortcomings in the research field (Chi, 1997; Creswell, 1994; Rourke & Anderson, 2004). The qualitative aspect of this approach focused on the verbal data analysis of the written comments in order to provide a much richer, more detailed, and more accurate representation of the students' knowledge and attitudes (Chi, 1997; Rourke & Anderson, 2004). To reduce the subjectiveness of qualitative coding and to obtain validation, quantitative measures along with the qualitative measures were blended together.

Coding Schemes. The data coding was accomplished through a recursive process of identifying themes in the text-based data for the open-ended questions (Jetton, 2003). During the preliminary coding process, emerging themes and categories were recorded independently by the two authors of this study. This data became the basis for the coding structure. We compared similarities and differences in the recurring themes and established specific categories for the perceived benefits as well as the difficulties, which guided us to more detailed coding. Through this iterative process, identifying themes in students' written production and from existing literature, two coding schemes (The Coding Scheme of the Perceived Benefits and The Coding Scheme of the Perceived Difficulties) were developed (See Tables 1 and 2).

For the perceived benefits, three categories emerged from the coding of the entire data set. These included: 1) the development of metacognitive knowledge (subcategories: task knowledge, person knowledge, and strategy knowledge); 2) the recognition of the value of a supportive learning community; and 3) a new understanding of how to use online communication technology tools. For the perceived difficulties, five categories emerged from the preliminary coding of the entire data set were: 1) cognitive conflicts; 2) individual differences; 3) group grading challenges; 4) time-zone scheduling problems; and 5) the challenges posed by online communication.

Table 1

Coding Scheme of the Perceived Benefits

Category	Sub-category	Definition	Example
Development of metacognitive knowledge	Task knowledge	Knowledge about the nature of the task as well as the type of processing demands that it places on the individual (Flavell, 1987). For this study, specific knowledge focused on a collaborative task.	"I learned how to put everyone's work together into one document."
	Person knowledge	General knowledge about one's own learning processes (Flavell, 1987).	"I realized that I am a good logical researcher that does not go off in too many directions."
	Strategy knowledge	Knowledge about both cognitive and metacognitive strategies, as well as conditional knowledge about when and where it is appropriate to use such strategies (Flavell, 1987).	"I learned that I need to be more assertive with issues that I want to see implemented."
Recognition of the value of a supportive learning community		A sense of community established through collaborative online group work, and students' recognition of the positive influence of their group on their own learning and the context in which learning takes place (Bransford et al, 2000).	"The group papers made me feel like a part of the class and not just someone aimlessly wandering out in cyberspace." "Group work allowed me to know more about others." "I was able to see other students' work, the team leader putting everything together and the group members trying to really discuss issues." "The best part was being able to see other class members' work."
New understanding of how to use online communication technology tools.		Learning about online communication technology tools and also constructively using them for the group work process in an online environment.	"I liked learning from other people in my group about technology and how to use it."

Table 2

Coding Scheme of the Perceived Difficulties

Category	Definition	Example
Cognitive conflicts	Awareness of differences in perspectives and opinions on the group's task and solutions (Cho & Schunn, 2003).	"There are different interpretations of the assignment." "It is hard to get everyone to have the same vision as you." "There was too much verbiage generated when two or more viewpoints were discussed."
Individual differences	Irreconcilable individual differences among group members, such as different work styles and pace.	"Many people have different work patterns. I am an early starter and like to get things organized quickly and, if possible, complete assignments before the deadline." "I like to complete my assignments early and sometimes many people like to complete assignments at the last minute. I am not really a great writer; therefore I must spend more time writing papers in order to receive my desired score." "Everyone works at a different pace."
Group grading challenges	Non-differentiated grading system for group members	"I did not like being at the mercy of a group for my grade. Not everyone carries the same workload, so it is not fair to receive the same grade." "It is unfair to motivate students to have to do the work for others in order to attain the grade they want."
Working across different time-zones	Difficulty scheduling, communicating and collaborating across different time zones within the U.S.	"It was also difficult working with so many time zones." "Even under the best of circumstances in which every group member is motivated, it is very difficult to coordinate schedules."
The challenges posed by online communication	Obstacles that developed during the online conversations, due to the unique challenges caused by virtual absenteeism, a lack of spontaneous response, facial expressions, and audio tones.	"If someone doesn't respond quickly, it is very frustrating. It is hard to know if it is for an important or frivolous reason" "Not having facial interactions."

Scoring Procedure of Written Protocols. Analysis of students' written protocols occurred at different phases. First, two coders segmented all the features in the students' answers using the coding schemes ("Segmenting stage"). This served as a preliminary data set. Following the preliminary segmentation, intercoder agreement on the preliminary segmented units was determined. Discrepancies were resolved through discussion. The two coders (the two authors of this paper) then individually coded the segmented units based on the coding schemes ("Coding stage"). Lastly, intercoder reliability was again checked for all answers and discrepancies were again resolved by discussion. Cautious action was taken to rule out the possibility that some students were simply more articulate or fluent in their written protocols. For instance, if a student described the same idea using different expressions, such as "collaboration" and "working as a group," only one point was assigned to the answer.

Intercoder reliability for the analysis of the written protocols was computed by percentage agreement. The two coders were blind to students' names. The intercoder reliability between the two raters ranged from 91% to 94% of agreement. Although there was some disagreement between the two coders, discrepancies were resolved by a second examination and discussions between the researchers.

Results and Discussion

Table 3 presents the results of the perceived benefits, by category, from highest percentage to lowest percentage. From the responses for perceived benefits, we found a total of 94 idea units. Out of 94 idea units, 57 idea units (60%) were related to the development of metacognitive knowledge (task knowledge 33%; person knowledge 13%; and strategy knowledge 15%). Thirty three idea units (35%) were found for the recognition of the value of a supportive learning community category. Four idea units (4%) were associated with learning about online communication technology tools. Figure 1 provides a graphic illustration of these results.

