Intergenerational learning through serious games: improving cybersecurity literacy of young and old

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Abstract. As today's society becomes increasingly digitized, it is crucial for both seniors and young people to develop safe online behaviors. Based on previous research, this position paper explores how serious games can serve as an effective tool for intergenerational learning, enabling seniors to improve their cybersecurity skills while allowing young people to share their digital expertise. Collaboration between these two demographics can enhance their understanding of safe online practices and develop a supportive learning environment, becoming a crucial strategy to foster a digitally secure and socially connected society.

Keywords: serious games· digital skills· intergenerational learning· cybersecurity· safe online practices.

1 Introduction

Although the internet plays a central role in everyday life, seniors and young people find themselves navigating a digital landscape with very different levels of familiarity and expertise. On the one hand, seniors may struggle with digital illiteracy and cybersecurity threats, but they also have a large and invaluable life experience. Their experience makes them more cautious in certain situations or better at identifying social engineering tactics based on real-world interactions (e.g., being more skeptical of unsolicited offers). On the other hand, young people typically possess greater technological fluency, but are more easily prey to ingenuity and lack of maturity. We posit that by combining their strengths through serious games, both groups could learn safe web practices together, overcoming generational barriers and fostering mutual support.

We know from previous research that older adults, while eager to participate in the digital world, often face significant barriers due to lack of experience and exposure to technology [2]. This research has shown that many seniors possess a keen desire to navigate the internet safely, particularly as they move towards greater digital independence. However, they often face challenges such as digital illiteracy, difficulties in understanding navigation, and fears related to cybersecurity threats [30]. This scenario (i) underscores the critical need for tailored educational interventions that enhance their digital skills while promoting safe online behaviors [23], and (ii) highlights the specific benefits of intergenerational learning and serious games, such as younger generations providing support and reducing fear of mistakes in a game environment.

Serious games offer an innovative solution for promoting intergenerational learning and enhancing cybersecurity awareness among seniors. These games create immersive learning experiences that engage players in a playful and motivating way, strengthening their cognitive abilities and mental agility. Research by Gutiérrez-Pérez *et al.* [10] indicates that when serious games are tailored to reflect the interests and daily experiences of older adults, they become particularly effective in promoting learning outcomes and behavioral changes regarding online safety.

In the context of cybersecurity education, serious games can effectively address the vulnerabilities that seniors face online, such as susceptibility to phishing attacks and misinformation [11, 18]. These games can simulate real-world online interactions, allowing seniors to practice and reinforce safe browsing habits in a controlled, risk-free environment (e.g., think of a game mechanic that mimics identifying a phishing email). Bernardino *et al.* [2] outline how such games can be instrumental in understanding cybersecurity issues, thereby empowering older adults to become more resilient and informed internet users.

Moreover, the pandemic period has significantly accelerated the shift towards digital communication and interactions, making it essential for seniors to adapt to online environments not just for engagement but also for maintaining family and social connections, thus promoting intergenerational exchange [7]. This necessity has galvanized efforts to implement intergenerational educational programs using serious games that convey cybersecurity concepts, bridging the generational divide while also equipping seniors with vital skills for the digital age [12]. So far, there have been a few research prototypes aimed specifically at the cybersecurity domain [9, 32].

In summary, intergenerational learning, facilitated through serious games, holds promise in improving cybersecurity education. This dual approach fosters digital literacy and encourages inclusive, lifelong learning, ensuring both older adults and young people can safely navigate the complexities of the online world.

2 The Role of Serious Games in Intergenerational Learning

Serious games for educational purposes are a powerful medium for facilitating intergenerational learning [19]. They combine the engaging elements of gaming with structured opportunities for knowledge sharing, collaboration, and skill acquisition. Serious games provide a unique platform where seniors can engage with younger individuals, fostering mutual understanding and skill development while overcoming common barriers associated with traditional educational methods [22]. Proper serious game design is instrumental in their effectiveness for intergenerational learning. For example, a player-friendly game interface and relevant real-life scenarios help reduce cognitive overload and facilitate smoother navigation for older adults. Additionally, features such as immediate feedback and iterative challenges can foster engagement and provide a sense of accomplishment, encouraging players to return to the game for further practice and learning.

