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Improving computer-based learning environments for the elderly end-user

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Abstract

Currently, there is a focus on the development of high-quality computer-based learning environments (CBLE). A special focus of this paper is on CBLE to assist in training the elderly end-user (EEU). This exploratory study discusses the results of a literature review that identifies codifiable factors related to training. The technical skill level of the older adult may require unique information system features to support training. A case study reveals how an elderly worker uses a computer-based training (CBT) application to improve his knowledge and satisfaction in the workplace. A framework is developed that may be used by application developers to help support training objectives in the context of the aging work population.

Keywords: Computer-based learning environments (CBLE), Computer-based training (CBT), systems design, case study, elderly end-user (EEU)

Introduction

The rapid development of computer-based learning environments (CBLEs) has been fueled by the advancement of information, communication, and multimedia technologies for both personal and workplace use. CBLEs reflect a training agenda that is administered using various media on computers rather than face-to-face instruction (Oduma et al., 2019). Computer-based training (CBT) applications and e-learning fall under the umbrella of the CBLE.

Organizations use a CBLE as an effective way to provide stakeholders (i.e., employees, customers, and collaborative partners) with immediate access to training and key information. This type of self-service training helps to achieve enterprise-wide reliability (Baker et al., 2020). Application developers that meet the needs of elderly end-users (EEU) may help to achieve key business objectives (i.e., the introduction of new products and compliance with new regulations) and obtain a unique competitive advantage.

Studies indicate that software developers have begun to acknowledge the EEU by applying adult learning principles in the development of CBLEs (Merriam et al., 2020; Belanger & Jordan, 2004; Cahoon, 1998). The use of technology is a critical asset in many industries and occupations. Therefore, the ability to use technology for training is essential for older adults. The application development community may also rely on the individual experiences of the elderly to improve their software.

There are many countries that have a high percentage of citizens aged 65 and over (Götmark et al., 2018). By 2050, it is projected that people aged 65 and older will represent 21 percent of the U.S. population, and those aged 85 and older will represent 5 percent of the population (Vespa et al., 2018). Often older workers

are pressured to exit the workplace at the age of 65 (Roser & Richie, 2019). The traditional chronological path of school, work, and retirement has changed. There is a growing segment of older workers reentering the workplace.

Interestingly, human resource managers note that they have a positive outlook on hiring older workers (Bersin & Chamorro-Premuzic, 2019). Overall, 24 percent said they did not see any disadvantages to hiring older employees (Bersin & Chamorro-Premuzic, 2019). However, older workers may face challenges in keeping up with technology developments (Hu et al., 2020).

Research most often looks at the elderly use of computer-based training (CBT) for help in personal activities and healthcare (Dermody et al., 2020; Pallavicini et al., 2018; Jin et al., 2019). Given both the increase in the age of the population and the impact of the CBLE, this paper has a special focus on helping software developers better understand codifiable factors that improve the elderly worker's training and productivity. Effective CBT for elderly workers may help prevent costly mistakes. The focus of this research explores training for the EEU in the daily work environment. The growing elderly audience requires effective CBT applications to be successful at work.

First, we survey the literature to explore concepts related to the development of CBLE. Key factors related to the development of high-quality CBLE are identified. Next, a case study is presented that identifies how the use of a CBT application by a 74-year-old man helps to increase his technology skill level and knowledge of inventory management. An exploratory framework is suggested that may be used by application developers in the context of an aging population and workforce. Finally, future research areas are suggested.

Literature Review

A primary source of data for this paper is a survey of literature on the development of computer-based learning environments (CBLE). The literature review includes studies on instructional design, cognitive engagement, learning styles, and pedagogical theories in information technology development (Seel et al., 2019). Data from these studies were then organized by grouping similar contexts of training, such as IT and general business training. A special focus is on the elderly end-user (EEU). The EEU is defined as those individuals who are 65 years and older and who rely on computer-enhanced processes to complete their work.