Table 3

The Perceived Benefits in Online Group Learning, from Highest to Lowest

Category	Sub-category	Number of Units	% of the total
Development of metacognitive knowledge	- Task knowledge	*(31)*	*(33%)*
	- Person knowledge	*(12)*	*(13%)*
	- Strategy knowledge	*(14)*	*(15%)*
sub-total		57	61%
Recognition of the value of a supportive learning community		33	35%
New understanding of how to use online communication technology tools		4	4%
Total		**94 units**	**100%**

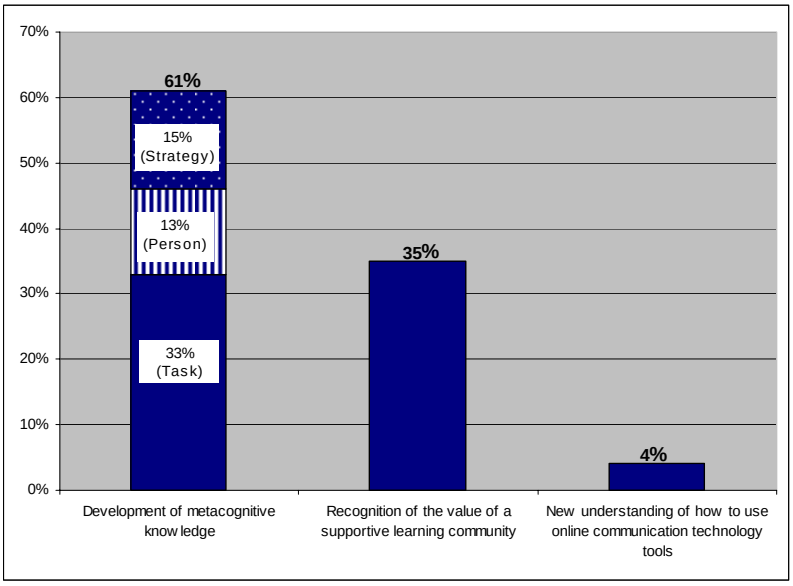

Figure 1. The perceived benefits of online group learning from highest to lowest

Table 4 presents results for perceived difficulties, by category, from the highest to lowest percentage. From the responses for perceived difficulties, we found a total of 62 idea units. Out of 62 idea units, twenty three idea units (37.1%) were associated with individual differences, fifteen idea units were related to online communications, and ten idea units involved cognitive conflicts. The remaining categories took up very small percentages: eight idea units (12.9%) were found for group grading challenges, and six idea units (9.7%) were for working across different time-zones. Figure 2 also illustrates these results.

Three students out of 26 reported that they did not encounter any difficulties in the completion of this online collaborative project. Their comments are as follows:

> "None, I cannot think of any particular item that I disliked about working on the group paper."
>
> "None, the online environment is a 'natural' platform for group work."
>
> "I was originally afraid that working together online wouldn't work, but after talking to each other in our groups that fear subsided and we jelled together to produce a group paper."

Table 4

Perceived Difficulties in Online Collaborative Group Learning: Highest to Lowest

Category	Number of Units	% of the total
Individual differences	23	37.1%
The challenges posed by online communication	15	24.2%
Cognitive conflicts	10	16.1%
Group grading challenges	8	12.9%
Working across different time-zones	6	9.7%
Total	**62**	**100%**

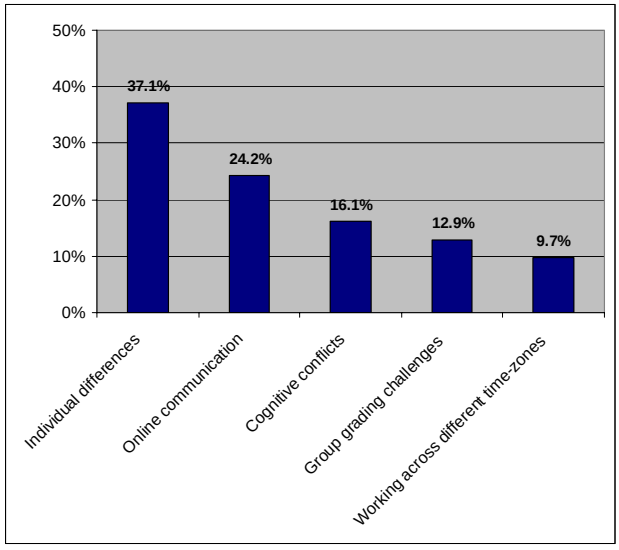

Figure 2. Perceived difficulties in online collaborative group learning from highest to lowest

The findings suggest that the online collaborative group work could be a valuable means for scaffolding and seemed to have a role both in facilitating and enhancing inservice teachers' metacognitive knowledge. It is important to note that many inservice teachers unconsciously developed metagonitive knowledge without the instructor's explicit intervention by engaging in group tasks, while also achieving the goals of the task itself at hand. This finding is aligned with Lin's assertion (2001) that a supportive online collaborative social environment has the potential to impact the development of metacognition.

Secondly, many teacher participants reported that they experienced benefits from supportive online group members which enhanced their own learning. In particular, belongingness and virtual presence seemed to be very affective factors, since they increased student motivation. Indeed, making classmates aware of their own presence in an online learning environment, either by contributing significantly to the group project or simply by posting short messages (e.g., "I agree" or "I don't agree") on the group discussion board, certainly proved to be beneficial in this online learning environment. When students did not see other group members' postings on the discussion board, they felt they were not functioning as a team. Without any tools to sustain social connections with their online classmates (e.g., being able to see who is online), group members frequently experienced frustration and had a hard time moving along. After all, it has been suggested that one of the benefits of online collaboration is the reduction of anxieties (Gokhale, 1995). Nonetheless, this study showed mixed results in relation to this. While some teachers reported that they felt relieved knowing they were on the right track, some reported a delay in responses made or no responses by team members, which increased their anxieties further. Based on the positive responses, though, we surmise that the online group work experience led some students to recognize the value of a supportive online learning community for their own learning.

Thirdly, learning about the integration of technology, such as instant messaging programs, may have been of value to the teachers, who might otherwise not have been aware of, interested in using, or not have had the opportunity to learn about such tools. This aspect is of particular importance for instructional technology programs, since teachers can experience how a certain technology may be utilized as a means of learning with technology (Jonassen, Peck, & Wilson, 1999).

This study also revealed difficulties that need attention before implementing online group projects. For example, it is presumed that individual differences, cognitive conflicts, and group grading challenges might not be unique difficulties in online environments, but common concerns pertaining to face-to-face collaborative learning as well. However, it is possible that these difficulties are actually more serious in online environments. Additionally, the two other perceived difficulties (online communications and working across different time-zones) were unique concerns pertaining to the online environment. Perhaps, the strong dependence on written-text and asynchronous communications, which are inherent aspects of online communication, may be difficult for many new online participants to get used to. Working across different time-zones might also be very problematic for those who can only communicate online at a specific time. These are areas that need to be explored in future research.

Among the other difficulties and frustrations participants faced was the implementation of a non-differentiated grading system. The instructor chose this "group grading" approach, so that every member would be prepared to take on the necessary responsibilities. However, this sometimes led students to feel less likely to contribute, because individuals became more dependent on others to do the work for them. This effect seems to be a more serious problem in online environments,

primarily because participants feel less guilty about not responding or not participating in the work process.

