

Analogue Games and Digital Literacy: The NetSmart Case Study with Older People

Claudilene Perim, Carla Sousa and Manuel José Damásio

Lusófona University, CICANT, Lisbon, Portugal

lena.perim@gmail.com

carla.patricia.sousa@ulusofona.pt

mjdamasio@ulusofona.pt

Abstract: In an era where digital proficiency is increasingly vital for full societal participation, older adults remain disproportionately underserved by digital literacy initiatives. Addressing this gap, the present study investigates the impact of *NetSmart*, a custom-designed analogue board game aimed at improving digital literacy among older adults. Developed through a participatory approach, *NetSmart* engages players in collaborative gameplay centred around digital safety, mobile device usage, and online interaction. The study employed a quasi-experimental pre-post design involving 42 participants aged 60 to 89, all previously introduced to foundational digital skills through local lifelong learning programs in Lisbon, Portugal. Participants attended a six-week intervention comprising guided gameplay sessions structured to promote reflective learning, skill reinforcement, and social interaction. Digital literacy was assessed through a 22-item questionnaire administered before and after the intervention. Quantitative analysis using the Wilcoxon signed-rank test revealed significant improvements in key areas: the ability to download and install applications ($p = .015$), update operating systems ($p = .037$), and understand the role of games in learning ($p = .020$). Additionally, post-intervention responses showed increased self-efficacy in educating others on digital safety and greater engagement with online gaming ($p = .033$ and $p = .013$, respectively). These findings underscore the potential of analogue Game-Based Learning (GBL) not only as a tool for developing digital competencies, but also as a means of enhancing older adults' autonomy, social engagement, and confidence in navigating digital environments. This aligns with a broader recognition of play as a dynamic and effective medium for adult learning—especially when educational approaches are sensitively adapted to the cognitive and emotional dimensions of aging. While the case study's context-specific nature and absence of a control group limit generalizability, the results nonetheless offer meaningful insights into how GBL can inform digital inclusion strategies for older populations. To build on these insights, future research should incorporate performance-based assessments alongside self-reported data and explore diverse settings to strengthen external validity.

Keywords: Older people, Game-Based learning, Digital literacy, Analogue games

1. Introduction

The increasing digitalization of services, social interactions, and everyday life has widened the generational gap in how people access and engage with technology. Older adults often face a combination of technological, cognitive, and emotional barriers that make it difficult to fully participate in today's digital society. In this context, digital literacy is more than a technical skill – it's a key to social inclusion, autonomy, and active participation in later life (Ng, 2012; Helsper and Van Deursen, 2017).

Although many programs aim to bridge this digital divide, traditional teaching methods often fall short in meeting the needs of older learners. These approaches may not align with their learning preferences or engage them meaningfully. In response, educational research has increasingly explored Game-Based Learning (GBL) to boost motivation, foster autonomy, and support skill development among adult learners (Romero et al., 2017; Hsiao et al., 2024). Games create safe and engaging environments for practice, feedback, exploration, and collaboration – key ingredients for effective learning.

While GBL has been widely studied among younger populations and in formal educational settings, its use in teaching digital literacy to older adults has received far less attention – especially from a quantitative standpoint. There is a growing need for solid evidence on how structured game-based interventions can support older adults in developing digital skills (Zou et al., 2021; Costa et al., 2022).

This study seeks to address that gap by examining the impact of *NetSmart*, a custom-designed board game created to enhance digital literacy in older adults. Using a pre and post evaluation design, we assess changes in participants' skills and perceptions after five guided sessions with the game. Our quantitative approach offers a clear lens into how playful, structured learning can benefit older adults in the context of lifelong learning and digital inclusion.

2. Theoretical Foundations

2.1 Lifelong Learning, Aging, and Social Participation

Lifelong learning is essential for keeping older adults engaged, independent, and connected in today's fast-changing digital world. As emphasized by UNESCO (2016), continuing to learn throughout life supports well-being, adaptability, and civic involvement. Yet, many older adults encounter real barriers when returning to learning environments—ranging from reduced self-confidence and negative age-related stereotypes to anxiety about using unfamiliar technologies (Formosa, 2014; Charness and Boot, 2022).

These challenges are often made worse by inequalities in access to education and digital infrastructure. To address them, educational practices need to be inclusive, empathetic, and meaningful. Aging also brings natural changes in memory, attention, and processing speed. As a result, effective learning environments for older adults should respect cognitive diversity and allow learners to move at their own pace (Czaja et al., 2019).

