

E-learning for Alzheimer's Disease: Advances and Progresses

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Abstract

With the increase of the aging population, the incidence rate of Alzheimer's disease (AD) is also rising. Faced with this challenge, e-learning, as an innovative educational method, has shown great potential in the care and management of Alzheimer's disease patients. This article reviews the application progress of E-learning in Alzheimer's disease. E-learning has revolutionized the field of education, providing learners with accessible and flexible learning opportunities. This paper provides an overview of various aspects of e-learning, including virtual classrooms, mobile learning, blended learning, Massive Open Online Courses (MOOCs), webinars, and the challenges associated with implementing e-learning.

The background section explores the evolution of e-learning, highlighting its rise in popularity and the advancements in technology that have facilitated its growth. Virtual classrooms for adult learners are discussed, showcasing how these online platforms facilitate interactive and collaborative learning experiences. Mobile learning for adult learners is examined, emphasizing the convenience and accessibility provided by mobile devices in delivering educational content.

Blended learning is another approach explored in this paper, which combines traditional face-to-face instruction with online components, offering a balanced learning experience. The benefits and challenges of implementing MOOCs, which provide free and open access to educational resources from top institutions, are also examined. Additionally, webinars are discussed as a popular method for delivering live online presentations and workshops to adult learners.

Finally, the paper addresses the challenges of E-learning, including technological barriers, lack of personal interaction, and the need for self-discipline and motivation. Strategies for overcoming these challenges are suggested, such as providing technical support and fostering online community engagement.

Overall, this paper provides valuable insights into the background and various approaches to E-learning, as well as the challenges encountered in its implementation. Understanding these aspects will help educators and institutions effectively harness the potential of E-learning to enhance adult education.

Keywords: Alzheimer's disease, E-learning, virtual classrooms, mobile learning, blended learning, Massive Open Online Courses (MOOCs), webinars

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1. Introduction

E-learning [1], short for "electronic learning," is a broad term that refers to the use of electronic technology, primarily the internet and digital devices, to facilitate and

deliver educational content and instruction. It encompasses a wide range of online educational activities, courses, and resources, and it can take various forms [2]. As shown in *Figure 1*, including:

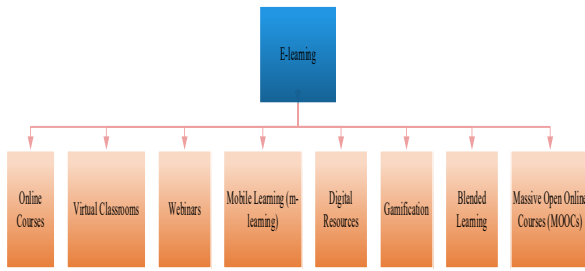


Figure 1. Various forms of E-learning

Online Courses: E-learning often involves structured online courses where students can access lectures, assignments, and materials via a website or a learning management system (LMS) [3]. These courses may be synchronous (live, real-time interaction) or asynchronous (self-paced).

Virtual Classrooms [4]: Virtual classrooms allow for real-time interaction between instructors and students, typically through video conferencing tools. This simulates a traditional classroom experience and facilitates discussions and Q&A sessions.

Webinars [5]: Webinars are online seminars or workshops that can be used for one-time events or ongoing educational series. They often involve live presentations, discussions, and audience participation.

Mobile Learning (m-learning) [6]: E-learning is not limited to desktop computers; it extends to mobile devices like smartphones and tablets. Many educational apps and platforms are designed for mobile learning.

Digital Resources: E-learning can also include educational resources like e-books, videos, podcasts, and interactive simulations that learners can access online. These resources provide self-directed learning opportunities [7].

Gamification [8]: Some e-learning programs incorporate game elements to make learning more engaging. Gamification can include quizzes, leaderboards, and rewards to motivate and challenge learners.

Blended Learning [9]: This approach combines traditional classroom instruction with online learning. It allows for flexibility and customization while maintaining face-to-face interaction.

Massive Open Online Courses (MOOCs) [10]: MOOCs are large-scale online courses designed to be accessible to a wide audience. They often provide free or low-cost access to high-quality educational content from universities and institutions.