Besides the aforementioned categories, there are other issues for online instructors to consider when implementing online group projects. For example, it is recommended that they consider whether the characteristics of group tasks (e.g., type of group task, requirements, and due dates, etc.) are suitable**,** taking into account the needs of the inservice teachers' full time employment. Many projects simply become too time-consuming and too cognitively demanding. Yet, at the same time, the participants also need to consider whether they would like to adhere to high standards within their program of study, and if they can meet these challenges of online graduate work while also balancing other responsibilities. Within many online graduate schools of education, there seems to be a gap between school standards, the instructor's standards, and the students' standards. Other aspects that need to be considered involve the class' attitudes toward collaboration. For this study, involving a group of inservice teachers, it was found that they tended to avoid potentially embarrassing situations, as well as circumstances in which they faced the possibility of offending another member of their group. As a result, they would often contact the instructor in order to resolve these concerns.

Conclusions and Future Studies

Although the constructivist teaching approach, emphasizing collaboration and reflective teaching, has become a major goal of many online teacher education programs, the usefulness of online group work is a subject of ongoing debate and needs to be discussed from a critical perspective. By providing empirical evidence, the current study highlights the need for a better understanding of how inservice teachers perceive their experiences while participating in online group tasks.

For this study, even though the teachers perceived difficulties while participating in the online group project, their positive experiences seemed to outweigh the negative ones. Especially enlightening was the importance of a supportive social environment for fostering metacognitive knowledge. Metacognitive knowledge clearly served a key role, which led to the successful completion of online collaborative group tasks. However, in order for this to take place, there should be awareness among online faculty and instructional designers of the need for a supportive learning environment.

Finally, this study leads to further research in regards to a) how we can help teachers develop more supportive online collaborative learning environments that reduce the difficulties found in this study; b) how we can further distinguish the ways in which students can achieve positive benefits that are not possible in face-to-face environments; and c) how online collaborative learning approaches are currently impacting teachers' knowledge and practice. For instance, in what ways do these online collaborative efforts offer a means of proper modeling that will be of value to teachers in their own classrooms? These questions require further exploration.

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Editor's Note: It is often stated that the success of a distance learning program is dependent on the quality of supporting services. Much of the research in distance education is focused on instructional design, learner characteristics, and performance. This research relates to services, gaps in service, business models, continuous quality improvement, and maintaining a competitive edge.

Improving the Service Quality of Distance Education

Rui-Ting Huang

USA / Taiwan

Abstract

There has been extensive research in theory and practice of teaching and learning in face-to-face, distance, and blended learning. In distance education, support services are more than delivery and feedback systems, they provide a means for continuous quality improvement. Research on support services informs organizations of ways to further improve teaching and learning, streamline business processes, and gain long-term competitive advantages.

Keywords: distance education, service quality, consumer satisfaction

Introduction

Advancements in information and communication technologies give people a more convenient life. They also have an important influence on the development of Distance Education (DE) (Salisbury, Pearson, Miller & Marett, 2002). Traditional education is subject to constraints of time, place and geographic distance. Technologies such as the Internet, television, radio and computers break those constraints in Distance Learning (DL) enabling people more opportunities to acquire knowledge, more power to decide their own learning path and speed (Alexander, 1999; Tarr, 1998), and achieve their lifelong learning needs (Claus & Dooley, 2005; Carriere, & Harvey, 2001).

Distance Learning has become an important learning option for education systems (Yilmaz, 2005) and training solutions in the Human Resource Development (HRD) area (Felix, 2006). The growth of the distance learning industry has been faster than expected (Huynh, Umesh & Valacich, 2003). Most importantly, in terms of organizational training, an investigation from the Fortune-500 companies indicates that over 80% of companies use distance learning or plan to do so (Hammond, 2001). Through distance learning, organizations have a more convenient, practical and cost-effective way to train the employees (Hammond, 2001; Whitney, 2006; David, 2006).

Due to the growth and competition in the distance learning market (Huynh, Umesh & Valacich, 2003), DL research includes the study of consumer aspects such as consumer services and satisfaction (Shaik, 2005; Granitz & Greene, 2003; Huynh, Umesh & Valacich, 2003). Feedback from learner give the instructor important data to determine how well the instructional program satisfies individual learner needs (Steyn & Schulze, 2003; Long, Tricker, Rangecroft, Gilroy, 1999). This in turn offers service providers in the marketplace important information to streamline the business process to improve the quality of distance learning services (Granitz & Greene, 2003; Steyn & Schulze, 2003). Quality services and support will help the service providers, institutions and organizations in DL get a competitive advantage in the marketplace (Shaik, 2005).

Kotler (1999) points out an unchangeable principle for a successful business - satisfy the customers' need. Consumer service is closely related to customer satisfaction and consumer satisfaction has a critical influence on the profits and performance of institutions and

organizations (Fornell, 1992; Mittal & Lassar, 1998; Wong, 2000). That is why organizations emphasize the importance of consumer service and satisfaction.

Students and learners are the customers of educational service providers (Moisio& Smeds, 2004; Tricker, Rangecroft & Long, 2005; Granitz & Greene, 2003; Long, Tricker, Rangecroft & Gilroy, 1999; Shaik, 2005; Douglas & Douglas, 2006). For service providers to have a long-term competitive advantages in the distance learning market (Shaik, 2005), researchers in DL should pay more attention to studies related to consumer service and satisfaction. As the distance learning industry has become mature in the educational marketplace (Huynh, Umesh & Valacich, 2003), it is providing learners with convenient and flexible learning alternatives (Alexander, 1999; Tarr, 1998). It is also giving organizations alternative cost-effective and timely training solution to effectively and efficiently implement the human resource development plans (Hammond, 2001; Whitney, 2006; David, 2006).

The Problem Statement

Distance learning institutions and service providers provide support to individuals and groups, and learners are increasingly considered as customers in the educational service industry (Moisio and Smeds 2004; Tricker, Rangecroft and Long 2005; Granitz and Greene 2003; Long, Tricker, Rangecroft and Gilroy 1999; Shaik 2005; Douglas and Douglas 2006). Additional research is needed on service aspects of distance learning (Moisio & Smeds, 2004). Services and consumer perspective have not been studied extensively in traditional education (Stevenson & Sander, 1998). In fact, the key differentiation between the service quality concept and traditional evaluation concept lies in the concept of service encounter. Redman and Mathews (1998) state that “this true quality is evaluated by the consumer during and after the service encounter” (p. 60). As distance learning continues to grow and mature in the marketplace, the focus on consumer service may offer the service providers new insights (Moisio & Smeds, 2004) to help them streamline the business process , improve the quality of future service in distance learning (Granitz & Greene, 2003; Steyn & Schulze, 2003) and gain long-term competitive advantages (Shaik, 2005).

Literature Review

The consumer service perspective is closely associated with the evolution of the business strategies in the distance learning industry. Until recently, the distance learning business model, the distance learning institutions and organizations were responsible for program development, knowledge packaging, instructional administration, record keeping and achievement certification (Lang & Zhao, 2000). Evolution of business strategies in the distance learning industry included joint- ventures, strategic alliances, partnerships, and outsourcing (Huynh, Umesh & Valacich, 2003). This evolved to the current business models.

