The effects of jigsaw- and constructive controversy-based collaborative learning strategies on older adults' eHealth literacy

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A collaborative eHealth literacy intervention for older adults was developed using two collaborative learning strategies (jigsaw and constructive controversy) and tested by comparing learning outcomes with those produced using individualistic learning strategies. This paper presents results from an experiment conducted from October 2011 to March 2012 using a 2x2 mixed factorial design where learning method (individualistic; collaborative) was the between-participants variable and time of measurement (pre; post) was the within-participants variable. In total, 172 participants (age range: 50-87; *M*=67.58; *SD*=7.47) were randomly assigned to the collaborative learning or individualistic learning condition (collaborative: 75; individualistic: 97). The interventions comprised four 2-hour sessions held at a public library. Univariate repeated measures analyses detected a significant difference in computer and web knowledge by learning method, with individualistic learning outperforming collaborative learning: $F_{1,127}$=7.13; p=0.009. No significant difference was detected in computer and web skill $F_{1,125}$=2.30; p=1.32, or eHealth literacy skill $F_{1,123}$=1.96; p=1.64. The results suggest individualistic learning outperforms collaborative learning for simple recall tasks, but not complex tasks requiring knowledge transfer.

Keywords: eHealth literacy, collaborative learning, older adults

Health literacy is "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions"[1]. Low health literacy correlates to higher mortality rates in older adults[2,3] along with negative health consequences for those with heart failure[4], kidney disease[5], and pulmonary disease[6]. Among older adults in the U.S., only 3% possess proficiency in health literacy[7].

Information and communication technologies (ICT) play an increasingly vital role for healthcare consumers, with 80% of U.S. Internet users searching for health information online[8]. Other online health activities gaining popularity include tracking personal health data, consulting reviews of drugs and health services, and connecting with others sharing health interests[9]. Using these services requires eHealth literacy, or "the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem"[10]. Problematically, in the USA only 53% of adults age 65 and above use the Internet[11] and many lack sufficient eHealth literacy to use online health resources[12,13].

eHealth interventions offer an effective method for increasing older adults' eHealth literacy[14-17]. Prior research[16,17] indicated collaborative learning (CL), where learners learn from not only the instructor but also their peers[18,19], could be an effective method for improving older adults' eHealth literacy[15-17]. Using these studies as a foundation, in this study we adapted two collaborative learning strategies (jigsaw and constructive controversy), proven effective for younger learners in formal education settings[20], to an eHealth literacy intervention designed for older adult learners. A key difference between this study and prior studies[16,17] on CL is the explicit use of the highly structured jigsaw and constructive controversy strategies in this study while prior studies involved less structured CL activities. This article reports the adaptation of the jigsaw and constructive controversy CL strategies to an eHealth literacy intervention for older adults, along with the outcome of an experiment comparing the effects of learning condition (collaborative versus individualistic) on older adults' learning outcomes.

Literature Review

Theoretical support

Collaborative learning, defined as "any instructional method in which students work together in small groups toward a common goal"[21] contrasts with learning methods promoting competition or limiting interaction among peers. CL is adaptable to a diverse range of curricula[19,22] and has been used with different age groups[15,19,23]. A meta-analysis examining more than 300 studies offered strong support for CL outperforming individualistic learning (IL) in formal educational and professional settings[20].

Theories supporting CL include the social interdependence theory, cognitive-developmental theory, and behavioral learning theory[24]. Social interdependence theory argues that group members' actions influence individuals' learning outcomes[25]. CL can promote positive interdependence, where individuals believe their goals can be achieved only if other group members also achieve their goals. Positive interdependence produces better learning outcomes than negative interdependence, where individual achievement depends on others not achieving their goals[26]. Cognitive-developmental theory asserts interaction improves learning outcomes by promoting cognitive development[27]. By collaborating with experienced peers, less experienced learners improve their ability to a degree not possible if working alone[28]. Last, behavioral learning theory asserts that rewards or sanctions motivate learners to increase effort in collaboration[24].

