Building Online Educational Games for Seniors: The Bingo Game Revisited

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Summary: What do we know about the ergonomic conditions that are needed to create an effective online educational game for seniors? Two approaches were used to establish these conditions: a comparative analysis of the literature on the subject and a survey of seniors (55 and older) about their digital gaming habits. This paper presents the ergonomic criteria, in terms of design and user-friendliness, which were used to adapt the Bingo game to make it an online educational game.

Introduction

Online games aimed at seniors need to address the particular needs and physical limitations of this target group. Several researchers have attempted to use commercial digital games in their investigations with seniors, while others have adapted games or have done research to establish requirements for seniors' digital games.. However, research is still limited about the ergonomic requirements of online games created for seniors.

These are being studied as part of a project funded by an Insight Grant from Canada's Social Sciences and Humanities Research Council. The goal is to examine, through the use of online games designed for seniors, the key factors for effective implementation of digital games for this audience. More specifically, our study has the following objectives: 1) develop and publicize online educational games for maintaining or adopting healthy lifestyles for retired seniors 55 years and older; 2) test these games with the target audience to check their ergonomic quality (design and user-friendliness) and 3) test these games with the target audience in order to assess the effect they have on the adoption of healthy lifestyles. In this brief paper, we describe the pedagogical and technological adaptations we made to an online Bingo game to introduce learning content, taking into account the ergonomic criteria that we identified in the literature for seniors 55 and older.

Seniors and Games

The aging population represents a serious challenge for healthcare systems and social insurance in the 21st century. The proportion of people aged 60 and over is growing faster than other age groups and is expected to reach two billion in 2050 (Aalbers, Baars, & Olde Rickert, 2011). In 2010, almost five million Canadians were over the age of 64 years. In 2036, they will number more than 10 million (HRSDC, 2011).

These aging seniors are facing the decline of their physical and cognitive abilities, loss of long-term companions and social support, changes in their familial or professional environment, different lifestyles, and the increased likelihood of developing chronic and disabling diseases. But what are they doing to improve their quality of life? Can games help them effectively meet the challenges of aging?

An increasing number of studies have demonstrated that video games can have a positive impact on seniors: digital games can provide physical training for seniors and can overcome their isolation. These studies also show that the effects of these games depend on the needs and individual characteristics of seniors and that systems need to be developed that are capable of adapting to the demands of this population. An inappropriate design can act as a barrier to seniors' use of games, thus reducing the games' physical, cognitive and social benefits and consequently seniors' health and quality of life (Whitlock, McLaughlin, & Allaire, 2011). It is therefore important to ensure that games offered to seniors have appropriate ergonomics.

In the case of online educational games, the ergonomist develops solutions that inform and guide the user while minimizing the cognitive information load as much as possible. In order to establish the ergonomic indicators of online games for seniors, we rely on two quality criteria: 1) the design: the components of the game must adapt to the characteristics of the users, and 2) user-friendliness: the game must be easy to use. We now examine how we addressed these criteria during the educational adaptation and computerization of the Bingo game for seniors.

The adaptation of the Bingo Game

According to a survey of 932 Canadian seniors, the game Bingo turns out to be the most mentioned game by respondents. Figure 1 presents a description of the game. In the remainder of this paper, we look at how the structure and content of this popular game have been adapted to create an educational online game for seniors.

Goal of the game: To be the first player to complete their card and shout Bingo. **Number of players:** Variable **Games materials**: 1-15 16-30 31-45 46-60 61-75 A Bingo ball cage and 75 balls, a ball board, tokens and Bingo cards with five rows and five columns. Each column is associated with a letter of the word BINGO and contains 15 randomly drawn numbers	**Rules** 1. All players receive a numbered card and tokens. 2. Players place a token in the center box which is free. 3. A number is announced. 4. The player places a token if the number is on their card. 5. The game can end in four ways, determined at the start of the game: • The player who has completed a vertical, horizontal or diagonal row of boxes and who is the first to shout "Bingo" is declared the winner. • The player who has completed all the boxes on their card and who is the first to shout "Covered Card" is declared the winner. • The player who covers all the numbers that form the contour of the card (the top and bottom rows and the columns on each side of the card) and who is the first to shout "Bingo" is declared the winner. • The player who covers all the numbers of the two diagonals (from one corner to the other in both directions) and who is the first to shout "Bingo" is declared the winner.