Approaches that encourage active participation, foster social interaction, and create emotionally safe spaces are more likely to succeed in keeping older adults engaged and motivated to learn. By nurturing not just intellectual but also social and emotional engagement, such environments support learning that is both meaningful and sustainable.

2.2 Digital Literacy in Later Life

Digital literacy goes beyond knowing how to use a computer or smartphone. It includes the ability to find, evaluate, understand, and apply digital information in meaningful and critical ways (Ng, 2012). For older adults, this often means more than acquiring technical skills – it's about building confidence, feeling that technology is useful in their lives, and developing a sense of autonomy in digital environments.

These aspects are shaped by personal histories, the level of support from friends or family, and emotional comfort with technology (Lee and Coughlin, 2015). Many older adults face psychological and practical barriers to digital engagement, such as low self-efficacy, fear of making mistakes, or inaccessible instruction (Neves et al., 2018; Helsper and Van Deursen, 2017).

Overcoming these challenges requires learning environments that are welcoming, user-friendly, and tailored to the needs of older users. When digital literacy education is rooted in empathy and respect for learners' experiences, it has the potential to empower older adults—not just to use technology, but to engage with it meaningfully and confidently.

2.3 Game-Based Learning and Older Adults

GBL is an approach that uses the structure and elements of games – like rules, feedback, and goals – to support meaningful learning. Unlike gamification, which adds game-like features to traditional content, GBL is centred on learning through play. It fosters engagement, reflection, and motivation by creating immersive and interactive experiences (Plass et al., 2015).

Although often associated with younger learners, GBL is increasingly being recognized as a valuable tool in adult education, including programs for older adults (Perim et al., 2024). For those with limited experience using digital tools, GBL offers a low-pressure way to explore new skills. It creates space for experimentation, where failure is safe and part of the process. This is especially important for older adults, who may face anxiety or self-doubt when learning new technologies.

Recent research has explored GBL with older populations in a range of settings. For instance, cognitive games have been shown to support memory, attention, and executive functioning (Kueider et al., 2012; Bercovitz et al., 2020). Other studies have used games to teach health management skills, improve health literacy, and encourage behaviour change (Vázquez et al., 2021; Guimarães et al., 2023). Still others have focused on promoting intergenerational learning and reducing social isolation through collaborative games (Volda and Greenberg, 2021; De Schutter, 2023).

Across these diverse applications, games do more than support skill-building—they enhance emotional well-being, build self-efficacy, and create a sense of belonging. These are crucial ingredients for improving quality of life in later years, and they make GBL a promising approach for digital literacy education with older adults.

3. Methodology

This study uses a quantitative, *quasi*-experimental pre and post design to assess how a GBL intervention impacts digital literacy among older adults. This design is appropriate for evaluating educational interventions where random assignment is not feasible but pre- and post-measures allow for within-group comparison (Campbell and Stanley, 1963; Creswell and Creswell, 2018). The study builds upon a prior qualitative investigation conducted with the same participants (see Perim et al, in press), institutions, and pedagogical tools, offering a valuable opportunity to compare results and deepen understanding of how older adults engage with technology-focused learning in both experiential and reflective dimensions (Creswell and Plano Clark, 2018)

3.1 Participants and Context

The study involved 42 older adults aged 60 to 89 ($M = 74.14$; $SD = 7.08$), 38 females (90.5%), and four males (9.5%), recruited from community centres and lifelong learning programs in the Greater Lisbon area. These institutions promote active aging and educational inclusion through participatory pedagogical approaches (Formosa, 2014; Loos, 2020). All participants voluntarily consented and had previously completed introductory digital literacy programs, providing a shared baseline that enabled more experiential learning through game-based educational models (Ng, 2012; Romero et al., 2017).

From the gathered data, it is relevant to note that most of the participants (97.6%) reported being able to make or receive phone calls. Regarding digital media habits, 68.3% used their phones to search for information, 70.7% for updates, and 51.2% for entertainment. Nearly half of the participants (48.8%) indicated they used their phones to play games, and 50% reported using them to access services. In contrast, only 19.5% reported having access to streaming services.

3.2 The NetSmart Game

The intervention was centred around *NetSmart: Discover Your Digital Literacy Level!*, a custom-designed educational board game developed specifically for this study. The game was conceptualized based on principles of GBL and inclusive adult education, promoting critical digital skills in a collaborative, hands-on, and motivational environment (Plass et al., 2015; Whitton and Langan, 2019).

