Bridging The Digital Divide: The Impact Of Computer Training, Internet And E-mail Use On Levels Of Cognition, Depression, And Social Functioning In Older Adults

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Abstract— **In this quasi-experimental study, we examined the impact of computer training and access to Internet and e-mail on levels of depression, social isolation, and cognition in long-term care (LTC) residents aged 55 or greater. The study population consisted of 23 LTC residents in two counties in northeastern Pennsylvania. Inclusion criteria included a Mini-Mental State Exam (MMSE) [1] score of 24 or greater, the ability to read a computer screen and use an input device. Pre-test post-test measures included the Mini-Mental State Exam (MMSE), Geriatric Depression Scale-Short Form [2], and SF-36 Short-Form Survey [3]. Subjects received technology training using the ACTION curriculum [4]. Generations Online, a software tool designed specifically for elders, was used for email and Internet searches [5]. Using repeated measures t-test on square root transformations of pre and post GDS-SF [2] scores the researcher detected no significant difference in depression following the intervention ($M_{(Pre)} = 1.347$; $M_{(Post)} = 1.449$; $t = -.672$, $p = .512$). Pre and post SF subscale scores showed no significant difference in social functioning following the intervention ($M_{(Pre)} = 89.8438$; $M_{(Post)} = 89.8438$). Repeated measures t-test on original MMSE [1] scale scores pre and post intervention showed no significant differences in cognition ($M_{(Pre)} = 28.56$; $M_{(Post)} = 28.06$; $t = 0.696$, $p = .497$). There was a high degree of skew in some of the pre-test, post-test responses within the SF-36[3] measures. Square root and inverse transformations did not completely correct the skew with all measures. A review of the raw data showed that subjects had low levels of depression or no depression at baseline. A one-way ANOVA of GDS-SF [2] scores by number of training sessions detected a significant difference between groups (interaction) on both pre and post intervention scores ($F_{(Pre)} = 12.83$, $p = .001$; $F_{(Post)} = 8.22$; $p = .005$). This finding suggests that increasing the number of training sessions may offer a beneficial effect on level of depression due to the increased interaction during training.**

I. Introduction

Too often, the elderly have been ignored as consumers of technology. Technological advances that society takes for granted largely are often not available to seniors. Lack of age appropriate, accessible, and user-friendly technology has created a gap for this vulnerable population. According to the Pew Wired Seniors Report, while 56% of all Americans go online, only 15% of Americans over the age of 65 have access to the Internet. [6]. This is unfortunate because the Internet has been posited to help with social isolation of elders [7].

Though many institutionalized older adults do not have computer or Internet access, research suggests that those who do experience a positive effect on their quality of life. improvement in cognition and decreased depression [8].

The Internet offers the potential opportunity to provide enhanced social support and psychological well being. It can be used for increasing communication access; exploration of hobbies and interests; obtaining consumer information; and accessing community resources [7]. The purpose of this project was to focus on eliminating boundaries of time and distance that currently serve to isolate residents of LTC facilities. The following hypotheses were tested: 1). Older adults in this study will experience a decrease in level of depression following the training intervention, 2). Older adults in this study will experience an improvement in level of cognition following the training intervention, 3). Older adults in this study will experience a change in level of social functioning following the intervention, 4.) Older adults in this study will experience a change in perceptions of general health (GH) following the intervention.

II. Sample

Institutional review board approval was obtained at Misericordia University. Approval was also obtained from the Pennsylvania Department of Health. Several information sessions about the study were conducted at each facility. A convenience sample of adults aged 58 and above was utilized. Twenty-seven subjects were recruited and 23 were enrolled. Of the enrolled subjects, three subjects were lost due to mortality and four were lost prior to pre-testing due to early patient discharge. The sample size (n) was 16. Subjects ranged in age from 58-91 with a mean age of 74.25 years. Only one participant had prior experience with using a computer.

III. Methods

Following the obtaining of informed consent, data were collected and training was conducted at three long-term care facilities (two for-profit, one not-for-profit) in Luzerne and Lackawanna counties in Northeastern Pennsylvania. Prior to the initiation of the first phase of training, subjects were pre-tested using the demographic survey, the Mini Mental State Exam (MMSE), the Geriatric Depression Scale Short Form (GDS-SF), and the Short Form Health Survey (SF-36).

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Older adults are open to learning about computers [9], however, they have been found to experience a decline in cognitive and processing abilities such as related computer task errors, and required longer time to perform on the computer [10],[11]. Subjects' success at initial computer training is considered the most important predictor of continued computer use in older adults using an electronic bulletin board. Use of active, self-paced computer training programs appear to be the most successful for older adults Following pre-testing, the subjects received training using a self-paced format with the *ACTION Curriculum*, a low literacy computer training curriculum developed by the Coalition of African, Asian European, and Latino Immigrants of Illinois . The text is supplemented with graphics and material is reinforced through repetition of key points. For email and Internet searches, the *Generations Online* email software product was used.