The Game Design

Various aspects of the game must be adapted in terms of design to create an educational game for seniors (Callari, Ciairano and Re, 2012; De Schutter, 2011; Diaz-Orueta, Facal, Herman Nap and Ranga, 2012; Hwang, Hong, Hao and Jong, 2011; Lopez-Martinez, Santiago-Ramajo, Caracuel, Valls-Serrano, Hornos, & Rodriguez-Fortiz, 2011; Marin, Lawrence, Navarro & Sax, 2011 ; Ogomori, Nagamachi, Ishihara, Ishihara, and Kohchi, 2011; Pham and Theng, 2012; Sauvé, 2010a; Shang-Ti, Huang, & Chiang, 2012; Theng, Chua, & Pham, 2012; Whitlock, McLaughlin and Allaire, 2011; Wu, Miao, Tao, and Helander, 2012).

Competition. The game must create competition among seniors to maintain their interest. The game must (1) be short in duration (between 5 and 15 minutes), (2) include rules that determine the winner or winners and the loser or losers, (3) provide a scoring system that allows seniors to measure their performance, and (4) allow for gains for a positive result and losses for a negative result that will be less than the gains in order to maintain the interest of seniors who have little knowledge on the subject matter of the game. During the design of the Bingo educational game, we first established it would take three participants or more to create competition between seniors. We gave the opportunity to vary the duration of the game by allowing players to choose how the game ends and thus decide the playing time: a complete row of vertical boxes requires less time than a full card or the contour of the card (Figure 2A). We opted to see the scoring system in the game interface at any time for each player (Figure 5). Then we inserted points that reward or penalize the player according to whether they answer the question correctly or not, which in turn allows the player to place a token in one of the boxes on the card. The penalty is 50% less than the gain in order to maintain the interest of players, in particular, for those who have little knowledge about the content to be learned. Finally, we changed the rules that determine the winners and losers in the context of an online game without a game master: the first player to click on the Bingo button after correctly placing their tokens on the Bingo card wins 50 points. Players who have a "Bingo" at the same time but were not fast enough to click on the "Bingo" button first, only receive 25 additional points. Should a player click on the Bingo button and not have their tokens placed correctly, the game continues and the player loses 25 points.

Challenge. The game must maintain a constant challenge for the players. It must introduce components that maintain a sense of uncertainty about the outcome of the game. It includes mechanisms that allow players to adapt the game based on their capabilities (reaction time, degree of difficulty, etc.). Thus, the learning content of the game must take into account the prior knowledge of the seniors for whom it is intended, and the questions must offer varying degrees of difficulty in order to promote the participation of all players, even those with little knowledge on the subject matter at hand. Mechanisms must also be provided to ensure that the outcome of a game remains uncertain, including: (1) the controlled addition of random events, for example, Bonus cards

distributed by the computer system to reduce the gap between opponents who are sometimes too strong or too weak; and (2) the level of difficulty of the questions from one game to another. During the adaptation of the game, we have put in place mechanisms (Figure 2B) that allow players to choose from three levels of difficulty at the start of the game. These levels are based on the knowledge of the seniors concerning the learning content (easy, medium and difficult) of the game. We also integrated into the game mechanics Bonus balls that are drawn at random during the game, thus reducing the gap between the players that are too strong and those that are weaker (easy = 3, medium = 2 and difficult = 1).

Figure 2. Main page interface of the game

Game content: To ensure effective learning, the game must incorporate learning content while maintaining a balance between learning time and play time to maintain the player's interest. This content should be split up to create simple questions in order to avoid cognitive overload for the seniors. The use of closed questions (True / False, Multiple choice with one or more answers), sentence completion, or matching objects facilitates participation and is less demanding for seniors with memory problems. The elements of the content must be repetitive so that the senior who sees the same information reappear, recognizes and considers it useful for their progression in the game. To ensure this repetition, we limit the number of questions or learning activities in the game so that they can be reused multiple times during the same game. During the adaptation of the game, we built a mechanism to display a question every time the number of a ball drawn at random is on a card of one or more players. If the player answers the question correctly, a token appears in the box and the player earns points (20 points for an easy question, 30 points for a medium question and 50 points for a difficult question). If the player does not correctly answer the question, the token will not appear in the box and the player loses half of the points allocated to the question. We prepared 40 questions instead of 75 (the number of balls) to ensure that these questions come at least twice during a game whose aim is to complete a full card.