NetSmart consists of a flexible vinyl game board (120 cm × 80 cm), 100 multiple-choice question cards in four levels of difficulty, 100 answer cards, a die, and coloured tokens for scoring. The layout features Wi-Fi-style icons that simulate increasing digital complexity, encouraging a scaffolded learning experience. Topics include identifying scams, creating secure passwords, adjusting privacy settings, recognizing fake links, and using email and messaging apps – selected based on known challenges among older digital users (Lee and Coughlin, 2015; Helsper and Van Deursen, 2017). Figure 1 illustrates the *NetSmart* game board along with its components, as they were used during the intervention sessions.



Figure 1: *NetSmart* board and components

Gameplay involves small groups (3 to 5 participants) who roll the die to select categories, collaboratively discuss answers, and reflect on outcomes. Correct answers earn team points; incorrect ones award points to the board, representing the “challenges” of the digital world. This game mechanic supports social learning, critical thinking, and emotional safety – features identified as essential for older adult learners (Gee, 2020; De Schutter, 2023).

Accessibility was a priority: all cards were printed in large format (12cm × 8.5 cm), laminated for reusability, and designed with removable adhesive labels for continuous content updates.

3.3 Intervention Procedures

The intervention occurred over six weeks (from January to February 2025), with weekly in-person sessions lasting from 75 to 80 minutes. Each session followed a three-phase structure: (1) a brief conceptual introduction; (2) group gameplay; and (3) a facilitated discussion. The first session was a full-group demonstration. From the second week onward, participants were split into smaller groups for structured, turn-based play.

Facilitators guided the experience by reading questions aloud, encouraging discussion, clarifying concepts, and supporting reflection. Their role aligns with research emphasizing the importance of pedagogical mediation in GBL settings – especially where adult learners exhibit diverse cognitive, motivational, and emotional profiles (Munoz et al., 2019; Whitton and Langan, 2019).

At the end of each session, scores were shared, and informal feedback was gathered. These post-session reflections contributed to a broader understanding of learning engagement and group dynamics.

3.4 Data Collection and Analysis

Participants completed a digital literacy questionnaire before and after the intervention. The survey measured self-perceived confidence and ability in performing digital tasks aligned with the game content. Such instruments are widely used in older adult digital inclusion research, as they capture both competence and affective dimensions (Kueider et al., 2012; Zou et al., 2021). It was composed of 22 items and based of previous approaches to measure media and digital literacy, developed with different populations (Costa et al., 2018), while adapted for the characteristics of older adults. Table 1, in the results section, presents the 22 items gathered both in pre- and post-GBL intervention with *NetSmart* (see columns “Item no.” and “Item text”). Those were answered through a 5-point Likert scale.

Prior to participation, all individuals were informed about the objectives, procedures, potential risks, and benefits of the study. Written informed consent was obtained from all participants in accordance with ethical research standards.

Due to the ordinal nature and non-normal distribution of the data, the Wilcoxon signed-rank test was applied to evaluate significant differences in pre- and post-intervention scores. These tests and descriptive statistics were computed using JASP (Version 0.19.3).

4. Results

As explained above, a first exploratory step of the statistical analysis expressed that all the variables of the questionnaire with potential significant differences had a non-normal distribution – through Shapiro-Wilk testing ($p < .05$) – Wilcoxon signed-rank test was adopted to test differences between pre- and post- intervention, as well as medians for descriptives statistics. This procedure was, therefore, calculated for the 22 variables in the study (see Table 1 items). The full results are presented in Table 2.

Table 1: Full questionnaire items and results from the Wilcoxon signed-rank of the pre- and post-intervention questionnaire (N = 42)

Item	Item text	Pre-Intervention Median	Pre-Intervention Median	W	Z	p
1	Browsing the internet for information.	4.0	5.0	12.0	-1.580	.112
2	Downloading and installing apps on your mobile phone.	3.0	4.0	4.5	-2.344	.015
3	Use social networks such as Facebook, Instagram or Tik Tok.	4.0	4.0	38.5	-0.039	1.00
4	Create and use secure passwords.	3.0	3.0	56.0	-1.285	.190
5	Identify fake or dubious news.	2.0	3.0	45.5	-0.439	.677
6	Use an email to send and receive messages.	4.0	5.0	6.0	-1.680	.098