Americans today are working longer, resulting in an unprecedented transformation of the workplace. According to the U.S. Bureau of Labor Statistics, some negative preconceptions may exist regarding the elderly worker's eagerness to use technology and learn new ways of doing things, however, two age groups, 65 to 74 years old and 75 and older, are expected to have faster annual rates of labor force growth than that of any others (Toosi & Torpey, 2017). Over the decade from 2014 to 2024, the labor force growth rate for 65- to 74-year-olds is projected to be about 4.5% annually, and about 6.4% annually for those 75 and older (Toosi & Torpey, 2017).

These significant changes in the age of the workforce present challenges for application developers. One challenge refers to a better understanding of how to update the EEU's technology skills. (Collins & Casey, 2017). The COVID-19 pandemic heightened the importance of computer-based training to teach these skills to the EEU (Kang, 2021). Additionally, the pandemic created more of an openness to a diverse range of CBT applications within companies. Therefore, incorporating previously validated adult learning models may increase the likelihood of successful training.

Learning Models

The conventional learning model relies on a pedagogical approach (Davenport and Davenport, 1985; Holmes and Abington-Cooper, 2000). The model applies to teaching both children and adults. Some suggest that the pedagogical approach may not adequately support adult learning (Delahaye, et al., 1994; Knowles et al., 1998). These studies propose using an andragogical approach that focuses on an older learner.

Research compares pedagogical and andragogical (i.e., adult learning models) in terms of instructional design theory (Delahaye et al., 1994). A pedagogical model is based on teacher-directed instruction and promotes dependency on the instructor. However, as workers become older, they become more motivated to learn to solve immediate problems in their lives (Davenport and Davenport, 1985). The basic assumptions of adult learning principles refer to the ability and desire of the trainee to take personal responsibility for learning the domain of knowledge (Omoregie, 2019). This also reflects a move away from subject-centeredness to performance-centeredness (Davenport and Davenport, 1985).

Four factors that bridge learning to CBLEs surfaced from the review of literature. The discussion below identifies how CBLEs used in training incorporates these factors.

Four factors of Computer-based Learning Environments

Key factors represent a means for codifying realistic and relevant contexts and tasks, through which individuals may develop a deeper understanding of the skills necessary to be successful in work. The factors are (1) Content, (2) User Interface, (3) Structure, and (4) Presentation. Table 1 presents a framework that identifies a CBT application's four factors, descriptions, and example features.

Table 1. Factors of the CBLE and Application Features (adapted from Winston, 2005)

CBLE Factor	Description	Example Features
Content	The pieces of information are included in the application.	Descriptive and explanative information. Perceptive data.
User Interface	How users interact with individual pieces of information.	Graphical User Interface Navigation Virtual Environments.
Structure	The organization of data and description of the manipulation of data, which the application performs.	Object-oriented/relational databases. Web and streaming servers. Artificial Intelligence.
Presentation	How application content and functions are shown to the user.	Include relational aspects of media elements. Visualization techniques; and application of design principles.

The relationship between CBLE factors and adult learning is explored below.

Content

Content includes both the descriptive and explanative information embedded in the CBLE (Lim and Benbasat, 2002). Descriptive information refers to facts in the knowledge domain. Information becomes explanative when the facts are connected through useful relationships. Developer programmed content may be extended through experiential data added by end-user notes and historic evaluation scores.

Additionally, to support adult learning, developers will incorporate clear explanations on how end-users may modify a training application to display only the content they need to learn (Fidishun, 2000). Content may incorporate an evaluation of the level of proficiency in the material studied and identification of material still required for training to achieve specified learning goals**.** This evaluation feature should also provide the flexibility to change to a different learning style.