One of the primary benefits of serious games is their ability to promote **engagement and motivation** among players [4]. For many seniors, the prospect of learning new digital skills can be daunting; however, the interactive and immersive nature of serious games transforms the learning experience into an enjoyable activity. Unlike conventional educational methods that may feel monotonous or intimidating, games allow older adults to explore and experiment in a playful environment, encouraging risk-taking and reducing anxiety over performance. A gamified approach can significantly increase their willingness to participate in learning activities, especially when supported by younger generations who can help navigate the technology.

Many serious games promote **collaborative interactions**, and some are even directly aimed at training or assessing such skills [1, 20]. This is another key component for intergenerational learning: when seniors and younger players participate in team-based gaming experiences, they engage in dialogue, share insights, and help each other solve problems. This collaborative learning environment can create numerous opportunities for younger players to communicate essential digital skills and cybersecurity knowledge, while seniors can contribute valuable life experiences, contextual understanding and decision making. Such interactions not only facilitate the transfer of knowledge but also build social bonds and reduce stereotypes, leading to a more inclusive learning experience.

By design, many serious games immerse players in scenarios relevant to their real lives, encouraging context-based learning. This may foster discussions between older and younger players about digital practices, such as online security and privacy – a crucial aspect in today's digital environments. For instance, as seniors navigate through a gameplay scenario that mimics phishing attempts or risky browsing practices, younger players can share tips that make the process easier and more intuitive. This reciprocal **exchange of knowledge** enriches the learning experience for both groups and emphasizes the value of collaboration across generations.

Serious games can be instrumental in improving **digital literacy** and fostering **cybersecurity awareness** [24]. By simulating real-world scenarios, these games allow seniors to gain hands-on experience in identifying threats and employing safe practices. For example, games may present challenges that require players to detect suspicious emails or navigate unsafe websites, reinforcing essential skills while simultaneously educating them about the importance of online safety. Moreover, younger participants can guide seniors during these challenges, thereby deepening their own understanding of cybersecurity issues as they teach and support their peers.

Beyond skill acquisition, serious games play a critical role in enhancing the **emotional and social well-being** of seniors. By creating a shared experience that fosters interaction and enjoyment, serious games can combat feelings of isolation that often affect older adults. Engaging in games with younger individuals not only boosts confidence in digital interactions but also provides opportunities for socialization and connection, which are vital for mental health and overall well-being. These positive emotional outcomes further reinforce the learning

process, as participants are more likely to engage in learning opportunities when they feel socially connected.

Another important aspect of serious games is their ability to create a **safe and supportive learning environment** for all players. Mistakes made in game contexts do not carry the same consequences as in real life; therefore, players can experiment with different strategies without fear of personal repercussions. This safety net encourages exploration and learning from failures, a critical element in developing digital skills and cybersecurity knowledge, where trial and error often lead to deeper understanding and competency.

3 Benefits of Intergenerational Learning through Gaming

Evidence from pilot programs, such as the 'Cyber Seniors' initiative [1], has shown that older adults gain significant confidence and skills through structured sessions alongside younger facilitators. Furthermore, intergenerational learning through gaming offers a multitude of benefits, bridging gaps between different age groups while fostering mutual understanding, collaboration, and skill development [14]. The integration of gaming as a platform for learning provides innovative pathways for engagement and knowledge sharing across generations, as explained below.

Gaming requires communication for successful collaboration, which encourages players from different generations to articulate their thoughts, discuss game mechanics and share strategies. This interaction helps to break down barriers, enhancing verbal and non-verbal **communication skills**. Seniors can learn to express technical concepts more clearly, while younger players develop patience and adaptability when explaining processes to their older peers. This exchange nurtures a more inclusive dialogue around technology and learning.

Seniors often possess valuable life experiences and practical problem-solving skills, while younger players bring in familiarity with new technologies and digital tools [8]. This synergy fosters a **collaborative learning environment** where perspectives from both age groups enrich the overall experience. For instance, while playing a serious game focused on cybersecurity, seniors might share their critical thinking strategies (e.g. recognizing social engineering tactics based on real-world scams), while younger players might impart technical skills necessary for navigating digital threats. Moreover, explaining technical concepts to someone less familiar can also deepen the younger person's understanding.

Engaging in gaming experiences together helps build **empathy and understanding**. By working towards common goals and facing challenges as a team, players develop an appreciation for each other's strengths and capabilities. This interaction promotes respect for each other's experiences and backgrounds, reducing stereotypes and fostering closeness between generations. Being able to empathize with varying perspectives enhances social cohesion and community spirit.