Recent work uses the cognitive load theory to explain factors influencing successful CL[29,30]. Cognitive load theory bifurcates memory into: (i) working memory, which handles small amounts of information for a limited time; and (ii) long-term memory, which features an unlimited capacity for storing information[31]. Information must be processed in working memory before entering long-term memory. Cognitive load theory predicts that reducing the cognitive demands learning tasks make on working memory improves learning[31].

CL may reduce demands on working memory for complex learning tasks[32]. Task complexity depends on the number and degree to which information elements interact, with high-complexity tasks containing a larger number of information elements that interact to a greater degree and low-complexity tasks containing fewer information elements that interact less[33]. Collaborators engaging in complex learning tasks can distribute cognitive load across their individual working memories, reducing cognitive load for each individual[34]. However, CL requires group members to communicate and coordinate collaboration, generating a cognitive load not present in IL. From this perspective, CL works best when the distribution advantage exceeds the additional cognitive load necessary to coordinate CL. Empirical evidence suggests CL outperforms IL for high-complexity, but not low-complexity tasks[30,33].

Similarly, learning goals can influence CL. A study of 70 high school biology students found IL outperformed CL on tests of learners' recall of learning material, but CL outperformed IL on tests applying learning material to problem solving[36].

These studies suggest CL is most effective for complex tasks where learners transfer and apply, not recall, new knowledge. However, both studies used high school participants and may not generalize to older adults. Older adults experience two broad categories of age-related cognitive decline influencing learning: (i) reductions in cognitive speed; and (ii) reductions in cognitive control[37]. Reduced cognitive speed causes older adults to process information more slowly than younger learners[38,39], and occurs over the life span[40]. As a result, older adults require more time to complete learning tasks[38,39]. Reduced cognitive control makes coordinating information in working memory more difficult, impairing older learners' performance on complex tasks[37]. Combined, these changes in cognitive abilities could affect how learning method influences older adults' learning.

Collaborative scripts

In addition to theory, much work exists on structuring CL interventions. Interventions impose structure by controlling group composition (e.g., age, expertise, gender, etc.) or by structuring collaborative interactions[41]. A popular method of structuring CL is using scripts, defined as "a set of instructions regarding how the group members should interact, how they should collaborate and how they should solve [a] problem"[41]. In a meta-analysis of 158 studies, Johnson, Johnson, and Stanne[42] examined eight commonly used scripts, and found that CL scripts improved learner achievement when compared to scripts using IL or competitive learning. These results suggest CL scripts provide an empirically proven approach to structuring CL activities.

Significant gaps exist in the literature examining the use of scripts in CL with older adults. Interventions with older adults typically ask learners to collaborate but impose little structure. For example, Margett and Willis[23] found no significant difference existed between CL and IL for older learners completing a cognitive training course. Participants in both conditions received identical training materials to complete at home, with the only difference being that the collaborative condition highlighted sections of the materials to work on collaboratively with a partner[23]. Providing insufficient structure for CL offers one explanation for why no difference was found in their study. Similarly, in a series of studies Xie[15-17] found no statistically significant difference in eHealth literacy learning outcomes between older adults in the CL and IL conditions. These studies structured collaboration through periodic instructions for learners to compare notes or discuss topics with peers[16] or by providing learners with handouts listing group discussion questions[17]. However, these techniques provide less structure than methods like jigsaw or constructive controversy, which use more detailed instructions to orchestrate collaboration. Again, insufficient structure may explain the finding of no significant difference in learning outcomes between the CL and the IL condition in these prior studies.

Little known research exists investigating the use of scripts with older adults, so their effectiveness with older adults remains unclear. Differences between older and younger learners could influence scripts' effectiveness. For example, group rewards can be used to incentivize younger learners in formal learning settings to collaborate. However, older learners' motivations to learn about subjects like eHealth literacy in informal learning settings may differ significantly from younger learners in formal settings[16], and evidence exists that older adults often possess high motivation to learn and participate in CL settings[43]. These differences between older and younger learners could potentially influence the effectiveness of CL scripts, although additional research is necessary to determine if and how these differences affect learning outcomes.