Content developers should ensure that end users can choose a preferred learning style. Visual learners like to observe through pictures, mapping, videos, and the use of notes with distinct colors or highlighting (Hackl & Ermolina, 2019). Auditory learners synthesize information through sound, rhymes, jingles, and recordings of data to improve their memory (Hackl & Ermolina, 2019). Kinesthetic learners strive to physically understand what they are studying (Iqbal, et al., 2019). Learners that prefer to read will look for the content provided in the form of manuals (Huang et al., 2020).

User Interface

The user interface (UI) of a training application is embodied in visual navigation capabilities. During the development phase, navigation is built into the application as preplanned events that are linked together by different paths (Rodrigues, 2000). A key feature of CBLE could be an intelligent guide, or avatar, which helps EEUs reach their training goals using the shortest and least costly path (Huart et al., 2004).

A user interface that provides for non-linear navigation allows adults to follow a path that will appropriately reflect their training needs and the organization's requirements. It may also include a capability for branching, which is the ability to select from several diverse types of training modules.

Modules may be chosen by the EEU that focus on application area knowledge or evaluations that provide rewards based on test results. If the navigation is linked to both trainee and organization requirements, then the user interface should provide easy access to advanced content.

Structure

Structure often corresponds with pedagogical models. The two main models refer to (1) behavioral and (2) constructivist. A behavioral approach involves a role model. Further, the approach suggests imitating and extending the role model's behavior (Rodrigues, 2000). Applications influenced by this approach will employ on-demand delivery of tutor demonstrations, drills, and reinforcement (Hawa et al., 2002). The constructivist method requires a hierarchical data structure that supports a step-by-step learning process and the division of content by proficiency level.

The structure and organization of data in CBT applications that support a constructivist approach focus on clear hyperlinks, hypermedia, and autonomous access to a range of pathways (Jha, 2017). System features

may include hands-on practice and the facility to question concepts along with real-time feedback. In addition, the use of artificial intelligence provides a mechanism for storing an individual's learning record and offering personalized rewards based on that record.

Presentation

Presentation refers to the format of the text, speech, animation, and video within the CBT application (Huart et al., 2004). Application developers control the presentation of information through programming, compressing, and delivering media. The quality of the media will directly impact the clarity of the information passed on to the user (Brath, 2005). Poor media quality will greatly impede learning. The deprecation of media quality is reflected in the user not being able to see clearly what is going on in an animation or not being able to understand the spoken word in an audio recording (Stein and Frolick, 2001).

The presentation of information may be partially controlled by the end-user through interactive linking, scaffolding, and visual techniques (Arghode & Brieger, 2017). The end-user who sorts and combines distinct types of media will contribute to and improve the aesthetic and emotional presentation of information (i.e., the sound is often used to offer a commentary that supplements text) (Thomas, 2003).

Developers that include multiple forms of media may assist EEUs who have preferred learning styles such as visual or auditory. The use of maps, dashboards, and charts also helps to enhance the CBLE. For example, the ability for the end-user to zoom in on selected information for details may help to filter the information.

Most CBT applications enable end-users to work at their own speed and repeat exercises as needed to build knowledge that can be applied in work situations. Older workers, often through their previous experiences, determine the best ways to develop a critical understanding of contexts and problems. Table 2 outlines each factor by a pedagogical goal and adult learning objectives.

Table 2. Relationship among factors, pedagogical and adult learning goals (adapted Winston, 2012)

CBT Application Factor	Pedagogical Goal	Adult Learning Objective
Content	Explain proper/improper application of principles, contrasting benefits with costs. Presenting examples of content in different contexts in a knowledge domain	Identify sources of information. Extend ideas to new topics. Record self-evaluations and include end-user prior experiences.
User Interface	Provide instant feedback and help and hands-on (interactive) exercises. Enabling repetition and the ability to enact on-demand review of content.	Enable accessible networks of information through individually chosen paths of navigation.
Structure	Achieve behaviorist and constructivist models of learning.	Build cognitive scaffolds.
Presentation	Deliver high-quality media to clarify and refine information.	Personalize views of data and information.