Gaming stimulates lifelong learning, as it encourages players to explore new concepts and skills in a low-pressure environment. This is particularly beneficial

[1] https://cyberseniors.org/

for seniors who may feel hesitant about embracing new technologies. Through playful experiences with younger generations, seniors are more likely to develop a **growth mindset**, realizing that learning is an ongoing process that does not diminish with age. This boosts their confidence in using technology and encourages continued exploration of digital tools in everyday life.

By playing together with younger people, seniors can experience increased **social interaction**, combating possible feelings of loneliness and isolation. Social engagement through gaming fosters connections and friendships, providing seniors with a support network that is essential for their emotional well-being. Younger players can help foster community by including seniors in group games and activities, ensuring that everyone feels valued and connected within the gaming experience.

Games often require strategic thinking, problem-solving, and decision-making skills. By engaging in gaming, seniors can exercise and enhance their **cognitive abilities**, which are crucial for maintaining mental agility as they age. Simultaneously, younger players can refine their critical thinking and analytical skills as they navigate challenges and learn from the accumulated experience of their older counterparts. The cooperative problem-solving tasks inherent in games encourage engagement that is mentally stimulating for both generations.

At its core, gaming is about enjoyment. The fun elements of gaming create a relaxed atmosphere conducive to learning, where the fear of failure is minimized. Such **playful environments** typically increase motivation and dedication to learning. When both generations engage in enjoyable activities, they naturally become more inclined to participate and invest in the learning process. This shared enjoyment strengthens bonds and cultivates a positive view of intergenerational interactions.

4 Digital Literacy Skills Built Through Serious Games

According to Eurostat [25], the population of the European Union (EU) at the beginning of 2024 was estimated at 449.3 million people, a fifth of whom were over the age of 65 years. This percentage increased by 0.3% in 26 EU countries compared to 2023, with only Malta showing a decrease. This number will tend to grow due to an increase in average life expectancy and low birth rates.

According to a Pew Research Center 2024 survey [28] and an AARP's Tech Trends 2025 report [17], 90% of seniors are online with their own smartphones, spending more time browsing the web, communicating with others, shopping online, and navigating to where they need to go. Other researchers found that seniors spend more than an hour a day on social media sites such as YouTube and Facebook [29]. Another interesting finding of this research was that 50% of seniors use their smartphones to play games and 70% of seniors prefer to search for information online. Technology is perceived positively and as an enrichment in the lives of seniors, helping with daily tasks and making aging easier.

As they age, seniors face a decline in visual acuity, which makes it harder to see small objects and instructions/captions or to locate information. They also face a change in their motor skills, which impairs their ability to maintain continuous and steady movements that are difficult to control with the mouse.

Moreover, with the decline of cognitive processes, elderly people have less attention, working memory, problem solving and reasoning skills, which can be stringent in remembering information or processing the load of information [3, 16]. These limitations can be overcome through the appropriate design principles of effective serious games, such as user-friendly design, clear information, and small challenges.

Research by de la Hera *et al.* [13] showed that intergenerational digital games strengthen family bonds by strengthening relationships, introducing new topics of conversation, avoiding social friction, improving communication, and creating opportunities for younger and older adults to share their learning. Furthermore, games also improve mutual understanding by discovering their family members' skills and knowledge, and they reduce social anxiety, especially for older adults who face situations of social isolation.

Huang *et al.* [15] showed that game-based approaches to cybersecurity and privacy in academic papers were targeted at students from elementary school to college level, as well as players aged 5–25 and professionals. However, none of these approaches were specifically developed for seniors. Also, the topics of interest for the non-technical audience include network security, technology-specific topics, threats and corresponding defensive strategies, and privacy and data protection.

Educational, game-based approaches are important for building digital literacy and cybersecurity knowledge among students of various age groups. Adapting and customizing content based on age, knowledge level and educational background ensures it remains relevant and engaging for all learners [15].

