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TEACHING FOOD SAFETY: A COMPARISON OF COMPUTER-MEDIATED VERSUS FACE-TO-FACE COOPERATIVE LEARNING

A Thesis in

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ABSTRACT

This study investigated the effectiveness of interactive technology in improving middle school students' food safety knowledge and self-reported food handling behaviors in a one-month intervention comparing two strategies, computer-mediated versus face-to-face cooperative learning. Variables associated with successful outcomes were explored. A pretest-, post-test, delayed post-test design with a control group (no treatment) was employed. Total number of students was 178. Instruction consisted of studying food safety with an interactive CD-ROM (dyads) and with a cooperative Jigsaw-type assignment (groups of four) with either printed materials or the Internet.

Pretest food safety knowledge was fairly good (7.2 ± 1.7 out of 10 points), although 22% of the students reported frequently taking risks in their food handling, and 22% reported prior experience with foodborne illness. Significant increase in knowledge after the CD-ROM study (5%, $p = .04$) was indicated for the entire experimental group (CMC in particular) with significant further gain in knowledge for boys in the FTF cooperative study (10%, $p = .05$), but a significant loss for boys in the CMC (-12%, $p = .04\%$) and non-significant gains for the girls. The one-month improvement in self-reported food handling behaviors was significant for both groups although the gain in knowledge was significant only for the FTF group. For the girls, both treatments resulted in improvement in self-reported food handling behaviors, but only FTF in gain in knowledge. For the boys neither was effective. However, no significant differences in the one-month gain scores between the two experimental groups were indicated. Variables associated with learning outcomes included prior computer experience, interest in studying food safety, perceptions related to food safety, and satisfaction with the cooperative assignment as a helpful learning tool, all of which favored the girls. These findings indicate that CMC can be considered a viable medium for school-based health education in cooperative learning environments in middle schools with ample access to computers and the Internet.

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Chapter 1

INTRODUCTION

Computer-assisted instruction has been found to be effective in K-12 learning settings (Carew, Chamberlain & Alster 1997). Especially when combined with cooperative learning assignments, it has lead to equal or greater gains in knowledge and skills than traditional classroom instruction (Rysavy & Sales 1990; Mevarech 1993; Repman 1993). The current educational trend is to augment classroom bound computer-assisted instruction with Web-based activities, opening the classroom to wider resources and connections worldwide (Itzkan 1993; Derry 1997; Hedberg, Brown & Arrighi 1997).

While it has been the Clinton-Gore administration's initiative that every student have access to the Internet (Report to the Nation 1996), very little research has been done in evaluating the effectiveness of supplementing computer-assisted instruction with Web-based activities (computer-mediated communication, CMC) in K-12 learning settings (Althaus 1997; Butler 1997). Even at the university level, with only a few exceptions (Hiltz 1986; Hiltz 1990; Marttunen 1992; Althaus 1997), there has been almost no systematic effort to gather data on student performance that could be used to test hypotheses about the effectiveness of this approach. As a result, there is still relatively little hard evidence to support the notion that CMC technology can help create learning environments superior to traditional face-to-face (FTF) settings (Althaus 1997).

In health communication, the use of computers and CMC has mostly been limited to clinical, patient care, or post-secondary settings (Carew, Chamberlain & Alster 1997; Kolasa et al. 1997; Thomas, Cahill & Santilli 1997). However, the use of these technologies for preventive health education among younger populations would yield an even greater impact (Austin 1995; Lieberman 1997). Interactive technology has the potential to enhance children's and adolescents' motivation to adopt new health behaviors through strengthening perceived self-efficacy, providing vicarious experience, performance accomplishment, verbal persuasion, and social support through case-based scenarios and facilitated interaction via CMC (Dede & Fontana 1995; Brennan & Fink 1997; Street & Rimal 1997). Integrating computer technology into health education instead of male dominated math and science curricula could help balance the reported gender gap in computer attitudes and experience (AAUW 1991; Pelgrum 1992) in K-12 settings.

Although important for both genders, food safety education is often forgotten as part of health education. While schools have reduced emphasis on instruction of safe food handling, almost one third of the individuals in American food service occupations are under 20 years old, and in many households, adolescents are often responsible for preparing their own meals. The need for enhanced food safety education has been recognized both in the U.S. (American Meat Institute & Food Marketing Institute 1996;

USDA 1998; USDA & FSIS 1998; USDA 1999) and Europe (The European Commission 1999) with the launch of national initiatives to find ways to effectively educate the consumers, especially the young, the food preparers of the future.

Purpose of the Study

We still do not know whether computer-assisted instruction and computer-mediated communication (online) are effective tools for school-based health education. Very little information is available on how to best implement interactive technology in classroom instruction to achieve maximum benefit.

The purpose of this study was to investigate the effectiveness of cooperative computer-assisted, school-based food safety education in increasing middle school students' food safety knowledge and safe food handling behaviors. It tested the consistency of the effects of the instructional method (cooperative learning) delivered by alternative media, computer-mediated and face-to-face, identifying attributes that may differently impact learning. The main hypothesis was that in cooperative learning environments, learning does not depend upon the medium but is more affected by students' background characteristics and opinions related to the instruction. Based upon prior research such characteristics were hypothesized to be related to computer experience and opinions related to the content.

Objectives of the Study

The objectives of the study were:

- to examine student perceptions of food safety, the level of food safety knowledge and the frequency of self-reported safe food handling practices.

- to investigate the effectiveness of a cooperative computer-assisted learning environment in increasing middle school students' food safety knowledge and safe food handling behaviors.

- to evaluate the relative effectiveness of computer-mediated versus face-to-face cooperative assignments in supporting learning and the adoption of safe food handling behaviors among middle school students.

The specific research questions for this study were:

1. What is the current level of food safety knowledge and safe food handling behaviors among middle school students?

2. Is there an increase in middle school students' food safety knowledge immediately after a 1-session CD-ROM based cooperative instruction?

3. Is there an additional increase in food safety knowledge and an increase in self-reported safe food handling practices after two subsequent weekly sessions utilizing cooperative learning assignments?

4. Is there a difference in the effectiveness of computer-mediated versus face-to-face collaboration between student groups in increasing middle school students' food safety knowledge and self-reported safe food handling behaviors?

5. Which student characteristics are associated with learning outcomes?
    - Gender
    - Prior computer experience and computer attitudes
    - Motivation (Interest)
    - Perceived threat of foodborne illness
    - Perceived self-efficacy and response efficacy
    - Opinions about the instruction and cooperative work.

Need for the Study

The importance of food safety education has increased with the increase in foodborne illness and the emergence of new deadly strains of bacteria. Since most outbreaks occur in large public gatherings and in non-industrialized settings, health educators have been forced to seek new and more efficient channels to educate the public on safe food handling and the prevention of foodborne illness.

The spread of computer technology provides a new medium for health education and health communication, yet very few studies have investigated the use of this medium and even fewer studies have been carried out in K-12 classroom settings. There still exists a need to study the effectiveness of computer-mediated health communication in supporting learning and health behavior change among adolescents. This study explored effective ways to integrate interactive computer technology into classroom instruction. It adds to the research on the effectiveness of interactive computer technology and especially the relative effectiveness of computer-mediated communication for nutrition education in cooperative learning environments.

Assumptions

In this study it was assumed that students across the participating schools were academically equal, had equal access to sufficient computer technology, and had comparable computer skills. Their teachers were also assumed to be supportive of both cooperative face-to-face and computer-mediated group work.

Operational Definitions

CD-ROMs are optical disks utilizing the same technology as audio compact discs. CD-ROMs can hold gigabytes of information, and without straining the hard drive space can play multimedia productions with the required speed. CD-ROM-based instructional material can be designed to support highly interactive learning.

Computer-assisted instruction (CAI) refers to instruction, which utilizes computers as learning tools. Parts or all of the instructional content can be placed on the computer, most often in the form of multimedia presentations on a CD-ROM. Such educational CD-ROMs can be designed for individual study or for cooperative study in pairs or groups, with suggestions for group discussions on the topic.

Computer-mediated communication (CMC) refers to communication, which takes place through the computer. CMC utilizes Web-based communication tools either asynchronous, such as web-sites as information resource, email, bulletin (message) boards, and mail-listings (LISTSERV), which can be accessed at the user's convenience, or synchronous, such as chat-rooms, which require simultaneous presence of the users.

Cooperative learning (CL) refers to a teaching and learning strategy in which students work in groups toward a shared, common, goal with a group reward, which is dependent upon individual learning. Teacher serves as a facilitator of such cooperative work providing the materials and help after the group members have been consulted. CL can be arranged to resemble simple "working in groups", without the mentioned goal, responsibility and reward structure, but this has been found less effective in increasing academic achievement.

Face-to-face instruction (FTF) refers to classroom teaching strategy in which teacher and students are in the same room, interacting face-to-face.

Food safety education refers to instruction in food safety issues, risks and the severity of foodborne illness, and the preventive measures, i.e., safe food handling procedures.

Health communication refers to the communicative process of health education. Health communication can use various media to disseminate health information to and between target populations or persons to promote public health.

Health education refers to any set of learning experiences designed to facilitate the voluntary adoption of health enhancing behaviors.

Interactive technology refers to computer-based programs designed to support interaction between the learner and the program. Effective interaction allows the user to get the required job done. Users can write or point and click their answers, which lead to alternative paths of action in the program. This also refers to technologies, which support interaction between users of the program, either at the computer or through the computer (CMC technologies).

Learning outcomes in this study refer to changes in knowledge and changes in self-reported behaviors. Additionally, attitudes and changes in them were assessed.

Middle school student refers to American school children in grades 6 through 7 or 8, depending upon the school district. In this study, grades 7 and 8.

Nutrition education is considered a part of health education, which concerns increasing knowledge, changing attitudes and increasing healthy dietary choices and behaviors to enhance health and reduce the risk of disease. It covers food safety education to ensure a safe food supply.

Perceived self-efficacy refers to a person's appraisal of his or her capabilities of performing a task successfully, based upon his or her prior experience and expectations of the anticipated outcomes.

Perceived threat refers to a person's combined appraisal of his or her personal risk of (**susceptibility** to) a health hazard and the seriousness (**severity**) of the possible consequence.

Perceived response efficacy refers to a person's belief of the benefits and the usefulness or effectiveness of the proposed actions in preventing the health hazard.

Relative effectiveness refers to the comparison of different approaches with each other in reference to a standard or rather to a control group in this study.

Teaching strategy in this study refers to the instructional approach used, including the media used.

Web-based refers to content on the Internet, the network of computers across the world, presented in a well-designed graphical interface, the Web, easily accessible with a World Wide Web browser (Mosaic, Netscape Navigator, Microsoft Internet Explorer).

Chapter 2

REVIEW OF THE LITERATURE

During the past decade, interactive computer technology has made its way to classrooms, and after the initial frustration among teachers, the need for continuing education has shifted from learning to use the technology to implementing it effectively in daily classroom instruction (CEO Forum on Education & Technology 1999; Sherry et al. 2000). The new technologies offer a promising medium for (health) education, with their novelty value on the one hand, and their capability of making learning more fun for children on the other (Lieberman 1992; Light & Littleton 1999). Computer-assisted instruction (CAI) has been shown to offer an academically superior learning environment compared to the traditional face-to-face (FTF) classroom environment, but whether the Web-based instruction utilizing computer-mediated communication (CMC) tools can do this is currently under study. In both the CAI and FTF learning environments, the use of cooperative learning methods has been shown to be more effective than individual study or competitive study in many school subjects (Johnson, Johnson & Stanne 1985; Slavin 1998; Hakkarainen et al. 1999). Considering health education, cooperative learning environments can provide a place for social support, vicarious experience, sense of accomplishment, and interpersonal communication (Lieberman 1997), variables crucial to the adoption of health enhancing behaviors (Rogers 1995; Bandura 1997). In health education interventions, computers have been shown to naturally encourage group work (Street & Rimal 1997) and therefore could be considered an effective medium for food safety education, which is in need of new innovative tools to reach younger audiences. To gain a better understanding of the issues involved in selecting an effective medium and instructional strategy for food safety education, this literature review will explain why teaching food safety has gained importance during the past decade (needs assessment), how interactive computer technology, computer-assisted instruction and computer-mediated communication technologies, could help in responding to this need, and the theoretical framework of this study.

Food Safety Education

The Need for Food Safety Education

The need for targeting younger populations with innovative food safety education has been voiced by several researchers reporting on food safety knowledge, attitudes and practices among adult populations (Williamson, Gravani & Lawless 1992; Albrecht 1995; Altekruse et al. 1995; Unklesbay, Sneed & Toma 1998; ADA & ConAgra 1999; Bruhn & Schutz 1999; Jay, Comar & Govenlock 1999).

Surveys among several representative samples of U.S. residents (Williamson, Gravani & Lawless 1992, Albrecht 1995; Altekruse et al. 1995; ADA & ConAgra 1999; Bruhn & Schutz 1999), Australians (Jay, Comar & Govenlock 1999), and UK residents (Walker 1996) have consistently reported that food safety knowledge tends to increase with age, females tend to have higher scores than males and that respondents under the age of 35 have showed the most need for additional food safety education. Furthermore, respondents from the city tend to have lower scores than people from rural areas (Albrecht 1995), and the “occasional cooks” tend to report more unsafe food handling (Altekruse et al. 1995; Angelillo et al. 2000). Overall, from one tenth to one half of the respondents took deliberate risks in their food handling.

The key problem areas in food handling reported in these studies still coincide with the ones listed by Bryan (1988) in the eighties: incorrect thawing of frozen foods, improper hot holding, inadequate heating, tasting unsafe foods, and lack of knowledge of correct refrigeration temperatures, proper hand washing, sources of cross-contamination and its control.

Although not quite aware of the food safety rules, adults have showed a fairly good awareness of foodborne pathogens (Williamson, Gravani & Lawless 1992). Higher level of knowledge of the pathogens has been shown to correlate with corresponding food safety precautions (Altekruse et al. 1995). In a sample of 1620 randomly selected U.S. residents above 18 years of age, surveyed by FDA (Altekruse et al. 1995), those who were able to specify a food vehicle for the transmission of Salmonella were more likely to report washing their hands and cutting boards after contact with raw meat or poultry than were those who were unable to specify a food vehicle. This has led the researchers to conclude that a basic knowledge of microbiology may motivate consumers to use safe food-handling practices. Furthermore, it has been suggested that a recommendation to provide consumers with information about the risks for contamination of foods with foodborne pathogens, similar to the etiological strategy used by the food industry to control hazards during food processing (USDA 1989), may be supported by these findings (Altekruse et al. 1995).

Only a handful of studies have been conducted to explore the food safety knowledge and practices among younger populations, from childhood to college-age.

While 10-50% of adults tend to report frequent risk taking in food handling, half of the California, Missouri, and Ohio (n=824) college students surveyed by Unklesbay, Sneed and Toma (1998) reported frequently risk taking. Close to half of the students knew that luncheon processed meats had to be refrigerated to avoid risk of foodborne illness, or that you cannot identify all unsafe food by the way they look and smell, but fewer knew that properly cooking meat does make it safe to eat. Most of the respondents either visually inspected for doneness of cooked meat or tasted it. Seven percent of the respondents reported eating either raw fish or hamburger and 12% reported eating raw eggs, both of which are risky behaviors. This finding is reassuring when compared to an FDA report (FDA, USDA, EPA, CDC, 1997), according to which 23% of the public ate undercooked hamburger and 50% ate raw or undercooked eggs (Unklesbay, Sneed & Toma 1998).

Based upon the findings from these surveys, the investigators have concluded that knowledge and practices are not always positively correlated (Unklesbay, Sneed & Toma 1998; Altekruse et al. 1995; ADA & ConAgra 1999). However, most consumers consider themselves very or somewhat informed about food safety, and only one fifth consider themselves not at all informed (Bruhn & Schutz 1999). At the same time, among 605 Californian consumers, physical symptoms associated with foodborne illness had been experienced by family members in one fifth to one half of the households, with most common symptoms of upset stomach, diarrhea, flu, fever, nausea and vomiting (Bruhn & Schutz 1999).

Accordingly, Bruhn and Schutz (1999) concluded that adults' food handling and consumption behaviors are influenced by beliefs about foodborne illness (Bruhn & Schutz 1999). This was also the conclusion in a 1993 study on the interrelationship between perceived knowledge, control and risk associated with a range of food related hazards targeted at the individual, other people and society among 186 UK consumers (Frewer, Shepherd & Sparks 1994). Frewer and colleagues' study (1994) indicated that individuals seem to assume that they are invulnerable to hazards, and that information is directed at individuals less knowledgeable than themselves. The perceived risk of food poisoning from food prepared at home was smaller than that from food prepared by others. This "optimistic bias" and "illusion of understanding", according to Frewer and colleagues (1994), may be the cause why public information campaigns often fail to achieve behavior change. The highest risks were associated with a high fat diet, use of pesticides, and food poisoning from food prepared by others, whereas food poisoning from food prepared at home was a smaller risk than risk from alcohol abuse, microwaves, food irradiation, genetic manipulation of animals, of micro-organism or of plants. For all potential hazards measured in this study, personal risk was seen as being less than for other people (Frewer, Shepherd & Sparks 1994).

In line with Frewer and colleagues' (1994) findings, college students surveyed by Unklesbay, Sneed and Toma (1998) did not feel they were responsible for making sure their food was safe, although they did agree with the statement that their decisions and actions impacted their risk for foodborne illness (Unklesbay, Sneed & Toma 1998). Furthermore, one third of the Australians (Jay, Comar & Govenlock 1999) did not recognize that the home is a likely place to contract food poisoning. A recent report by Herrmann, Warland and Sterngold (2000) indicated that one fourth of the 1,100 adult

Americans interviewed were concerned with food safety, one third with both food safety and nutrition, while others were concerned with nutrition only.

Children's Food Safety Knowledge, Attitudes and Behaviors

It has been shown that children adopt their parents food choices to some extent (Birch, Zimmerman & Hind 1980; Michela & Contento 1986; Nader et al. 1989), much in line with the Social Learning Theory which posits that children learn from their environment by modeling (Bandura 1986). What about food handling behaviors? Do younger children adopt their parents' or elder siblings' food handling behaviors? Data on children's food safety knowledge and food handling behaviors is still scarce.

In 1999, Diamond and colleagues reported on an intervention to teach Safe Food, Safe Kids Food Safety Curriculum to 382 4th grade students in Northwest Ohio (Diamond, Pobocik & Horowitz 1999). Eight classrooms were enrolled in the treatment group and eight in the control group. Significant differences in gain in knowledge were shown between treatment and control groups after three lessons. The majority of the treatment group was also shown to practice correct food safety skills in the areas of hygiene, food handling, and food preparation. The researchers suggested educating all school-aged children on food safety knowledge and safe food-handling skills to help decrease the outbreaks of foodborne disease.

Michelman (1998) reported on changes in food safety knowledge among 110 8th grade students, who participated in computer-assisted food safety instruction in Pennsylvania in 1998. The knowledge questionnaire, consisting of six multiple-choice questions, showed a significant increase in knowledge from 3.08 ± 1.23 to 4.49 ± 1.38 ($p = .0001$). These 8th graders reported sometimes worrying about food safety, with a small but significant increase in worry at the end of the one-hour study session (3.07 ± 1.1 vs. 2.95 ± 1.14 on a scale from 1 to 5, where 1 was "always" $p = .028$). Home was considered the most likely place where harmful bacteria could be found by 16% of the children, whereas school was named by 47%, and restaurant by 25%. At the end of the one-hour study session with an interactive CD-ROM, *"Students Serving it Safe"* (Michelman et al. 1999), which showcased school food service personnel as instructors of food safety, school was named the riskiest place by only 22%, home now by 21%, while restaurants were named most often, by 54% of the children (a significant change for school, $p = .0001$, was reported by the researcher).

Haapala and colleagues (2000c) reported on food safety knowledge and practices among Finnish 9th grade students participating in a cooperative CD-ROM assisted and computer-mediated communication intervention. A sample of 73, 16-17-year old Finnish students studied in English to communicate with American college students on line while a control group (n=80) received no instruction. Students studied the *"Students Serving it Safe"* CD-ROM (Michelman et al. 1999) in a one-hour-session, and during two subsequent weekly double periods (90 minutes) they published and solved cooperative food safety case studies on the Internet cooperating with American mentors (n=13) through the Internet. On the safe food handling behavior index of 11 key behaviors, the Finnish adolescents (n=153) scored fairly well, an average of 3.6 ± 0.6, with 1 indicating never, 2 = almost never, 3 = sometimes, 4 = almost every time, and 5 = every time professing safe food handling. However, 15% scored below an average of 3.0, sometimes, and 44% below 3.5, which could still be considered rather risky behavior. One third (30%) of the students seldom (options: never, almost never, sometimes) washed their hands at home before handling food, 88% seldom washed hands before eating at school cafeteria or in a restaurant. Also, 44% would seldom use paper towels instead of a cloth towel to dry their hands, 29% would seldom check the expiration dates on foods before consuming, 11% seldom washed hands between handling raw meat and fresh produce, 37% would seldom clean surfaces before handling food on them, 90% seldom checked the refrigerator temperature, 27% seldom chilled foods within 2 hours, and 41% seldom chilled foods within 4 hours, 30% would *often* (options: sometimes, almost every time, every time) taste foods to check for safety, and 12% would often eat moldy bread after removing the moldy spot.