CBT applications vary in quality. On the low end of the range, CBT applications are a slide presentation that requires a user to click on each slide to move forward or backward (Andress & Leary, 2017). Higher quality applications may require the end-user to actively engage in animated training. Examples include dragging content around the screen and choosing a path of work-related concepts. A higher level of

engagement provides the end-user with both informal and formal assessment of their knowledge on a topic (Andress & Leary, 2017).

Methodology

Based on the above literature review a question that guides this case study is how factors of CBLE application design improve the older worker's performance. A case study was selected because a primary goal is to understand how an aging population may remain competitive by increasing its knowledge and performance. Yin (1994) recommends a case study as the preferred research strategy when "the focus is on a contemporary phenomenon within some real-life context," when "how" questions are being posed (p. 1), and when the context involves events over which the investigator has little or no control.

Data Collection Strategy

The data collection method employed in this study was an open-ended interview. The interviewee spent 4 hours a week with the trainee for over 6 months. Appendix 1 presents an abbreviated version of the interview guide. To protect the participant's confidentiality, a pseudonym was generated. With this caveat, the trainee declared a willingness to discuss his experiences openly.

Case Description

The participant, John Harris is 74 years old. John has been retired for four years from the banking industry where he served in a management position. His position required communication with a younger generation, both as a co-worker and with his customers. Terminology and cues that reflect commonplace knowledge, concerning various business situations, deteriorated as John was no longer using business language. This use of business language often must be relearned when an older worker returns because of changes to business terminology.

In his current position as a Sales Associate and Customer Service Agent, John must deal with customers' inquiries into products, their usage, and his opinion of what product he might select. His customers range from younger adults to the elderly.

The use of the CBT application by a person who is 74 and working provides a contextual scenario that is important to any study on the factors of training application development for the older workforce. This case provides a perspective on the effectiveness of CBLE as a knowledge platform. Further, this case explores how an older adult, at a later age, is required to use information, communication, and multimedia technologies to remain competitive in a workplace environment

In this case study, John relies on an inventory management software system for his work at a major retail store. This application assists John in better understanding how to improve the skills needed for customer service. An important aspect of the application provided John with the opportunity to practice his critical-thinking skills and address possible problem-solving issues through a set of customer-related exercises. Finally, the application content areas provided a basic level of understanding of concepts in inventory management.

The inventory management training system centered on skill-building. The company John is working for identified the most important skills that were necessary to learn. These include the ability to use the

inventory program to update product counts, compile daily reports on spreadsheets, and improve analytical and problem-solving strategies.

Findings

The findings discuss key topics related to CBLE development and the concerns of the EEU in training on specific applications related to daily work. Table 3 identifies key problems of the elderly end-user, suggested strategies for the end-user, and supporting evidence from the case study.

Table 3. Problems, Case Evidence and Strategies for EEU

Problem	Evidence from case	Strategy for EEU
Memory: Complexity of the knowledge domain.	"There are 100's of individual items to memorize."	Use repetition and provide the capability to start over at any place; chunk small bits of information.
Achievement of status and intrinsic rewards: Immediate evaluation either in the application or through real-world context	"I received 12 badges fairly quickly, which boosted my confidence of successfully performing my job."	Source of content has name recognition; brag on super-star credentials who approve the technology and are known for their expertise in the application area.
Incomplete information: Complexity of the knowledge domain.	"Just the introduction to supply chain management was difficult. It did not even get to the topic of delivery wait times."	Publicize additional training module development (for example: discuss reorder levels for products and forecasts of delivery.
Lack of technical acumen: Easy to use.	"Simply press 2 keys to see the information the customer needs."	Provide just-in-time data in terms of questions, evaluation, and explanations.

The main concern for John as he entered the workforce was the use of new technologies. An important feature of the inventory management training application was to provide John with the necessary technology and computer-based tools that would be needed for him to complete his job.
Using this application required John to navigate through different computer screens to locate information, such as inventory levels. John reported that having the different screens for input assisted him with data collection and offered helpful suggestions in completing the forms.