Selecting collaborative scripts

We developed a list of potential scripts to use in this study by reviewing the literature to identify which scripts would be most effective for teaching eHealth curriculum to older adults. This list excludes scripts reliant on competition (which uses negative interdependence) or that require participants to work by themselves to complete quizzes or tests (which reduces the focus and time spent on collaboration). Scripts we considered include reciprocal peer questioning, co-op co-op, complex instruction, jigsaw and constructive controversy (*Table 1*). Based on the key features for scripts, we selected the jigsaw and constructive controversy scripts to answer the research question: "What effect does learning method (collaborative; individualistic) have on learning outcomes?"

Method

Design

The experiment used a 2x2 mixed factorial design using learning method (individualistic; collaborative) for the between-participants variable and time of measurement (pre; post) for the within-participants variable.

Instructional materials

Instructional material for this study used the 'Helping older adults search for health information online: A Toolkit for Trainers' [44]. This freely available Toolkit teaches older adults to search, locate, comprehend, and use health information on NIH sponsored websites. The Toolkit teaches the material through modules. Each module includes a lesson plan, glossary of computer and Internet terms, and practice activities. This study used two modules from the Toolkit. Module one, titled 'Internet Basics', was selected because it provides introductory instruction on using a computer, the Internet, and health websites. Module two, titled 'Evaluating Health Websites', was selected because it focuses on evaluating the quality of health websites, a fundamental eHealth literacy skill[10]. Together, the modules teach learners the basic skills and knowledge to locate and apply online health information.

Modules designed for IL

We adapted the selected modules to CL using the jigsaw and constructive controversy scripts. We pilot tested our adaptation in October 2011 in four two-hour sessions, with four to seven older adults participating in each session (data from these pilot testing sessions were excluded from statistical analyses reported below). The sessions included 90 minutes of activities, followed by a 30-minute discussion with participants. Afterwards, researchers discussed and revised module lesson plans using participants' feedback. This process produced final lesson plans for CL versions of the modules (*Table 2*).

Research sites

The chosen libraries included the Hyattsville and New Carrollton branches of the Prince George's County Memorial Library System located in Prince George's County, Maryland. These libraries provided free Internet on desktop computers, staff aid, and meeting rooms to assist the study. Public transportation (both subway and bus) serves these libraries. The experiments occurred in the computer area of each library.

Participants

Participant recruitment employed standard recruitment strategies, such as posting recruitment flyers at library sites, advertising in local print publications (e.g. newsletters for older adults) and the county library system's newsletter. In total, 172 older adults participated between October 2011-March 2012 (*Table 3*).

After recruitment, we scheduled participants to attend classes. We randomly assigned classes to either the collaborative or individualistic condition (*Figure 1*). This produced 75 participants in