Item	Item text	Pre-Intervention Median	Pre-Intervention Median	W	Z	p
7	Play online games.	3.5	4.0	32.0	-1.287	.199
8	Using WhatsApp to send messages or make calls.	5.0	5.0	7.5	-1.099	.301
9	Understand what cookies and terms of conditions are on websites.	2.0	3.0	24.0	-1.177	.241
10	Protect my devices (computer and mobile phone) with secure passwords.	2.0	3.0	35.5	-1.067	.288
11	Configure basic settings on my mobile phone, such as Wi-Fi or volume.	4.0	4.0	33.0	-0.471	.644
12	Identify and not share fake news.	1.0	3.0	23.5	-1.821	.067
13	Send emails with attachments.	4.0	5.0	7.0	-1.540	.138
14	Educate friends and family about good online safety practices.	2.0	3.5	27.0	-2.120	.033
15	Use games as a tool to learn new things.	1.0	3.0	16.0	-2.291	.020
16	Organise documents and digital files in folders on my computer or mobile phone.	2.0	2.5	22.0	-1.642	.098
17	Update applications and operating systems to keep my devices safe.	2.0	3.0	7.0	-2.090	.037
18	Use cloud storage services (such as Google Drive or OneDrive) to store documents.	2.0	3.0	23.0	-1.255	.208
19	Make secure passwords.	3.0	3.0	56.0	-1.285	.190
20	Recognise and avoid fraudulent links, messages and emails.	2.0	4.0	48.0	-1.034	.303
21	Play video games on the internet.	2.0	4.0	13.5	-2.448	.013
22	Connect online (social networks) with people who like the same things as me.	3.0	3.0	15.5	-1.556	.126

The obtained results, although not uniformly, show the potential impact of *NetSmart* in some specific skills and aspects of older adults' digital literacy. First, item two ("Downloading and installing apps on your mobile phone") showed significantly higher values from the pre-questionnaire ($M = 2.68$; $SD = 1.36$) to the post-questionnaire ($M = 3.40$; $SD = 1.19$); $W = 4.5$, $Z = -2.344$, $p = .015$. Item fourteen ("Educate friends and family about good online safety practices") also presented impact from the *NetSmart* game-based intervention with significantly higher results between the pre-intervention ($M = 2.22$; $SD = 1.34$), and the post-intervention ($M = 3.08$; $SD = 1.38$); $W = 27.0$, $Z = -2.120$, $p = .033$. Moreover, also item fifteen ("Use games as a tool to learn new things") presented similar results, with significantly higher values of self-perceived ability in post-intervention ($M = 2.83$; $SD = 1.34$) than in pre-intervention ($M = 1.87$; $SD = 1.27$); $W = 16.0$, $Z = -2.291$, $p = .020$.

Two more pairs of pre- and post-intervention variables presented significant differences. Item 17 ("Update applications and operating systems to keep my devices safe") presented significantly higher values between the pre-GBL intervention moment ($M = 2.16$; $SD = 1.29$) and the post-GBL intervention moment ($M = 3.00$; $SD = 1.45$); $W = 7.0$, $Z = -2.090$, $p = .037$. Similarly, item 21 ("Play video games on the internet") also showed significantly higher values from the pre-questionnaire ($M = 1.84$; $SD = 1.18$) to the post-questionnaire ($M = 3.08$; $SD = 1.44$); $W = 13.5$, $Z = -2.448$, $p = .013$.

For the remaining items of the questionnaire no statistically significant differences were found.

5. Discussion

The present study intended to address the potential of *NetSmart* in promoting the digital literacy of older adults, through the development of a case study. Through this quasi-experimental approach, it is possible to highlight its impact in some of the self-perceived skills of the target audience's digital literacy and related aspects, although not all the tested items. Most specifically, this analogue game presented a relevant impact in enhancing how older adults perceive their ability to keep their own devices' safety settings, through updates, and through their ability to install the required apps. Moreover, the findings suggest a potential multiplier effect of the *NetSmart* game, as participants reported a significantly increased ability to educate and support their friends and family on safe online practices following the intervention. This perceived shift indicates that such interventions may extend their impact beyond individual learning, fostering knowledge transfer within participants' social networks. Notably, this outcome aligns with existing research highlighting the role of GBL in promoting intergenerational interaction and communication between older adults and their family members (Wu et al., 2020), as well as supporting cross-generational learning dynamics (Perim et al., 2024).