The Business Model in Distance Education

Huynh et al. (2003) propose that there are four types of business models in the distance learning industry. The first is the corporate university model represented by enterprises like General Electric, Disney and Motorola. The target goal of corporate universities is to provide their employees with in-house distance training programs. The advantage of this business model is that corporate universities can address their specific training needs. They develop, design and deliver distance training program for their employees. This is a practical approach for large corporations and multinational organizations. It may not be economically affordable for small companies.

The second business model is the virtual university. Representative enterprises include University of Phoenix Online, Concord University Online Law School, and Capella University. Most service

providers for the virtual university model are proprietary and for-profit organizations. Their target population is working adults who seek a professional degree or enhanced knowledge and skills through DE. The virtual university is sometimes considered a threat to traditional universities because it provides the adult learners with a convenient, flexible, cost-saving alternative to a traditional university for achieving professional degrees and lifelong learning.

The third business model is the spin-off distance-learning venture model where a prestigious university such as Columbia University, Stanford University, or Carnegie Mellon University, collaborates with private for-profit distance learning organization. This creates a value-chain partnership. The target population in this model is professionals and business executives who don't intend to get a degree, but to acquire professional knowledge from a high-quality program.

The fourth type of business model is the strategic alliance. This business model refers to a partnership or alliance with different universities and industries. The goal of this business model is to increase economies of scale to reduce costs and gain competitive advantages in the distance learning educational marketplace. The target population of this business model includes corporate employees, professionals and off-campus students. Although this business model can let each partner exploit its own competitive advantage to maximize the total profits, management and coordination are key issues.

Each of these distance learning models focus on the service need of its target population so that service providers can streamline the business process to improve the quality of future distance learning services (Granitz & Greene, 2003; Steyn & Schulze, 2003) and get long-term competitive advantages (Shaik, 2005).

What is the key that differentiates between the service quality concept and traditional evaluation? The answer is in the concept of service encounter. Redman and Mathews (1998) state that "true quality is evaluated by the consumer during and after the service encounter" (p. 60). Through the consumer service perspective, researchers in may get different insights (Moisio & Smeds, 2004) to help distance learning service providers survive ever-increasing market competition (Huynh, Umesh & Valacich, 2003).

The PZB Service Quality Model

The service quality model and the role of consumers' and learners' satisfaction is an essential part of service quality studies. The Disconfirmation Paradigm (Brady, 2001; Redman & Mathews, 1998), Parasuraman et al. (1985) enables the Service Quality Model to measure differences between consumers' perception and expectation of service quality.

According to the PZB model (Figure 1), there are five gaps.

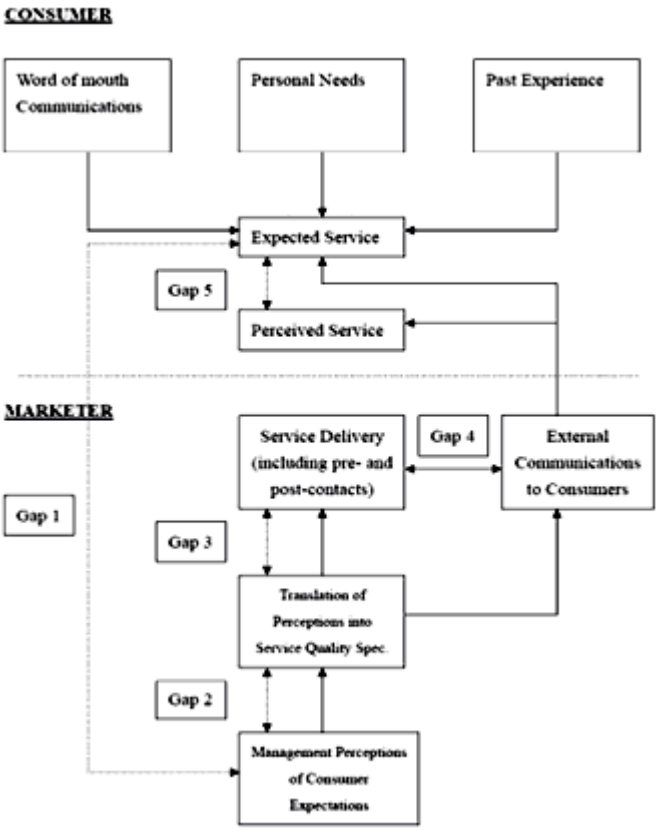
The first gap refers to the difference between customers' expected service and management's perceptions of customers' expectations. This gap means that management may not correctly perceive customer expectations.

The second gap refers to the difference between management perceptions of customers' expectations and service quality specifications. This gap means that although the people in management level may perceive the correct expectations of the customers, they may not have suitable and sufficient service quality specifications.

The third gap refers to the difference between service quality specifications and the real service delivery. This gap means that although the service providers may have suitable and sufficient service quality specifications, they may not have the satisfactory service delivery in the real situation. That may be because service providers lack well-trained employees to deliver satisfactory service.

The fourth gap refers to the difference between the service delivered and external communication about the service with customers. That is, the service providers may not have suitable and sufficient communication with the customers or the service providers may have commitments that exceed what they can do or they may not sufficiently inform the customers of what they have done.

The fifth gap is the difference between consumer expectation and their perception of service quality - measured by the difference between what customers expect and what customers perceive about the service. In addition, gap 5 is a function of gap 1, gap 2, gap 3, and gap 4; that is, Gap 5= f (gap1, gap2, gap3, gap4). This means that the service quality is closely related to management perception, marketing, personnel management, communications with customers, service specifications and delivery. Based on theoretical development of the PZB Service Quality Model, the SERVQUAL (SERVice QUALity) instrument was proposed in 1988.



Source: Parasuraman, A., Zeithaml, V. A. & Berry, L. L. (1985). A Conceptual Model of Service Quality and Its Implications for Future Research. *Journal of Marketing, 49(4),* 41-50.

Figure 1: PZB Service Quality Model

Consumer and Learner Satisfaction

Consumer satisfaction plays a very important role in business administration, not only because it has direct influence on the performance of the organizations (Wong, 2000; Fornell, 1992), but because it is highly associated with the competitive advantages of the institutions and organizations in the marketplace (Greenland, Coshall, & Combe, 2006). In distance learning, as institutions and organizations provide the learners with training and learning services, students and learners are customers in the educational service settings (Stevenson & Sander, 1998; Moisio

& Smeds, 2004; Douglas & Douglas, 2006). Customer satisfaction can reasonably be considered to be learner satisfaction.

In educational studies, the learners' satisfaction has been widely used as a critical dependent variable to evaluate success of the programs. Compared with other outcome variables in educational studies, learner satisfaction is not an equivocal and obscure indicator. It shows the success of communication between learners and instructors, which is a measure quality and success of the entire program (Thurmond, Wambach, & Conners, 2002). The learner is one of the important stakeholders in the educational arena (Yeung, 2001; Yang & Cornelious, 2004). As for distance learning, it is reasonable that the learners' perception will be considered as a crucial indicator to evaluate the quality of distance education (Steyn & Schulze, 2003).