Feedback. The game must provide feedback to support the learning of the defined content. Immediate feedback, related to each learning task, allows the player to identify successful activities and those they have failed. The game must incorporate mechanisms that: (1) highlight the results of each learning activity through visual or audible feedback (success or failure) such as a smiley face or sad face, positive or negative sounds, or points earned that increase a player's score; (2) correct incorrect answers through textual, visual or audible feedback on the content of the learning activity or provide additional information to sustain interest in the case of positive responses; and (3) allow players to see what they have learned by providing an overview of the results of the game's learning activities, together with teaching materials to review subject matter that has not been learned. The game should also provide feedback linked to players' actions throughout the game in order for players to see the results of their actions during the game. It is rare that a game is completely intuitive, so hints or a tutorial should be included to guide the player throughout the game. This tutorial should be available as needed by the players. For seniors, guidance about actions that need to be taken must be available to reassure them and reduce their cognitive load. The tutorial or a digital assistant to guide players should be available at all times by a single click. This simplifies game use by eliminating the need to quickly learn the rules of the game, thereby reducing the cognitive load. Hints, examples and demonstrations are necessary to avoid the types of errors that reduce seniors' motivation. These should be explicit and use the imperative verb form. Finally, error messages must be clear and always appear at the same place on the screen. During the adaptation of the game, we have integrated visual feedback in the question card window (Figure 3); it uses a smiley or sad face to communicate the results of game (A) and textual and audible feedback to explain the correct answer (B). When the game is

over, each senior can see their learning process in a personalized environment. An accessible tutorial (Figure 4), if needed, has been included to guide seniors throughout the game. They may at any time close or open it with a single click. We have also made available to seniors a short video that explains the flow of the game.
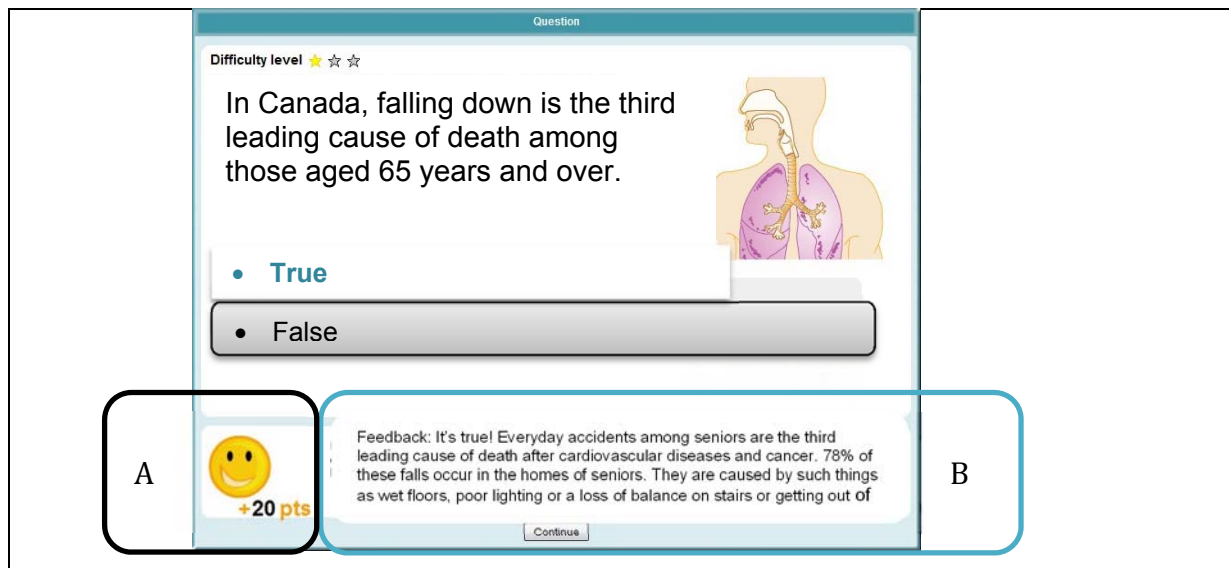

Figure 3. Question Cards

Figure 4. Example of a tutorial

The game's user-friendliness

Studies have found that seniors' problems with technology use are most frequently associated with user-friendliness and could be solved by appropriate design of the screen display and game navigation (Pearrow 2007; Hwang, Hong Hao and Jong, 2011; Marin, Lawrence, Navarro, and Sax, 2011; Sauvé, 2010b; Whitlock, McLaughlin and Allaire, 2011).