In this study, although no significant improvement was indicated on the food-handling index, significant improvement was detected in the self-reported frequency of washing hands at school or in a restaurant (2.2 ± 1.0 vs. 2.7 ± 1.2, p = .05). A significant increase in knowledge was detected from pretest to post-test, after the CD-ROM session, 4.5 ± 1.8 to 5.8 ± 1.9, p = .001, with no further increase at delayed post-test, one week after the two weekly computer-mediated communication sessions.

The alarming finding of 11-29% of the students reporting risky behavior, and 20% having at least possibly experienced a foodborne illness may to some extent be explained by the perceptions of personal risk and severity of the health threat. This group of Finnish 9th graders (n=153) perceived their risk of foodborne illness small, 1.9 ± 1.0 on a scale from 1 = very small, 5 = very high. Students explained their view in free comments published on the Internet: “My parents and the school food service personnel are safe and they know how to handle food safely”, “No risk, because we live in a Western society”, and “We never make food, Mom does”, and “Even a small child knows how to handle food safely.” However, of the 153 students in five schools, 20% had experienced a foodborne illness or were not sure of it (6% and 14%, respectively). This is comparable to Bruhn and Schutz’ (1999) finding among Californian adult population, in which 21-53% had experienced some symptoms of foodborne illness.

In the Finnish study, when asked for suggestions on how to best educate the public about food safety, the students mentioned interventions like the one they had participated in, i.e., at school, to everybody, as a compulsory subject, and with the computers and the Internet. Whereas, among American and Australian adults, the most convenient delivery channels for the food safety education, were television programming, magazines and newspapers (ADA & ConAgra 1999; Jay, Comar & Govenlock 1999).

Overall, it can be concluded that people, both the young and the old, seem to think they know how to handle food safely, but their self-reported food handling behaviors do not match up to this knowledge (Frewer, Shepherd & Sparks 1994; ADA & ConAgra 1999; Bruhn & Schutz 1999; Haapala et al. 2000). Surveys among adults and educational studies among children conducted in the 90’s have revealed gaps in food safety knowledge and between food safety knowledge and food handling practices reported by the participants. From 10% to 50% of people take deliberate risks in their food handling, which correspond to the statistics, which indicate that in the 90's, over 10% of the U.S. population experienced a foodborne illness each year, at an annual cost of $10 billion to the national economy (Todd 1989). These results also partly explain the statistics from past decades stating that out of the 7,219 foodborne illness outbreaks where the site of mishandling was reported, 79% implicated food from commercial or institutional establishment, 21% from home (Bean & Griffin 1990). An estimated 25% of these could have been avoided by safe food handling practices (USDA 1989). Centers for Disease Control and Prevention most recent estimates state that foodborne diseases cause 76 million illnesses, 325,000 hospitalizations and 5,000 deaths in the United States each year (Mead et al. 1999). Based upon smaller numbers of annual cases (6.5 - 33 million), but higher estimate of deaths (9,000), earlier estimates of the medical costs and productivity losses for 7 specific pathogens in food have been estimated to range between $6.5 billion and $34.9 billion annually, not including the chronic illness caused by some foodborne pathogens (FDA, USDA, EPA, CDC, 1997).

Food Safety Education Resources

Some common constructs for food safety education have been derived from the aforementioned data reflecting the most often violated, crucial food handling practices requiring attention in U.S. households. These most common violations identified by Bryan in the 80's (1988), are still valid at the turn of the century, and are still reflected in the five key constructs commonly chosen for educational interventions. In the following list, I have bolded the key constructs also used in this study and indicated the corresponding violations listed by Bryan (1988).

1. **Check foods**. Violations listed by Bryan include using contaminated raw foods/ingredients and using foods from unsafe sources.
2. **Cook foods to proper temperatures**. Violations include inadequate cooking, inadequate reheating, and improper hot holding.
3. **Chill promptly**. Violations include improper cooling, leaving cooked foods at room temperature, storing foods in large containers in refrigerator, and leaving 12 or more hours between preparing and eating the meal.
4. **Separate, avoid cross-contamination**. Violations include improper cleaning of equipment and utensils, allowing cross-contamination from raw to cooked foods.
5. **Wash your hands**. Violations include handling of foods by colonized /infected persons, and more recently reported violation of the washing hands altogether, or not long enough or not with soap.

With these key constructs as the basis for the content, food safety education has attempted to increase public awareness and knowledge of foodborne pathogens and to promote the simple steps of prevention of foodborne illness at home and in small catering/food production establishments. The media, on the other hand, have increased fear or feeling of personal susceptibility to foodborne illness by publicizing the most gruesome stories of foodborne illness outbreaks pointing the finger at small and medium size catering (group feeding events), while the all too common cases of foodborne illness at home go unnoticed (ADA & ConAgra 1999).

The National Food Safety Initiative, launched by the President in 1996 (USDA 1998; USDA 1999) has encouraged several innovative approaches to increase the awareness, knowledge and safe food handling practices of the public.

The Fight BAC™ campaign was launched in 1997 by the Partnership for Food Safety Education (1997) consisting of more than 500 national, state and local organizations from the public health, government, consumer and industry sectors to educate the public. The colorful printed materials and the well designed website (at http://www.fightbac.org) have attempted to increase awareness of the most common foodborne pathogens and the simple preventive steps applicable in every household. The web site also serves as a great resource for information on food safety. Also the Federal government agencies have websites, which provide an enormous amount of information for those interested. For example see the FDA site: http://www.FoodSafety.gov/.

In 1997, the European Union also launched its food safety campaign (website at: http://europa.eu.int/comm/food/index_en.html) to encourage each member state to design campaigns to "inform and educate the European consumer about the complex issues concerning food safety and their health, by conveying a few, simple messages." No evaluation reports on the effects of these campaigns have been published at this point.

Also, the American Dietetic Association and ConAgra Foundation have adopted food safety as a major educational topic. *Home Food Safety It's in Your Hands™* web site was set up in 1999 to distribute educational materials to nutrition educators and to serve as an information source to both the educators and the public.

All these resources provide tools for increasing knowledge of food safety. However, as pointed out by Contento and colleagues (1995) in their review of two decades of nutrition education, the knowledge-attitude-behavior communications model does not work unless special attention is paid to increasing motivation, strengthening the perceptions of self-efficacy through providing ample possibilities for practicing the new behaviors, providing feedback and a supportive environment, and allowing for peer interaction. Theoretically driven, behaviorally focused health education interventions have been shown to have the best potential of being effective in achieving knowledge, attitude and behavior change (Contento et al. 1995).

Such a more behaviorally focused educational tool is the previously described *"Students Serving it Safe"* CD-ROM linking school cafeteria and classroom to effectively learn food safety at the computer (Michelman et al. 1999). When implemented with cooperative computer-mediated activities it has been shown to improve Finnish adolescents' self-reported food handling practices as well as to increase knowledge of food safety (Haapala et al. 2000).

School-based Food Safety Education

At school, safe food handling is emphasized in school food service (at meal times) and supervised by the teachers. Formally it is taught as part of elementary level Nutrition curricula, as part of Family and Consumer Science or Life Sciences curricula in Middle school, and is possibly integrated into Health Education or other subjects, also in high school. Materials used include out-dated textbooks, more recent videotapes and new web sites, which serve as resources and sites for ordering more recent printed material for classroom use. The approach in these materials is that of fear appeals in an attempt to raise children's awareness and perception of the severity of foodborne illness, and to draw their attention to their personal susceptibility. The recommended steps of prevention are simple and catchy. The utmost goal is to raise awareness of the risks involved and knowledge of the preventive steps, thus encouraging students to put the safe food handling procedures into practice in food preparation at school. However, most often food safety instruction is an anecdotal part of other subjects.

School-based food safety education tends to be grade-oriented like other school subjects, which does not necessarily lead to learning as defined by recent psychology textbooks: a relatively durable change in behavior or knowledge that is due to experience (Weiten 2000), but only to short term performance on achievement tests. Furthermore, behavior change is seldom assessed as a criterion for grades in school, where the emphasis has been placed on changes in knowledge. The new National Health Education Standards (2000) encourage schools to prepare students to be "health literate", critical thinkers who can use the computer technology to access valid health information but also can demonstrate the ability to practice health-enhancing behaviors and reduce health risks. Methods, how to meet these standards, or how to assess this type of achievement at school, are still to be developed.

Health education has been defined as any combination of learning experiences designed to facilitate voluntary actions conducive to health (Green & Kreuter 1999). This definition does not emphasize the change process possibly needed in order to act in a way conducive to health as much as does the definition of nutrition education set a few years earlier by Contento and colleagues (1995): any set of learning experiences designed to facilitate the voluntary adoption of eating and other nutrition-related behaviors conducive to health and well being. The National Task Force on the Preparation and Practice of Health Educators (1985) defined it as the process of assisting individuals, acting separately or collectively, to make informed decisions about matters affecting their personal health and that of others.

Based upon these definitions and suggestions, effective food safety education should make children aware of the resources offered by the federal and private agencies (on the Internet), teach students to critically evaluate media coverage through the knowledge they've gained in working on cooperative projects about food safety issues, the common foodborne pathogens, the mechanism of human defense systems to fight bacterial invasion, and the common preventive measures. Instruction should let students be the active participants in solving problems related to real-life like situations to enhance their personal health and that of the others.

This type of meaningful learning is supported by a learning process which is based upon several cognitivist theories and models (Dewey 1938; Ausubel 1968; Bandura 1986; Collins, Brown & Newman 1989; Wittrock 1992; Engestrom et al. 1995; Jonassen 1995). The process entails the arousal of initial motivation, clear orientation to the subject so that students know where in the mesh of prior knowledge and experience this new piece of information can be integrated, then the presentation of new knowledge and its testing in real-life (like) situations (case-based scenarios, see Riesbeck & Schank 1989), reflection on personal performance relative to the other students and the used model, refining the performance by referring back to the resources, and additional testing and feedback from peers and the teacher. As a result a new, personal interpretation of the presented material and (food handling) practices is formed in the brain, which process has recently been called "construction of new knowledge" (Simons 1993). Constructing new knowledge, i.e., learning, is best facilitated by working in a group of learners in a cooperative learning environment as described by Slavin (1998) and has been effectively used in many school subjects.

Cooperative Learning

Cooperative learning refers to a teaching and learning strategy, in which students work in groups toward a shared, common goal with a group reward, which is dependent upon individual learning. Teacher serves as a facilitator of such cooperative work providing the materials and help after the group members have been consulted. Cooperative learning can be arranged to resemble simple "working in groups", without the mentioned goal, responsibility and reward structure, but this has been found less effective in increasing academic achievement (Slavin 1998).

The reason for higher achievement occurring in cooperative learning has been explained from the helping behavior, the explanations given and received by peers (Grossack 1954; Vygotsky 1978; Webb 1985; Wittrock 1992; Ryan & Pintrich 1997). Answering fellow students' questions with an explanation, instead of a simple yes or no (terminal answers), forces students to reflect upon their own understanding and helps the student who initially sought help. Through observing others explain and engaging in the explaining on their turn, students develop their comprehension skills and build strategies for the future, as if being cognitive apprentices in a model described by Collins, Brown and Newman (1989).

Cooperative Learning and Gender

The effect of gender (Webb 1985) and academic standing (Webb 1985; Stevens & Slavin 1995) on learning in a group are positively exploited when arranging groups with equal numbers of boys and girls and not mixing students with equal or extreme skills. In

Webb's studies (1985), when 7th-11th grade students worked in groups of four in which girls were outnumbered by boys, boys tended to ignore the girl; if boys were outnumbered by girls, girls gave their attention to helping the one boy in the group. However, using cooperative methods assigning each student an individual task, each required to reach the group's goal, gender does not have such an effect. Low ability students have been shown to benefit from receiving explanations from others, either from students at their level or from higher ability students. Medium ability students tend to be ignored in a group of low and high ability students, whereas the high ability students working only with matched peers do not give any or very little explanations falsely thinking that everybody knows it all anyway (Webb 1985). A one-year study on the effects of cooperative work in normal 6th grader classrooms on gifted students' achievement as compared to gifted students in pull-out groups for gifted only showed greater gains for those in the cooperative groups (Stevens & Slavin 1995). In interventions longer than 4 weeks, cooperative groups have also led to greater gains for mainstreamed learning disabled children (Stevens & Slavin 1995).

In conclusion, cooperative learning methods are excellent tools for increasing student interaction and academic achievement, and are well suited for teaching new health behaviors, but how does one ensure student motivation to study? The group reward in the cooperative learning model, according to cognitivist theorists should be one of solving an internal cognitive conflict aroused by a skilled teacher at the beginning of the cooperative learning session (Piaget 1932; Inhelder & Piaget 1958; Perret-Clermont 1980). The alternative would be external motivators, such as grades, recognition, or material rewards, which according to self-efficacy researchers (based upon a construct in the Social Learning Theory), have not been able to maintain sustained motivation to study in the face of difficulties (Zimmerman 1987; Schunk 1989; Bandura 1997).

Efficacy and Threat Appraisals As Predictors of Motivation

According to the Social Learning Theory (Bandura 1986), perceived self-efficacy refers to a person's appraisal of his or her capabilities of performing a task successfully, based upon prior experience and expectations of the anticipated outcomes. Self-efficacy researchers posit that self-efficacy is the major predictor of self-regulation of motivation (Tuckman 1990; Bandura 1997). Accordingly, students with low perceived self-efficacy would be less interested in studying and paying attention to what is being taught no matter what Instructional method or media. People with high level of perceived self-efficacy set more challenging goals for themselves, persist in the face of difficulties, and have been shown to gain academically more than peers with lower perceived self-efficacy (Zimmerman 1987; Schunk 1989; Bandura 1997), to be more likely to adopt new, health enhancing behaviors (Maibach, Flora & Nass 1991), and the more knowledge correlates with actions (Rimal 2000).

Self-efficacy appraisal is also one of the key components in the Protection Motivation Theory (Rogers 1975), which helps explain why people would pay attention to the health message, and why they would change their behaviors. Protection Motivation Theory by Rogers (1975) suggests that response to a threat is contingent on two cognitive processes: threat appraisal and coping appraisal. The former entails an assessment of the individual's personal risk of harm (susceptibility) and an assessment of the severity of the harm. The latter is comprised of the individual's perceptions of the recommended response efficacy and an assessment of his/her ability to carry out this response (response-efficacy and self-efficacy). The theory asserts that cognitive, rather than affective, processes determine message response, and that the fearful content in the message motivates the audience to think about ways of protecting themselves, but that feelings of fearfulness alone do not drive change (Rogers 1975).

The theory predicts a significant interaction between threat (a combination of perceived risk and severity) and coping ability (a combination of self- and response-efficacy). High threat combined with low coping ability should result in a boomerang effect: if people are threatened but have no effective means of protecting themselves, persuasion and intentions to change behaviors are expected to be very low (Rogers 1975; Knight Lapinski & Witte 1998).

In this study attempting to improve children's food handling knowledge and behaviors, constructs (perceived self-efficacy, response-efficacy, severity and susceptibility) from both the Social Learning Theory (Bandura 1986) and the Protection Motivation Theory (Rogers 1975) were explored as variables associated with learning outcomes.

Computer-Assisted Instruction (CAI)

Computer-assisted instruction uses computers as instructional media, which can support highly interactive multimedia presentations as learning tools. While the novelty-effect of these tools is wearing off, the computer's ever increasing capability of supporting fascinating multimedia presentations and interaction with the user is gaining more attention and enthusiasm among K-12 users. Computers can make learning more fun, relevant and compelling to the children (Lieberman 1992; Street & Rimal 1997; Light & Littleton 1999). Several educational CD-ROMs on health related issues capable of the multimedia presentations are on the market, and research on their effectiveness in improving children's health behaviors is ongoing. Often these educational programs encourage group work, but few are designed to facilitate cooperation with the required guidance. Most are designed for individual study although used in pairs or in groups, due to lack of computers at school or sometimes out of students' own choice.

CAI in Educational Settings

The incredibly fast spread of computers and other technology on the jobs has set new requirements for the young entering the work force. The new employees need to be technology literate and able to use technology efficiently to access information and communicate their ideas to the other members of their team. Computer skills and technological literacy are crucial skills to learn while at school (A SCANS Report 1991; Report to the Nation 1996). Also, the National Health Education Standards (2000), stress the concept of "health literacy", being able to critically evaluate and use the existing material, including the Web-based material, to advocate for a healthy life-style.

At school, factors limiting CAI include the inadequate number of computers, inadequate funding for software (educational CD-ROMs) and lack of teacher training on how to actually integrate CAI into existing curricula (Collis & Carleer 1993; CEO Forum on Education & Technology 2000). Results from the 1987-1990 international research on computers in education (Pelgrum 1992) with 70,000 respondents, showed that at the elementary-school level, computer availability in Portugal, France, The Netherlands and New Zealand ranged between two and four while in Japan ten computers per school were found, and in Canada (British Columbia), Israel and the United States, sixteen to eighteen computers per school could be counted. A more recent report from the U.S. (CEO Forum on Education & Technology 2000) indicated an average of ten students per computer in 1995-1996, and five students per computer in 1998-1999. Furthermore, it indicated that 95% of schools and 72 % of classrooms were connected to the Internet, but only 27%-30% of teachers applied the Internet for student research or problem solving activities, and only 8% used it for multimedia classroom presentations. This report indicated an average of 9 students per computer with Internet access in 1998-1999, i.e. a computer capable of multimedia presentations, while in 1995-1996 the number of students per such a computer was 24 (CEO Forum on Education & Technology 2000).

Gender and Attitudes toward CAI

In all 21 countries participating in the international study reported by Pelgrum, (1992), computer use in schools was dominated by males. Daily practice of computer use in schools too strongly suggested to students that such use was predominately a male activity, not suitable for females. A positive attitude towards mathematics and physics has been found to be related to a positive attitude towards computer literacy (Makrakis & Sawada 1996). It has been suggested that the association of computers with science and mathematics, subjects which appeal more to boys than to girls, may turn girls away from taking computer courses and thus reinforces present gender differences.

There are a number of studies showing that girls do find themselves less competent in and less fond of computer studies than boys do; however, there are also studies to state the opposite: girls believe that they are just as able to learn programming and other requisite skills as are boys (Loyd, Loyd & Gressard 1987; Elkjaer 1992; Corston & Colman 1996; Benson 1997). On the other hand, males in many studies tend to hold more stereotyped attitudes about who is capable of using computers. This mixture of attitudes can be seen in several international studies: among Canadian and Chinese 8th and 12th grade students (Collis & Williams 1987), and Swedish and Japanese 9th grade students (Makrakis & Sawada 1996). In China, Japan and Canada, both genders placed computers in the "male domain", but differed in their conception of girls' capabilities with computers, with only girls showing trust in them. In Sweden, both genders placed computers in "equal domain"; both also considered boys to be better with computers. In the United States, the situation tends to resemble that in China, Japan and Canada: only boys place computers to the "male domain", both genders believe in equal capabilities (or rights) to participate in computer work, but more often girls still feel uncomfortable and less competent with computers (Shashaani 1993).

Reasons for less favorable attitudes and computer skills among girls may include the socialization process (Elkjaer 1992), the process of passing on to new generations the norms and beliefs of our culture, which influences the way parents bring up their children, for example buying a home computer for their son than their daughter (Busch 1995), the way teachers teach by favoring male response and enthusiasm (Brophy & Good 1970; Good 1987; AAUW 1991), the way media presents the two genders, and the way computers and software are marketed (Nye 1991). Also, the fact that the computer curriculum is often planned around programming, and programming courses appear in conjunction with math, a "male domain" (Reinen & Plomp 1993), may play an important role.

Three factors have been found to contribute to the motivation of girls: computer practice, computer at home, and best friend's liking of computers. Usually girls know less and master less computer tasks; this could be simply due to inexperience among girls. This concurs with Levin and Gordon’s (1989) finding that prior computer experience is more accurate a predictor than gender of competence, level of usage, and attitudes toward computers (Levin & Gordon 1989). Those, who own computers at home have shown more positive attitudes toward computers, have felt a greater need for computers in their lives, and have been more motivated to become familiar with them already in the late 80’s (Levin & Gordon 1989). This may be truer now at the turn of the century when girls and boys are reported to have equal access to computers in many Western countries like Finland (Haapala et al. 2000).

Besides making sure girls and boys have equal access to computers at home, the school plays an important role since teachers are important role models to be imitated. It is contended that bringing girls into contact with women who are employed in science and math or computer literacy courses is an important means of positively influencing the choices and performance of girls (Reinen & Plomp 1993). Suggestions on how schools could become actively involved in decreasing gender differences set forth by Reinen and Plomp (1993) include involving more female teachers in computer education to serve as role models, not letting computer education become a hard science course, letting girls spend just as much time at the computer as boys, and making sure that computer classes do not overlap other subjects typically favored by girls.

Cooperative Learning and CAI

In today's classrooms, with the above mentioned gender differences, it is a challenge to successfully incorporate computers into any educational situation and achieve gender equity in academic achievement. The best results have been achieved with cooperative learning methods (Johnson, Johnson & Stanne 1985; Underwood, McCaffrey & Underwood 1990; Mevarech & Light 1992; Mevarech 1993; Repman 1993; Light & Littleton 1999; Underwood & Underwood 1999). Most studies on computer-based learning still focus on describing gender differences in attitudes, and not on the effects of using different instructional arrangements on these gender differences. Furthermore, studies that focus on instructional methods, seldom apply true cooperative learning methods, but instead assign students to simple, traditional group work (or pairs), and call it "cooperative learning". Unfortunately, when interpreting the reported results of these studies, it is not always apparent exactly ho w cooperative their learning methods were.