The remaining results of this study further emphasise the relevance of games and playfulness in the life contexts of older people, and how GBL can capitalise on this. Firstly, after the game-based intervention with *NetSmart*, participants felt more able to use games as tools to learn new things, which highlights a certain notion of process transferability to other games and even contexts. Moreover, the differences found on their perceived ability to play video games on the internet after the intervention also show how analogue and digital games common environment – “the magic circle” (Huizinga, 1949) – also reinforces a certain transferability of their interest in playfulness from analogue through digital environments. By feeling safer playing and more digital literate, they also felt more able to play other types of games, which might assume a relevant role in their free time occupation.

5.1 Limitations and Future Directions

Although the study presents relevant findings, it is a bounded system approach (case study), emphasizing the context dependency and difficulty generalizability of those. Moreover, the adoption of a *quasi*-experimental research design – with no control group – and the lack of transversal impacts in all assessed skills are also worth mentioning.

Future studies should target these issues, while also triangulate the players' self-perceived skills, respective impacts, and actual skills assessments, through task completion and knowledge tests.

The team is currently working in the final mixed-methods results of this research, which will also explore in-depth the gaming sessions, the players behaviours and performance, as a path to explain the different impacted skills, as well as the ones without significant differences.

Acknowledgement

This study was funded by national funds through the FCT - Foundation for Science and Technology, I.P., under project GameIN (2022.07939. PTDC) – available at <https://doi.org/10.54499/2022.07939.PTDC>.

Ethics Declaration: This study did not require formal ethical clearance. However, it was conducted in accordance with strict ethical standards to ensure the protection of participants' rights and privacy. Informed consent was obtained from all participants after clear communication of the study's objectives and potential risks. Participant anonymity was maintained through data anonymization, and appropriate accommodations—such as visual aids and flexible pacing—were offered to support individuals with cognitive or physical limitations.

AI Statement: This article was proofread and edited for language clarity using Grammarly and Generative AI tools. These tools were employed solely for linguistic enhancement, with no impact on the content, arguments, or conclusions. The authors, for whom English is not the primary language, retain full responsibility for the work's intellectual integrity.

References

- Bercovitz, K., Rosales, S., Mendoza, J. and Martínez, D. (2020) 'Serious games to train executive functions in aging: A systematic review', *Frontiers in Psychology*, 11, p. 578340. doi:10.3389/fpsyg.2020.578340.
- Campbell, D.T. and Stanley, J.C. (1963) *Experimental and quasi-experimental designs for research*. Boston: Houghton Mifflin.
- Charness, N. and Boot, W.R. (2022) 'Technology, gaming, and social interaction in aging', *Current Directions in Psychological Science*, 31(1), pp. 41–48. doi:10.1177/09637214211055122.