Technology specifications for hardware components included computers equipped with a 2.53 GHz Intel Celeron processor, 40 Gigabyte hard drive, 256 megabytes of random access memory (RAM),. Input device were Microsoft EZ Ball, Kensington Expert Four Button Trackball, Hewlett Packard optical mouse, Visi-Key enhanced visibility Internet keyboard (QWERTY key layout) and Big Keys LX (QWERTY alpha key layout) keyboard input devices, and speakers. Output devices consisted of a 17" inch cathode ray tube (CRT) monitor and a networked color printer. A magnifier overlay screen was also used. Software components included Windows XP home edition operating system with accessibility tool for enlargement of type, audio reader and graphics modifications, Generations Online software application, Internet Explorer version 6.0 web browser. The computers were donated each facility at the conclusion of the study. Digital subscriber line (DSL) service was donated to the LTC facilities for the duration of the study by a local telephone company.

Due to the multiple co-morbidities and functional problems of many of the subjects within the study, the researchers utilized assistive devices as appropriate to facilitate subjects' use of technology. All subjects used magnifier screens and enlarged display icons and type, and either a trackball or optical mouse. Visi-Key and Big Key LX alphanumeric keyboards as well as standard keywords were used.

Subjects received three to six, standardized, self-paced training sessions by a trained research assistant. Six subjects required three training sessions, six subjects required five training sessions, and four subjects had six training sessions using the ACTION Curriculum. The number of sessions was based on subjects' abilities to successfully complete the requisite skills required to turn the computer on and off, use input and output devices, access and search the Internet, send and receive an email message and to utilize the intergenerational dialogue feature. In addition, each resident received a hard copy of the training materials. The researchers visited the facilities regularly to evaluate progress and to assist residents as needed. They also worked with 'early adopters' within the subject pool using a train-the-trainer model to help these individuals offer support to other subjects in the study group. At the completion of the study, subjects were post-tested using the MMSE, the GDS-SF, and the SF-36

IV. RESULTS

1). Older adults in this study will experience a decrease in level of depression following the training intervention. Hypothesis 1 was not supported. Cronbach's alpha for internal consistency reliability was not performed as GDS-SF summary scores were used. Pre-intervention score showed normal distribution of scores. Post- intervention score showed a skewed distribution of scores. A square root transformation was completed to correct skew of post-intervention GDS-SF score with correction of skew. Square root transformation was used for both pre and post scores to detect differences in pre and post GDS-SF scores. Using repeated measures t-test on square root transformations of pre and post GDS scores the researchers detected no significant difference ($M_{(Pre)} = 1.347$; $M_{(Post)} = 1.449$; $t = -.672$, $p = .512$). Pre and post GDS differences by age, gender, and education were completed. Age: One-way ANOVA for pre and post GDS by age with no significant results ($F_{(Pre)} = .203$, $p = .956$; $F_{(Post)} = .570$, $p = .793$). Gender One- way ANOVA for pre and post GDS-SF by gender with no significant results ($F_{(Pre)} = .464$, $p = .507$; $F_{(Post)} = .218$; $p = .648$). Education: One-way ANOVA for pre and post GDS-SF by education was run with no significant results ($F_{(Pre)} = .164$, $p = .919$; $F_{(Post)} = .059$; $p = .981$).A one-way ANOVA of GDS-SF scores by number of training session detected a significant difference between groups (interaction) on both pre and post intervention scores ($F_{(Pre)} = 12.83$, $p = .001$; $F_{(Post)} = 8.22$; $p = .005$). There was no difference in level of depression following the intervention.

2). Older adults in this study will experience an improvement in level of cognition following the training intervention. Hypothesis 2 was not supported. Cronbach's alpha for internal consistency reliability was not performed as MMSE summary scores were used. Pre-intervention score showed skewed results. The researchers attempted to correct skew with square root, log, and inverse transformations with no result. After outliers were removed (MMSE pre score < 27), skew was removed. Post intervention score showed skewed results. Outliers were removed (MMSE post score < 27) and skew was removed. Pre and post MMSE differences by age, gender, and education. One-way ANOVA for pre and post MMSE by age showed no significant results ($F_{(Pre)} = 1.783$, $p = .534$; $F_{(Post)} = 14.348$, $p = .204$). One-way ANOVA for pre and post MMSE by gender with no significant results ($F_{(Pre)} = 3.225$, $p = .094$; $F_{(Post)} = .001$, $p = .972$). One-way ANOVA for pre and post MMSE by education level with no significant results ($F_{(Pre)} = .707$, $p = .566$; $F_{(Post)} = 1.244$, $p = .337$).