Johnson, Johnson and Stanne's (1985) study on 8th graders (n=71) working at a problem-solving computer program (map reading and navigation) showed that cooperative learning methods promoted greater quantity and quality of daily achievement, and higher performance than competitive or individual learning methods used in this group. This was particularly true for girls. However, in other studies, it has been stated that girls work best in all female groups (Pryor 1995), or in groups with equal numbers of boys and girls (Webb 1985), and that boys do well in any combination (Webb 1985; Pryor 1995). Underwood, McCaffrey and Underwood (1990) studied mixed-gender groupings in computer-assisted learning and concluded that mixed-gender groups or pairs do not work well. Their results held for boys and for girls. Barbieri and Light (1992) reported that in mixed-gender pairs, the boys use the mouse and control the use of the program; whereas in girl-girl pairs, the students take turns running the show. Interestingly, with younger age groups (7-year-olds and 11-12-year-olds) the results have been more positive concerning mixed-gender pairs (1992). Based upon their studies on the effects of gender and social facilitation in computer classrooms Corston and Colman (1996) have suggested that it may be desirable for early experience of computers in the school setting to take place in same-sex groups, so that girls are exposed from an early stage on to the potential social facilitation of a female audience or cofactors. The presence of boys may inhibit girls' skill acquisition (Corston & Colman 1996).

These findings have led researchers to question the use of mixed-gender pairs or groups, and to suggest letting girls always work in pairs, and letting boys be competitive and work individually. This, in my mind, would seem to widen the gap between genders and hinder the learning of cooperative and social skills. However, our current knowledge on the interactions between genders in computer classrooms is not unanimous (Underwood & Underwood 1999). Perhaps, instead of segregating students based on gender, teachers and parents could be urged to pay more attention to balancing out the differences between boys' and girls' initial level of knowledge, experience and competence with computers through modifying socialization processes (Elkjaer 1992) and policy making (in schools) and simply providing girls with more time at the computers, as suggested by Reinen and Plomp (1993).

Overall, these conflicting results may imply that the instructional methods used were not cooperative learning, but traditional learning in a group. In the traditional group work students are simply assigned to work together on a project, but no specific individual tasks are assigned by the teacher or by the program. Thus it is possible for some students to slack off and let the other students do the work. In cooperative learning each student is given a task, which is an integral part of the final product, and individual performance will affect the others and the final product. This infers individual accountability and group rewards, which are the two major requirements for successful cooperation. Without proper instruction by the teacher and/or the software, stereotypical roles will emerge or prevail: boys will take dominance due to being more experienced with computers, and girls will be pushed away from the computers. Proper use of cooperative learning methods may abolish these worries if task-related roles are assigned for each student, irrespective of the gender. Successful use of cooperative methods with CAI requires a teacher well rehearsed in the field, access to cooperative software, and a supportive environment to allow for true interaction between boys and girls as equals.

In this study, CAI was placed in the “female domain” of food handling and food safety and students worked in mixed-gender groups of four with equal numbers of boys and girls, each given an individual task integral to the group’s process. These groups were split into dyads for the CD-ROM session, during which cooperative learning consisted of negotiation of responses to self-study questions in real-life like situations in food handling presented on the computer. With this cooperative structure, this study explored the effects of gender differences in prior computer experience, access and attitudes on learning in CAI. Furthermore, motivational factors and student opinions about the cooperative aspect, the meaningfulness of the CAI itself, and the amount of information provided were assessed to explore some of the aforementioned debatable issues in CAI.

Computer-Mediated Communication (CMC)

Computer-mediated communication, CMC, refers to communication between networked computers to connect people at spatially separated locations through the use of e-mail, conferencing systems (bulletin boards etc.), and chat rooms. It also includes access to the vast amount of information (databases) available on the Internet and information transfer through file transfer protocols (ftp) (Jonassen 1995; Santoro 1995).

Access to CMC

The constant increase in Internet penetration all over the world is increasing the use of this medium for education. In the U.S., close to 40% of the population have a home computer and half of them have an Internet connection. Younger, richer and urban populations more often have this access as compared to the older, poorer and rural populations reported by the U.S. Department of Commerce in the Falling Through the Net: Defining the Digital Divide-Report (2000). Also, there is a racial and ethnic gap in access: white Americans have double the access as compared to African Americans or Mexican Americans (U.S. Department of Commerce 2000).

President Clinton's initiative to provide every child in America with Internet access and to connect all classrooms with it led many to believe that this is the panacea of education (Butler 1997). However, diffusion of this innovation has not been quite so quick (U.S. Department of Commerce 2000) due to its cost and difficulty to operate, low trialability, and its still debatable advantage; four rate-limiting attributes of an innovation (Rogers 1995). CMC and the overall use of the Internet is observable, which according to the Diffusion of Innovations Theory (Rogers 1995) increases its use, but educators and school boards still have wanted to be ascertained of its advantages in the field of education (Derry 1997; Sherry et al. 2000).

Although 95% of American schools, and an average of 72 % of classrooms, were connected to the Internet in 1999, only 39% of the classrooms in the poorest schools (71% or more students eligible for free or reduced-price school lunch) had Internet access. The number of students per computer almost doubled from 9 on the average to 16 in the poorest schools. The report indicated a rare use of the Internet for student-centered instruction in addition to the clear racial and ethnic disparity in accessing the Internet in school: while 21% of white students used the Internet at school, only 12% of Hispanic and 15% of African American students had the same opportunity (U.S. Department of Commerce 2000).

Naturally, the most disadvantaged schools struggle the most with the common problems: schools do not have enough computers or the existing computers are not sufficiently powerful to support multimedia presentations, the Internet connections are too slow, and they do not have enough training or resources for training. The President's Technology Literacy Challenge (2000) and the introduction of partnerships between schools and local companies may help in the attempt to close the digital divide and provide the computers and the required training for the students and teachers in all American schools.

CMC in Educational Settings

CMC use for education has mostly involved universities, and research on its effectiveness comes from these settings, which can provide a well-established network, computer specialists, and training for both the teachers and the students. Examples include the extensive studies by Hiltz (1986; 1990) and Harasim (1990) in Open University settings providing instruction to thousands of (engineering) students. Their pioneering studies have resulted in several publications on the special attributes of CMC that may enhance student attitudes toward the medium and the content taught, and on the technical roadblocks and special requirements of the CMC technology (Hiltz 1988; Harasim 1990; Hiltz 1993). It is only recently that more publications on the effectiveness of CMC in educational endeavors, i.e., its impact on learning, have emerged to join the few earlier ones (Hiltz 1986; Phillips & Santoro 1989; Hiltz 1988; Hiltz 1990; Marttunen 1992; Hiltz 1993; Althaus 1997; Haapala et al. 2000).

To stress the importance of technology and the computer technologies in the future, the new National Health Education Standards (2000) encourage schools to prepare students to be critical thinkers, self-directed, responsible citizens and effective communicators so that they can evaluate the health messages and nutrition information with a critical mind. When students are introduced to health information on the Internet (and elsewhere) they need to be able to evaluate its trustworthiness.

Up till now, CMC has been used for health/nutrition education in a limited scope in the educational settings. One of the early experimenters is the BARN research group at the University of Wisconsin in Madison (Gustafson et al. 1987; Bosworth & Gustafson 1991) having studied the effectiveness of the Body Awareness Network System in increasing adolescents' responsible health behaviors (cigarette, drug, and sex-education). Their promising results have shown that more often than not, several students gathered to study the program in a group, although it was meant for self-study. Another example of health education utilizing the CMC technologies is the ComputerLink, a social support link for home caretakers of Alzheimer's patients (Brennan, Moore & Fink 1995; Brennan & Fink 1997). Results from the ComputerLink were encouraging showing frequent use of the bulletin board by people isolated by the 24-hour task they had undertaken.

CMC technologies provide excellent opportunities for sharing experiences and soliciting social support from peers. Although very little research is done on the effectiveness of CMC in health and nutrition education, the Internet currently offers plenty of health information, self-help sites with bulletin boards and support systems with chat rooms. For example, in the U.S. the United States Department of Agriculture has recently published a Website, "Promoting Good Nutrition", offering quick self-analysis of dietary intake. In many countries, public and private companies or some enthusiastic individuals have established web sites, which allow for easy assessment of daily energy intake and/or expenditure in daily activities. It is clear that CMC offers an easy access to information. However, in order for mere knowledge to lead into meaningful learning, i.e., a relatively durable change in behavior or knowledge that is due to experience (Weiten 2000), articulation of learning goals and discussion between learners needs to take place. The above mentioned "self-help" sites do not allow for facilitated peer interaction between learners/users.

In educational settings, like the virtual nutrition seminars for medical students in North Carolina, the purpose is to discuss nutrition issues in addition to traditional lectures (Kolasa et al. 1999). Virtual discussions on nutrition and health have also been tested with pregnant and parenting adolescents in the NEON project in Ohio (Medeiros et al. 1999).

Cooperative Learning and CMC

The objective of health/nutrition education is to facilitate the voluntary adoption of food choices and dietary and health behaviors conducive to health (Contento et al. 1995; Green & Kreuter 1999) through individual or collective activities (National Task Force for the Training of Health Educators 1985). The last part is important when considering CMC in health and nutrition education, because CMC can be very useful in supporting collaborative work in a community of self-directed learners (Santoro 1995).

For the past two decades, stand-alone programs, like educational CD-ROMs, have offered the most interactive, most complex, and most sensory vivid information and simulation environments, but now the networks are beginning to provide access to these multimedia environments as bandwidth technology has improved and become more readily available in homes, schools, health clinics, work sites, and community centers (Butler 1997; Lieberman 1997; Street & Rimal 1997). At this point, CD-ROM programs can be complemented with face-to-face or computer-mediated activities to promote critical thinking through peer interaction, discussion, and cognitive processing of the new material (Dede & Fontana 1995; Butler 1997; Hardin & Reis 1997), and to facilitate the adoption of new ideas (Rogers 1995) through experimentation and social support (Bandura 1997; Brennan & Fink 1997).

The Special Attributes of CMC Associated with Learning Outcomes

The two greatest advantages of computer-mediated communication compared to face-to-face communication are the facts that communication is written rather than spoken and that communication is asynchronous (Phillips & Santoro 1989; Harasim 1990; Brennan & Fink 1997). This creates a situation of social anonymity, which in turn leads to less inhibited communication and more equal participation by the shy, introverted and more reflective users (Kiesler, Siegel & McGuire 1984; Zimmerman 1987; Phillips & Santoro 1989; Brennan & Fink 1997; Hakkarainen et al. 1999). Furthermore, place-independence of the networks, allows for user interaction across the nation and the world. Utilizing this aspect of the networked communication can promote true multiculturalism in health communication, and it can extend health communication's reach to marginalized cultural groups (Roblyer, Dozier-Henry & Burnette 1996; Kreps, Bonaguro & Query Jr 1998). Next, I will take a closer look into the special attributes of CMC which have been associated with its impact on learning:

1. CMC is text-based. CMC requires written, rather than verbal dialogue, which has been shown to lead to deeper consideration of the messages, more equal participation by the shy and the bold students, and more equal participation in classroom communication by gender (Phillips & Santoro 1989; Dubrowski, Kiesler & Sethna 1991; Tella 1992; May 1994; Walther 1994; Walther 1996, Scardamalia & Bereiter 1993/1994). The text-based communication encourages cognitive processing of information before it is expressed to others. Text, which is published on the Internet, has been shown to be better organized and better written than text, which is written for the teacher only (Cohen & Riel 1989; Phillips & Santoro 1989; Marttunen 1992).

2. CMC is student-centered. Student-centered learning in CMC is supported by the fact that instructor contribution can be minimized to 10-15% of the message volume compared with 80% of the time in traditional teaching settings (Winkelmans 1988; Harasim 1990; Niemi et al. 1999). However, this poses one of the most demanding tasks for the instructor in CMC. Hiltz (1993) has concluded that the success of a CMC course depends upon the instructor's skills to activate students and to encourage writing and participation by posing stimulating questions. Furthermore, students who do take the initiative to participate and to interact with other students and the instructor online have been shown to gain the most from CMC courses (Hiltz 1993).

3. CMC supports conversation and collaboration. The CMC environment supports peer interaction and expert consultation in a process of social negotiation. As students explore issues, take positions, discuss those with peers, reflect on and re-evaluate their own positions, knowledge is constructed in a meaningful way (Harasim 1990; Scardamalia & Bereiter 1993/1994; Jonassen 1995; Ruokamo & Pohjolainen 1999).

The computers, and the World Wide Web and CMC in particular, have provided a new medium for mass communication, supporting both one-to-many and many-to-many communication and, as predicted by McQuail (1987) and Golding & Murdock (1989) in their analyses on mass communication's future, the gaps in access to information and capacity to use information have been widened by social-economic inequality (CEO Forum on Education & Technology 2000). More than ever, there is a place for the social-cultural theories of mass communication, which support the attempts of the Clinton/Gore administration to provide EVERY child in the nation with Internet access (Report to the Nation 1996 and The President's Technology Literacy Challenge 2000).

The threat of social isolation due to very high use of media (McQuail 1987) like the computers, has subsided with results from studies (Robinson & Walters 1986; Robinson 1989) where young computer users spontaneously form into groups at the computer, and the encouraging results of increased attention and learning among learning-disabled and emotionally disturbed children (Zimmerman 1987; Margolies 1991), and a study on successfully reducing friction between boys and girls at the computer (Hoyles, Healy & Pozzi 1992), and Parks' study (1996) on making friends in Cyberspace.

Based upon results from a study of Finnish upper grade girls and boys participating in CMC activities in English, Tella (1992) has suggested that girls may become more drawn to computers than boys, as soon as they realize the great opportunities provided by CMC to collaborate with others and to express oneself in writing, especially in a foreign language, skills in which girls excel. When CMC has been used to support collaboration on projects in history and -civics class, girls have been less enthusiastic than boys of this attribute of CMC (Niemi et al. 1999).

4. CMC is time-and place independent. CMC can be accessed at a time convenient to the user. Messages can be read and replied to when the user wishes to do so. However, at school, students are limited by the period of study, and usually are required to contribute when the teacher requires them to do so. Still, there is not the same immediacy of communication as in face-to-face communication, where response is expected (and interpreted) immediately, even if only as a facial expression. This feature gives the learner time to think about what is said (written) and what the response would or should be. At the university level and in distance learning, time-independence has been shown to allow for increased student-student interaction and student-teacher interaction, one of the most appreciated attributes of the medium (Hiltz 1993; Santoro 1995).

Place independence opens the world to the learner. This may be an advantage to classroom learning through the feeling of belonging to a larger community of learners, and bringing diversity into thinking. CMC can bring together learners from other parts of the world, and unite the urban and rural areas, and therefore has been suggested a means to combine teaching resources (CEO Forum on Education & Technology 2000).

5. CMC entails interactive computer capabilities. CMC gives students the opportunity to retrieve a vast amount of information in the middle of a conversation, “mingle” between conversation groups (chat-rooms), run self-assessment tests with interactive quizzes, and also to store the transcripts of conversations in the chat room and save the messages on the bulletin board. On the bulletin board, threads of discussion can be traced back to the beginning of the school year to help in self-reflection and understanding the thought processes learner’s go through. The amount of information provided in text form on the computer screen may be overwhelming and requires teacher guidance in sorting through. The amount of text learners are willing to read on screen may be limited, and in general, web course designers are advised against simply providing the face-to-face lecture notes on screen (Dix et al. 1998). As expressed by Phillips and Santoro (1989), CMC should not be intended for disseminating substantive amount of knowledge, but for accomplishing performance and output goals.

In summary, CMC can offer meaningful learning experiences when it is used to support the work of a collaborative community of enquiry (Jonassen 1995; Ruokamo & Pohjolainen 1999). A meaningful learning experience, as described earlier in this chapter, is one that requires the learner to be active in the learning process, setting the goals and objectives and the methods of enquiry, encourages constructive thinking, is situational and placed in real-life context, provides knowledge that is transferable, and provides a place for cooperation and conversations (Jonassen 1995; Ruokamo & Pohjolainen 1999). As described above, CMC can do this with the additional advantage to face-to-face learning provided by the necessity of written communication, allowing for time to think, and by the connection to a wider community of learners and a broad knowledge and information base in a real-life situation. How much these attributes (possibilities) affect children’s attitudes toward CMC and learning resulting from the use of CMC is still under research.

By connecting to a wider community of learners, CMC can offer a forum for social modeling to support learning. According to the Social Learning Theory (Bandura 1986), people learn through observational modeling. CMC can provide a safe, wide forum for observing others and for comparing personal contributions to others'. However, its introduction requires time with the group involved. One-shot deals at schools are not effective in enhancing learning, but longer interventions are required. Elementary and secondary school students are still not used to cooperation and even less so to cooperate through the computer, on the Internet (Niemi et al. 1999). Children sit at the computer thinking about cool web sites to go and explore, and to chat about funny things, not about using the CMC and the Internet for educational purposes (Haapala et al. 2000). Children tend to forget that CMC is not a game, but a tool for self-reflection, discussion on the topic, and for learning and that they are dealing with real people, only through the computer. Even among the college level students, self-directedness and cooperation are still new ideas. We are looking at a lot of work before a true global community of cooperative learners is established. Meanwhile, with the current technology, we need studies on CMC's impact on learning and the special attributes contributing to its success. The focus of this study was to explore how well CMC can support peer interaction and interpersonal communication on health related topics to enhance the adoption of new health behaviors. This study explored gender differences in prior computer experience, access and attitudes on learning outcomes in cooperative CMC and FTF instruction on food safety. Motivational factors and student opinions about the cooperative aspect, the meaningfulness of the CMC/FTF itself, and the amount of information provided, on paper versus on screen, were assessed to explore some of the aforementioned debatable attributes of CMC.

Theoretical Framework of the Study

This literature review has shown that we still lack information on the food safety knowledge, attitudes and food handling practices among the American children and adolescents. Furthermore, while computers and the Internet are becoming more available in K-12 settings, we still need to develop new innovative educational tools and strategies to effectively integrate the two into the existing curricula. Cooperative learning methods have been shown to enhance learning in many school subjects, and its use in health education both face-to-face and through the computer goes still unreported.

This study set out to evaluate the current level of food safety knowledge and food handling behaviors among the young and to explore the question about the relative effectiveness of an innovative instructional tool and instruction delivered face-to-face and via the computer in a cooperative learning environment.

Instead of doing a simple media comparison (Clark 1983; Clark 1994; Kozma 1994; Ross & Morrison 1995), this study emphasized testing the consistency of the effects of the instructional method, cooperative learning, delivered by alternative media identifying attributes that may differently impact learning. Based upon the Social

Learning Theory (Bandura 1986) and the Protection Motivation Theory (Rogers 1975), variables that may more strongly influence learning outcomes in this cooperative learning environment attempting to increase children's food safety knowledge and food handling behaviors include students' personal characteristics related to the instructional method, media, and the content.

Chapter 3

PROCEDURES OF THE STUDY

Population and Sample

The population of this study consisted of middle school students in five self-selected schools in central Pennsylvania. The principals of middle schools within 1-2 hours drive from The Pennsylvania State University were contacted by fax (Appendix A) and phone to recruit schools willing to integrate a four-session unit on food safety into their 7th or 8th grade Family and Consumer Sciences (FCS) or Life Sciences (LS) curricula. As a prerequisite, the schools were to have computer facilities with sufficient number of computers with CD-ROM drives and Internet access to accommodate dyadic work. Five schools, located in Altoona (7th grade FCS), Mount Union (7th grade FCS), Steelton (7th grade FCS), Williamsburg (7th grade LS) and Wingate (8th grade FCS), Pennsylvania, were successfully recruited to provide the sufficient number of students in a total of 17 classrooms for the study. The number of students recruited per school is presented in *Table 3.1*; however, schools are not identified in this study.

A priori power analyses were conducted in order to determine the minimum sample size, for a (3 (treatment group) x 2 (sex)) x 2 (pre-test/post-test) Repeated Measures Analysis of Variance, to detect medium effects, at alpha = .05. Results from GPOWER© analyses (Erdfelder, Faul & Buchner 1996) suggested a minimum sample size of 216 students. As presented in *Table 3.1*, these numbers were increased by 40% to allow for attrition due to normal absenteeism.

In each participating school, intact classrooms were randomly assigned by a toss of a coin to one of the two experimental conditions: face-to-face cooperative study, computer-mediated (on-line) cooperative study. Final group assignment was dictated by the availability of the computer classroom, i.e., coinciding computer availability and Family and Consumer Science instruction. In each school, one parallel classroom with approximately 30 students was recruited for the control condition.

Parental consent (Appendix B), student informed assent forms (Appendix C), and adequately filled questionnaires were obtained from a total of 243 students (21% attrition rate, mostly due to missing parental consent). However, school number 1 (*Table 3.1)* was excluded from final analysis based upon the results from a 3 (treatment) x 5 (schools) Repeated Measures ANOVA (pre- and delayed post-test data) indicating significant interaction between treatment and school. It was realized that in school number 1, the control group had received instruction in food safety from their regular teacher and from

Table 3.1: Student recruitment in five schools by treatment.

	School					
Treatment	**1**	**2**	**3**	**4**	**5**	**All**
Experimental						
F-t-F	25	29	21	12	13	100
CMC	20	29	22	20	13	104
Control	28	22	21	16	17	104
All	**73**	**80**	**64**	**48**	**43**	**308**

the field notes, it was also concluded that the treatment groups in this school differed in their academic performance. Furthermore, the CMC group in school 3 (*Table 3.1)* had to be excluded due to failure to treat, i.e., computer networks in this school failed on more than one occasion. The number of students, 178 in 12 classrooms, in the final sample of this study is presented in *Table 3.2,* by school and treatment.