In the business area, consumer satisfaction often denotes whether the service provider met the consumers' need (Steyn, & Schulze, 2003). Anderson, Fornell and Lehman (1994) propose there are at least two viewpoints in the definition of consumer satisfaction. The first viewpoint is a transaction-specific perspective, which refers to the consumers' post-purchase appraisal or judgment of the products or service based on expectations at the specific purchasing time or location. The second viewpoint is cumulative satisfaction, which refers to consumers' overall appraisal of purchasing and consuming experience toward the products or service. Therefore, we may regard learners' satisfaction as the learners' overall post-using evaluation toward the educational service.

The SERVQUAL and SERVPERF

Based on preliminary knowledge about the service quality model and the consumer satisfaction concept, there are two major assessment instruments (SERVQUAL and SERVPERF). The SERVQUAL (SERVice QUALity) instrument was proposed by the Parasuraman et al. (1988). In the beginning, they collected data from service industries such as appliance repair and maintenance, bank industry, credit card, securities brokerage, and long-distance phone companies. They initially developed a 97-item instrument to measure the service quality attribute. After eliminating the items with low correlation, they extracted five factors (tangibles, reliability, responsiveness, assurance, and empathy) with 22 service quality items, and claimed the generic nature of the five-dimension instrument.

Because the disconfirmation-based SERVQUAL instrument has advantages such as better diagnostic power (Jain & Gupta, 2004), and the parsimony of the instrument (Rohini & Mahadevappa, 2006), most researchers in the service quality area tend to prefer the disconfirmation-based SERVQUAL instrument (Abdullah, 2006; Brady, 2001). However, some researchers have been questioning its drawbacks related to the disconfirmation-based model (Redman & Mathews, 1998), process orientation, dimensionality, measuring scale, and the gap scores (Buttle, 1996; Coulthard, 2004; Clewes, 2003; Wetzels, Ruyter, & Lemmink, 2000).

To resolve problems related to the disconfirmation-based SERVQUAL instrument, Cronin and Taylor (1992) propose the performance-only SERVPERF (SERVice PERFormance) instrument to measure service quality. Comparing the validity and reliability of the SERVPERF with that of the disconfirmation-based SERVQUAL, they claim that SERVPERF is better than SERVQUAL in overall service quality measurement in empirical tests (Cronin & Taylor, 1992; Brady, Cronin, Brand, 2002; Jain & Gupta, 2004). The debate related to adoption of SERVQUAL or SERVPERF in service quality studies is not yet resolved. SERVPERF has better explanatory power in overall service quality measurement. On the other hand, SERVQUAL has better diagnostic power because of the P-E score measurement. Thus, selection of the service quality instruments will be determined by the intention of the researchers, service providers or decision-makers (Jain & Gupta, 2004).

Recommendation for Future Research

The DL-sQUAL instrument developed by Shaik, Lowe and Pinegar (2006) needs further validation. To address the need for quality improvement in distance learning and the needs of different target populations in the distance learning market, researchers need to conduct a comparative analysis among the SERVQUAL, the SERVPERF, and the DL-sQUAL instruments to further validate the appropriateness of different instruments for distance learning. Most importantly, debates related to the adoption of the P-E score method (SERVQUAL) or the perception-only method (SERVPERF) in the service quality studies have not been resolved because of the shortcomings of the service quality model. Researchers in DL may need to develop the distance learning service performance instrument (DL-SERVPERF) to address the specific needs of researchers, service providers and decision-makers.

Conclusion

Individual learners and groups of learners have a need for high-quality distance learning to assist them in fulfilling their lifelong learning goals. Organizational needs for high-quality distance training is increasing at an explosive rate because it is flexible, convenient, and cost-effective (Hammond, 2001; Whitney, 2006; David, 2006). Distance learning is expected to play an important role in Human Resource Development (HRD).

Distance learning and distance training require quality instruction and excellent technical and administrative support (Shaik, Lowe & Pinegar, 2006). Through educational services such as student advising, real-time information about courses, help desk and complaint handling, the institutions or service providers in DE can not only build, expand and sustain the perennial relationships with the target clients, but also create added-value in the DE program to further long-term competitive advantages in the DE marketplace (Shaik, 2005).

Last but not least, the idea of quality improvement and developing excellence is always a focal point propelling the HRD professional field (Swanson & Holton, 2001; Claus & Dooley, 2005). In order to achieve continuous and incessant quality improvement in distance education through the analysis of service quality and consumer satisfaction, researchers and practitioners must continue to grow new insights (Moisio & Smeds, 2004) to further provide the learners at the individual, group, and organizational level with good-quality distance learning and training service.

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Editor's Note: This research uses a pretest, posttest, delayed text model to test the efficacy of Computer Assisted Learning for university level students in science, mathematics and engineering in India.

Computer Assisted Learning (CAL) Strategy for "Numerical Methods Course" - an Experiment

Satish Rastogi, Ashok S. Pawar

India

Facilitating the learner to learn is very much associated with the efforts of a teacher to adapt the process for a specific learner. Creating an interest and active involvement with the learner is the responsibility of the teacher. In the words of Jack Koumi "If the teacher can create an enduring fascination for the subject matter, the job is almost over: the more the students love the subject, the less help they need in their studies." The strategy to be used should be affective or motivational rather than cognitive.

Computers are used in almost every aspect of daily life, and its widespread use has proved the tremendous potential of computer technology for helping mankind. Many experiments have been conducted in India to assess the effectiveness of computer technology in learning. Richard A. Shade and M. N. G. Mani, N. S. Yemul, K. K. Soni, Narayan Ugar, D. Ray, M. Chandwani Abhay Jain and S. Mukherjee, performed experiments to determine the effectiveness of computers in the teaching-learning process. Mukhopadhyay (1993) made a reference to Paliniapan V. P., Goyal D. R., Nachimuthu K., Subramaniam K., Malathi Rao & Usha Rao, Anil Kumar, Rastogi Rashmi, Mitra S., Gupta Madhu, Pant M.M., for developing computer strategies to learn different academic course content. These experiments enlightened investigators to develop the Computer Assisted Learning (CAL) strategy for degree students to learn the concept of Numerical Methods.

Learning Difficulties in Numerical Methods

The widespread use of digital computers in recent years in scientific research has made the study of Numerical Methods as important as the study of Mathematics. A number of Universities have introduced the course 'Numerical Methods' in the undergraduate science curricula. Learning tedious and difficult contents of Numerical Methods in the classroom is time consuming and boring. This creates apathy in the minds of learners and they try to ignore this content. Students require a process or technology to save their time and sustain a continuous interest among them. The investigators thought to take the advantage of CAL strategy and develop some software for learning Numerical Methods in an easier way.