Using repeated measures t-test with outliers removed was performed with no significant difference in pre and post measures. Using repeated measures t-test on original MMSE scale scores pre and post intervention was

performed with no significant difference detected ($M_{(Pre)}$ = 28.56 ; $M_{(Post)}$ = 28.06 ; t = 0.696, p = .497). There was no difference in cognitive function scores following the intervention

3). Level of social functioning in older adults in this study will experience a change following the intervention. Hypothesis 3 was not supported. Cronbach's alpha for the Social Functioning (SF) subscale of the SF36 with the pre-intervention group was r = .343 (.70 to .80 is acceptable for an existing tool) while the post intervention measure showed an increased internal consistency to .774 (unacceptable). Pre and post intervention scores- The researchers attempted to correct skew with square root, log, and inverse transformations with no result. Pre and post SF subscale scores showed no significant difference ($M_{(Pre)}$ = 89.8438; $M_{(Post)}$ = 89.8438). Because the mean was exactly the same no repeated measures t-test was performed. Because the mean was identical in pre and post intervention groups, no ancillary analyses were performed. There was no difference in social functioning following the intervention

4.) Older adults in this study will experience a change in perceptions of general health (GH) following the intervention. Cronbach's alpha for the GH subscale of the SF36 with the pre-intervention group was r = .730 (.70 to .80 is acceptable for an existing tool) while the post intervention measure showed a decline in internal consistency to .579 (unacceptable). Pre-intervention score distribution was a normal distribution. Post intervention score distribution showed normal distribution. Using repeated measures t-test for pre and post GH subscale scores no significant difference detected ($M_{(Pre)}$ = 58.5;$M_{(Post)}$ = 57.75; t = .250, p = .806). Pre and post GH subscale differences by age, gender and education. Age: A One-way ANOVA was run for pre and post GH subscale by age with no significant results ($F_{(Pre)}$ = 3.11, p = .420; $F_{(Post)}$ = 1.035, p = .658). One-way ANOVA for pre and post GH subscale by gender was run with no significant results ($F_{(Pre)}$ = .285, p = .602; $F_{(Post)}$ = .190; p = .670). One-way ANOVA for pre and post GH subscale by education showed no significant results ($F_{(Pre)}$ = .906, p = .467; $F_{(Post)}$ = 1.381; p = .296). There was no difference in perception of health following the intervention .

A one-way ANOVA of GDS-SF scores by number of training sessions detected a significant difference between groups (interaction) on both pre and post intervention scores ($F_{(Pre)}$ = 12.83, p = .001; $F_{(Post)}$ = 8.22; p = .005).

To avoid confounding data from using two measures both addressing emotional and mental health responses, the GDS-SF was used and the SF-36 subscale, Emotional and Mental Health, was not. Due to the inappropriateness of the questions for long-term care residents, the subscales of Physical Functioning and Role-Physical were not used. Several of the questions within this subscale asked for information that was not relevant to nursing home residents such as the number of flights of stairs climbed, ability to carry groceries and information related to job function.

V. Discussion

These non-significant findings may be attributable to not only an outlier effect but also may reflect the difference in time of day when pre-testing (morning) and post-testing (in the evening when residents are more fatigued but more easily available) was completed. Also, during the course of the study, some of the subjects experienced a decrease in medical status, which may have had an impact on testing. A review of the raw data showed that subjects had low levels of depression or no depression at baseline. In addition, this was a highly motivated group of subjects. Changing inclusion criteria to test subjects with mild to moderate depression may be helpful in future studies. It is doubtful that subjects with severe depression would be willing to participate in a similar research study.

The finding may indicate that increasing the number of training sessions might offer a beneficial effect on level of depression due to the increased interaction during training.

Additional considerations for future research should include the use of a different measure for health and social functioning that is more specific to older adults in long-term care settings. A larger sample size also would address issues related to statistical power. More stringent control over extraneous variables such as environment, particularly time of day for pre and post-testing are suggested. When analyzing the findings, it is important to consider whether the measurement variable should be more focused toward self-efficacy or self-concept. Subjects responded affirmatively to training and this became a social focus at two of the facilities. In future investigations, the notions of self-concept and self-efficacy should be considered for measurement. This may offer a better means of explaining the phenomenon of interest.

One of the overall benefits of this project was the ability to create a cost-effective replicable training model for use by other long-term care facilities. The researchers believe that they have done so by incorporating a free training curriculum, modestly priced elder-focused software and assistive devices that met the needs of a variety of users. The computers, printers and adaptive devices (screen magnifier, EZ Ball Trackball and optical mouse) and computer table used for the research training remained in each long-term care facility for the residents' continued use.

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