Gender distribution and the exact numbers of girls and boys in each treatment group are presented in *Table 3.3*.

The Office of Regulatory Compliance of The Pennsylvania State University approval (ORC #970837-A2) and the participating school districts' or the principal's approval were secured before the start of the study.

Table 3.2: Study sample: number of subjects in the three treatments in four schools.

	School				
Treatment	**2**	**3**	**4**	**5**	**All**
Experimental					
F-t-F	23	20	10	13	66
CMC	25	-	13	12	50
Control	18	19	12	13	62
All	**66**	**39**	**35**	**38**	**178**

Table 3.3: Study sample: number and distribution (%) of students in the three treatments by gender.

Treatment	Girls	Boys	All
Experimental			
F-t-F	35 (53)	31 (47)	66 (100)
CMC	30 (60)	20 (40)	50 (100)
Control	25 (40)	37 (60)	62 (100)
All	**90 (51)**	**88 (49)**	**178 (100)**

Design of the Study

The design of the study is presented in *Table 3.4.* The study was conducted using a quasi-experimental design, a variation of the nonequivalent control group design described by (Campbell & Stanley 1966), with pre-test, post-test, and delayed post-test at one month. An extra post-test was administered to assess student opinions immediately after the cooperative assignment.

On Day 0, pretest was administered in class (pencil and paper with scan sheets for all groups). After the pretest (Day 0), students practiced the Jigsaw-type work (described in detail under "The cooperative assignment") with four practice poll questions. At the beginning of the sessions on Day 14 and Day 21, small group discussion about food safety issues was encouraged with two simple questions related to food handling behaviors (see *Figure 3.1*). In CMC, the two questions were arranged as polls on the web site and the results were seen simultaneously on screen and discussed. Post-test was administered immediately after the CD-ROM session (Day 7) and after the second session of cooperative work (Day 21). Delayed post-test was administered a week after this to students in all three treatments (Day 29).

Study Protocol and Instrumentation

The researcher administered all tests and provided classroom instruction to control for the teacher effect as a threat to internal validity. All sessions were held during normal class periods (45 minutes). Participating teachers were thoroughly introduced to the study protocol on site and they were present in the classroom during the instruction.

Table 3.4: The design of the study.

	Day						
Treatment	**0**	**7**	**7**	**14**	**21**	**21**	**29**
Experimental							
FTF	KBQ	CD	KOQ	FTF	FTF	OQ	KBQ
CMC	KBQ	CD	KOQ	CMC	CMC	OQ	KBQ
Control	KBQ						KBQ

KBQ = Knowledge and Behavior Questionnaire (pretest, and delayed post-test)
CD = CD-ROM instruction
KOQ = Knowledge and Opinion Questionnaire (post-test)
FTF = Face-to-face cooperative learning assignment
CMC = Computer-mediated cooperative learning assignment
OQ = Opinion Questionnaire (post-test)

For the instruction, students were assigned first into groups of four (for the cooperative sessions) and within these groups into pairs (for the CD-ROM session). Student roster or the existing seating arrangement (around large tables) was used to form the groups with equal numbers of boys and girls whenever possible, but never an under representation of girls. Dyads were mixed or same gender.

Instruments used in this study included an interactive, educational CD-ROM, a face-to-face cooperative assignment, and a Web-based cooperative assignment on food safety. All instruments were used in a cooperative learning environment to meet the learning objectives set for the instruction. The study sessions aimed at strengthening the students' confidence in themselves as safe food handlers, increasing their knowledge of safe food handling and, overall, improving their self-reported food handling behaviors. New information was provided on the CD-ROM and a cooperative assignment while cognitive processing of the new knowledge was supported mainly through the cooperative work, discussing and solving case studies with the new knowledge.

CD-ROM

A revised version of "*Students Serving it Safe*" interactive CD-ROM (Haapala et al. 2001) on food safety for middle school students, developed by the research team and tested among Pennsylvanian middle school students (Michelman 1998), was used as the first, one-session component of the instruction. The use of CD-ROM technology allowed for a better display of a compelling, multimedia presentation on food safety than the current network capabilities in the schools could have supported. The CD-ROM provided

Day 0. Practice Jigsaw-type cooperation.
How many wash hands before handling food.
How many use paper towels to dry hands (instead of dish towels).
How many help prepare food at home.
How many fix their own snacks.
Day 14 and 21
Have you changed the way you handle food?
Have you noticed any unsafe food handling around you?

Figure 3.1: Poll questions on changes in food handling behaviors.

students with basic information on food safety in case-based scenarios. It contained sections in which the students had the opportunity to act as kitchen employees responsible for safe food handling. This new edition contained a vast amount of information on the 12 most common foodborne pathogens and it highlighted the simple rules of prevention. These five easy-to-memorize rules (*Figure 3.2*) were repeated several times and tested on the CD-ROM through a self-study quiz of 12 questions related to a case study.

Cooperative Assignment

The cooperative assignment, called "***BAC-At-Home***" (Haapala, Orlofsky & Probart 2000b), was designed to provide opportunities for student discussion and reflection on the topic and to facilitate learning and the adoption of new ideas and behaviors. The assignment followed Aronson's Jigsaw method (Aronson 1978) with team reward for individual learning as suggested in Jigsaw II (Slavin 1980). In brief, a case study was presented with four sets of 5-6 questions to "Expert groups" during the first session. A week prior, these Expert groups of four

"The 5 Rules of Prevention"

1. **Check:** Check expiration dates and overall appearance.
2. **Cook:** Cook foods to proper inner temperatures.
3. **Chill** promptly: Refrigerate foods fast and defrost in the refrigerator.
4. **Separate:** Separate raw meat, poultry and fish from other foods.
5. **Wash your hands** always before handling food.

Figure 3.2: The five rules of prevention emphasized in the instruction.

students, split into dyads, had studied the CD-ROM. Three of the expert groups specialized on four different pathogens and one expert group on two pathogens and the rules of prevention. Towards the end of the session new groups were formed with one (or two if there were more than 16 students in the class) expert from each of the four expert groups. Each expert was to explain their groups findings and based upon this the new groups were instructed to set their hypotheses of the cause, source and rule violation leading to the described foodborne illness. These groups continued to cooperate during the second cooperative session, to solve the case study with a new set of questions. All self-study questions were scored and summed up by the groups to introduce subtle inter group competition. However, finding the correct solution to the case study (cross-contamination by Campylobacter jenuni from holding raw chicken and ready-to-eat foods on the same cutting board) was the only reward, thus emphasizing internal motivation.

For the FTF treatment, the "***BAC-At-Home***" study packet designed by the research team (Haapala, Orlofsky & Probart 2000b) consisted of colorful, laminated, poster size case study pictures and index card size study cards, reference charts for the 12 pathogens, safe temperature charts, markers, and expert group specific study materials with self-study questions (in expert specific colors to help in the grouping process).

For the CMC treatment, the "***BAC @ Home***" (Haapala, Orlofsky & Probart 2000a) Web site (at: http://nutr88.hhdev.psu.edu/fsr/fsr_golive/fsr_study/welcome.html) was designed to provide the computer-mediated cooperative activities comparable to the "***BAC-At-Home***" FTF materials. The "***BAC @ Home***" Web-site contained the study material with interactive self-study quizzes, a virtual message board (Dr. B's Virtual Message Board Tool, version 2.13 for UNIX and Dr. B's Virtual Conferencing Tool, version 1.14 for UNIX) for the findings and hypotheses, and a virtual chat room for the groups to discuss their findings or to meet in the general chat area with their classmates just for fun. Photographs taken during the study sessions of all the participating students were posted on the site after each session.

Data Collection

Quantitative data was collected through pre-, post-, and delayed post-test questionnaires, with pencil and paper test and scan sheets for computerized data entry. Supervising professors at The Pennsylvania State University, experts in food safety, and high school Home Economics/Family and Consumer Sciences teachers determined the face, content, and construct validity of the instruments and instructional activities. All instruments were pilot tested for validity with one classroom (n= 20) in one of the participating schools to ascertain the understandability of the content and the questionnaire, after which minor changes were made to the questionnaire (Appendix D).

Discrete variables gathered information on gender, prior foodborne illness, participation in food preparation at home, work in food service outside of home, prior computer and Internet use and access to a home computer and internet. Combining the two discrete variables on computer and Internet access at home formed a new discrete variable, called computer access. Opinions about the amount of information provided on the CD-ROM and in the cooperative assignment were measured by one question each with Likert type scale from 1 = too little to 5 = too much (Q1 on post-test). Index variables formed in the study and the corresponding item numbers on the questionnaires are presented in *Table 3.5.*

The Food Safety Knowledge index consisted of 10 true-and-false questions pertaining to the key issues identified in prior research (see Chapter 2, Bryan 1988) and covered in the intervention. The Food Handling Behavior index consisted of 15 items, 12 itemized behaviors which measured the same key issues: Check Foods (2 items), Cook to Proper Temperatures (2 items), Chill Promptly (2 items), Separate Raw and Cooked Foods (3 items) and Wash Your Hands (3 items). Three items were checked in case students had not handled raw meat or chicken or fish, or had not eaten eggs or steak during the past month, allowing them the option to skip three questions pertaining to these foods. For the index, an aggregate score was calculated for each student as a mean of all self-reported behaviors. The number of reported behaviors varied from 8 to 12, with a mean of 11.5 ± 0.7 behaviors. For the index, the sum of scores for the itemized behaviors was divided by the number of behaviors reported by each student.

Table 3.5: Index variables, number of items in each, item numbers on the pretest questionnaire and internal consistency coefficients for each index.

Index variable	**Number of items**	**Item numbers**	**Internal consistency coefficient***
Computer liking	2	32-33	.60
Perceived self-efficacy (in safe food handling)	3	34-36	.48
Perceived severity (of foodborne illness)	2	37-38	.71
Perceived susceptibility (to foodborne illness)	4	39-42	.61
Knowledge on food safety	10	43-52*	.40
Self-reported food handling behaviors	12	1-15	.73
Helpfulness of the learning tools:			
CD-ROM	4	2-5	.76
FTF			.76
CMC			.83
Satisfaction with cooperation:			
Dyadic	3	6-8***	.74
Group			.82
Opinions about CMC technologies			
FTF	5	9-13***	.79
CMC			.68

* Chronbach's alpha for all except Kuder-Richardson estimate for the "Knowledge on food safety".
** for the EG, at delayed post-test: K-R = .51.
*** Post-test questionnaire

Data Analysis

All analyses, except for hand calculation of the Kuder-Richardson estimate, were conducted using SPSS® statistical package (SPSS Inc. 1999) and are listed in *Table 3.6*.

For all the index variables formed in the study (listed in *Table 3.5)*, internal consistency reliability coefficients were calculated using the Chronbach's alpha method for constructs with Likert-type scales and the Kuder-Richardson method for the knowledge questionnaire, which consisted of true-false questions.

At first, to establish equivalency of the groups across the five schools Analysis of Variance (ANOVA) and Repeated Measures ANOVA on the pretest and delayed post-test data was run. After setting aside one school and one group (CMC) in another school, the data was analyzed in the following way.

All comparisons between means at one point in time were first done with Multivariate Analysis of Variance (MANOVA) procedure in case of multiple dependent variables. Significant findings were followed-up by univariate ANOVAs, follow-up T-tests or LMATRIX procedure with Bonferroni adjustment for significance.

Change over time in knowledge, self-reported behaviors, and perceptions related to food safety were analyzed by Repeated Measures ANOVA, with follow-up T-tests or LMATRIX procedure with Bonferroni adjustment for significance.

All comparisons between group means were first done between genders in the entire sample. Then the analyses were conducted with the experimental and control group and gender as independent variables (fixed factors), and finally with the three treatments, FTF, CMC, and control, and gender as independent variables (fixed factors).

Associations between learning outcomes and the selected variables were analyzed by the Bivariate Correlation procedure computing the Pearson Product-Moment Correlation Coefficients.

Effect sizes were computed as the difference between each experimental and control group means divided by the control group's standard deviation (Glass, McGaw & O'Day 1981); Cohen 1992). An effect size of +0.25 or more can be considered educationally significant (Cohen 1988; Slavin 1998) meaning that the mean difference was 25% as large as the standard deviation.

Table 3.6: Statistical analyses conducted in the study.

Statistical Procedure	**Variables**
MANOVA (general linear model) - All by gender - EG, CG by gender - FTF, CMC, CG by gender	Knowledge and behavior scores at T-1, T-3 Computer related variables T-1 Food safety related variables T-1, T-3 Opinions about the instruction, on the index variables and the itemized variables: - CD at T-2 - Cooperative assignment at T-3 Opinions about the CMC technologies at T-3 Opinions about the cooperation at T-2, T-3
Univariate ANOVA (general linear model) - All by gender - EG, CG by gender - FTF, CMC, CG by gender	Knowledge scores at T-1, T-2, T-3 Behavior scores at T-1, T-3 Change in knowledge scores at T-2, T-3 Change in behavior scores at T-2, T-3 Opinions about the amount of information on the CD (T-2), in the cooperative assignment (T-3)
Repeated Measures ANOVA - All by gender - EG, CG by gender - FTF, CMC, CG by gender	Change in knowledge over time: - T-1 to T-2 - T-2 to T-3 - T-1 to T-2 to T-3 Change in self-reported behaviors over time: T-1 to T-3 Change in perceptions of - self-efficacy T-1 to T-3 - severity T-1 to T-3 - susceptibility T-1 to T-3 - response efficacy T-2 to T-3
Bivariate Correlations - EG - CMC - FTF - CMC by Gender - FTF by Gender	Change in knowledge over time: - T-1 to T-2 - T-2 to T-3 - T-1 to T-3 Change in self-reported behaviors over time: T-1 to T-3 Both With: - Treatment - Gender - Computer related variables - Food safety related variables - Changes in perceptions - Opinions about the instruction - Opinions about the cooperation - Preference to Internet and CMC

T-1 = Pretest, T-2 = Post-test, T-3 = Delayed Post-test
EG = experimental group, CG = Control group, FTF face-to-face instruction group,
CMC = computer-mediated communication group

Chapter 4

FINDINGS

Characteristics of the Sample

Students' use of computers and the Internet is presented in *Table 4.1* for the entire sample and for the experimental and control groups split by gender. In the entire sample, girls had access to a computer at home significantly less often than boys did. However, within treatments, this difference between genders was not significant (*Table 4.1*).

Students' participation in meal preparation, their interest in studying food safety and prior experience with foodborne illness is presented in *Table 4.2.* In the entire sample, no significant difference was detected between genders or treatments in preparing meals or snacks at home, working in food service, or having experienced a foodborne illness (*Table 4.2*). However, in the entire sample and in the experimental group, girls reported more agreement than boys with the statement "I am interested in studying food safety" (*Table 4.2*). Within the experimental group, the difference between genders was significant only in the CMC group with 83% of the girls being interested versus 55% of the boys ($p = .003$, results not shown here).

Mean scores for the index variables on student perceptions of self-efficacy, personal susceptibility and the severity of foodborne illness are presented in *Table 4.3.* In the entire sample, girls scored higher than boys on the perceived self-efficacy and the perceived severity scale. In the experimental group, girls scored higher than boys on the perceived self-efficacy scale. Within the experimental group, the difference between genders was significant only in the CMC group, as discussed later (data shown in *Table 4.14).*

Pretest Food Safety Knowledge and Safe Food Handling Behaviors

> Question 1: "What is the current level of food safety knowledge and safe food handling behaviors among middle school students?"

Mean scores on pretest food safety knowledge and self-reported food handling behaviors are presented in *Table 4.4* for the entire sample and both genders in each

Table 4.1: Computer use and computer liking in the experimental (EG) and the control group (CG) and the entire sample (All) by gender.

Computer related variable	EG			CG			All		
	Girls (n=65)	Boys (n=51)	Total (n=116)	Girls (n=25)	Boys (n=37)	Total (n=62)	Girls (n=90)	Boys (n=88)	Total (n=178)
	%	%	%	%	%	%	%	%	%
Prior computer experience									
> 5years	40	47	44	20	32	27	34	41	38
3-5 years	32	29	31	36	43	40	33	35	34
1-2 years	17	18	17	36	22	28	22	19	21
Less than a year	9	6	8	8	3	5	9	5	7
Computer use in hours									
Several hours per day (>3 hours)	17	12	15	20	27	24	18	18	18
A few hours per day (1-3 hours)	39	43	41	24	38	32	34	41	38
A few hours per week	26	33	29	44	24	33	31	30	30
Almost never	15	12	14	12	11	11	14	11	13
Computer access at home									
None	23	10	17	36	16	24	27	13*	20
Computer with no internet	9	14	11	16	11	13	11	13	12
Internet access	66	75	70	48	70	61	62	73	67
Computer liking.**									
$\geq$ 2.5 = Yes	95	94	95	96	95	95	94	93	95
< 2.5 = No	5	6	5	4	5	5	5	6	5
Internet Use									
Yes	91	88	90	92	87	89	91	88	89
No	8	12	10	8	13	11	8	12	10

* p = .028; ** index of two items with the scale 1 = Disagree, 2 = Slightly disagree, 3 = Slightly agree, 4 = Agree

Table 4.2: Food safety related characteristics in the experimental (EG) and the control group (CG), and the entire sample (All) by gender.

Food safety related variable	EG			CG			All		
	Girls (n=65)	Boys (n=51)	Total (n=116)	Girls (n=25)	Boys (n=37)	Total (n=62)	Girls (n=90)	Boys (n=88)	All (n=178)
	%	%	%	%	%	%	%	%	%
Prepare meals or snacks at home.									
Yes	95	88	92	92	89	90	94	89	92
No	3	12	7	8	11	10	4	11	8
Work in Food Service.									
Yes	3	8	5	12	3	7	6	6	6
No	94	92	93	98	97	93	91	94	93
Have been sick because of something they ate.									
Yes	23	24	23	20	16	18	22	21	21
No	25	33	28	40	41	40	29	36	33
Don't know	49	43	47	40	43	42	47	43	45
Interested in studying food safety (scale 1-4).									
"Slightly agree - Agree" = Yes	83	67**	75	68	49	56	78	59****	69
"Slightly disagree - Disagree" = No	17	33	24	32	48	42	21	40	31

** p = .004; *** p = .0001

Table 4.3: Mean scores on student perceptions related to food safety in the experimental (EG) and the control group (CG) and the entire sample (All) by gender.

	EG						**CG**						**Total**					
Index variable*	**Girls** (n=64)		**Boys** (n=51)		**Total** (n=115)		**Girls** (n=25)		**Boys** (n=37)		**Total** (n=62)		**Girls** (n=89)		**Boys** (n=88)		**All** (n=177)	
Perceived	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
- severity	3.8	0.4	3.6	0.6	3.7	0.5	3.6	0.5	3.3	1.0	3.4	0.8	3.8	0.4	3.5	0.8**	3.6	0,6
- susceptibility	2.3	0.7	2.1	0.7	2.2	0.7	2.3	0.7	2.2	0.7	2.3	0.7	2.3	0.7	2.2	0.7	2,2	0,7
- self-efficacy	3.6	0.4	3.4	0.6**	3.5	0.5	3.5	0.5	3.3	0.7	3.4	0.6	3.6	0.4	3.3	0.6**	3.4	0.6

*Scale: 1 = Disagree, 2 = Somewhat disagree, 3 = Slightly agree, 4 = Agree with high level of:

**p < .01, girls vs. boys

treatment. For the entire sample, the mean score on food safety knowledge was 7.2 ± 1.6 with a scale from 0-10 indicating the number of correct answers. No significant differences were detected between or within treatments.

Distribution of correct answers on pretest are shown for the entire sample in *Table 4.5.* Students' self-reported food handling behaviors, reported in *Table 4.4,* reached a mean of 3.9 ± 0.6 on a scale from 1 to 5, with 1 indicating "not once", 3 indicating "sometimes", and 5 indicating "every time professing safe food handling". In the entire sample, no significant difference was detected between genders or treatments. As indicated in *Table 4.6*, most frequently reported risky food handling behaviors were "seldom" washing hands before eating at school cafeteria or restaurant, "often" tasting foods to check if they are still safe to eat, and eating raw eggs or foods that contained raw eggs.

Table 4.4: Mean knowledge and self-reported food handling behavior scores and standard deviations at pretest (T-1) by treatment and gender.

	Knowledge T-1			**Self-reported Behavior T-1**	
Group	**Mean**	**S.D.**	**Group**	**Mean**	**S.D.**
FTF			**FTF**		
FTF Girls (n=34)	7.18	1.42	(n=34)	4.01	0.54
FTF Boys (n=29)	7.76	1.50	(n=31)	3.82	0.62
Total FTF (n=63)	7.44	1.48	(n=65)	3.92	0.58
CMC			**CMC**		
CMC Girls (n=29)	7.28	1.19	(n=30)	3.98	0.52
CMC Boys (n=20)	7.05	1.88	(n=20)	3.63	0.67
Total CMC (n=50)	7.18	1.50	(n=50)	3.83	0.60
EG (FTF + CMC)			**EG**		
EG Girls (n=63)	7.22	1.31	(n=64)	4.00	0.53
EG Boys (n=49)	7.47	1.68	(n=51)	3.74	0.64
Total EG (n=112)	7.33	1.48	(n=115)	3.88	0.59
Control			**Control**		
Control Girls (n=25)	7.38	1.86	(n=25)	3.91	0.38
Control Boys (n=37)	6.65	1.55	(n=37)	4.00	0.57
Total Control (n=62)	6.93	1.70	(n=62)	3.96	0.50
All			**All**		
Girls (n=88)	7.27	1.47	(n=89)	3.97	0.49
Boys (n=88)	7.10	1.65	(n=88)	3.85	0.62
All (n=176)	7.19	1.56	(n=177)	3.91	0.56

Table 4.5: Distribution of correct answers on the knowledge questionnaire at pretest (T-1) in the entire sample (All) (n=176).