Objectives of the Study

- Identify learners' difficulties in learning Numerical Methods.
- Prescribe a computer based Remedial Package for learning Numerical Methods course content.
- Examine the effectiveness of this strategy to enhance knowledge among target group learners.
- Assess the level of knowledge retention with the help of the CAL strategy.

- Determine the significance of difference between retention level and knowledge gained level by the target group.
- Compare the effectiveness of this strategy among different categories of learners.
- Improve the quality of CAL through learner opinion.

Hypotheses

- There is no significant difference in the level of learners' achievement of the target group between Pre-test and Post-test.
- There is no significant difference in the level of learners' achievement of the target group between Pre-test and Retention-test.
- There is no significant difference in the level of learners' achievement of the target group between Post-test and Retention-test.
- There is no significant opinion of the target group towards CAL strategy.

Significance of the Study

The content of Numerical Methods is very important to undergraduate and postgraduate students for solving application problems in Physics, Electronics, and Computer Science as is evident from a course content analysis. The long calculations are not reliable, boring, and students develop apathy towards this content. An urgent need was to have an innovative approach to developing an effective CAL strategy for learning this content. This experimental research is also very significant because it opens the doors of computer applications for learning tedious and difficult course content. The National Council of Teachers of Mathematics in U.S.A. has very rightly justified the use of computer in the learning and teaching of Mathematics as

> *"Teachers should use computers as tools to assist students with the exploration and discovery of concepts, with the transition from concrete experiences to abstract mathematical ideas, with the practice of skills, and with the process of problem solving. In mathematics education, the computer must be instructional aids and not the object of instruction"*.

Many researchers found that irrespective of the subject taught, the reasons for adopting CAL remain the same. The computer has been found to be useful as a means of (1) augmenting teaching/training methods, (2) accelerating the learning process, (3) experimenting in course development, (4) providing remedial instruction, (5) providing individualized instruction, (6) providing enrichment material, (7) achieving consistently higher teaching standards, (8) providing cost effective instruction, (9) providing 'on demand' instruction. This has motivated the investigators to see the effectiveness of CAL in learning Numerical Methods.

Limitations of the Study

This research is limited to students of undergraduate degree courses. Both males and females were selected for this study. Students from four disciplines: Physics, Electronics, Mathematics, and Computers were chosen for the purpose of comparison. This study was limited to the students of Sri Shivaji Vidya Prasarak Sanstha's Science College, Dhule, Maharashtra (India) for the sake of convenience and constraints of time and money. This was a self financing project and so investigators decided to select their sample from Dhule town only. Numerical Methods is a very vast subject. Every method cannot be included for this research. The investigators have selected

only the *Iterative methods* covering Bisection Method, *False Position Method, Newton-Raphson Method* for this project.

Research Methodology

(1) Population and Sample for the Study

This was an experimental research for assessing the effectiveness of CAL strategy to learn Numerical Methods. It was decided that the population for this study would be comprised of students studying Numerical Methods in Physics, Electronics, Computers and Mathematics at the undergraduate level in colleges affiliated with North-Maharashtra University, Jalgaon. At this time, there are twelve colleges where the 'Numerical Methods' course is taught at undergraduate level. Students studying this course at Shri Shivaji Vidya Prasarak Sanstha's Science College, Dhule, Maharashtra, India were taken as sample for this study.

(2) Tools Development

(a) Development of Achievement Test: The content covering Bisection Method, False Position Method, and Newton-Raphson Method was analyzed and a questionnaire having five open type Questions for a total of one hundred marks was constructed. For this purpose, the investigators selected about fifteen questions and submitted them to five experts in the field of Numerical Methods. After a long discussion, ten questions were dropped and five questions were kept in the Questionnaire. Ten questions were dropped because, in the opinion of all five experts, they were too simple. The students were allotted two hours to answer this Questionnaire. This test was used as Pre-test, Post-test and Retention-test. Students were asked to use a computer to solve these questions under the supervision of the investigators.

(b) Development of CAL Software: The investigators analyzed the content and explained it using simple language, picture and examples. The script developed was discussed with five software experts. After implementing their valuable suggestions, the script was made final for loading in the computer. The software was developed in Visual Basic. Executable programs of Numerical Methods are written in C++ language. This loaded script (software) was reviewed by software experts and some corrections were made based on their advice. This software was used for the purpose of this project.

(c) Essay Writing – A Tool for Learners' Opinion: The investigators requested students to write an essay covering their experiences and their opinion about the CAL strategy. These essays were examined to determine their opinion and experiences. Analysis revealed many common opinions; a few were specific. These were sorted to assess the acceptance of the CAL strategy.

The common points revealed that CAL was recognized as an approach to individualized instruction. Learners realized the importance of Computer Education. CAL can be used successfully for learning difficult Numerical Methods concepts. Educational Institutions will function differently if they use computer support for teaching and learning activities. CAL was considered to be cost effective. It helped learners to solve problems that were very difficult to solve manually. Once developed, CAL can be used for years by successive groups of students.

Specific problems were stated by some students. They complained that the cost of purchasing computers at their residence was beyond their means. They also noted frequent failure of the electricity supply in rural areas and their elementary (limited) knowledge of computer operations.

(3) Procedure

The investigators conducted a Pre-test and analyzed the student responses. Students were asked to study the CAL content and were assisted by the investigator with the help of computer for about one month. No time limit was imposed for learning so that students were able to learn at their

own rate. After one month, a Post-test was carried out. It was followed by the Retention-test after two months. Students were asked to write an essay about their experiences and opinions regarding various activities of this experiment. These opinions were analyzed and conclusions were drawn. This methodology was followed on a single group design.