E-learning has become increasingly popular in education and training settings due to its accessibility, scalability, flexibility, and cost-effectiveness. It can be used for formal education, professional development, skill acquisition, and lifelong learning. E-learning is particularly valuable in situations where physical attendance is not possible, such as remote or distance education, and it has played a significant role in making education more accessible to people around the world [11]. Paper structure is shown in Figure 2:

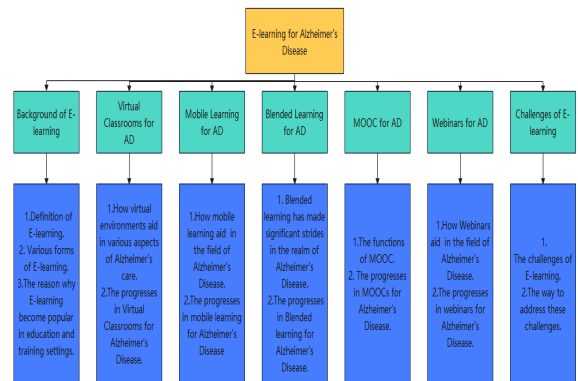


Figure 2. Paper structure

2. Virtual Classrooms for AD

In recent years, there have been significant strides in the development and implementation of virtual rooms for Alzheimer's Disease [12], aimed at improving the quality of life for individuals afflicted by this neurodegenerative condition [13]. These virtual environments leverage cutting-edge technology to create immersive and interactive spaces that can aid in various aspects of Alzheimer's care [14]. The progresses in this domain encompass several key areas, As shown in Figure 3, ranging from cognitive stimulation and rehabilitation to sensory stimulation and emotional well-being.

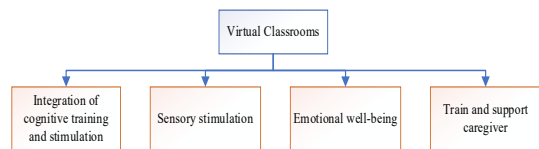


Figure 3. The progresses in Virtual Classrooms for Alzheimer's Disease

One notable area of progress involves the integration of cognitive training and stimulation within virtual rooms [15]. These environments are designed to engage patients in memory-enhancing activities, problem-solving exercises, and cognitive challenges. Through interactive simulations and exercises, individuals with Alzheimer's

Disease can benefit from cognitive rehabilitation, which may slow the decline of cognitive functions and enhance their overall mental well-being [16]. Such progresses have shown promise in enhancing cognitive functioning and delaying the onset of severe cognitive impairments.

Another significant development is the utilization of virtual rooms for sensory stimulation [17]. Alzheimer's patients [18] often experience sensory deficits, such as reduced vision, hearing, and tactile sensitivities [19]. Virtual environments can offer multisensory experiences that stimulate various senses, promoting engagement and emotional well-being. These progresses aim to improve the overall quality of life for Alzheimer's patients by providing them with enriching sensory experiences [20].

Emotional well-being is another focus area in the development of virtual rooms for Alzheimer's Disease. The technology allows for the creation of calming and familiar environments that can reduce stress and anxiety in individuals with Alzheimer's [21]. These virtual spaces can replicate familiar settings, such as a childhood home or a serene natural landscape, helping patients feel more at ease and connected to their past. The progresses in this aspect aim to enhance the emotional and psychological comfort of Alzheimer's patients, ultimately contributing to a higher quality of life.

Furthermore, advances in virtual rooms for Alzheimer's Disease extend to caregiver training and support. Caregivers can use these environments to gain practical experience in handling challenging situations that may arise in Alzheimer's care. Simulations can help caregivers develop empathy, learn effective communication strategies, and improve their overall caregiving skills. By addressing the needs of both patients and caregivers, these progresses offer a holistic approach to Alzheimer's care and support [22]. The progresses in Virtual Classrooms for Alzheimer's Disease are shown in *Table 1*:

Table 1. The progresses in Virtual Classrooms for Alzheimer's Disease

Virtual Classrooms for Progresses Alzheimer's Disease	
Integration of cognitive training and stimulation	engage patients in memory-enhancing activities, problem-solving exercises, and cognitive challenges and low the decline of cognitive functions and enhance their overall mental well-being.