Table 1. Description and key features of collaborative learning scripts

Script	Description	Key features	Selection/Rejection rationale
Constructive controversy (selected)	Learners work in pairs and are assigned opposing perspectives on an issue, individually developing arguments for their perspective; Pairs discuss each perspective and present their arguments; Learners switch perspectives and repeat the process of developing arguments and discussion; Last, pairs create a report synthesizing the perspectives[42]	-Collaborative groups work in pairs -Pairs develop opposing arguments -Pairs make reports synthesizing perspectives	-Promotes conceptual understanding of material -Helps explore different perspectives of a topic -Provides more structure to activities than complex instruction or co-op co-op
Jigsaw (selected)	Groups form with three to five members; Each member gets a portion of the learning material; Learners become 'experts' on their portion, and work with members of other groups responsible for that portion to master the material; Learners reform the original groups to teach each other about their portion of the material[19].	-Learners work with multiple groups -Each individual teaches other learners.	-Adaptable to teach diverse skills and concepts -Promotes positive interdependence among learners with diverse skills and experience -Inexperienced learners benefit by working with more experienced peers -Provides high levels of structure to activities
Reciprocal peer questioning (rejected)	Learners receive generic questions (e.g., "describe the main point of…?") about learning material from instructors; Learners individually develop specific questions using the generic questions for guidance, and then pose these questions to their group; Group members discuss the questions[46]	-Peer questioning -Peer-testing of comprehension	-Developing, asking, and discussing questions may be ineffective for teaching eHealth literacy to older adults
Complex instruction (rejected)	Class divides into groups, with each group responsible for accomplishing a different learning task related to the 'big idea'; Tasks are open-ended, with no pre-determined, correct solution or process for achieving that solution; Each group develops a report explaining their solution and presents the report to the class[47]	-Group tasks relate to a 'big idea' -No correct solution to tasks -Groups develop and present reports	-Provides little structure for activities
Co-op Co-op (rejected)	Groups choose a topic to explore and divide the topic into 'mini-topics'; Each learner is individually responsible for developing a presentation on a mini-topic; Mini-topic presentations are synthesized into a team presentation, which is presented to the class[48]	-Groups divide topics into mini-topics -Individuals report on mini-topics -Groups synthesize reports in a presentation	-Provides little structure for activities -Significant time spent working alone

collaborative condition and 97 participants in the individualistic condition.

Measures

Knowledge and skill

COMPUTER AND WEB KNOWLEDGE. Objective tests assessed participants' knowledge about computer components (e.g. monitor, keyboard) and the web (e.g. web address, link). Each test included 5 items. Participants received one point for each correct answer, and no points for incorrect answers. Scoring range: 0-5.

COMPUTER AND WEB SKILL. A procedural test measured participants' ability to perform basic computer and web tasks (e.g. maximize the webpage; click on a link; type medlineplus.gov into the address box; use the search box find information about flu). Participants received one point for completing a task without assistant and no point for failure to complete a task independently. The test included 20 operations. Scoring range: 0-20.

EHEALTH LITERACY SKILL. Participants evaluated 20 health information websites to assess the websites' quality. We chose ten websites from the Medical Library Association's list of recommended health websites[55], and ten websites from online advertising found on a commercial search engine. We evaluated these sites with guidelines from the National Library of Medicine

Table 2. Order and timing of activities with lesson planning summary for collaborative and individualistic learning

Activity (time)	**Teaching style and activity**		
	Collaborative		**Individualistic**
	Script	**Description**	**Description**
Session 1			
Consent form (5 min)	No script	On paper	
Pre-questionnaire (10 min)	No script	Demographics and experience	
Pre-test (10 min)	No script	Computer and web knowledge	
Pre-test (10 min)	No script	Computer and web skills	
Computer terms (55 min)	Jigsaw	Participants divide into two groups; Each group learns a different set of computer terms (e.g., mouse, monitor); Groups reform and participants teach members from the other group the terms they learned	Instructor teaches participants computer terms
Cursor activity (10 min)	Jigsaw	Participants work in pairs to learn about the different forms the cursor takes (arrow, I-beam, or hand); Participants take turns using the mouse to make each form appear on their screen	Instructor teaches participants about the cursor; Participants practice using the mouse on their own.
Wrap-up discussion (10 min)	No script	Facilitator leads a discussion of the module and encourages participants to address remaining questions	Instructor summarizes the module, answers questions
Session 2			
Internet terms (55 min)	Jigsaw	Participants divide into two groups; Each group learns a different set of Internet terms (e.g., browser); The groups reform and participants teach members from the other group the terms they learned	Instructor teaches participants Internet terms
Computer operations (55 min)	Jigsaw	Participants divide into two groups; Each group learns to perform different computer operation (e.g., open a browser); The groups reform and participants teach members from the other group the terms they learned	Instructor teaches participants computer operations
Wrap-up discussion (10 min)	No script	Facilitator leads a discussion of the module and encourages participants to address remaining questions	Instructor summarizes the module, answers questions
Session 3			
Pre-test (15 min)	No script	Website evaluation	
Pros/cons of Internet Health Information (20 min)	Constructive controversy	Each participant receives a handout with two viewpoints related to a discussion question. Participants read each viewpoint and record their thoughts about its pros/cons; In pairs, participants discuss the pros/cons	Instructor teaches participants about the importance of reliable health information
Evaluating the quality of health websites (65 min)	Jigsaw	Participants divide into two groups; Each group learns about four criteria to use when evaluating health websites (e.g., purpose of website, sponsor of website); The groups reform and participants teach members from the other group the criteria they learned	Instructor teaches participants about the eight criteria to use when evaluating health websites
Wrap-up discussion (10 min)	No script	Facilitator leads a discussion of the module and encourages participants to address remaining questions	Instructor summarizes the module, answers questions
Session 4			
Modules review	No script	On paper	
Post-test (10 min)	No script	Computer and web knowledge	
Post-test (20 min)	No script	Computer and web skill	
Post-test (15 min)	No script	Website evaluation	