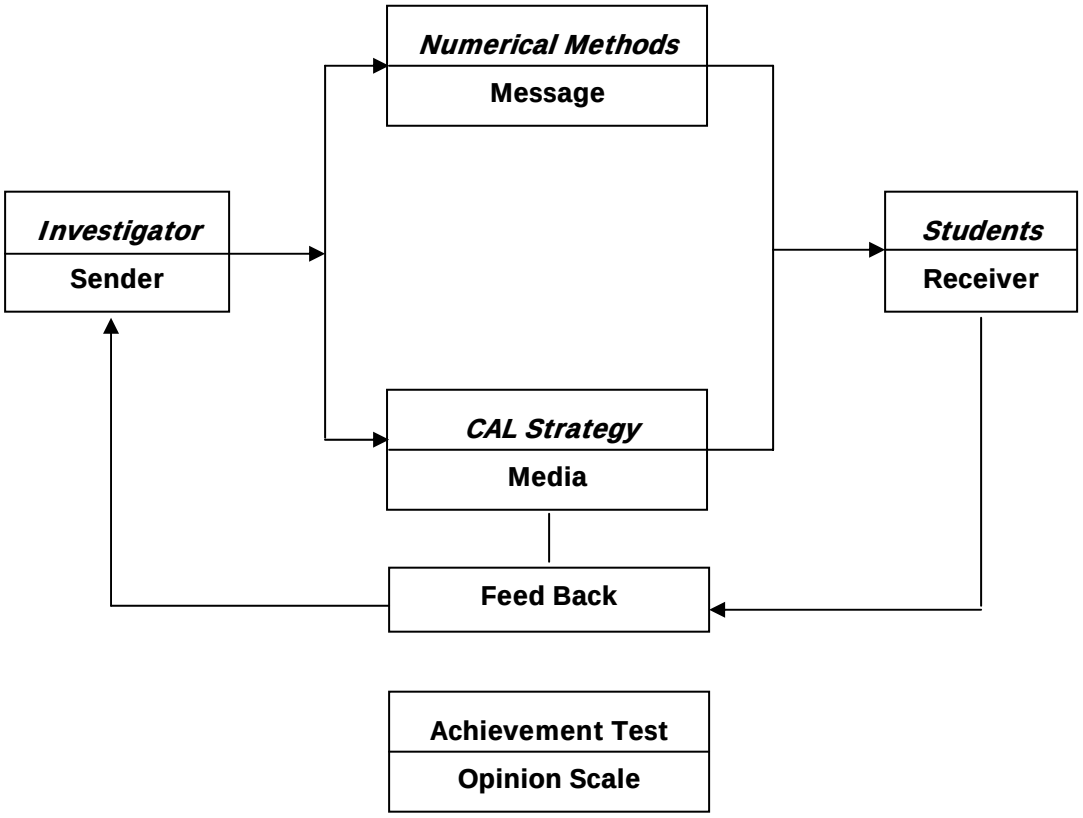

Figure 1. Experimental Design

Data Collection And Analysis

The marks obtained by the target group for Pre-test, Post-test and Retention-test were analyzed as per the objective of the study. There were forty four students taken in the sample. The distribution is shown below.

Table 1

Categorywise Distribution of Target Group (Total 44)

Group	Number of Students	Remarks
Electronics	10	Third Year - Bachelor of Science.
Computer	18	Third Year - Bachelor of Science.
Physics	11	Third Year - Bachelor of Science.
Mathematics	05	Third Year - Bachelor of Science.
Total	**44**	

The marks obtained by the students were analyzed statistically The Mean, Standard deviation and t-values are given in Table-2.

Table 2

Statistical Analysis of Target Group Performance
(Total 44)

Test	Mean	S.D.	t-values	Remarks
Pre-Test	25	9.2	*t_{12}=3.3136	t > 2.021 Significant at 0.05 Level
Post-Test	81	14.9	*t_{13}=2.8934	t > 2.704 Significant at 0.01 level
Retention-Test	82	18.0	**t_{23}=0.09250	

* Significant at 0.01 Level, ** Not significant at 0.05 Level

Table 2 reveals that there is significant difference in level of achievement between Pre-test and Post-test stages as well as between Pre-test and Retention-test stages because the 't' value obtained is much higher than the standard table value 2.704. The difference is not significant between Post-test and Retention-test even at 0.05 level as the 't' value obtained is much lower than the standard table value 2.021 .

The data indicated that the CAL strategy is very effective for learning Numerical Methods and resulted in significant change in the level of Knowledge. The Retention test showed that the target group retained almost similar level of information to the Post-test and so the forgetting factor was negligible (not significant).

Table 3

Statistical Analysis of Target Group Performance
[Electronics Group (Total : 10)]

Test	Mean	S.D.	t-values	Remarks
Pre-Test	26	7.1	*t_{12}=6.8421	t > 2.306 Significant at 0.05 Level
Post-Test	91	7.81	*t_{13}=5.6363	t > 3.355 Significant at 0.01 level
Retention-Test	88	12.08	**t_{23}=0.6000	

* Significant at 0.01 Level, ** Not significant at 0.05 Level

The target group had ten students from Electronics. Analysis of the data obtained from Pre-test, Post-test, and Retention-test revealed that the difference between Pre-test and Post-test as well as between Pre-test and Retention-test was highly significant at 0.01 level. The 't' value obtained is much higher than the standard table value 3.355. The difference is not significant between Post-test and Retention-test even at 0.05 level as the 't' value obtained is much lower than the standard table value 2.306 . This analysis indicates that CAL strategy was effective with the target group (Electronics).

Table 4 represents the computer group with eighteen students. The data revealed, after analysis, that the difference in scores between Pre-test and Post-test as well as between Pre-test and Retention-test were highly significant at 0.01 level. It is because the 't' value obtained is much higher than the standard table value 2.921 . The difference is not significant between Post-test and Retention-test even at 0.05 level as the 't' value obtained is much lower than the standard table value 2.020. This analysis indicates that CAL strategy was found much effective with target group (Computer).

Table 4

Statistical Analysis of Target Group Performance.

[Computer Group (Total :18)]

Test	Mean	S.D.	t-values	Remarks
Pre-Test	23	8	*t_{12}=3.5882	t > 2.020 Significant at 0.05 Level
Post-Test	84	15	*t_{13}=2.9729	t > 2.921 Significant at 0.01 level
Retention-Test	83	20	**t_{23}=0.0477	

* Significant at 0.01 Level, ** Not significant at 0.05 Level

The target group from Physics had eleven students.

Table 5

Statistical Analysis Of Target Group Performance
[Physics Group (Total : 11)]

Test	Mean	S.D.	t-values	Remarks
Pre-Test	28	9.3	*t_{12}=4.5001	t > 2.282 Significant at 0.05 Level
Post-Test	73	12.7	*t_{13}=4.0909	t > 3.250 Significant at 0.01 level
Retention-Test	73	11	**t_{23}=0.1000	

* Significant at 0.01 Level, ** Not significant at 0.05 Level

Data obtained from Pre-test, Post-test and Retention-test revealed, after analysis, that the difference of marks between Pre-test and Post-test as well as between Pre-test and Retention-test was highly significant at 0.01 level. This is because the 't' value obtained is much higher than the standard table value 3.250. The difference is not significant between Post-test and Retention-test even at 0.05 level as the 't' value obtained is much lower than the standard table value 2.282 . This analysis indicates that CAL strategy was found much effective with target group (Physics) also.

The target group from Mathematics had five students.

Table 6

Statistical Analysis Of Target Group Performance
[Maths Group (Total : 5)]

Test	Mean	S.D.	t-values	Remarks
Pre-Test	24	11	*t_{12}=5.1818	t > 3.182 Significant at 0.05 Level
Post-Test	81	05	*t_{13}=3.8125	t > 5.841 Significant at 0.01 level
Retention-Test	85	13	**t_{23}=0.4444	

* Significant at 0.01 Level, ** Not significant at 0.05 Level

Data obtained from Pre-test, Post-test and Retention-test revealed, after analysis, that the difference of marks between Pre-test and Post-test as well as between Pre-test and Retention-test was highly significant at 0.01 level. It is because the 't' value obtained is much higher than the standard table value 5.841. The difference is not significant between Post-test and Retention-test even at 0.05 level as the 't' value obtained is much lower than the standard table value 3.182 . This shows that the CAL strategy was effective with target group (Math).