Rule of prevention	**Test Item**	**n (%)**
Check foods	1. To make sure the milk is SAFE to drink, you should taste it instead of checking the expiration date. (False)*	156 (88)
	2. The canned tomatoes are no longer SAFE to eat, if the can is bulging out. (True)*	141 (79)
Cook to proper temperatures	3. The safest way to make sure meat is well done (thoroughly cooked) is to check its inner temperature with a meat thermometer. (True)*	112 (63)
	4. To be sure that the chicken wings are SAFE to eat, they should be cooked to an inner temperature of 100° Fahrenheit. (False)*	85 (48)
Chill promptly	5. Milk and cheese should be chilled (refrigerated) within 2 hours to keep them safe. (True)*	158 (89)
	6. The best temperature for most harmful bacteria to multiply is in the refrigerator, below 40° Fahrenheit. (False)*	105 (59)
Separate raw and cooked foods	7. Wiping off the cutting board with a clean paper towel between food items (raw meat and bread) will prevent harmful bacteria from spreading. (False)*	66 (37)
	8. To avoid cross-contamination you should separate raw chicken, meat and fish from ready-to-eat foods. (True)*	162 (91)
Wash your hands	9. Harmless bacteria from our hands can produce harmful toxins in foods. (True)*	128 (72)
	10. Before handling food, rinsing your hands under cold running water is enough to get rid of bacteria on your hands. (False)*	152 (85)

* Correct choice between true/false answers.

Table 4.6: Number of students reporting "seldom" and "often" engaging in safe food handling behaviors at pretest in the entire sample.

Rule	During the past month I have…	Seldom* n (%)	Often* n (%)	n**
Wash Your Hands	1. washed my hands before handling food/eating **at home.**	47 (27)	130 (73)	177
	2. washed my hands before eating **at school cafeteria/restaurant.**	126 (71)	51 (29)	177
	3. used paper towels to dry my hands.	51 (29)	125 (71)	176
Separate Raw and Cooked Foods	4. washed my hands between handling raw meat/chicken/fish and ready-to-eat foods.	24 (21)	90 (79)	114
	5. made sure raw meat is separated from ready-to-eat foods.	39 (23)	133 (77)	172
	6. made sure all surfaces are clean before handling food on them.	37 (21)	139 (79)	176
Chill Promptly	7. put foods that may spoil (milk, cheese, etc.) back to the refrigerator within 2 hours.	25 (14)	152 (86)	177
	8. put leftover foods (pizza, sandwiches, etc.) into the refrigerator within 2 hours.	34 (19)	142 (81)	176
Check Foods	9. checked the expiration dates on food packages before eating.	51 (29)	126 (71)	177
	10. not tasted foods to check if they are still safe to eat.	116 (66)	61 (34)	177
Cook to Proper °F	11. made sure my hamburgers or steaks are not bloody (clearly red inside) when I eat them.	32 (19)	139 (81)	171
	12. not eaten raw eggs or foods that contain raw eggs (like raw cookie dough).	88 (54)	76 (46)	164

* "Seldom" = combined categories of 1 = Not once, 2 = Almost not once, and 3 = Sometimes
"Often" = combined categories of 4 = Almost every time and 5 = Every time
** n varies due to option to skip questions related to meat products and eggs.

Learning Outcomes After the CD-ROM Session

Question 2: "Is there an increase in middle school students' food safety knowledge immediately after a 1-session CD-ROM based cooperative instruction?"

Mean knowledge scores, standard deviations, and gain scores from T-1 to T-2 are presented in *Table 4.7* for the experimental group. A significant increase in knowledge was indicated for the entire experimental group. However, the increase was statistically significant only for the girls (*Table 4.7).* The difference in gain scores between genders was not significant.

Table 4.7: Mean knowledge scores, standard deviations, and gain scores from T-1 to T-2 for the experimental group by gender.

Group	T-1 Mean	S.D.	T-2 Mean	S.D.	Gain	t	p	% gain over T-1
EG (FTF + CMC)								
EG Girls (n=63)	7.22	1.31	7.70	1.63	0.48	-2.5	0.016	6.6
EG Boys (n=49)	7.47	1.68	7.73	1.72	0.27	-0.8	0.44	3.6
Total EG (n=112)	7.33	1.48	7.71	1.67	0.38	-2.1	0.038	5.2

Learning Outcomes After the Cooperative Assignment

> Question 3: “Is there an additional increase in food safety knowledge and an increase in self-reported safe food handling practices after two subsequent weekly sessions utilizing cooperative learning assignments?”

Changes in Knowledge

Changes in the knowledge scores in the experimental group are presented in *Table 4.8*. In the experimental group (n=116), knowledge gain from T-1 to T-2 was maintained through the one-month study (T-1 vs. T-3), with no further improvement from T-2 to T-3. The change in knowledge among the control group from T-1 to T-3 was non-significant, which makes the increase in the experimental group educationally significant (effect size >.25). However, as presented in Table 4.8, this was true only for the girls.

Changes in Self-Reported Behaviors

Changes in the self-reported food handling behaviors are presented in *Table 4.9* for the experimental and the control group. A significant improvement was indicated for the experimental group; however when analyzed by gender, only the EG girls significantly improved their self-reported food handling behavior scores during the one-month study (*Table 4.9)*.

Overall, experimental group students improved their self-reported food handling behaviors, whereas the control group’s score went down (*Table 4.9*). This improvement was educationally significant (effect size >.25).

Table 4.8: Mean knowledge scores, standard deviations, gain scores, and effect sizes for the experimental and control groups by gender.

	EG						CG					
	Girls (n=63)		Boys (n=49)		Total EG (n=112)		Girls (n=25)		Boys (n=37)		Total CG (n=62)	
Time	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
T-1	7.22	1.31	7.47	1.68	7.33	1.48	7.38	1.86	6.65	1.55	6.93	1.70
T-2	7.70	1.62	7.73	1.71	7.72	1.67	-	-	-	-	-	-
T-3	7.89	1.61	7.76	1.92	7.83	1.75	7.29	1.71	6.78	1.60	6.98	1.65
Gain T-1 to T-2	0.48	1.52*	0.27	2.37	0.38	1.93*	-	-	-	-	-	-
Gain T-2 to T-3	0.19	1.84	0.02	2.16	0.12	1.98	-	-	-	-	-	-
Gain T-1 to T-3	0.61	1.92*	0.33	1.70	0.49	1.83***	-0.08	1.59	0.13	1.78	0.05	1.70
Effect size at T-1	-0.08		0.50		0.23		-	-	-	-	-	-
Effect size at T-3	0.32		0.61		0.50		-	-	-	-	-	-

Effect size equals the difference in treatment means divided by the control standard deviation.
* p < .05; *** p < .001

Table 4.9: Mean self-reported food handling behavior scores, standard deviations, gain scores, and effect sizes for the experimental and control groups by gender.

	EG						CG					
	Girls (n=64)		Boys (n=51)		Total EG (n=115)		Girls (n=25)		Boys (n=37)		Total CG (n=62)	
Time	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
T-1	4.00	0.53	3.74	0.64	3.88	0.59	3.91	0.38	4.00	0.57	3.96	0.50
T-3	4.22	0.47	3.88	0.76	4.07	0.64	3.97	0.52	3.80	0.65	3.87	0.61
Gain T-1 to T-3	0.23	0.49****	0.14	0.58	0.19	0.53****	0.06	0.52	-0.19	0.83	0.09	0.73
Effect size at T-1	0.24		-0.46		-0.16		-	-	-	-	-	-
Effect size at T-3	0.48		0.12		0.33		-	-	-	-	-	-

Effect size equals the difference in treatment means divided by the control standard deviation.
***p < .0001

Relative Effectiveness of the FTF and CMC Teaching Strategies

> Question 4: "Is there a difference in the effectiveness of computer-mediated versus face-to-face collaboration between student groups in increasing middle school students' food safety knowledge and self-reported safe food handling behaviors?"

Changes in Knowledge

Mean knowledge scores, standard deviations, gain scores and effect sizes for the two experimental groups, the experimental group and the control group are presented in *Table 4.10: T-1 to T-2; Table 4.11: T-2 to T-3; and Table 4.12: T-1 to T-3*. Significant improvement in knowledge from pretest to delayed post-test was indicated only for the FTF group. No significant differences were indicated between genders.

As presented in *Table 4.10, Table 4.11 and Table 4.12*, the entire FTF group scored significantly higher at T-3 compared to T-1, whereas CMC group scored higher only at T-2, but again slightly lower at T-3. Overall, knowledge gain from T-2 to T-3 was significantly greater for the FTF group than for the CMC group.

For girls, no significant difference in gain from T-2 to T-3 was indicated between the two experimental groups, but there was a significant difference for boys (*Table 4.11).*

Over the one-month study, for girls within the FTF group, knowledge scores at T-2 were significantly higher than at T-1, and slightly higher still at T-3, keeping the overall gain in knowledge significantly higher at T-3. For the FTF boys, the biggest increase in knowledge took place during the cooperative assignment, from T-2 to T-3, but the overall change from T-1 to T-3 was not significant. For the CMC girls, all increases in knowledge were non-significant, whereas the CMC boys scored significantly higher at T-2, and then again lower at T-3, with an overall non-significant effect from T-1 to T-3.

The findings concerning changes in knowledge indicate that boys in the FTF group gained in knowledge from the cooperative group (*Table 4.11*), whereas boys in the CMC group gained only from the CD-ROM session (*Table 4.10*). This gain among CMC boys was partly lost during the cooperative study (*Table 4.11*). Girls in the FTF group consistently gained in knowledge, as did girls in the CMC group. The overall differences between gain scores at T-3 between genders and treatments were non-significant. However, the effect sizes shown in *Table 4.12* indicated educationally significant results (effect size > 0.25) only for the FTF group girls, and the FTF group as a whole.

Table 4.10: Mean knowledge scores, standard deviations and gain scores at T-1 and T-2 for the experimental group by treatment and gender.

Group	T-1 Mean	S.D.	T-2 Mean	S.D.	Gain	t	p	% gain over T-1
FTF								
FTF Girls (n=34)	7.18	1.42	7.79	1.72	0.62	-2.1	0.04	8.6
FTF Boys (n=29)	7.76	1.50	7.31	1.91	-0.45	1.0	0.31	-5.8
Total FTF (n=63)	7.44	1.48	7.57	1.81	0.13	-0.5	0.63	1.7
CMC								
CMC Girls (n=29)	7.28	1.19	7.59	1.55	0.31	-1.3	0.21	4.3
CMC Boys (n=20)	7.05	1.88	8.35	1.18	1.30	-2.8	0.011	18.4
Total CMC (n=50)	7.18	1.50	7.90	1.45	0.71	-2.9	0.005	9.9
EG (FTF + CMC)								
EG Girls (n=63)	7.22	1.31	7.70	1.63	0.48	-2.5	0.016	6.6
EG Boys (n=49)	7.47	1.68	7.73	1.72	0.27	-0.8	0.44	3.6
Total EG (n=112)	7.33	1.48	7.71	1.67	0.38	-2.1	0.038	5.2

Table 4.11: Mean knowledge scores, standard deviations and gain scores from T-2 to T-3 for the experimental group by treatment and gender.

Group	T-2 Mean	S.D.	T-3 Mean	S.D.	Gain	t	p	% gain over T-2
FTF								
FTF Girls (n=34)	7.80	1.69	8.00	1.46	0.20	-0.6	0.545	2.6
FTF Boys (n=29)	7.31	1.91	8.07	1.79	0.76	-2.1	0.042	10.4
Total FTF (n=63)	7.58	1.80	8.03	1.60	0.45	-1.9	0.066	5.9
CMC								
CMC Girls (n=29)	7.59	1.55	7.76	1.81	0.17	-0.5	0.601	2.2
CMC Boys (n=20)	8.35	1.18	7.30	2.05	-1.05	2.3	0.035	-12.5
Total CMC (n=50)	7.90	1.45	7.57	1.90	-0.33	1.2	0.25	-4.2
EG (FTF + CMC)								
EG Girls (n=63)	7.70	1.62	7.89	1.61	0.19	-0.8	0.419	2.5
EG Boys (n=49)	7.73	1.71	7.76	1.92	0.03	0.1	0.95	0.4
Total EG (n=112)	7.72	1.67	7.83	1.75	0.12	-0.6	0.537	1.6

Table 4.12: Mean knowledge scores, standard deviations, gain scores, and effect sizes from T-1 to T-3 by treatment and gender.

Group	T-1 Mean	S.D.	T-3 Mean	S.D.	Gain	t	p	% gain over T-1	Effect size T-1	Effect size T-3
FTF										
FTF Girls (n=34)	7.18	1.42	8.00	1.46	0.82	-2.4	0.021	11.4	-0.11	0.42
FTF Boys (n=29)	7.76	1.50	8.07	1.79	0.38	-1.2	0.24	5.1	0.66	0.80
Total FTF (n=63)	7.44	1.48	8.03	1.60	0.61	-2.6	0.011	8.4	0.29	0.64
CMC										
CMC Girls (n=29)	7.28	1.19	7.76	1.81	0.37	-1.1	0.29	5.1	-0.04	0.22
CMC Boys (n=20)	7.05	1.88	7.30	2.05	0.25	-0.7	0.49	3.5	0.26	0.32
Total CMC (n=50)	7.18	1.50	7.57	1.90	0.32	-1.3	0.20	4.4	0.18	0.33
EG (FTF + CMC)										
EG Girls (n=63)	7.22	1.31	7.89	1.61	0.61	-2.5	0.014	8.4	-0.08	0.32
EG Boys (n=49)	7.47	1.68	7.76	1.92	0.33	-1.4	0.169	4.4	0.50	0.61
Total EG (n=112)	7.33	1.48	7.83	1.75	0.49	-2.9	0.005	6.7	0.23	0.50
Control										
Control Girls (n=25)	7.38	1.86	7.29	1.71	-0.08	0.3	0.799	-1.1		
Control Boys (n=37)	6.65	1.55	6.78	1.60	0.13	-0.5	0.65	2.1		
Control (n=62)	6.93	1.70	6.98	1.65	0.05	-0.2	0.82	0.7		

Effect size equals the difference in treatment means divided by the control standard deviation.

Changes in Self-Reported Behaviors

Mean self-reported behavior scores, standard deviations, gain scores and effect sizes for the two experimental groups and the control group at T-1 and T-3 are presented in *Table 4.13.* Both experimental groups showed a statistically and educationally significant (effect size > .25) increase in the scores from T-1 to T-3.

The increase in self-reported safe food handling behavior score was significant only for the girls in both experimental groups, but non-significant for the control group girls and for boys in all three treatments. The change within CMC group boys approached significance. The effect sizes indicated educationally significant results (effect size > 0.25) for girls in the FTF group only.

Table 4.13: Mean self-reported food handling behavior scores, standard deviations and gain scores from T-1 to T-3 by treatment and gender.

Group	T-1 Mean	S.D.	T-3 Mean	S.D.	Gain	t	p	% gain over T-1	Effect size T-1	Effect size T-3
FTF										
FTF Girls (n=34)	4.01	0.54	4.27	0.44	0.26	-3.1	0.004	6.4	0.26	0.58
FTF Boys (n=31)	3.82	0.62	3.88	0.74	0.05	-0.6	0.575	1.3	-0.32	0.12
Total FTF (n=65)	3.92	0.58	4.08	0.63	0.16	-2.5	0.014	4.1	-0.08	0.34
CMC										
CMC Girls (n=30)	3.98	0.52	4.17	0.50	0.19	-2.1	0.047	4.8	0.18	0.38
CMC Boys (n=20)	3.63	0.67	3.90	0.82	0.27	-1.9	0.067	7.4	-0.65	0.15
Total CMC (n=50)	3.83	0.60	4.06	0.65	0.22	-2.9	0.006	5.7	-0.26	0.31
EG (FTF + CMC)										
EG Girls (n=64)	4.00	0.53	4.22	0.47	0.22	-3.7	0.0001	5.5	0.24	0.48
EG Boys (n=51)	3.74	0.64	3.88	0.76	0.14	-1.7	0.089	3.7	-0.46	0.12
Total EG (n=115)	3.88	0.59	4.07	0.64	0.19	-3.8	0.0001	4.9	-0.16	0.33
Control										
Control Girls (n=25)	3.91	0.38	3.97	0.52	0.06	-0.5	0.588	1.5		
Control Boys (n=37)	4.00	0.57	3.80	0.65	-0.19	1.4	0.177	-4.7		
Total Control (n=62)	3.96	0.50	3.87	0.61	0.09	0.9	0.34	2.3		

Effect size equals the difference in treatment means divided by the control standard deviation.

Changes in Perceptions Related To Food Safety

Mean scores and standard deviations for students' pretest and delayed post-test perceptions related to food safety are presented in *Table 4.14* for the three treatment groups split by gender. No significant differences were detected between the entire groups, however there were significant interactions between treatment and gender.

Although the change in perceived severity from pre- to delayed post-test was not significant for any of the groups, girls in the control group scored higher than boys on the delayed post-test perceived severity scale.

On the perceived susceptibility scale, a significant increase was detected for the CMC girls ($p = .003$). At delayed post-test they scored the highest on this scale.

On the perceived self-efficacy scale at pretest, boys in the CMC group scored significantly lower than did boys in the FTF group and girls in both groups but significantly improved their score by delayed post-test. At delayed post-test, a significant difference was detected only between control group girls and boys (*Table 4.14*).

No change was indicated for the perception of response efficacy, measured at T-2 and T-3. The mean scores already at T-2 were high for all groups (see *Table 4.14*).

Opinions About the Instruction

Student opinions about the CD-ROM are presented in *Table 4.15*. No significant difference between girls and boys was indicated for the opinion about the amount of information on the CD-ROM. However, a significant difference in the opinions about the CD-ROM as a helpful learning tool was indicated with boys scoring lower than girls on this index variable (see Table 3.6 for items). A closer look into the itemized statements revealed that significantly more girls than boys agreed with the statement "I would do this type of (CD-ROM) work again", (mean score for girls, 3.6 ± 0.7 vs. 3.2 ± 1.1 for boys, T-test, $p = .04$). Although no significant difference between boys and girls was indicated on the index variable for cooperation, boys tended to agree less with one of the items: "Working in pairs helped me learn more than I would have on my own", 2.8 ± 1.2 for boys vs. 3.3 ± 1.0 for girls, T-test, $p = .03$.

Opinions about the cooperative group assignment are presented separately for the two experimental groups, FTF and CMC, in *Table 4.16.* No significant differences between groups or genders were detected on the three index variables: the assignment as a helpful learning tool, satisfaction with cooperation, and preference to use CMC technology for studying.

Table 4.14: Perceptions related to food safety at pretest (T-1) and delayed post-test (T-3) by treatment and gender.

	FTF						CMC						Control					
Index variable*	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Perceived	**Girls** (n=34)		**Boys** (n=29)		**Total** (n=63)		**Girls** (n=30)		**Boys** (n=20)		**Total** (n=50)		**Girls** (n=24)		**Boys** (n=35)		**Total** (n=59)	
- severity T-1	3.8	0.4	3.6	0.6	3.7	0.5	3.8	0.4	3.8	0.6	3.8	0.5	3.6	0.5	3.3	1.0	3.4	0.8
- severity T-3**	3.7	0.5	3.6	0.5	3.7	0.5	3.8	0.6	3.5	0.9	3.7	0.7	3.7	0.3	3.3	0.9	3.4	0.7
	Girls (n=33)		**Boys** (n=29)		**Total** (n=62)		**Girls** (n=30)		**Boys** (n=20)		**Total** (n=50)		**Girls** (n=22)		**Boys** (n=37)		**Total** (n=59)	
- susceptibility T-1	2.3	0.5	2.1	0.7	2.2	0.6	2.4	0.7	2.2	0.7	2.3	0.7	2.4	0.7	2.2	0.7	2.3	0.7
- susceptibility T-3***	2.3	0.9	1.9	0.7	2.1	0.9	2.9	0.8	2.4	0.8	2.7	0.9	2.6	0.9	2.3	0.8	2.4	0.8
	Girls (n=34)		**Boys** (n=29)		**Total** (n=63)		**Girls** (n=30)		**Boys** (n=20)		**Total** (n=50)		**Girls** (n=25)		**Boys** (n=37)		**Total** (n=62)	
- self-efficacy T-1	3.6	0.4	3.5	0.4	3.6	0.4	3.6	0.4	3.1	0.7	3.4	0.6	3.5	0.5	3.3	0.7	3.4	0.6
- self-efficacy T-3****	3.7	0.5	3.7	0.7	3.7	0.6	3.7	0.7	3.5	0.7	3.6	0.7	3.7	0.5	3.2	0.8	3.4	0.7
	Girls (n=34)		**Boys** (n=30)		**Total** (n=64)		**Girls** (n=30)		**Boys** (n=20)		**Total** (n=50)							
- response efficacy T-2	3.8	0.6	3.8	0.5	3.8	0.6	3.6	0.8	3.6	0.7	3.6	0.8						
- response efficacy T-3	3.8	0.6	3.6	0.8	3.7	0.7	3.5	0.9	3.4	1.0	3.4	1.0						

*Scale: 1 = Disagree, 2 = Somewhat disagree, 3 = Slightly agree, 4 = Agree with high level.