The display screen of the game and the learning activities. First of all, the game must use a standard screen display framework.. t is important that the game displays in the same way from one computer to another. Moreover, scroll bars should be avoided. The game display must maximize content visibility and minimize download time. The game and learning activities should also be seen in their entirety on the width of the screen without the need to use a horizontal scroll bar. The rules, the tutorial or instructions, and the players' scores must be in the players' field of vision and visible on different types of computer screens. The movement of characters or tokens in the visual environment or game board must be taken into account in order to avoid difficulty in accessing important learning information. In addition, the size of players' tokens must be in proportion to the size of the squares. During the adaptation of the Bingo game, we restricted the display size of the game board to the smallest resolution used by our target audience: 1024X768 (Figure 5). For screens with larger dimensions, we inserted a background of the same color as the background of the board and programmed the display so that the board is positioned in the center of the screen. This window is always visible regardless of other superimposed windows that appear. A second window may appear superimposed onto the game board. It contains questions, answers, feedback, the tutorial or the rules of the game. The size of this window is variable but always smaller than the board.

Navigation in the game. The game should provide easy navigation and must meet certain conditions. At all times, the board, tokens, navigation buttons, instructions, score and rules must be displayed and accessible to ensure that the game runs smoothly. It is also important to consider that the repeated use of the mouse to access a game component slows the pace of the game and hinders the motivation of players. It is preferable that players access all the elements that they need with a simple click. The game must use known symbols or icons to facilitate player actions and to avoid errors due to misunderstanding. Symbols and icons must be the same on all pages of the game and located close to required actions. Finally, moving interface elements such as new windows and cascading menus should be avoided, as should games with more than three superimposed windows; these hinder the intuitiveness of the game and seniors' concentration. During the adaptation of the game, we divided the game interface into three zones (Figure 5): a) the Bingo card, rules, and tutorial; b) information on the game's progress: the type of game, randomly drawn ball, and the Bingo button for ending the game; and c) information related to the actions of players: players' names and their scores as well as the control of the microphone and chat. All player actions are done using single clicks. We opted for buttons with words rather than symbols for ease of use by seniors who were not born in the digital age. Finally, we limited the number of superimposed windows to a maximum of two. When a second window appears in the center of the screen, the game board will be grayed out and become inactive.

Figure 5. Game Interface

The controller used to play the game. The game console (machine) should be adjustable to the physical limitations of the players. Research studies have most commonly investigated the keyboard and manual game controller. They suggest avoiding small buttons that require significant manual dexterity, as well as controllers that require a lot of manipulation because these are difficult for seniors to use. Game design should avoid double actions that require the player to precisely control a cursor on the screen while needing to correctly press a button to obtain the desired result. Controller buttons should be sensitive enough to respond to a light touch yet solid enough to support a strong hit, and large enough to be easily seen and pressed by seniors. One-handed game controllers, such as a computer mouse or a Wii controller, are preferable, as these are more accessible for seniors than those that are designed to be used with two hands. During the game adaptation, we eliminated all actions that require a double click to perform an action, whether to answer questions, to place a token on a square, or to interact with other players using real time verbal communication tools. In addition, during game testing and experimentation, we have provided touch sensitive screens and virtual keyboards (with adjustable size for the keyboard keys) to accommodate seniors' physical limitations.

Conclusion

As part of this developmental research, contents of three games for seniors are being prepared. These contents will be included in Bingo, a generic shell for educational games, which has been developed by taking into account the ergonomic criteria that we identified from the literature; for references and more detail, see

. These games and the instruments of measurement (questionnaire and interview) will be tested in the spring of March 2014 with thirty seniors aged 55 and over to obtain their feedback on the ergonomic aspects built into the games. These first results will be presented during the paper presentation. This results will allow us to review the games and to experiment on them in the autumn of 2014 with seniors (n=150) in both French and English.

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