Table 3. Participant characteristics in the collaborative and individualistic learning group, compared with chi-square tests for two-independent-samples; confidence limit 0.05; GED= General Educational Development; SD=standard deviation;=mean and SD are given instead of n and %*

Variable	Total		Comparison				
	n	%	Collaborative		Individualistic		p value
			n	%	n	%	
Age, year*	68	7	67	7	68	8	
Gender							0.96
Female	97	58	42	58	55	58	
Male	70	24	30	42	40	42	
Highest level of education							0.17
Less than high school graduate	12	7	4	6	8	8	
High school graduate / GED	50	30	21	30	29	31	
Vocational training	19	11	6	8	13	14	
Some college/associate's degree	41	25	15	21	26	27	
BA / BSc	24	14	14	19	10	11	
MA / MSc / Postgraduate training	19	11	12	17	7	7	
PhD / DSc	2	1	0	0	2	2	
Ethnic group							0.44
African American	129	77	55	76	74	78	
Caucasian	20	12	12	17	8	8	
Asian	8	5	2	3	6	6	
Native American / Alaska / Hawaiian	1	1	0	0	1	1	
Multi-racial	7	4	2	3	5	5	
Other	2	1	1	1	1	1	
Household income, US$							0.43
≤20,000	44	28	14	25	30	40	
20,000-29,999	25	16	9	16	16	21	
30,000-39,999	21	13	9	16	12	16	
40,000-49,999	7	4	4	7	3	4	
50,000-59,999	9	6	6	11	3	4	
60,000-69,999	8	5	5	9	3	4	
70,000-99,999	15	10	8	14	7	9	
≥100,000	4	3	2	4	2	3	
Health status							0.41
Poor	4	2	3	4	1	1	
Fair	43	26	22	30	21	22	
Good	78	47	29	40	49	52	
Very good	27	16	12	16	15	16	
Excellent	15	9	7	10	8	9	
English as primary language							0.74
Yes	148	88	65	89	83	87	
No	20	12	8	11	12	13	
Computer use frequency							0.46
Never	34	20	12	17	22	23	
<Once a month	25	15	9	13	16	17	
>Once a month	34	14	13	18	11	12	
Once a week	12	7	4	6	8	8	
Every 2-3 days	19	11	7	10	12	13	
Everyday	53	32	27	38	26	27	
Internet use frequency							0.60
Never	29	17	10	14	19	20	
<Once a month	18	11	7	10	11	12	
>Once a month	22	13	11	15	11	12	
Once a week	9	5	4	6	5	5	
Every 2-3 days	22	13	7	10	15	16	
Everyday	67	40	33	46	34	36	

of the NIH (*Table 4*). The sites endorsed by the Medical Library Association scored between 10 and 13 (best score possible: 13) while the online advertising websites scored between 0-5. Our independent evaluation indicates the ten sites recommended by the Medical Library Association were high quality while the ten advertising sites were low quality.