** at T-1 and T-3 CG girls > CG boys, $p<.001$.

*** at T-3 CMC girls > FTF and CG girls, $F(2,167) = 4.4$, $p = .013$; and largest increase from T-1 to T-3 within girl groups, $F(2,165) = 3.0$, $p = .05$.

**** at T-1 CMC boys < CMC girls $F(1,171) = 12.32$, $p = .001$; CMC boys < FTF and CG boys, $F(2,171) = 4.13$, $p = .018$, and largest increase in CMC from T-1 to T-3 within boy groups, $F(2,169) = 3.2$, $p = .05$. At T-3, CG boys < CG girls, $F(1,171) = 7.9$, $p = .005$.

Table 4.15: Opinions about the CD-ROM instruction for the experimental group by gender.

	EG Girls (n=64)		**EG Boys** (n=50)		
Opinions	**Mean**	**S.D.**	**Mean**	**S.D.**	
Amount of information.*	3.2	0.6	3.1	0.8	
Index variables**					
Helpfulness to learning.	3.4	0.6	3.1	0.8	p = .05, girls vs. boys
Satisfaction with dyadic work.	3.5	0.8	3.2	0.8	

* 1 = Too little, 2 = Somewhat too little, 3 = Just right, 4 = Somewhat too much, 5 = Too much
** 1 = Disagree, 2 = Slightly disagree, 3 = Slightly agree, 4 = Agree

Distribution, mean scores and standard deviations on student opinions about the special attributes of CMC technologies are presented in *Table 4.17* for the two experimental groups. Significant differences were detected between groups. CMC group placed more importance on the effect of Internet publishing on their work, and on reading all this material on the Internet (*Table 4.17)*.

On the itemized opinions, the CMC group girls agreed more often than CMC group boys with the statement “I think I learned a lot from this assignment” (3.4 ± 0.9 vs. 2.8 ± 0.7, p = .014). The CMC group girls also agreed more often than boys with the question of equal participation (3.3 ± 1.1 vs. 2.5 ±1.2, p = .05) and more often with “cooperation helped me learn more” (3.2 ± 1.2 vs. 2.5 ±1.2, p = .024).

Table 4.16: Mean scores for opinions about the learning assignment by treatment and gender.

	FTF						CMC					
	Girls (n=34)		**Boys** (n=29)		**Total FTF** (n=63)		**Girls** (n=29)		**Boys** (n=17)		**Total CMC** (n=46)	
Opinions	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Amount of information in the group assignment.*	3.2	0.6	3.2	0.5	3.2	0.6	3.2	0.6	2.9	0.8	3.1	0.6
Index variables**	**Girls** (n=31)		**Boys** (n=25)		**Total FTF** (n=56)		**Girls** (n=28)		**Boys** (n=14)		**Total CMC** (n=42)	
Group assignment's helpfulness to learning.	3.1	0.8	3.0	0.8	3.0	0.8	3.2	0.8	2.8	0.7	3.1	0.8
Satisfaction with cooperative work.	3.2	0.7	3.0	0.9	3.2	0.8	3.3	1.0	2.7	1.0	3.1	1.0
Preference to CMC.	3.0	0.8	3.0	0.8	3.1	0.7	3.4	0.7	3.3	0.6	3.4	0.6

* 1 = Too little, 2 = Somewhat too little, 3 = Just right, 4 = Somewhat too much, 5 = Too much

** 1 = Disagree, 2 = Slightly disagree, 3 = Slightly agree, 4 = Agree

Table 4.17: Distribution (%), mean scores and standard deviations for student opinions about the use of CMC technologies in the two experimental groups.

Index	**Group**	**Statement**	**Disagree 1**	**Slightly disagree 2**	**Slightly agree 3**	**Agree 4**	**FTF n=56, CMC n=46 Mean**	**S.D.**	
Internet publishing	FTF (n=60)	1. I would have done a better job if my results had been published on the Internet.	22	17	38	23	2.6	1.1	*
	CMC (n=46)	1. I would have done a better job if my results had been published only in class.*R	52	26	11	11	3.2	1.0	
Read on the Internet	FTF (n=58)	2. I would have liked to read all this information and more on the Internet.	10	9	41	40	3.1	1.0	**
	CMC (n=46)	2. I would have liked to read all this information on paper instead of on the Internet.*R	78	13	7	2	3.7	0.7	
Open to the world	FTF (n=59)	3. I would have liked to work with students from other schools on the Internet in addition to working with my own classmates.	17	17	25	41	2.9	1.1	
	CMC (n=46)	3. I would have liked to work only with my own classmates without students from other schools.*R	59	6	11	24	3.0	1.3	
Prefer the computer	FTF (n=59)	4. I would rather have worked with the computer instead of with these pictures and paper.	3	7	29	61	3.5	0.8	
	CMC (n=46)	4. I would rather have worked with pencil and printed pictures instead of doing it with the computer.*R	82	9	9	0	3.7	0.6	
Added interest	FTF (n=59)	5. The computer would have increased my interest to study food safety.	10	12	30	48	3.2	1.0	
	CMC (n=46)	5. Working without the computer would have increased my interest to study food safety. *R	63	22	4	11	3.4	1.0	

* = MANOVA $F(1,98) = 6.1$, $p = .015$, ** $F(1,98) = 11.4$, $p = .001$.

*R = Item scoring was reversed for calculating the mean.

Variables Associated With Learning Outcomes

> Question 5: "Which student characteristics are associated with learning outcomes: gender, prior computer experience and computer attitudes, motivation (interest), perceived threat of foodborne illness, perceived self-efficacy and response efficacy, opinions about the instruction and cooperative work?"

Bivariate Correlations at Post-test (T-2)

Results from the bivariate correlations at T-2, with only knowledge measured as an outcome, are shown in *Table 4.18.* In the experimental group, knowledge gain at T-2 (learning from the CD-ROM session dyadic work) was negatively correlated with pretest perceived self-efficacy and student perceptions of the amount of information provided on the CD-ROM. These were positively correlated with pretest knowledge, which was negatively correlated with gain in knowledge at T-2 ($r = -.55$, $p = .0001$). However, change in perceived self-efficacy from T-1 to T-3 was positively correlated with gain in knowledge at T-2 ($r = .27$, $p = .004$).

Those who knew more about food safety at pretest tended to gain less, to have higher perceived self-efficacy and to consider the amount of information provided on the CD-ROM just right or abundant. Those who learned from the CD-ROM were more likely to improve their self-efficacy score in the one-month study.

Bivariate Correlations at Delayed Post-test (T-3)

In the experimental group (FTF + CMC), treatment did not significantly correlate with T-3 learning outcomes. Therefore, correlation coefficients are presented in Tables 4.21 and 4.22 separately for the FTF and CMC groups.

FTF Group

In the FTF group, gain in knowledge at T-3 was negatively correlated with pretest knowledge ($r = -.55$, $p = .0001$) and positively correlated with prior years of experience with computers and perceived response efficacy of the proposed preventive steps at T-3 (*Table 4.19)* and improvement in it from T-1 to T-3 ($r = .42$, $p = .001$).

Those who gained in knowledge were likely to have a low pretest knowledge score, have more experience with computers, and to believe the presented methods to be

Table 4.18: Bivariate correlation coefficients for the experimental group (FTF + CMC).

Variable	**Change in Knowledge**			**Change in Self-reported behavior**
	T-1–T-2	**T-2–T-3**	**T-1–T-3**	**T-1–T-3**
Treatment	0.15	-0.20*	-0.08	0.06
Gender	-0.05	0.04	-0.08	-0.08
Prior computer experience (years)	0.04	0.13	0.19*	-0.18
Computer use (hours per week)	-0.04	0.15	0.14	0.11
Computer/Internet access at home.	-0.01	0.19	0.23*	0.02
Computer liking (at home and at school)	-0.13	0.01	-0.13	-0.11
Motivation (Interested in)	0.01	0.02	0.06	0.20*
Perceived self-efficacy	-0.26**	0.20*	0.06	-0.05
Perceived response efficacy T-2	0.06	-0.18	-0.04	-0.01
Perceived response efficacy T-3	0.06		0.16*	0.18
Perceived severity	-0.03	0.01	-0.05	-0.13
Perceived susceptibility	-0.07	0.04	-0.04	-0.03
Amount of information on the CD	-0.34****	0.10	-0.06	-0.05
Satisfaction with the CD as a learning tool	0.05	-0.22*	-0.06	-0.09
Satisfaction with dyadic cooperation	0.17	-0.14	-0.04	-0.03
Amount of information in the assignment	0.17	0.10	-0.07	0.14
Satisfaction with the assignment as a helpful learning tool.	0.21*	-0.22*	0.04	0.30*
Satisfaction with cooperation	0.15	-0.14	0.03	0.09
Opinions about CMC technology (preference to Internet and CMC)	-0.14	-0.19	-0.07	-0.08

* p = .05, ** p = .01, **** p = .0001

efficacious in preventing foodborne illness. Furthermore, students with computer and Internet access at home tended to have more experience with computers ($r = .32$, $p = .009$) and to use them more frequently on a daily basis ($r = .52$, $p = .0001$). Pretest knowledge scores were not significantly correlated with computer related background characteristics. Computer issues did not significantly correlate with opinions about the assignment or perceived self-efficacy or interest in studying food safety.

Change in self-reported behavior score was not significantly correlated with any of the baseline variables, except for the negative correlation with pretest food handling behaviors ($r = -.35$, $p = .004$). However, change in self-reported behavior score was positively correlated with change in perceived self-efficacy in the FTF group ($r = .25$, $p = .05$). The more the FTF students' perceived self-efficacy improved, the more their self-reported food handling behaviors improved during the one-month study.

Opinions about the learning assignment did not significantly correlate with outcomes in the FTF group. However, those who considered the assignment helpful for their learning were more likely satisfied with the cooperation within the group ($r = .54$, $p = .0001$) and would have preferred the CMC strategy ($r = .34$, $p = .011$).

CMC Group

In the CMC group, learning outcomes at T-3 did not significantly correlate with prior experience with computers. Gain in knowledge from T-1 to T-3 was negatively correlated with pretest knowledge ($r = -.30$, $p = .03$), positively correlated with delayed post-test knowledge scores ($r = .68$, $p = .0001$), and did not significantly correlate with other predictors (*Table 4.20*).

The more the CMC students learned from the CD-ROM, the more their perceived self-efficacy score improved ($r = .30$, $p = .04$) and the less their perceived susceptibility increased from T-1 to T-3 ($r = -.42$, $p = .002$). The more the susceptibility score increased, the more they learned from the cooperative assignment (T-2 to T-3) ($r = .42$, $p = .003$).

Change in self-reported food handling behaviors correlated positively with opinions about the learning assignment's helpfulness as a learning tool and opinions about the amount of information in the assignment.

Positive opinions about the learning assignment as a helpful learning tool correlated with satisfaction with cooperation within the group ($r = .58$, $p = .0001$) and with the amount of information provided in the assignment (just right or abundant) ($r = .40$, $p = .007$). Students who considered the amount of information in the assignment abundant were more likely to report higher perceived self-efficacy ($r = .33$, $p = .03$). Preference to CMC technology correlated positively with computer experience ($r = .33$, $p = .03$), and computer liking ($r = .47$, $p = .001$), the two variables that correlated with each other ($r = .45$, $p = .001$).

These correlations can be summarized as follows: those who knew more about food safety at pretest, gained less from the intervention, were more likely to handle food more safely and to trust in themselves as safe food handlers and to perceive a foodborne illness more severe. Boys were more likely than girls to report less safe food handling behaviors, to be less interested in studying food safety and to trust less in themselves as safe food preparers.

Table 4.19: Bivariate correlation coefficients for the FTF group.

Variable	Change in Knowledge T-1 – T-3	Change in Self-reported Behavior T-1–T-3
Gender	-0.12	-0.20
Prior computer experience (years)	0.25*	-0.16
Computer use (hours per week)	0.21	0.04
Computer and Internet access at home	0.24	0.03
Computer liking	-0.17	-0.19
Motivation (Interested in)	0.13	0.17
Perceived self-efficacy	0.02	-0.13
Perceived response efficacy T3	0.42**	0.01
Perceived severity	-0.01	-0.15
Perceived susceptibility	-0.02	0.04
Amount of information in the assignment	-0.11	-0.14
Satisfaction with the assignment as a helpful learning tool	0.04	0.13
Satisfaction with cooperation	-0.01	-0.03
Preference to Internet and CMC	-0.01	-0.05

* p = .05, ** p = .01

Table 4.20: Bivariate correlation coefficients for the CMC group.

Variable	**Change in Knowledge T-1 – T-3**	**Change in Self-reported Behavior T-1–T-3**
Gender	-0.03	0.07
Prior computer experience (years)	-0.03	-0.20
Computer use (hours per week)	0.11	0.17
Computer and Internet access at home	0.19	0.03
Computer liking	-0.13	-0.04
Motivation (Interested in)	-0.05	0.24
Perceived self-efficacy	-0.16	0.03
Perceived response efficacy T-3	0.07	0.01
Perceived severity	-0.10	-0.13
Perceived susceptibility	-0.06	-0.07
Amount of information in the assignment	-0.02	0.48***
Satisfaction with the assignment as a helpful learning tool	0.05	0.53****
Satisfaction with cooperation	0.08	0.23
Preference to Internet and CMC	0.10	0.14

*** p = .001, **** p = .0001

Chapter 5

DISCUSSION

This study investigated the relative effectiveness of two teaching strategies, face-to-face and computer-mediated cooperative learning, in improving food safety knowledge and self-reported food handling behaviors among middle school students. Instruction consisted of one session with an interactive CD-ROM working in dyads and two sessions with a cooperative assignment communicating in groups of four either face-to-face or via the computer. The results in this study indicated no difference in learning outcomes between the two modes of delivery. Variation in learning outcomes was more affected by student background characteristics and opinions about the instruction than by the media (mode of delivery), and these were related to gender although no significant difference was detected in learning outcomes between genders. This study is unique at the secondary level. The findings concur with those at the university level (Phillips & Santoro 1989; Harasim 1990; Cheng et al. 1991; Hiltz 1986; Hiltz 1990; 1993; Marttunen 1992; Althaus 1997) and offer support to the suggestion that girls would be more interested and successful in computers and computer-assisted instruction if instructional methods and the context were different from competition and basic science (Pelgrum 1992; Reinen & Plomp 1993; AAUW 2000).

Pretest Food Safety Knowledge and Safe Food Handling Behaviors

As one of its main objectives, at a time when no data on children's and adolescents' food safety knowledge and practices was available, this study set out to explore the current level of food safety knowledge and the safety of food handling behaviors among the young Americans. These were determined to be slightly better than among the adult population in the United States (Williamson, Gravani & Lawless 1992; Albrecht 1995; Altekruse et al. 1995; Unklesbay, Sneed & Toma 1998; ADA & ConAgra 1999) and other Western countries, Australia (Jay, Comar & Govenlock 1999) and UK (Bruhn & Schutz 1999), and adolescents in Finland (Haapala et al. 2000), another comparable Western country.

Students in this study had a fairly good level of food safety knowledge at pretest scoring 7.19 ± 1.56 on a scale of 10. No difference was indicated between genders, unlike among adult Americans with females scoring higher than males (Williamson, Gravani & Lawless 1992). This concurs with the finding that boys and girls in this study equally participated in meal and snack preparation at home whereas with age, females tend to get more practice with food handling and food safety issues and may therefore score higher.

On the knowledge questionnaire at pretest, the students had the most difficulties with items that dealt with issues, which not necessarily concerned the students at this young age when older family members usually are more responsible for cooking and cleaning. Items more concerned with students' daily and more habitual food handling, such as washing hands or checking foods before eating, or chilling foods, were mastered by most of the students. However, also these adolescents will soon grow up to be in charge of meal preparation, and therefore, will need to master all of these basic food safety rules in the future.

One fifth of these students reported frequently taking risks in their food handling and one fifth reported having been sick because of something they ate, while 10% - 50% of adults have reported frequent risk taking (Williamson, Gravani & Lawless 1992; Albrecht 1995; Altekruse et al. 1995; Unklesbay, Sneed & Toma 1998; ADA & ConAgra 1999) and over 10% have reported having experienced a foodborne illness (Todd 1989). These findings support the national initiatives (American Meat Institute & Food Marketing Institute 1996; USDA 1998; USDA & FSIS 1998; USDA 1999) for broad-based food-safety education among the consumers and especially the young, food preparers of the future. This study showed that interactive technology, CD-ROM and CMC, could offer viable tools for teaching food safety to the young.

Learning Outcomes After the CD-ROM Session

The second research question concerned the effectiveness of an interactive CD-ROM on food safety in a cooperative learning environment in middle school classrooms. Studying the CD-ROM in dyads during a 45-minute class period resulted in knowledge gain among the girls. Although statistically significant, the gain was small, 0.48 ± 1.52 ($p < .05$), on a scale of 10. For the entire experimental group, the gain was 0.38 ± 1.93, $p < .05$.

Slightly greater gains have been shown in previous studies with the first version of this CD-ROM when using only six content specific multiple-choice questions (Michelman 1998) or ten multiple-choice questions with double the time to study the CD-ROM in an English as foreign language classroom (Haapala et al. 2000). It was concluded that in this study, both the true-false knowledge questionnaire, which may have run into a ceiling effect (scores ranging 2-10 with a mode of 8.0 points at both tests), and the short class period (45 minutes), might have negatively affected the learning outcomes.

Although this food safety instruction was integrated into their studies, doing well on the questionnaire, overall, was not tied to the students' grade, which may have reduced students' motivation to do well even if they had learned more from the CD-ROM. Also, the pairs of students used a considerable amount of time to find a mutually agreeable password to log on to the program (a new feature allowing for personalized feedback with the students' names on the screen), which further decreased the time to study. The researcher's marking that the students did not have enough time to test everything on the CD-ROM connected with the small (although significant $p < .05$) gains in knowledge in this study indicate that if used as a sole component of food safety instruction, and if testing was to be performed immediately afterwards, this CD-ROM on food safety might be more effective if allowed more than a 45-minute period of time or if students were allowed to work on their own when time is limited.

The boys' non-significant gain in knowledge may partly be explained by their less favorable opinions about working in pairs. This difference in attitudes concurs with findings from other studies among 8th graders, where girls preferred to work in pairs; boys rather worked on their own at the computer (Benson 1997). However, in this study, the association between knowledge gain and opinions about the dyadic work was non-significant for the boys, but significantly positive for the girls ($r = .33$, $p < .001$), a finding that would not warrant allowing boys to always work on their own as suggested by Corston & Colman (1996). Rather, allowing more time for cooperative study at the computer would give all students the needed experience with computers and working in a team, the skills for real-life. Furthermore, cooperative study has been shown to lead to equal or greater achievement than individual or competitive use of computers (Trowbridge & Durnin 1984; Johnson, Johnson & Stanne 1985; Carrier & Sales 1987; Rysavy & Sales 1990; Mevarech, Silber & Fine 1991).

The boys' learning outcomes may also have been affected by their lower level of interest in the topic and their lower level of confidence in themselves as safe food handlers (perceived self-efficacy). These variables serve as self-regulators of motivation to study, especially in the face of difficulties (Schunk 1989; Bandura 1997), and both serve as motivators to take preventive action (Rogers 1975). By the end of the one-month study, these gender differences in interest and perceived self-efficacy were no longer indicated. The more the boys' perceived self-efficacy score improved during the study the more they had gained from the CD-ROM ($r = .36$, $p < .05$), and in fact, the more they learned during the entire study and the more improvement they reported in their food handling behaviors. These findings concur with those from studies on the effects of self-efficacy (and its changes) on the adoption of health behaviors (Maibach, Flora & Nass 1991), and the findings on its effects on academic achievement (Schunk 1989; Tuckman 1990; Bandura 1997). These findings also suggest that interactive technology has the potential to strengthen adolescents' perceived self-efficacy through providing vicarious experience, performance accomplishment, verbal persuasion, and social support through case-based scenarios and facilitated interaction (Dede & Fontana 1995; Brennan & Fink 1997; Street & Rimal 1997).

The main purpose of the CD-ROM instruction in this study was to introduce the five food safety rules in a highly interactive multimedia presentation for further discussion in the following group assignment. Lending support to the Social Learning Theory (Bandura 1986) and the cooperative learning model (Slavin 1980), those who had lower pretest knowledge scores tended to gain more from the CD-ROM session, to catch up with the others on the basic rules, and those who learned less from the CD-ROM tended to gain more from the group assignment. Furthermore, opinions about the CD-ROM indicated that the more the students learned from the CD-ROM, the more they liked the subsequent group assignment and the more likely they were to feel that the CD-

ROM contained just the right or sometimes too little information. The latter association relates to the fact that within the 45-minute period, only the main section, stressing the five food safety rules, of the CD-ROM was studied, and the more challenging sections covering the foodborne pathogens were covered in the group assignment. These findings led us to conclude that this short, 45-minute period of CD-ROM instruction with a significant increase in knowledge in this group of students had fulfilled its purpose.

Learning Outcomes After the Cooperative Assignment

The third research question concerned the overall effectiveness of the cooperative teaching strategy which was designed to encourage self-reflection and discussion on the issues presented on the CD-ROM. Further reflection and additional time for decision making to take preventive action in personal food handling was allowed by the delay between the last meeting and the delayed post-test at one month.