These tables indicate that CAL strategy was effective in assisting students in all target groups to learn Numerical Methods.

Table 7

Statistical Analysis of Performance of Learners in Subgroups

Group	N	Pre-test		Post-Test		Retention-Test		Remarks
		M	σ	M	σ	M	σ	
Electronics	10	26	7	91	7.8	81	12	The CAL strategy brought remarkable change in the level of achievement
Computer	18	23	8	84	15	83	20	
Physics	11	28	9	73	12	73	11	
Mathematics.	05	24	11	81	05	85	13	

Table 8

Comparison of Performance of Learners in Subgroups

Group	Pre-Test	Post-Test	Retention-Test
Electronics-Computer df=26	t_{12}=1.038 Not Significant at 0.05 level	t_{12}=1.6279 Not Significant at 0.05 level	t_{12}=1.3333 Not Significant at 0.05 level
Electronics-Physics df=19	t_{13}=0.571 Not Significant at 0.05 level	t_{13}=4.1383 Significant at 0.01 level	t_{13}=1.600 Not Significant at 0.05 level
Electronics-Maths df=13	t_{14}=0.400 Not Significant at 0.05 level	t_{14}=3.0156 Significant at 0.01 level	t_{14}=0.5882 Not Significant at 0.05 level
Computer-Physics df=27	t_{23}=1.5625 Not Significant at 0.05 level	t_{23}=1.800 Not Significant at 0.05 level	t_{23}=1.7543 Not Significant at 0.05 level
Computer-Maths df=21	t_{24}=0.1923 Not Significant at 0.05 level	t_{24}=0.7281 Not Significant at 0.05 level	t_{24}=0.2704 Not Significant at 0.05 level
Physics-Maths df=14	t_{34}=0.7194 Not Significant at 0.05 level	t_{34}=1.7575 Not Significant at 0.05 level	t_{34}=1.8118 Not Significant at 0.05 level

Tables 7 and 8 compare the performance of learners in various subgroups at three stages. Data analysis for Pre-test indicates that the difference between Electronics and Computer, Electronics and Physics, Electronics and Mathematics, Computer and Physics, Computer and Mathematics, Physics and Mathematics were not significant at 0.05 level. Hence performance of all four groups was identical in Pre-test. The data analysis for Post-test indicates that the difference between Electronics-Computer, Computer-Physics, Computer-Mathematics and Physics-Mathematics, groups were not significant even at 0.05 level. But, the difference between Electronics-Physics and Electronics- Mathematics were significant at 0.01 level.

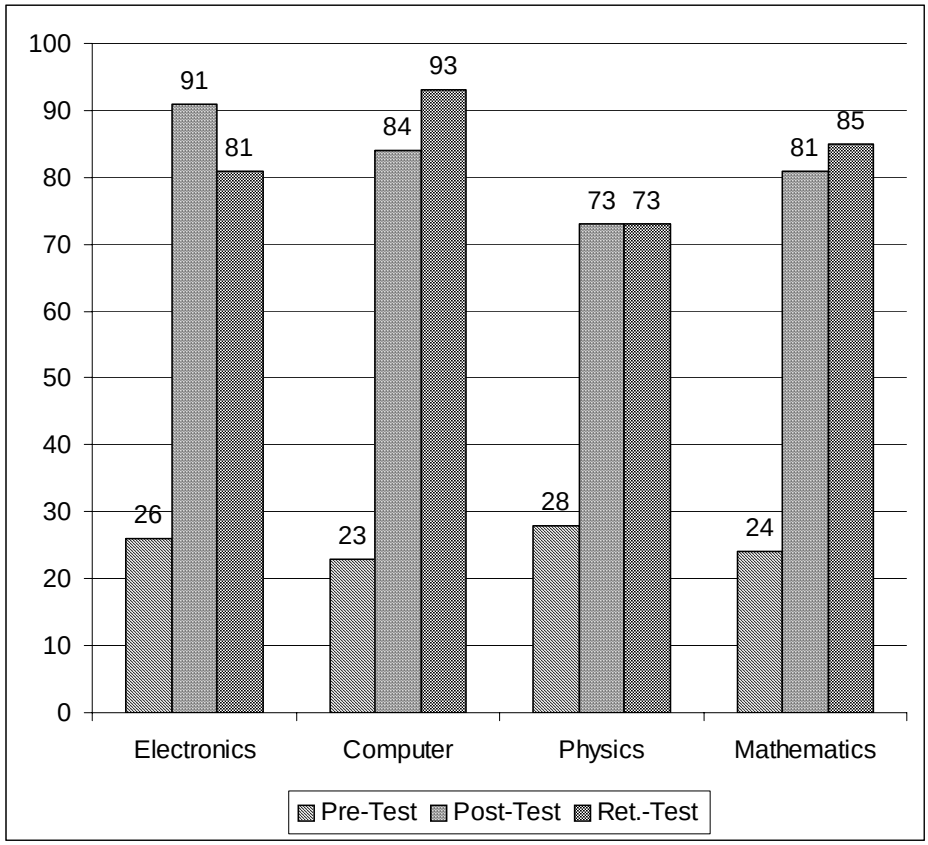

Figure 2. Graphical presentation of learner performance in all four groups

Data analysis for the Retention-test indicates that the performance of all four groups was identical, because the difference found was not significant at 0.05 level. The essays, written by students about their experiences and opinions towards CAL witnessed that they enjoyed the CAL strategy and maintained high creativity, interest and motivation levels during the experiment. Some of them wanted similar strategies for the remaining content in Numerical Methods. The analysis indicates that the difference between Pre-test and Post-test was highly significant and so Hypothesis number one was not accepted. The difference in the level of achievement of the target group between Pre-test and Retention-test was highly significant, so Hypothesis number two was not accepted. The difference in the level of achievement of the target group between Post-test and Retention-test was not found significant even at 0.05 level and so Hypothesis number three was accepted. The opinion of the learners regarding CAL obtained through essays indicate that there was no controversy among them about their opinion and every body enjoyed and was interested in learning with the help of CAL strategy. Thus the Hypothesis number four was not accepted.

Conclusion

The CAL strategy developed by the investigator raised the level of achievement in Numerical Methods among third year Bachelor of Science (B.Sc.) students. It is recommended that similar strategies for other content be developed and the effectiveness be studied. This experiment opened the door for researchers to conduct similar experiments for other target groups in Numerical Methods content. It may also motivate the researchers to develop CAL software for other subjects.

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