Next, we randomly arranged the order of the 20 websites and presented them to the participants to evaluate. Participants correctly assessed a

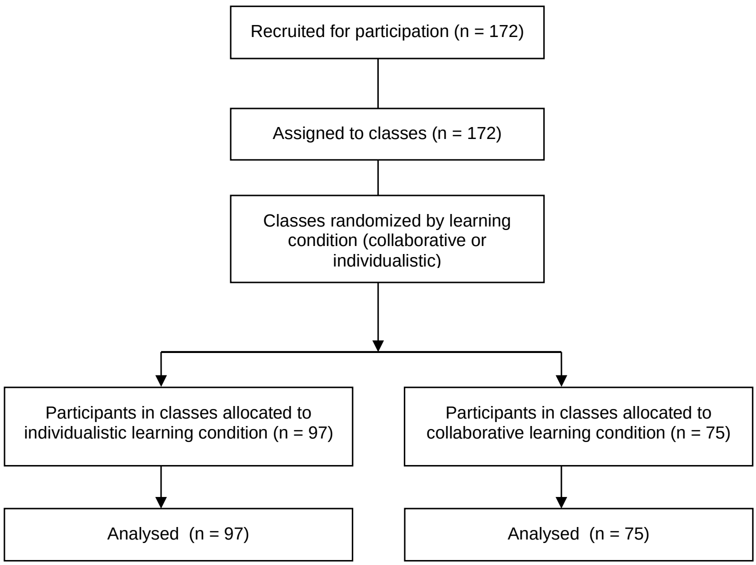

Figure 1. Consolidated standards of reporting trials diagram

website if they scored the Medical Library Association websites as high quality or the other sites as low quality. Each correct assessment earned one point, while incorrect answers earned no points. Answers marked uncertain earned no points. Scoring range: 0-20.

PRIOR EXPERIENCE WITH COMPUTERS AND THE INTERNET. Measure of the length and frequency of participants' computer and Internet use.

BASIC DEMOGRAPHICS. Measured age, gender, race/ethnicity, education, self-reported health status, annual household income, and primary language.

Procedure

Classes met four times over two weeks at a library site from 09:00-11:00H. Each participant used a desktop computer with high speed Internet. Participants completed a consent form approved by the researchers' Institutional Review Board before beginning the study (*Table 5*).

In session one, participants first completed baseline questionnaires and tests assessing prior computer and Internet experience, demographic information, computer and web knowledge, and computer and web skills. These activities required 45 minutes. Next, participants began module one. In session two, participants completed module one. In session three, participants first completed a pretest website evaluation of 20 health information websites. This testing occurred in session three because it requires basic web skills taught in module one. Testing took 15 minutes. Participants then completed module two.

Session four began with a 30-minute review with two activities: (i) computer and web terms review and (ii) website evaluation practice. For activity one, participants received handouts with 26 computer and web terms. Participants reviewed the terms on their own (individualistic condition) or in pairs (collaborative condition) to confirm understanding. For activity two, participants evaluated the Center for Disease Control and Prevention website[45] by themselves (individualistic condition) or in pairs (collaborative condition). Subsequently, participants completed post-testing assessments of computer and web knowledge, computer and web skill, and the website evaluation of 20 health information websites.

Table 4. Website evaluation criteria from the US National Library of Medicine's tutorial[49]

Area	Criterion
Provider	Whether a website says who is in charge of the site
	Whether a website explains why they are providing the site
	Whether the website provides its contact information
Funding	Whether the website explains where the money to support the site comes from
	Whether the website has advertisements, and if any, whether the advertisements are labeled
Quality	Whether the website explains where the information on the site comes from
	Whether the website explains how content on the site is selected
	Whether the information that goes on the site is reviewed by experts
	Whether the website avoids unbelievable or emotional claims
	Whether the information on the website is up-to-date
Privacy	Whether the website asks for personal information
	If the website does ask for personal information, whether it tells the user how such information will be used
	Whether the user is comfortable with how his or her personal information will be used

Data analysis
The primary statistical analyses used in testing the hypotheses were different techniques of analysis of variance (ANOVA), including multivariate repeated measures analysis and univariate repeated measures analysis. To compare the collaborative and individualistic samples, we used chi-square tests for two-independent-samples.