Sensory stimulation	offer multisensory experiences that stimulate various senses and promote engagement and emotional well-being, improve the overall quality of life for Alzheimer's patients.
Emotional well-being	reduce stress and anxiety in individuals with Alzheimer's and replicate familiar settings and enhance the emotional and psychological comfort of Alzheimer's patients, ultimately contributing to a higher quality of life.
Train and support caregiver	caregivers can gain practical experience in handling challenging situations that may arise in Alzheimer's care and help caregivers develop empathy and learn effective communication strategies and improve their overall caregiving skills.

3. Mobile Learning for AD

mobile learning has emerged as a promising tool in the field of Alzheimer's Disease [23] management and care. This technology leverages the ubiquity of smartphones and tablets to provide accessible and convenient educational resources for patients, caregivers, and healthcare professionals [24]. The progresses in mobile learning for Alzheimer's Disease span several key areas, As shown in *Figure 4*, including cognitive rehabilitation, caregiver support, patient empowerment, and the dissemination of up-to-date information.

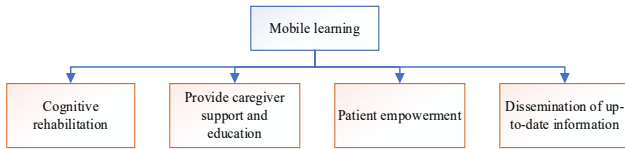


Figure 4. The progresses in mobile learning for Alzheimer's Disease

One significant advancement is the development of mobile applications specifically tailored to cognitive rehabilitation for individuals with Alzheimer's Disease [25]. These apps offer a range of interactive exercises and memory-enhancing activities designed to stimulate cognitive functions [26]. Through the convenience of mobile devices, patients can engage in these exercises at their own pace and on their preferred schedules. These progresses are especially beneficial for individuals with Alzheimer's Disease by supporting cognitive health and potentially slowing cognitive decline.

Mobile learning is also playing a pivotal role in providing caregiver support and education. Caregivers often face complex challenges in managing the care of Alzheimer's patients. Mobile apps and platforms offer educational resources, training modules, and information that can empower caregivers with knowledge and skills [27]. This assists them in providing more effective care, managing challenging behaviors, and enhancing the overall well-being of the patients they support.

Patient empowerment is another notable aspect of progress in mobile learning for Alzheimer's Disease. Through mobile applications, patients can gain a better understanding of their condition, access personalized care plans, and actively participate in their own care management [28]. These apps can promote self-management skills, improving a sense of control and autonomy among Alzheimer's patients. By fostering engagement and self-advocacy, these progresses contribute to the well-being and quality of life of individuals with Alzheimer's Disease.

Furthermore, mobile learning facilitates the dissemination of current research findings and information related to Alzheimer's Disease [29, 30]. Patients, caregivers, and healthcare professionals can access the latest updates, treatment options, and support resources through mobile platforms. This ensures that stakeholders are well-informed and equipped with the most up-to-date knowledge and tools for Alzheimer's care [31]. The progresses in this domain help bridge the gap between research and practice, ultimately leading to more effective and informed care for Alzheimer's patients. The progresses in Mobile learning for Alzheimer's Disease are shown in *Table 2*:

Table 2. The progresses in mobile learning for Alzheimer's Disease

Mobile learning for Alzheimer's Disease	
Cognitive rehabilitation	offer a range of interactive exercises and memory-enhancing activities designed to stimulate cognitive functions and patients can engage in these exercises at their own pace and on their preferred schedules, which are beneficial for individuals with Alzheimer's Disease.
Provide caregiver support and education	offer educational resources, training modules, and information that can empower caregivers with knowledge and skills, assists them in providing more effective care and manage challenging behaviors and enhance the overall well-being of the patients they support.
Patient empowerment	patients can gain a better understanding of their condition and access personalized care plans, and actively participate in their own care management through mobile applications.
Dissemination of up-to-date information	patients, caregivers, and healthcare professionals can access the latest updates, treatment options, and support resources through mobile platforms, ensures that stakeholders are well-informed and equipped with the

most up-to-date knowledge and tools for Alzheimer's care.