Quayyum *et al.* [26] pointed out that decreasing cybersecurity risks for children requires increasing cybersecurity awareness and ensuring safe internet use. We believe this is not only necessary for children aged 9–18, but seniors are also vulnerable to the same cybersecurity threats, for example:

1. *online privacy*;
2. *online harassment*, including cyberbullying and cyberstalking, which can have psychological and social impacts, and unwanted communication via technological channels;
3. *stranger danger*, including risks associated with interactions with strangers, such as catfishing and identity theft, and oversharing personal information, which can lead to
4. *social engineering* attacks and phishing, where older adults and children are vulnerable to fraudulent websites;
5. *content-related risks*, including inappropriate content Violent, pornographic or illegal content; invasive advertising; and spam;
6. *sexual solicitation*, e.g. sexting and receiving sexually explicit requests from strangers or acquaintances;
7. *technology-based threats*, including malware, viruses and device hacking;
8. *economic risks*: excessive online spending due to access to payment methods can lead to online gambling and financial fraud.
9. *internet addiction* contributes to risky behaviors and has a negative offline impact. It is also associated with poor cyber-wellness;

10. *password practices and management*: a lack of password security literacy makes seniors and children vulnerable [26].

In recent times, educational institutions such as senior universities, adult education, and ICT classes help develop the right skills, making sure a tutor or teacher helps seniors become familiar with digital technologies [6]. Bernardino *et al.* noted that seniors not only want to become familiar with digital technologies, but mainly wish to stay in touch with their family and friends by emailing or chatting on social media platforms [3]. Their research showed that a serious game for seniors should follow some critical guidelines: (1) the learning process must be accessible by focusing on the game and the learning purpose; (2) the game design and presentation must be user-friendly to avoid cognitive overload; (3) the game must support players' daily tasks by helping them remember small things that are done in their usual routine; (4) the information must be clear and easy to understand and read; and (5) the game must progress in small challenges to increase motivation and competition among classmates.

Bernardino *et al.* [3] designed their serious game around three topics, with information and challenges as follows:

1. **Personal data**, focusing on creating a strong password, knowing the policies of online services, teaching how to keep mobile devices updated, understanding how to avoid scams and online advertising.
2. **Fake news** detection, by checking the address of *https://* and searching for news on a reliable news site.
3. **Online shopping**, where the senior was challenged to analyze and detect fake shopping websites and red flags when shopping online.

During game play, seniors who were more comfortable with computers progressed quickly, while those who were less comfortable finished the game with the help of tutors. This research found that board and card games were the most challenging, but also the most entertaining for seniors. Online shopping was the most anxiety-provoking topic, although the one with the highest interest for seniors. Despite the great challenge and the initial discomfort and anxiety, older adults' knowledge of web safety, and safe behavior skills improved with gameplay. The tutors played an important role helping navigate safe environments, thus allowing elderly people to be more confident in facing digital challenges.

Today's elderly people have a larger social network that includes their children and friends, which encourages them to learn to use the internet not only to connect with others, but also to use technology to engage in meaningful activities [21]. Digital learning is still a challenge for elderly people due to the mix of anxiety and lack of confidence in using technology, but research has also found that they enjoy the opportunity for intergenerational interaction with youth [31, 33].

Findings by Bernardino *et al.* [3] have shown that an intergenerational, game-based approach to learning, sharing experiences and dialogue facilitates collaborative problem-solving and reflection through realistic, scenario-based challenges,

and increases cybersecurity awareness among children and older adults. Cybersecurity awareness is multidimensional, involving knowledge, attitudes, skills and behaviors. Both groups face distinct but overlapping online threats, including phishing, cyberbullying and identity theft, as well as a limited understanding of password security and online etiquette. However, with the support of interactions and teamwork, these conflicts were resolved. Children often proposed ideas or offered emotional support, while seniors emphasized shared decision-making and nurturing. This promoted stronger connections and improved understanding between generations. Furthermore, both groups increased their confidence in using technology, although older adults required more tech support, often aided by children [5, 27].

5 Conclusion

We posit that intergenerational learning facilitated by serious games is not merely a beneficial approach, but a crucial strategy to foster a digitally secure and socially connected society. Integrating young people into the serious gaming experience aimed at enhancing seniors' cybersecurity awareness can lead to mutual benefits, bridging the digital divide, and cultivating safe online behaviors in both groups. We argue that such an intergenerational strategy promotes reciprocal learning, strengthens social relationships and creates a collaborative community that values both digital literacy and shared experiences.

To fully realize this vision, future research should focus on optimal design features of serious games dealing with cybersecurity, and find effective strategies to facilitate intergenerational interaction, for instance, exploring the use of generative AI. Empirical studies on these games can then assess their effectiveness in improving knowledge and attitudes toward cybersecurity across different age groups.

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