Results

Comparing groups

Chi-square tests found no significant difference for demographic variables between the experimental groups. These findings suggest the IL and CL groups were comparable in these regards, as expected given the random assignment of study participants to the experimental groups (*Table 3*).

CL versus IL

Univariate repeated measures analyses detected a significant difference in computer and web knowledge changes based on learning method with IL outperforming CL (*Table 5*): $F_{1,127}$=7.13; p=0.018. No significant difference was detected in computer and web skill $F_{1,125}$=2.30; p=0.264, or in eHealth literacy skill based on learning method, $F_{1,123}$=1.96; p=0.328.

Discussion

Adapting and testing theory-driven, empirically verified CL scripts developed for younger learners in formal learning settings[20] to an eHealth literacy intervention for older learners offers a novel approach unreported in the literature. This study's findings indicate IL produced significantly greater gains in computer and web knowledge acquisition than CL, but detected no significant difference in computer and web skill or eHealth literacy skill between the learning conditions. Several factors may explain the findings, including: (i) learning task complexity; (ii) learning goal; (iii) the level of structure provided by the CL scripts (jigsaw and constructive controversy); and (iv) group composition.

First, learning task complexity may explain why IL outperformed CL in computer and web knowledge acquisition. Prior research suggests for low-complexity learning tasks, the cognitive load required to coordinate CL exceeds the benefit of distributing cognitive load among collaborators[33]. Complexity depends on the number of information elements a learning task requires, and the elements' degree of interaction[33]. In this study, learning computer and web knowledge could be considered less complex in comparison to learning computer and web skills or eHealth literacy skills. For example, the eHealth literacy skills evaluated in this study required participants to learn and systematically apply nine evaluation criteria to determine the quality of health information websites. In contrast, for computer and web knowledge, our study design required participants to learn definitions of computer and Internet terms without considering how the definitions interact. From a cognitive load perspective, learning computer and web knowledge, as assessed in this study, may be insufficiently complex for CL to demonstrate superiority over IL.

Second, differences in learning goals may explain why IL outperformed CL for computer and Web knowledge acquisition. Evidence exists that IL outperforms CL for learning goals requiring learners to recall content, while CL outperforms IL when learners must transfer and apply knowledge to new contexts[35]. In this study, the computer and web knowledge pre- and posttest required learners to recall the definitions of terms, but not transfer and apply their knowledge of these terms to different contexts (i.e., questions about terms could be correctly answered by recalling their definitions). In contrast, the computer and web skill and the eHealth literacy skill tests asked learners to apply knowledge to novel problem-solving contexts (e.g., learners assessed the quality of new health information websites using criteria learned in the tutorial). This distinction may explain why IL outperformed CL for improving computer and web knowledge acquisition, but not computer and web skills or eHealth literacy skills.

Third, the amount of structure provided by CL scripts may also explain why CL did not outperform IL. Prior studies using CL with older adults provided little structure to CL and found no significant difference between CL and IL[23,15-17]. We selected the jigsaw and constructive controversy scripts to add structure using theory-driven, empirically verified strategies[19]. However, differenc-

Table 5. Pre- and post-test data for collaborative and individualistic learning; SD=Standard deviation; significant differences in pre-post changes in the univariate repeated measures analyses are in bold