4. Blended Learning for AD

Blended learning, which combines traditional in-person instruction with online education, has made significant strides in the realm of Alzheimer's Disease management and care [32]. These advances are designed to enhance the overall quality of care provided to individuals with Alzheimer's and their caregivers. The progresses in blended learning for Alzheimer's Disease encompass various aspects, As shown in *Figure 5*, including caregiver training, patient engagement, personalized care, and multidisciplinary collaboration [33].

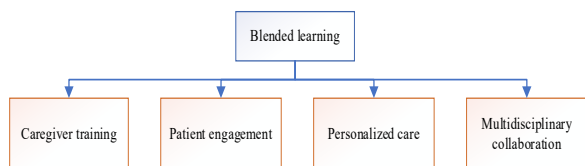


Figure 5. The progresses in Blended learning for Alzheimer's Disease

One of the notable areas of progress is the integration of caregiver training within blended learning environments. Caregivers play a crucial role in the care of individuals with Alzheimer's Disease [34], and blended learning approaches offer a balanced combination of in-person and online resources to provide caregivers with practical knowledge and skills [35]. This approach enables caregivers to receive comprehensive training, including hands-on skills and techniques for managing the challenges associated with Alzheimer's care.

Blended learning also facilitates patient engagement by incorporating face-to-face interactions with healthcare professionals and the use of online tools and resources. This approach allows patients to benefit from in-person assessments, treatment plans, and emotional support, while also accessing supplementary online materials for cognitive stimulation and social engagement. Such progresses aim to create a well-rounded care experience that addresses the cognitive, emotional, and physical needs of Alzheimer's patients [36].

Personalized care plans have become more refined through blended learning approaches. Healthcare professionals can use a combination of in-person evaluations and remote monitoring tools to tailor care plans to the specific needs and progression of each patient [37]. This personalization helps ensure that individuals with Alzheimer's Disease [38] receive care that is more

precisely matched to their condition, leading to improved outcomes and a better quality of life.

Furthermore, multidisciplinary collaboration has been enhanced by blended learning in Alzheimer's care. Care teams, including physicians, nurses, therapists, and social workers, can coordinate care more effectively through the use of digital tools and online resources [39]. This improves communication and information sharing among the various professionals involved in Alzheimer's care, resulting in a more holistic and coordinated approach to patient management. These progresses promote a well-rounded and collaborative healthcare model, ultimately benefiting Alzheimer's patients and their caregivers. The progresses in Blended learning for Alzheimer's Disease are shown in *Table 3*:

Table 3. The progresses in Blended learning for Alzheimer's Disease

Blended learning for Progresses Alzheimer's Disease	
Caregiver training	<ul style="list-style-type: none"> offer a balanced combination of in-person and online resources to provide caregivers with practical knowledge and skills and enable caregivers to receive comprehensive training, including hands-on skills and techniques for managing the challenges associated with Alzheimer's care.
Patient engagement	<ul style="list-style-type: none"> allow patients to benefit from in-person assessments, treatment plans, and emotional support, while also accessing supplementary online materials for cognitive stimulation and social engagement, create a well-rounded care experience that addresses the cognitive, emotional, and physical needs of

	Alzheimer's patients.
Personalized care	<ul style="list-style-type: none"> use a combination of in-person evaluations and remote monitoring tools to tailor care plans to the specific needs and progression of each patient and ensure individuals with Alzheimer's Disease receive care is more precisely matched to their condition, leading to improved outcomes and a better quality of life.
Multidisciplinary collaboration	<ul style="list-style-type: none"> care teams can coordinate care more effectively through the use of digital tools and online resources, promote a well-rounded and collaborative healthcare model, ultimately benefiting Alzheimer's patients and their caregivers.

One of the most prominent areas of progress is the provision of public education and awareness through MOOCs [41]. These courses offer individuals from various backgrounds the opportunity to learn about Alzheimer's Disease [42], its symptoms, risk factors, and caregiving strategies. By making this information accessible to the public, MOOCs contribute to dispelling misconceptions and reducing the stigma associated with the disease. This progress fosters a better-informed society and encourages early diagnosis and improved support for affected individuals and their families [43].

MOOCs have also become instrumental in caregiver training. Caregivers, who play a vital role in the lives of Alzheimer's patients, can access specialized courses that offer comprehensive training on dementia care, behavioral management, and coping strategies. These courses provide caregivers with practical skills, enhancing their ability to provide effective care and support to individuals with Alzheimer's Disease [44].