Learning outcomes at one-month indicated significant gain in knowledge (0.61 ± 1.92, $p < .05$ (8.4%, effect size .40), for the girls. Also, a significant improvement in the self-reported food handling behaviors (0.23 ± 0.49, on a scale of 5, $p < .0001$) was indicated for the girls. The effect size, .24 (the difference between the experimental group mean score divided by the control group standard deviation), indicates that this 5.5% improvement among the experimental group girls when compared to the control girls was not educationally significant (Cohen 1992).

The finding that boys did not improve their scores in this study may best be explained by the reasons discussed above: boys were less interested in the topic, less confident in food handling at pretest, and overall held less favorable opinions about cooperative work. In prior research involving computers, girls have held less favorable opinions, because in the past computers have been integrated into subject areas and instructional strategies (individual and/or competitive) usually not favored by girls (AAUW 1991; Pelgrum 1992; Reinen & Plomp 1993; AAUW 2000). However, in this study in spite the difference in opinions, the difference in gain scores between genders was not significant. We could have collapsed the gender grouping, but doing so we would not have detected some interesting associations related to gender as discussed below.

Overall, it needs to be pointed out that in this study, the instruction in class consisted of only three sessions (and two testing sessions), which greatly limited its chances of achieving greater learning outcomes. Other studies attempting to increase critical thinking or applied knowledge in a cooperative computer-based learning setting have concluded the effect time too short even after nine weekly 45-minute sessions (Repman 1993). A longer intervention might have also shown greater changes in the self-reported food handling behaviors, as suggested by a review of two decades of nutrition education (Contento et al. 1995).

Relative Effectiveness of the FTF and CMC Teaching Strategies

Supporting the main hypothesis, the two learning environments were equally effective as indicated by the non-significant differences in gain scores between the two groups and between genders over the one-month study. When compared to the control group, students in both experimental groups improved their self-reported food handling behaviors with effect sizes of .42 for the FTF group and .57 for the CMC group. Students in the FTF group improved their knowledge scores with an effect size of .33.

To compare the results with prior research, effect size (ES) was calculated for the non-significant differences between the CMC group and the FTF group (whereas the effect sizes reported in this study compare each experimental group with the control group): ES for knowledge was -.01 and ES for self-reported food handling behaviors was .12. In Kulik and Kulik's (1991) review, comparable results with no difference in achievement between students in computer-assisted (CAI) and conventional instruction were reported in half of the 248 studies reviewed. CAI (off-line) raised final examination scores in a typical study by .30 standard deviations (effect size of .30) when compared to the conventional one. Effects were smaller for interventions lasting for more than four weeks and when the same instructor taught both CAI and conventional classes (controlling for teacher effect, as in this study). At the secondary level, the shorter (2-3-week) interventions showed effect sizes of -.42 to .16 for CAI (in chemistry and science), which sets this study in medium to high range. The ones lasting for a year or two showed effect sizes of .05 to .88 in math and reading (Kulik & Kulik 1991). However, in this study, the FTF instruction was not "conventional" but highly learner-centered, well-structured cooperative work, in line with cooperative instruction for which effect sizes of .30 to .90 (comparing cooperative to conventional instruction) have been reported (Slavin 1998).

Although the one-month results, in this study are clear, there were confusing findings for treatment within gender. For the girls, the cooperative assignment, irrespective of medium, was able to maintain the small gain in knowledge after the CD-ROM session with non-significant increase at delayed post-test in either treatment. However, the overall one-month gain in knowledge was significant only for the FTF girls (effect size = .53). Improvement in the self-reported food handling behaviors was significant for girls in both groups, but educationally significant (effect size = .32) only for the FTF girls. For the boys in both experimental groups, the overall one-month gains in knowledge and self-reported food handling behaviors were non-significant.

The two sessions with the cooperative assignment were effective in supporting gain in knowledge only among the FTF group boys, who had not gained from the CD-ROM session; whereas in the CMC cooperative sessions, the boys lost some of the knowledge gained during the CD-ROM study. This gender related finding might indicate that more sharing of knowledge took place during the FTF than the CMC assignment as suggested by Webb's (1985) findings that in the face-to-face settings, girls tend to help the boys in their group. Boys tend to dominate classroom face-to-face activities (Webb 1985), but the computer-mediated communication tends to allow for more equal participation (Phillips & Santoro 1989; Dubrowski, Kiesler & Sethna 1991; Scardamalia

& Bereiter 1993/1994; May 1994; Walther 1994; Walther 1996), and may favor girls in the text-based communication (Tella 1992). At the computers in this study, the girls possibly paid more attention to their personal learning than to helping boys.

In the CMC group, the finding that the girls held more positive opinions about the cooperative work at the computers concurs with the findings from studies among American middle school students (Benson 1997; Barbieri & Light 1992) and Finnish high school students (Tella 1992; Haapala et al. 2000), but are quite contrary to the notions of girls being intimidated by the presence of boys at the computers (Underwood, McCaffrey & Underwood 1990; Elkjaer 1992; Shashaani 1993; Corston & Colman 1996). The positive opinions among girls in this study may be due to the equalizing effects of cooperative learning methods and the connection with the topic of food safety that could be considered to belong into the "female domain" (Makrakis & Sawada 1996). As discussed above, integrating computation across the curriculum and using it to solve real-life problems in a cooperative environment has been suggested by the AAUW Technology Commission (AAUW 2000) to support better learning for all, while inviting more girls into technology.

Overall, this study indicated that when food safety is taught in a cooperative learning environment, learning outcomes are not as much affected by the medium as by computer experience, interest in the topic, efficacy and risk appraisals related to food safety and opinions about the instruction. These associations are much in line with those in Hiltz' (1993) study at the university level and support the suggestions that learning in a computer environment is not dependent upon gender but other characteristics related to gender, like computer experience (Levin & Gordon 1989). The finding that the two modes of delivery were equally effective is important because this could encourage the use of CMC and Web-based instruction as a convenient and easily up-dated and compelling tool for food safety education at school and in after-school activities in a time when computers have become more readily available and are of such interest to children.

Variables Associated With Learning Outcomes

As suggested by the main hypothesis in this study, treatment (mode of delivery) was not associated with learning outcomes at one month, although it did have an effect on boys' learning from the cooperative assignment. Since the CD-ROM instruction and the cooperative assignment were integral, and the effect of the former could not be separated from that of the latter, we cannot draw conclusions about learning from the cooperative assignment, per se, but can only explore variables that might have affected learning within these instructional sessions and need to consider the instructional strategy as a whole when judging the effects of the media.

Lending more support to the recent debate over non-significant media effects on learning (Clark 1994; Kozma 1994;) and Hiltz's (1993) findings at the university level, learning outcomes in this study were more affected by the chosen background characteristics and student opinions about the instruction. Strongest associations with gain in knowledge in the entire experimental group were indicated for computer access and computer experience followed by perceived response efficacy of the suggested preventive methods. For improvement in the self-reported food handling behaviors, the strongest associations were with satisfaction with the cooperative assignment and interest in the topic.

In the light of prior research (Levin & Gordon 1989; Reinen & Plomp 1993), it was surprising that the computer-related variables did not significantly correlate with learning outcomes immediately after the CD-ROM instruction, but that the effect of computer experience in the FTF girls was apparent at delayed post-test, three weeks after the computer instruction per se. However, more recent studies (e.g. Althaus 1997; Haapala et al. 2000) have shown the same kind of lack of association suggesting a trend towards gender equality at computers in the age groups studied. In this study, the students were experienced with computers and both the girls and the boys liked to use computers. Furthermore, these students had greater access to home computers (80%) than Americans in general (40%) (U.S. Department of Commerce 2000), and 79% of the students in this study used the Internet for school related information search (Internet at school), which greatly differs from the American average (21%, U.S. Department of Commerce 2000). Still, the gender gap suggested by other researchers (Busch 1995) was evident in this sample as indicated by the fact that boys more often than girls had access to a home computer, which may have affected learning among girls.

Although no difference was indicated between girls in the two experimental groups, computer experience correlated with learning from the CD-ROM session for the CMC girls; whereas for the FTF girls this correlation showed up only at delayed post-test, as mentioned above. This would imply that those with more experience would be more at ease at the computer to fully enjoy computers' capabilities to support sensory vivid presentations of the content thus facilitating storage of the new information in the learner's memory structures and retrieval of this stored information at a later date as described by Lieberman (1992), Wittrock (1992), Brennan and Fink (1997), Street and Rimal (1997), and Weiten (2000). Supported by the theoretical framework of this study, especially the Social Learning Theory (Bandura 1986) and cooperative learning model (Slavin 1980; Wittrock 1992; Stevens & Slavin 1995), we may conclude that the use of a cooperative approach in and with educational CD-ROMs, allowing for peer-discussion, was beneficial. Computers can be more convenient to use and often hold more information than do books (Gustafson et al. 1987) and they allow for interaction with the learning material (Dede & Fontana 1995; Brennan & Fink 1997; Street & Rimal 1997), as did the CD-ROM in this study. In prior research, the beneficial effect of peer discussion and cooperation has been reported in several studies involving traditional classroom instruction (Webb 1985; Slavin 1998) and computer-assisted instruction (Rysavy & Sales 1990; Pryor 1995), and in studies involving CMC technology at the university level (Marttunen 1992; Althaus 1997).

The second most common association with learning outcomes was predicted by the second theory comprising the theoretical framework of this study, the Protection-Motivation Theory (Rogers 1975). The perceived response efficacy, i.e., how effective the proposed measures are perceived to be, correlated positively with change in knowledge, although not with change in self-reported behaviors as suggested by the theory. However, within the two experimental groups, changes in the four perceptions assessed in this study were associated with both learning outcomes: change in the perceived response efficacy with gain in knowledge, and changes in perceived self-efficacy, susceptibility and severity with the self-reported food handling. These associations lend support to the conclusions by Contento and colleagues (1995) in their review of twenty years of nutrition education, and current researchers in the field of risk communication (Knight Lapinski & Witte 1998) that these variables should be affected to improve the effectiveness of health education.

In spite of the positive correlations between the changes in perceptions and improvement in the self-reported food handling in this study, the overall improvement in the latter was small. This may be related to the finding that these students seemed to have an overly trusting perception about the safety of food handling around them, with a small reduction within the CMC group at one-month. At pre-test almost every fourth student (23%) in the entire experimental group reported having been sick because of something they ate and yet, although they perceived the severity of foodborne illness high (3.7 ± 0.5 on a scale of 4), they considered their susceptibility fairly low (2.2 ± 0.7 on a scale of 4). As suggested by the Protection-Motivation Theory (Rogers 1975), people who perceive either their risk (combined susceptibility and severity appraisal) and/or their personal coping ability small (efficacy appraisal) are less likely to take preventive action.

The finding that significant changes in the perceptions of susceptibility and self-efficacy were indicated for the CMC group, in particular, concurs with findings from a food safety study among college students and food co-op shoppers receiving two treatments, print only and interactive video workshop, indicating greater levels of trust change in the interactive student audience (Mather 1992). In Mather's study (1992), the interactive workshop was concluded to affect more change in trust (trusting the government agencies, food industry and producers to provide safe foods) through encouraging more critical thinking. The greater level of involvement with the content in multimedia programs may explain this affect (Chaffee & Roser 1986) and supports the use of this mode of delivery in health/food safety education among the young.

Finally, the strongest association with the improvement in the self-reported food handling behaviors was indicated for student satisfaction with the cooperative assignment and interest in the topic, the former especially in the CMC group, which concurs with the findings at the university level (Hiltz 1993). As discussed above, girls held more favorable opinions and were more interested in the topic in this study. Student opinions about the use of CMC technologies indicated no differences between genders but suggested that the use of CMC was well liked by most of the students (less than10 % rather disliked it).

The associations between student opinions and improvement in the self-reported food handling behaviors in the CMC group may be related to the fact that in a CMC learning environment, learning is more learner-centered (Winkelmans 1988; Harasim 1990; Niemi et al. 1999). Learner-centered or learner-driven choices can lead to positive behavioral outcomes (Gould & Anderson 2000), but they can also reduce the gain in knowledge due to skipping or reducing emphasis on the factual parts of the program

(Cowie et al. 1994; Gould & Anderson 2000). It has been suggested that the CMC learning environment can minimize teacher time in classroom discussions to 10-15% of the message volume compared with 80% of the time in traditional teaching settings (Winkelmans 1988; Harasim 1990; Niemi et al. 1999). Judging by the researcher's field experience this was very much true in this study. In the CMC group, teacher (researcher) advice was asked for issues concerning the technology, or the program interface, not so much the content, whereas in the FTF group, students tended to expect more advice and help with the content questions. In the CMC learning environment, students more aptly took an active role in class, even if only to play with the program. Students often clicked through each page and quiz as fast as possible, instead of reading the material on the first round, as if they were expecting the program (the teacher) to give the answers at the end. This concurs with Cowie and colleagues' (1994) finding that students in many Western countries still expect the "proper" answer from the lecturer, instead of engaging in peer discussion to find innovative solutions at the computer (Cowie et al. 1994). This could explain why students in the CMC group did not gain in factual knowledge. However, the involvement with the CMC activities seems to have been high enough to result in a positive trend in the self-reported food handling behaviors.

The field notes also indicated that the photographs of the students being posted on the web site increased student involvement with the CMC program. New photographs were added as the study progressed. This may have added to their interest and their satisfaction with the assignment through adding to their feeling of social presence (Short, Williams & Christie 1976). The social presence theory (Short, Williams & Christie 1976) posits that the salience of another person in an interaction depends on the number of channels or codes available with a medium. The more nonverbal channels, the more social presence and the more personal the messages become (thus adding to involvement). In the same way, the fact that one of the members of the research team was always virtually present in the chat room area added to the students' feeling of social presence in this study, although the students voiced their preference to chatting with the students from the other schools. This was not possible due to the logistics of scheduling classes in the four schools, and no class met simultaneously (synchronously). In the future, this aspect of CMC should be emphasized to increase students' engagement with the content and its meaning. However, this requires more than 45 minutes of time per study session. Reports on technology-enriched school interventions (Collis & Carleer 1993), in fact, have shown major improvement in the overall satisfaction with instruction although associations with learning outcomes have been more difficult to show in such school-wide interventions lasting for several years.

Overall, the correlation analyses gave support to the main hypothesis indicating that in these cooperative learning environments, the media, per se, did not affect learning outcomes, but stronger effect was suggested from student background characteristics and opinions about the instruction. Computer access and experience, perceived effectiveness of the suggested behaviors, changes in the perceptions related to food safety, interest in studying food safety and satisfaction with the cooperative assignment were all associated with learning outcomes in this study and most favored positive outcomes among girls.

The finding that girls achieved equally with the boys in this computer-assisted instruction, supports the recent conclusion of the AAUW Educational Foundation Commission on Technology, Gender, and Teacher Education (AAUW 2000) that girls and women are not computer phobic, but simply voice a legitimate need to transform the software, the way computer science is taught and the goals we have for using computer technology. In this study, infusing computer technology into food safety education within existing curricula with real-life skill goals and true interaction with and at the computer kept the girls interested and involved in the learning activities and led to equal learning for all.

The above discussion has covered many of the limitations of this study, which are still listed below.

Limitations of the Study

Limitations of this study are as follows:

1. Although the classrooms were randomized to treatments, the schools were self-selected.
2. Schools were required to have sophisticated computer classrooms large enough to accommodate at least 16 students working in pairs.
3. Internet connections at most of the schools were so slow that the bulletin board and the chat room could be used only to a limited extent thus reducing the amount of sharing of information and findings (cooperation) between students.
4. Lessons were conducted by the researcher rehearsed in leading Jigsaw-type cooperative work both in the traditional classroom and the computer lab.
5. Students were aware of being observed and may have been aware of the differences between experimental conditions. Therefore both the Hawthorne effect, improvement due to mere inclusion in the study, and John Henry effect, the FTF group wanting to do better than the CMC group, may set limits to external validity of the findings.
6. Final sample size was small. Due to contamination of the control group in one of the schools almost one third of the students had to be set aside from final statistical analysis.
7. The outcome measures were not as reliable as desired. Kuder-Richardson formula estimate of internal consistency reliability of the knowledge questionnaire at pretest (.40) was lower than recommended. For the Experimental group at delayed post-test, the K-R was .51. In future studies, the knowledge questionnaire should be improved, not to run into the ceiling effect: difficulty to improve the already high scores as seen in this study.
8. Although the reliability coefficient for the behavior questionnaire was high (.73), it dealt with self-reported behaviors and therefore was prone to response variation (bias) by the subjects.

9. The instruction in class consisted of only three sessions, which greatly limited its chances of achieving significant learning outcomes.
10. This three-session food safety instruction was not tied to the students' grade, which may have reduced students' motivation to do well in this study.
11. Classroom conditions varied greatly during the one-month study setting a threat to reliability of testing. The state of Pennsylvania experienced some very hot days during the study (in May 2000) while most of the schools were not air-conditioned. Heat may have affected students' mood and attention span. Furthermore, in one of the schools, a fire drill cut into class time and in another, the study ran for one additional week due to technology problems at the School District level.

Chapter 6

SUMMARY AND CONCLUSIONS

Summary of the Findings

The purpose of this study was to investigate the effectiveness of cooperative computer-assisted, school-based food safety education in increasing middle school students' food safety knowledge and safe food handling behaviors. It tested the consistency of the effects of the instructional method, cooperative learning, delivered by alternative media, computer-mediated and face-to-face, and identified attributes that may differently impact learning. The study used a pretest-, post-test, delayed post-test design with three conditions, face-to-face (FTF) instruction, computer-mediated communication (CMC), and control (no treatment). A total of 178 students from four schools in central Pennsylvania participated in the study.

The findings of the study indicated that these students had a fairly good command of the basic food safety facts and, on average, reported fairly safe food handling behaviors. However, one fifth of the students reported frequently taking risks in their food handling and one fifth had been sick because of something they ate, which indicated a need for food safety education.

Studying food safety with the interactive CD-ROM in a cooperative setting resulted in a small but significant increase in knowledge, which was maintained during the cooperative assignment, with no additional increase in knowledge during the one-month study. The self-reported food handling behaviors improved significantly. However, findings from the cooperative assignment, per se, indicated differences for treatment within gender. Boys gained in knowledge from the FTF cooperative assignment, whereas boys in the CMC group lost some of the knowledge gained during the CD-ROM session. During the cooperative assignment, girls' knowledge score improved equally but non-significantly in the two experimental groups.

At delayed post-test, at one-month, no difference was detected in learning outcomes between the two experimental groups, which indicated that in these cooperative learning environments, CMC, as a new teaching strategy, was as good as the traditional FTF instruction. The one-month improvement in self-reported food handling behaviors was significant for both groups although the gain in knowledge was significant only for the FTF group. For the girls, both treatments resulted in improvement in self-reported food handling behaviors, but only FTF in gain in knowledge. For the boys neither was effective.

It was concluded that the educational media did not affect learning outcomes, which were more likely to be associated with the selected student background characteristics and opinions about the content of the instruction itself. Variables associated with gain in knowledge included: computer access, prior computer experience, and perceived response efficacy at delayed post-test. Variables associated with improvement in the self-reported food handling behaviors included: interest in studying food safety and satisfaction with the cooperative assignment as a helpful learning tool. In addition, changes in the perceptions related to food safety were associated with gains in knowledge and the self-reported food handling behaviors within the two experimental treatments.

Conclusions and Implications

The findings from this study indicate that computer-mediated communication (CMC) technologies can be considered a viable medium for cooperative school-based health education in middle schools with ample access to computers and the Internet. This is based on the finding that no difference in learning outcomes was indicated between the FTF and CMC groups.

This study showed that when cooperative computer-assisted instruction is integrated into a subject area in which the girls have greater confidence and interest, they achieve academically just as well as or better than the boys. In the future, more studies involving computers in female domains are needed to confirm the findings of equalizing student skills between "female and male skills" by using well-designed cooperative learning assignments. However, successful cooperative methods require longer interventions, in order to exploit their capabilities of supporting active student participation and reflection on the topic. More time is required for sharing opinions and for reflection, especially in asynchronous communication using the CMC technology.

The strengthening of the perceptions related to food safety and foodborne illness was associated with gain in knowledge and improvement in self-reported food handling behaviors. Based upon this finding, it would be beneficial to design health education programs to affect these perceptions among the adolescents no matter what the medium used. Students' great appreciation for computers, and the positive outcomes in the computer-assisted and the CMC learning environments should encourage more computer use for instruction in middle schools.

Recommendations

Based upon the findings in this study, more frequent integration of computers and computer-mediated communication technology into instruction and health education in K-12 settings can be recommended. The integration is likely to be successful if the instruction is based upon cooperative methods to support peer interaction and negotiation of solutions to relevant case studies. Presented in the compelling multimedia environment, the instruction is likely to enhance the level of involvement of the students in active learning. Health education in particular should more readily use the new medium in order to capture the interest of the young audiences and to increase the level involvement in the health message.

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Appendix A

Recruitment Fax

PENNSTATE

1 8 5 5

Penn State Nutrition Center
College of Health and Human Development

(814) 865-6323
FAX: 814-865-5870
5 Henderson Bldg.
The Pennsylvania State University
University Park, PA 16802

FAX

TO:	________________	**FROM:**	Irja Haapala, MS, RD
	________________		PhD Candidate, Nutrition
ADDRESS:	________________	**ADDRESS:**	5 Henderson Bldg, PSU
PHONE:	________________	**PHONE:**	814-865-3534
FAX:	________________	**FAX:**	814-865-5870

Dear :

As you know, computer-assisted instruction and the Internet are being promoted as excellent teaching tools, yet, the most effective strategies for use of computers in teaching have not yet been identified. This is an area that I would like to study in completing my doctoral research at Penn State University.