Variable	Teaching style							
	Collaborative				Individualistic			
	Pre		Post		Pre		Post	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Computer and web knowledge	**13.46**	**3.92**	**16.67**	**2.98**	**11.13**	**4.61**	**16.66**	**3.95**
Computer and web skill	7.94	5.70	14.94	4.11	7.03	5.7	12.58	4.96
eHealth literacy skill	3.73	3.12	5.15	3.29	4.49	2.99	6.84	3.84

es between older and younger learners may make these scripts less effective for older learners. Evidence exists that older adults possess high motivation to participate in collaborative settings[43], and are more task-oriented than younger learners[56]. Based on these distinctions, older learners may require some, but not too much, structure to effectively collaborate. We selected scripts for this study in part because they impose high levels of structure (*Table 1*). However, jigsaw uses structure to motivate and focus learners through positive interdependence[19]. For motivated and focused older learners, this additional structure may distract learning, imposing extraneous cognitive load. Less structured scripts giving learners greater autonomy over their learning[47,50] may better match the characteristics of older learners.

Fourth, group composition may have influenced the CL scripts' efficacy. Prior interventions[16,17] found characteristics of CL groups, such as computer and web experience, gender, and prior familiarity with peers did not influence CL outcomes[16,17]. A key distinction between those studies and this study is the use of scripts. This distinction is potentially significant because jigsaw structures CL to maximize the benefits of diverse groups by promoting interdependence among learners with different experience and proficiencies[19]. Further, cognitive developmental theory predicts collaboration with more experienced peers increases learners' ability to levels unattainable working alone[28]. Combined, these factors suggest group diversity could influence these scripts' efficacy. A large proportion of participants in this study reported infrequent computer and web use, suggesting homogeneity for their computer experience and ability. However, this study did not control group composition as a strategy for improving CL.

Taken in conjunction, these explanations suggest interventions that tailor learning strategies based on the characteristics of learning task, learning goal, and the learners themselves could improve learning outcomes. Low-complexity learning tasks requiring knowledge recall could use IL, while high-complexity learning tasks requiring knowledge transfer could use CL. For tasks using CL, amount of structure and group composition could be tailored for relevant learner characteristics, such as motivation and prior experience. With this approach, interventions could use both CL and IL in an intervention, matching the most effective method for each task.

Limitations and future directions

Several limitations should be noted for this study. First, the non-representative nature of the sample means results should be generalized with caution. The participants selected themselves for participation and possessed sufficient interest, health, and mobility to participate in a study at the public library. Although results may not generalize to the entire older population, they offer insight into the segment of the older population likely to participate and benefit from computer training programs offered at public libraries. Additionally, African-Americans comprised the majority of participants. While reaching ethnic minorities presents an important strength of this study, it means results may not generalize to other ethnic groups. The naturalistic setting created both limitations and advantages. Confounding factors, like environmental disruptions (e.g., noise), can occur in naturalistic settings. However, these settings likely better reflect environmental influences than laboratory settings. Future research on CL could examine setting's influence on collaboration. Environmental factors, such as noise, may make coordinating collaboration more difficult for older learners in informal learning settings.

The results suggest areas for future CL research. First, future research should evaluate the user group composition to structure CL in conjunction with different scripts. Second, future research should investigate the efficacy of matching learning method to learning goal. Third, future research should investigate the efficacy of scripts that provide appropriate amount of structure to CL. Fourth, future research should clarify the influence of task complexity on learning goal. Another area for future research is clarifying the influence of peer instruction (e.g., older adult instructors). While the CL scripts included some peer instruction, the IL condition used younger, trained instructors. Clarifying the influence of instructor characteristics could potentially improve both IL and CL learning outcomes.

Conclusion

The results indicate IL produced significantly larger gains in computer and web knowledge acquisition than CL, but detected no significant difference in learning method for computer and web skill or eHealth literacy skill. Potential explanations for IL outperforming CL for computer and web knowledge acquisition, but not other measures, include: learning task complexity, learning goal, the level of structure provided by CL scripts used in this study, and group composition. Additional research should investigate if and how these factors influence the effectiveness of learning method for older adult eHealth literacy interventions.

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