- Costa, C. et al. (2018) 'Desenvolvimento e Validação da Escala de Literacia Mediática e Informacional para Alunos dos 2º e 3º Ciclos do Ensino Básico em Portugal,' *Revista Lusófona De Educação*, (41), pp. 11–28. doi:10.24140/issn.1645-7250.rle41.01.
- Costa, E., Dias, I. and Mealha, Ó. (2022) 'Involving older adults in the design process: A human-centric Design Thinking approach', *Interaction Design and Architecture(s) Journal*, 54, pp. 134–154.
- Creswell, J.W. and Creswell, J.D. (2018) *Research design: Qualitative, quantitative, and mixed methods approaches*. 5th edn. Thousand Oaks, CA: SAGE Publications.
- Creswell, J.W. and Plano Clark, V.L. (2018) *Designing and conducting mixed methods research*. 3rd edn. Thousand Oaks, CA: SAGE Publications.
- Czaja, S.J., Boot, W.R., Charness, N. and Rogers, W.A. (2019) *Designing for older adults: Principles and creative human factors approaches*. 3rd edn. Boca Raton, FL: CRC Press.
- De Schutter, B. (2023) 'The role of play in later life: Benefits and challenges of game-based interventions for older adults', *Games and Culture*. Advance online publication. doi:10.1177/15554120231153168.
- Formosa, M. (2014) 'Four decades of universities of the third age: Past, present, future', *Ageing & Society*, 34(1), pp. 42–66. doi:10.1017/S0144686X12000797.
- Gee, J.P. (2020) *What video games have to teach us about learning and literacy*. 2nd edn. New York: Macmillan.
- Guimarães, C., Ferreira, D., Silva, M. and Almeida, L. (2023) 'Game-based interventions to promote health literacy in older adults: A scoping review', *BMC Geriatrics*, 23, p. 145. doi:10.1186/s12877-023-03841-3.
- Helsper, E.J. and Van Deursen, A.J.A.M. (2017) 'Digital skills in Europe: Research and policy', in Servaes, J. (ed.) *Handbook of communication for development and social change*. Singapore: Springer, pp. 423–434.
- Hsiao, W.Y., Chen, C.H. and Chen, P.C. (2024) 'Investigating the effects of different game-based learning on the health care knowledge and emotions for middle-aged and older adults', *Interactive Learning Environments*. Advance online publication. doi:10.1080/10494820.2024.2408550.
- Huizinga, J. (1949) *Homo Ludens: A study of the play-element in culture*. London: Routledge & Kegan Paul.
- Kueider, A.M., Parisi, J.M., Gross, A.L. and Rebok, G.W. (2012) 'Cognitive training for older adults: What is it and does it work?', *Aging Health*, 8(5), pp. 507–520. doi:10.2217/ahe.12.58.
- Lee, C. and Coughlin, J.F. (2015) 'Older adults' adoption of technology: An integrated approach to identifying determinants and barriers', *Journal of Product Innovation Management*, 32(5), pp. 747–759. doi:10.1111/jpim.12176.
- Loos, E. (2020) 'Senior citizens: Digital immigrants in their own country? Observations from the Netherlands', *Telematics and Informatics*, 48, p. 101343. doi:10.1016/j.tele.2020.101343.
- Munoz, J.E., Gonçalves, A. and Gouveia, É.R. (2019) 'Lessons learned from gamifying functional fitness training through human-centred design methods in older adults', *Games for Health Journal*, 8(6), pp. 432–439. doi:10.1089/g4h.2018.0028.
- Neves, B.B., Franz, R.L., Munteanu, C. and Baecker, R. (2018) 'Adoption and abandonment of technology by older adults: Toward a unified framework', *The Gerontologist*, 58(5), pp. 814–825. doi:10.1093/geront/gny013.
- Ng, W. (2012) 'Can we teach digital natives digital literacy?', *Computers & Education*, 59(3), pp. 1065–1078. doi:10.1016/j.compedu.2012.04.016.
- Perim, C., Sousa, C. and Damásio, M.J. (2024) 'Game-based learning for fostering digital literacy in older adults: An intergenerational approach', in Zhou, J. and Gao, Q. (eds.) *Human aspects of IT for the aged population. Design, interaction and technology acceptance*. Cham: Springer, pp. 242–260. doi:10.1007/978-3-031-61543-6_18.
- Perim, C., Sousa, C. and Damásio, M.J. (in press) 'Digital Literacy and Older People: A Case Study in Lifelong Learning Institutions in Lisbon', *Educational Gerontology*.
- Plass, J.L., Homer, B.D. and Kinzer, C.K. (2015) 'Foundations of game-based learning', *Educational Psychologist*, 50(4), pp. 258–283. doi:10.1080/00461520.2015.1122533.
- Romero, M., Proulx, J.N. and Arnab, S. (2017) 'Learning mechanics and game mechanics under the perspective of self-determination theory to foster motivation in digital game-based learning', *Simulation & Gaming*, 48(2), pp. 190–212. doi:10.1177/1046878116674399.
- Vázquez, F.L., Torres, Á., Otero, P. and Díaz, O. (2021) 'Effectiveness of a health education board game for older adults with chronic diseases', *Educational Gerontology*, 47(3), pp. 103–114. doi:10.1080/03601277.2021.1873877.
- Voida, A. and Greenberg, S. (2021) 'Gaming together: Co-experience and social context in later-life play', *Journal of the Association for Information Science and Technology*, 72(10), pp. 1263–1274. doi:10.1002/asi.24480.
- Whitton, N. and Langan, M. (2019) 'Learning with games: Social impact and the older adult learner', *Educational Gerontology*, 45(2), pp. 89–101. doi:10.1080/03601277.2019.1585064.
- Wu, Y.S., Chang, T.W. and Datta, S. (2020) 'Developing the Interaction for Family Reacting with Care to Elderly', in Rau, P.L. (ed.) *Cross-Cultural Design. Applications in Health, Learning, Communication, and Creativity*. Lecture Notes in Computer Science, vol. 12193. Cham: Springer. doi:10.1007/978-3-030-49913-6_17.
- Zou, D., Zhang, R., Xie, H. and Wang, F.L. (2021) 'Digital game-based learning of information literacy: Effects of gameplay modes on university students' learning performance, motivation, self-efficacy and flow', *Australasian Journal of Educational Technology*, 37(1), pp. 97–112. doi:10.14742/ajet.6682.