Dr. Claudia Probart's research group has developed a CD-ROM for middle school students on the topic of food safety. Food safety is a rising concern in the US with the recently well-publicized outbreaks of foodborne illnesses. It is especially relevant for young adolescents who are increasingly more responsible for their own food preparation, as well as food preparation for others.

I have added classroom-based, as well as Internet-based activities to this CD-ROM and would like to test the effectiveness of these strategies in delivering the food safety content knowledge, as well as effecting behavior change. I am currently looking for schools that might be interested in participating in this project.

For your participation, you would receive free copies of the CD-ROM program, presenter's manuals, and classroom strategies for use of the program. This type of research could make in-roads into learning how to optimize the use of emerging technologies in the classroom.

I hope to begin testing in January or February. I need a middle school level classroom (or classrooms) of students for one class session per week for 4 weeks. I also need access to a computer lab that has CD-ROM capabilities and Internet access.

I hope that you are interested in being involved in this important study. If you're interested in discussing this project with me, you can contact me at 814-865-3534, or you can return this fax to me and let me know when is a good time to contact you. Thanks in advance for your interest.

_______ I am interested in discussing this research study with you. Please call me at____________ (phone number) at the following time(s):______________.

_______ We are unable to be involved in your study at this time.

Appendix B

Parental Consent Form

Evaluation of a Food Safety Tool-Kit Linking Cafeteria and Classroom

Irja Haapala, M.S., R.D., and Claudia Probart, Ph.D., R.D., L.D.

Description of Study

The purpose of this study is to find out how middle school students respond to a CD-ROM linking cafeteria and classroom through classroom testing. The subject of the tool-kit is food safety. The study will be conducted during four class periods over approximately one month. Students will complete a pre-test, and then they will have an opportunity to explore the CD-ROM, and take a post-test. During subsequent class periods students will work on a World Wide Web-based assignment related to the CD-ROM content. Students will work on this assignment cooperatively in groups and will communicate with students at other schools internationally, through use of the Internet. Students working on the Internet will participate in secure (password-protected) chat room sessions, and will post their completed assignments on this secure site. All postings will be reviewed by the researchers prior to posting to the group. Following completion of this assignment, students will take another test to assess changes in knowledge, attitude, and behavior related to food safety. Some students will take the three tests before participating in the instruction. The results of the tests will be kept confidential, will be destroyed after the project is complete, and will not be part of the student's grade. Photographs may be taken to display the research findings; however, names will never be associated with the pictures.

There are no risks involved. All data will be kept in strict confidence, and no names will appear with the data or in any subsequent reports.

The results of this study will allow the researchers to learn more about how to create more effective materials and educational strategies for middle school students, specifically on the extremely important issue of food safety. We feel that your child will find this program to be fun, as well as educational.

If you have any questions or concerns, please contact Dr. Claudia Probart at 814-865-7054.

(Please tear off and return to investigator)

Permission for my Child to Participate

I, ____, give permission to have

my child,___________________________________, participate in a classroom testing of a food safety tool-kit. I understand that there are no risks involved. I understand that my child is free to decline to answer any specific questions without penalty.
I further understand that I am free to withdraw my consent and terminate my child's participation at any time.

_________________________________ _______________________

Signature of Parent Guardian Date

Appendix C

Informed Assent Form

Assent from 8-13 year olds

“We’re going to try out some lessons and a CD-ROM about food safety during four class periods. We are going to have you answer some questions before and after the lessons to see what you have learned. You will not be graded; no one will even know which answers are yours because you will not write your name on the answer sheet. By participating in the lessons and answering the questions, you will be helping us to develop lessons for kids your age. I hope that you will be happy to participate, OK?”

____
Witness’ Signature

Appendix D

Questionnaires

Here are some questions about computers, food safety, and about the way you handle food.

Directions: Fill out the BUBBLE SHEET WITH A #2 PENCIL.

Note that:
"SAFE food" means food, which does not make you sick.
"UNSAFE food" CAN make you sick.

During the past month I have...

	Not once	Almost not once	Sometimes	Almost every time	Every time
1. …washed my hands before handling food/eating **at home**.	A	B	C	D	E
2. …washed my hands before eating **at school cafeteria/restaurant**.	A	B	C	D	E
3. …used paper towels to dry my hands.	A	B	C	D	E

4. … handled raw meat/chicken/fish. A) Yes B) No

If "no", then SKIP to question **6**.

	Not once	Almost not once	Sometimes	Almost every time	Every time
5. …washed my hands between handling raw meat /chicken/fish and ready-to-eat foods.	A	B	C	D	E
6. …made sure raw meat is separated from ready-to-eat foods.	A	B	C	D	E
7. …made sure all surfaces are clean before handling food on them.	A	B	C	D	E
8. …put foods that may spoil (milk, cheese, etc.) back to the refrigerator within 2 hours.	A	B	C	D	E
9. …put leftover foods (pizza, sandwiches, etc.) into the refrigerator within 2 hours.	A	B	C	D	E

10. …checked the expiration dates on food packages before eating. A B C D E

11. …tasted foods to check if they are still safe to eat. A B C D E

12. … have eaten hamburgers or steaks. A) Yes B) No

If "no", then SKIP to question **14.**

13. …made sure my hamburgers or steaks are not bloody (clearly red inside) when I eat them. A B C D E

14. …have eaten eggs. A) Yes B) No

If "no", then SKIP to question **16.**

15. …eaten raw eggs or foods that contain raw eggs (like raw cookie dough). A B C D E

Please turn to next page.

Please circle the choice that best represents *you and your* opinion.
CIRCLE YOUR CHOICE ON THE BUBBLE SHEET

16. I am A. a girl B. a boy.

17. I have been using computers for
    A. more than 5 years.
    B. 3-5 years.
    C. 1-2 years.
    D. less than a year.

18. I use a computer
    A. several hours per day (>3 hours).
    B. a few hours per day (1-3 hours).
    C. a few hours per week.
    D. almost never.

19. I use the Internet. A. Yes. B. No, SKIP to question **26**.

20. I use the Internet for: e-mail A. Yes B. No
21. for chat-rooms A. Yes B. No
22. for games A. Yes B. No
23. for personal information search A. Yes B. No
24. for school related information search A. Yes B. No
25. for keeping a personal Web-site. A. Yes B. No

26. I have a computer I can use at home. A. Yes B. No

27 I have access to the Internet at home. A. Yes B. No

28. I prepare meals or snacks at home. A. Yes B. No

29. I work in food service outside of home. A. Yes B. No

30. I have been sick because of something I ate (foodborne illness). A. Yes B. No C. I don't know

Please turn to next page.

Note that:
"SAFE food" means food, which does not make you sick.
"UNSAFE food" CAN make you sick.

CIRCLE YOUR CHOICE ON THE BUBBLE SHEET!

	Disagree	**Slightly disagree**	**Slightly agree**	**Agree**
11. I am interested in studying food safety.	A	B	C	D
12. I like to use computers.	A	B	C	D
13. I like to use computers at school.	A	B	C	D
14. I know how to handle food safely.	A	B	C	D
15. I can personally do a lot to prevent bacteria from getting into my food.	A	B	C	D
16. I believe I can learn how to handle food safely.	A	B	C	D
17. I think UNSAFE food can make people really sick.	A	B	C	D
18. I think UNSAFE food can be life threatening.	A	B	C	D
19. Because I live in USA, my risk of getting sick from UNSAFE food is very small.	A	B	C	D
20. I think food and water in USA are SAFE to eat and drink.	A	B	C	D
21. Because my food is prepared by my parents (or other SAFE food preparers), my risk of getting sick from UNSAFE food is very small.	A	B	C	D
22. I think my risk of getting sick because of eating UNSAFE food is low.	A	B	C	D

Please Turn to Next Page!

Note that:
"SAFE food" means food, which does not make you sick.
"UNSAFE food" CAN make you sick.

CIRCLE YOUR CHOICE ON THE BUBBLE SHEET!
Next, decide whether the following statements are A) True or B) False.
In your refrigerator you have raw chicken wings, cheese, canned tomatoes, milk, and bagels.

	A **B**
23. To make sure the milk is SAFE to drink, you hould taste it instead of checking the expiration date.	TRUE / FALSE
24. The canned tomatoes are no longer SAFE to eat, if the can is bulging out.	TRUE / FALSE
25. The safest way to make sure meat is well done (thoroughly cooked) is to check its inner temperature with a meat thermometer.	TRUE / FALSE
26. To be sure that the chicken wings are SAFE to eat, they should be cooked to an inner temperature of 100° Fahrenheit.	TRUE / FALSE
27. Milk and cheese should be chilled (refrigerated) within 2 hours to keep them safe.	TRUE / FALSE
28. The best temperature for most harmful bacteria to multiply is in the refrigerator, below 40° Fahrenheit.	TRUE / FALSE
29. Wiping off the cutting board with a clean paper towel between food items (raw meat and bread) will prevent harmful bacteria from spreading.	TRUE / FALSE
30. To avoid cross-contamination you should separate raw chicken, meat and fish from ready-to-eat foods.	TRUE / FALSE
31. Harmless bacteria from our hands can produce harmful toxins in foods.	TRUE / FALSE
32. Before handling food, rinsing your hands under cold running water is enough to get rid of bacteria on your hands.	TRUE / FALSE

Thank you!

Note that:
"SAFE food" means food, which does not make you sick.
"UNSAFE food" CAN make you sick.

CIRCLE YOUR CHOICE ON THE BUBBLE SHEET!

1. I think that the amount of information provided on the CD-ROM was:

Too little	Somewhat too little	Just right	Somewhat too much	Too much
A	B	C	D	E

	Disagree	**Slightly disagree**	**Slightly agree**	**Agree**
2. I enjoyed studying food safety with this CD.	A	B	C	D
3. I think I learned a lot from this CD.	A	B	C	D
4. I had to be very active with this CD.	A	B	C	D
5. I would do this type of an assignment again.	A	B	C	D
6. Working in pairs helped me learn more than I would have on my own.	A	B	C	D
7. Both of us participated equally.	A	B	C	D
8. I am satisfied with the way we worked together.	A	B	C	D
9. I believe the recommended steps can effectively prevent foodborne illness.	A	B	C	D
10. I know how to handle food safely.	A	B	C	D
11. I can personally do a lot to prevent bacteria from getting into my food.	A	B	C	D
12. I believe I can learn how to handle food safely.	A	B	C	D

Please turn to next page!

Note that:
"SAFE food" means food, which does not make you sick.
"UNSAFE food" CAN make you sick.

CIRCLE YOUR CHOICE ON THE BUBBLE SHEET!

	Disagree	Slightly disagree	Slightly agree	Agree
13. I think UNSAFE food can make people really sick.	A	B	C	D
14. I think UNSAFE food can be life threatening.	A	B	C	D
15. Because I live in USA, my risk of getting sick from UNSAFE food is very small.	A	B	C	D
16. I think food and water in USA are SAFE to eat and drink.	A	B	C	D
17. Because my food is prepared by my parents (or other SAFE food preparers), my risk of getting sick from UNSAFE food is very small.	A	B	C	D
18. I think my risk of getting sick because of eating UNSAFE food is low.	A	B	C	D

Please Turn to Next Page!

Note that:
"SAFE food" means food, which does not make you sick.
"UNSAFE food" CAN make you sick.

CIRCLE YOUR CHOICE ON THE BUBBLE SHEET!
Let's look at the refrigerator story again. Which statements are A) True and which are B) False?
In your refrigerator you have raw chicken wings, cheese, canned tomatoes, milk, and bagels.

	A B
19. The best temperature for most harmful bacteria to multiply is in the refrigerator, below 40° Fahrenheit.	TRUE / FALSE
20. The safest way to make sure meat is well done (thoroughly cooked) is to check its inner temperature with a meat thermometer.	TRUE / FALSE
21. Before handling food, rinsing your hands under cold running water is enough to get rid of bacteria on your hands.	TRUE / FALSE
22. To avoid cross-contamination you should separate raw chicken, meat and fish from ready-to-eat foods.	TRUE / FALSE
23. Milk and cheese should be chilled (refrigerated) within 2 hours to keep them safe.	TRUE / FALSE
24. To be sure that the chicken wings are SAFE to eat, they should be cooked to an inner temperature of 100° Fahrenheit.	TRUE / FALSE
25. Harmless bacteria from our hands can produce harmful toxins in foods.	TRUE / FALSE
26. To make sure the milk is SAFE to drink, you should taste it instead of checking the expiration date.	TRUE / FALSE
27. Wiping off the cutting board with a clean paper towel between food items (raw meat and bread) will prevent harmful bacteria from spreading.	TRUE / FALSE
28. The canned tomatoes are no longer SAFE to eat, if the can is bulging out.	TRUE / FALSE

Thank you!

Here are some questions about the group assignment!

Directions: Fill out the BUBBLE SHEET WITH A #2 PENCIL.

1. I think that the amount of information provided in this group assignment was:

Too little	Somewhat too little	Just right	Somewhat too much	Too much
A	B	C	D	E

	Disagree	Slightly disagree	Slightly agree	Agree
2. I enjoyed studying food safety with this group assignment.	A	B	C	D
3. I think I learned a lot from this assignment.	A	B	C	D
4. I had to be very active in this assignment.	A	B	C	D
5. I would do this type of work again.	A	B	C	D
6. Working in groups helped me learn more than I would have on my own.	A	B	C	D
7. All of us participated equally.	A	B	C	D
8. I am satisfied with the way we worked together.	A	B	C	D

Please turn to next page!

CIRCLE YOUR CHOICE ON THE BUBBLE SHEET!

Other students did this assignment on the Internet. They were able to find more information on the Internet if they wanted to. They shared their results with students from other schools. Everybody posted the results on the Internet for the whole world to see.

What are your opinions:

	Disagree	Slightly disagree	Slightly agree	Agree
9. I would have done a better job if my results had been published on the Internet.	A	B	C	D
10. I would have liked to read all this information and more on the Internet (instead of on paper like we did).	A	B	C	D
11. I would have liked to work with students from other schools on the Internet in addition to working with my own classmates.	A	B	C	D
12. I would rather have worked with the computer instead of with these pictures and paper.	A	B	C	D
13. The computer would have increased my interest to study food safety.	A	B	C	D

Thank you!

Here are some questions about the group assignment!

Directions: Fill out the BUBBLE SHEET WITH A #2 PENCIL.

1. I think that the amount of information provided in this group assignment was:

Too little	Somewhat too little	Just right	Somewhat too much	Too much
A	B	C	D	E

	Disagree	**Slightly disagree**	**Slightly agree**	**Agree**
2. I enjoyed studying food safety with this group assignment.	A	B	C	D
3. I think I learned a lot from this assignment.	A	B	C	D
4. I had to be very active in this assignment.	A	B	C	D
5. I would do this type of work again.	A	B	C	D
6. Working in groups helped me learn more than I would have on my own.	A	B	C	D
7. All of us participated equally.	A	B	C	D
8. I am satisfied with the way we worked together.	A	B	C	D

Please turn to next page!

CIRCLE YOUR CHOICE ON THE BUBBLE SHEET!

Other students did this assignment without the Internet. They used the CD-ROM but worked in groups with printed pictures and information about the case study. They shared their results in class, face to face.

What are your opinions:

	Disagree	**Slightly disagree**	**Slightly agree**	**Agree**
9. I would have done a better job if my results had been published only in class (and not on the Internet).	A	B	C	D
10. I would have liked to read all this information on paper instead of on the Internet.	A	B	C	D
11. I would have liked to work only with my own classmates without the students from other schools.	A	B	C	D
12. I would rather have worked with paper and pencil and printed pictures instead of doing it with the computer.	A	B	C	D
13. Working without the computer would have increased my interest to study food safety.	A	B	C	D

Thank you!

Here are some questions about computers, food safety, and about the way you handle food.
Directions: Fill out the BUBBLE SHEET WITH A #2 PENCIL.

Note that:
"SAFE food" means food, which does not make you sick.
"UNSAFE food" CAN make you sick.

During the past month I have...

	Not once	Almost not once	Sometimes	Almost every time	Every time
1. …washed my hands before handling food/eating **at home**.	A	B	C	D	E
2. …washed my hands before eating **at school cafeteria/restaurant**.	A	B	C	D	E
3. …used paper towels to dry my hands.	A	B	C	D	E
4. … handled raw meat/chicken/fish.	A) Yes	B) No			
If "no", then SKIP to question **6**.					
5. …washed my hands between handling raw meat /chicken/fish and ready-to-eat foods.	A	B	C	D	E
6. …made sure raw meat is separated from ready-to-eat foods.	A	B	C	D	E
7. …made sure all surfaces are clean before handling food on them.	A	B	C	D	E
8. …put foods that may spoil (milk, cheese, etc.) back to the refrigerator within 2 hours.	A	B	C	D	E
9. …put leftover foods (pizza, sandwiches, etc.) into the refrigerator within 2 hours.	A	B	C	D	E

10. …checked the expiration dates on food packages before eating.	A	B	C	D	E
11. …tasted foods to check if they are still safe to eat.	A	B	C	D	E

12. … have eaten hamburgers or steaks. A) Yes B) No

If "no", then SKIP to question **14.**

13. …made sure my hamburgers or steaks are not bloody (clearly red inside) when I eat them.	A	B	C	D	E

14. …have eaten eggs. A) Yes B) No

If "no", then SKIP to question **16.**

15. …eaten raw eggs or foods that contain raw eggs (like raw cookie dough).	A	B	C	D	E

Please turn to next page.

Note that:
"SAFE food" means food, which does not make you sick.
"UNSAFE food" CAN make you sick.

CIRCLE YOUR CHOICE ON THE BUBBLE SHEET!

16. I prepare meals or snacks at home. a) Yes b) No

17. I work in food service outside of home. a) Yes b) No

18. I have been sick because of something I ate (foodborne illness). a) Yes b) No c) I don't know

	Disagree	Slightly disagree	Slightly agree	Agree
19. I believe the recommended steps can effectively prevent foodborne illness.	A	B	C	D
20. I know how to handle food safely.	A	B	C	D
21. I can personally do a lot to prevent bacteria from getting into my food.	A	B	C	D
22. I believe I can learn how to handle food safely.	A	B	C	D
23. I think UNSAFE food can make people really sick.	A	B	C	D
24. I think UNSAFE food can be life threatening.	A	B	C	D
25. Because I live in USA, my risk of getting sick from UNSAFE food is very small.	A	B	C	D
26. I think food and water in USA are SAFE to eat and drink.	A	B	C	D
27. Because my food is prepared by my parents (or other SAFE food preparer), my risk of getting sick from UNSAFE food is very small.	A	B	C	D
28. I think my risk of getting sick because of eating UNSAFE food is low.	A	B	C	D

Please Turn to Next Page!

Note that:
"SAFE food" means food, which does not make you sick.
"UNSAFE food" CAN make you sick.

CIRCLE YOUR CHOICE ON THE BUBBLE SHEET!
Next, decide whether the following statements are A) True or B) False.
In your refrigerator you have raw chicken wings, cheese, canned tomatoes, milk, and bagels.

	A B
29. Before handling food, rinsing your hands under cold running water is enough to get rid of bacteria on your hands.	TRUE / FALSE
30. To avoid cross-contamination you should separate raw chicken, meat and fish from ready-to-eat foods.	TRUE / FALSE
31. The canned tomatoes are no longer SAFE to eat, if the can is bulging out.	TRUE / FALSE
32. The safest way to make sure meat is well done (thoroughly cooked) is to check its inner temperature with a meat thermometer.	TRUE / FALSE
33. To be sure that the chicken wings are SAFE to eat, they should be cooked to an inner temperature of 100° Fahrenheit.	TRUE / FALSE
34. Milk and cheese should be chilled (refrigerated) within 2 hours to keep them safe.	TRUE / FALSE
35. Harmless bacteria from our hands can produce harmful toxins in foods.	TRUE / FALSE
36. The best temperature for most harmful bacteria to multiply is in the refrigerator, below 40° Fahrenheit.	TRUE / FALSE
37. Wiping off the cutting board with a clean paper towel between food items (raw meat and bread) will prevent harmful bacteria from spreading.	TRUE / FALSE
38. To make sure the milk is SAFE to drink, you should taste it instead of checking the expiration date.	TRUE / FALSE

Thank you!

VITA

Irja Haapala

Education: I received my Master of Science Degree in Nutrition in 1992 from the University of Kuopio, Finland, and my Teaching Certification in 1995 from the Vocational Teacher Education College of Jyväskylä, Finland. In 1983, I received my Secretarial Diploma from the International Business College in El Paso, Texas.

Work Experience: During the years of 1996 – 2000 I have worked as a research assistant at the ITEL- Innovative Technology in Education Lab and Project PA at The Pennsylvania State University, Department of Nutrition. Prior to this, I worked as an amanuensis at the Department of Nutrition, at the University of Kuopio, Finland. Between the years of 1991 and 1996, I worked as an authorized nutritionist in both public and private medical centers, a project researcher, a teacher, a lecturer and an international clinical monitor. During and prior my Master's studies, I worked part-time in Health Institutes both in Finland and abroad.

Publications and Honors: I have published five abstracts and one paper on the role of computer-assisted and computer-mediated learning and cooperation among varying age groups, also in international settings, and on sports nutrition. Publications are underway on these topics. Also, I have helped publish a report on Advisor Advisee Relationships at the Pennsylvania State University as a student senator and representative in the senate committee on research (1996-1998). I have served as the first President of the Nutrition Student Association at the University of Kuopio, Finland in 1984-1985.