Professional development in the field of Alzheimer's Disease has benefited from MOOCs as well. Healthcare professionals, including physicians, nurses, and therapists, can access advanced courses to stay updated on the latest research, treatment options, and best practices in Alzheimer's care [45]. This progress ensures that the healthcare workforce is well-equipped to provide the most current and evidence-based care to Alzheimer's patients.

Furthermore, MOOCs facilitate the dissemination of research findings and emerging treatment modalities in the field of Alzheimer's Disease. Researchers and academics can use these platforms to share their work, connect with peers, and engage in interdisciplinary collaborations. This progress accelerates the translation of research into practice and contributes to ongoing advancements in Alzheimer's care and treatment. MOOCs, therefore, serve as a conduit for the latest scientific knowledge to reach those who can directly benefit from it [46]. The progresses in MOOC for Alzheimer's Disease are shown in Table 4:

5. MOOC for AD

Massive Open Online Courses (MOOCs) have emerged as a transformative platform for disseminating knowledge and resources related to Alzheimer's Disease [40]. These online courses have made significant strides in addressing the informational needs of a global audience, spanning patients, caregivers, healthcare professionals, and researchers. The progresses in MOOCs for Alzheimer's Disease encompass several key areas, As shown in Figure 6, including public education, caregiver training, professional development, and research dissemination.

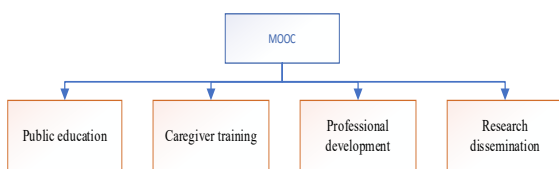


Figure 6. The progresses in MOOCs for Alzheimer's Disease

Table 4. The progresses in MOOC for Alzheimer's Disease

MOOC for Alzheimer's Progresses Disease	
Public education	<ul style="list-style-type: none"> offer individuals from various backgrounds the opportunity to learn about Alzheimer's Disease, its symptoms, risk factors, and caregiving strategies, foster a better-informed

- society and encourages early diagnosis and improved support for affected individuals and their families.
- Caregiver training

 - caregiver training can access specialized courses that offer comprehensive training on dementia care, behavioral management, and coping strategies, provide caregivers with practical skills, enhance their ability to provide effective care and support to individuals with Alzheimer's Disease.
- Professional development

 - Healthcare professionals can access advanced courses to stay updated on the latest research, treatment options, and best practices in Alzheimer's care, ensure that the healthcare workforce is well-equipped to provide the most current and evidence-based care to Alzheimer's patients.
- Research dissemination

 - Researchers and academics can use these platforms to share their work, connect with peers, and engage in interdisciplinary collaborations, accelerate the translation of research into practice and contributes to ongoing advancements in Alzheimer's care and treatment.

Alzheimer's Disease. These online seminars offer a platform for real-time communication and engagement among diverse stakeholders, including patients, caregivers, healthcare professionals, and researchers [47]. The progresses in webinars for Alzheimer's Disease encompass several key areas, As shown in *Figure 7*, such as education, support, research dissemination, and global networking.



Figure 7. The progresses in webinars for Alzheimer's Disease

One of the significant advances in the field is the use of webinars for educational purposes. These sessions provide an accessible and cost-effective way to educate a wide audience about Alzheimer's Disease [48]. They cover topics ranging from understanding the disease and its early signs to discussing caregiving strategies and coping mechanisms. By reaching individuals from different backgrounds and geographic locations, webinars contribute to the dissemination of knowledge and information, fostering greater awareness and understanding of Alzheimer's Disease [49].

Webinars have also become a vital platform for offering support to caregivers and family members of individuals with Alzheimer's. These sessions provide a forum for sharing experiences, addressing concerns, and offering guidance on managing the challenges associated with Alzheimer's care. Webinars allow participants to interact with experts and fellow caregivers, creating a supportive community that can help reduce the emotional burden and burnout often experienced in caregiving roles [50].