A second aspect that surfaced is the need for continuous rewards that provide momentum for learning. This may be addressed by ensuring that intrinsic rewards, such as increased self-confidence and status, are achieved during training. Within this application, John received badges for the successful completion of tasks. Finally, the impact of including an expert in the field helps motivate the EEU.

Contributors to Quality

The findings of the case study suggest some preliminary areas of focus for CBLE developers to help extend system features geared for a general end-user population to one focused on the elderly user. Two areas of focus are the content and user interface factors. Table 4 presents suggestions on how adult learning principles (Winston, 2012) may aid developers in increasing the probability of achieving a high-quality application.

Table 4. Potential ways to improve the quality of CBLE for the EEU

Adult Learning Principles	Increase Probability of a High-Quality Application	Application Factor
Relate to the predominant source of application content	Highly regarded expert.	Content: Observable credentials.
Evaluation	Use one-click to see evaluation; and answer problems and questions with explanations.	Navigation: Ease of use.
Self-directed	Repetition of complex information.	Navigation: Choose a path.
Intrinsic reward	Improve personal best.	Content: Associate evaluations with real-world achievement and status.
The leading role of the learner	Life experiences of the EEU are a source of improved learning.	Content: Allow ad hoc notes to be entered and provide an easy method to bookmark topics.

Discussion

This research suggests learning principles may be embedded in domain-specific CBT applications. Well-known experts, who participate in the development of content with opinion and knowledge, provide an encouraging experience to the EEU. Further, the incorporation of system features that support the attainment of intrinsic rewards corresponds with an employee that solves a challenging problem and feels successful. Finally, an interface that includes a facility for the EEU to add personal notes and ad hoc thoughts based on prior experience, in conjunction with content data, may improve training results as well as the overall satisfaction of the CBLE for less experienced end-users.

A limitation of this study is the reliance on one case. A multiple case study may be conducted using the factors and potential ways for improving the quality of EEU training. Further studies may reveal other factors essential to EEUs, such as identifying constructs of application development that will improve technology adoption and knowledge. Yet, another study on the elderly worker may focus on categorizing types of errors related to the software use and simulate practice trials, such as in spreadsheet design.

This study has begun to explore the concerns of the elderly still working in organizations and suggests ways of increasing the probability of implementing a high-quality CBLE. A focus of the case is the use of a CBLE with a domain-specific CBT application. Organizations may find new avenues of increasing employee productivity by maintaining a partnership with the elderly population and workforce that is steeped in experiential knowledge and supported by current computer-based applications.

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Appendix 1: Abbreviated Interview Guide

Name: Age: Occupation:

Technology

What is your computer experience? (Probe: Do you use the computer for email, online classes, personal productivity, or video?).

What is the title of the CBT application?

How long have you been using the CBT application? Have long have you used the CBT application?

What aspect of the CBT application do you like best?

What is the worst (most difficult) part of using the CBT application?

Information and Learning Style

What information are you learning (Probe: Why is that important to you? What did it add to your knowledge?). Don't understand the question

How do you acquire the information? (Probe: Through programmed use such as reading and test-taking, reading and application, then test, watching a simulation, trial, and error).

Does the way you acquire this information make a difference to the actions you take with this new knowledge?

Do you know what type of learner you are? (Probe: What is your learning style?).

Objectives

What are your expectations in using the application? (Probe: How are they met?).

Have you seen improvements in your work since using the CBT application? (Probe: if there are improvements, then are their other aspects - taking medicine, sleeping better, less stress. etc.).

How do you determine if your change in performance and competitiveness is attributed to the CBT? (Probe: a record of performance, how long did it take to see an increase in performance?).

How was your performance measured? (Probe: Self-evaluation, Performance on a CBT test module, rewards?)