Additionally, webinars serve as a means of disseminating research findings and best practices in Alzheimer's Disease. Researchers and healthcare professionals use webinars to present their work, discuss breakthroughs, and share the latest advancements in diagnosis and treatment [51]. These educational opportunities facilitate the translation of research into practical care, ultimately benefiting patients and caregivers. Webinars also allow for global networking and collaboration, connecting experts from various regions to foster interdisciplinary research and improve the overall understanding and management of Alzheimer's Disease [52].

Webinars have made significant progress in the Alzheimer's Disease field by promoting education, support, research dissemination, and global networking.

6. Webinars for AD

Webinars have emerged as a dynamic and interactive medium for sharing knowledge and information related to

This dynamic medium serves as a valuable platform for sharing knowledge and experiences, ultimately contributing to improved care and quality of life for those affected by Alzheimer's Disease [53]. The progresses in Webinars for Alzheimer's Disease are shown in *Table 5*:

Table 5. The progresses in Webinars for Alzheimer's Disease

Webinars for Alzheimer's Disease Progresses	
Education	<ul style="list-style-type: none"> provide an accessible and cost-effective way to educate a wide audience about Alzheimer's Disease, contribute to the dissemination of knowledge and information and foster greater awareness and understanding of Alzheimer's Disease.
Support to caregivers	<ul style="list-style-type: none"> provide a forum for sharing experiences, addressing concerns, and offering guidance on managing the challenges associated with Alzheimer's care, allow participants to interact with experts and fellow caregivers and create a supportive community that can help reduce the emotional burden and burnout often experienced in caregiving roles.
Disseminate research	<ul style="list-style-type: none"> Researchers and healthcare professionals can use webinars to present their work, discuss breakthroughs, and share the latest advancements in diagnosis and treatment, which facilitate the translation of research into practical care, ultimately benefiting patients and caregivers.

Global networking

- This dynamic medium serves as a valuable platform for sharing knowledge and experiences, ultimately contributing to improved care and quality of life for those affected by Alzheimer's Disease.

7. Challenges of E-learning

While e-learning offers numerous advantages, it also comes with several challenges that need to be addressed to ensure its effectiveness and accessibility. These challenges encompass various aspects, including technology, learner engagement, equity, quality assurance, and isolation, As shown in *Figure 8*:

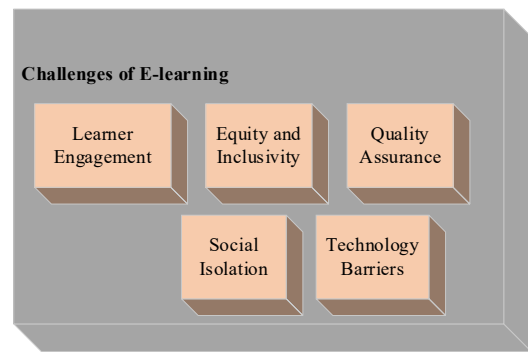


Figure 8. Challenges of E-learning

Technology Barriers: One of the most significant challenges in e-learning is the technology barrier [54]. Not all students or learners have equal access to the necessary digital devices, internet connectivity, and software. This digital divide can result in unequal educational opportunities, with some individuals being left at a disadvantage due to their lack of access to essential technology.

Learner Engagement: Maintaining learner engagement in online environments can be challenging. Without face-to-face interactions and the physical presence of instructors and peers, some students may struggle to stay motivated and focused. The absence of real-time feedback and immediate interaction can lead to disengagement and reduced learning outcomes [55].

Equity and Inclusivity: E-learning may inadvertently exacerbate existing disparities in education [56]. Students with disabilities, those from underprivileged backgrounds, or those who require special accommodations can face

barriers to accessing and benefiting from e-learning. Educational institutions must ensure that e-learning platforms are designed to be inclusive and accessible to all learners.

Quality Assurance: Ensuring the quality of online courses and programs is a persistent challenge. With the proliferation of e-learning platforms, varying levels of quality and rigor are evident. It is essential to establish standardized quality assurance measures to guarantee that e-learning offerings meet educational standards and provide valuable learning experiences [57].

Social Isolation: The absence of in-person interactions and the social aspect of traditional classrooms can lead to feelings of social isolation in e-learning. Students may miss the camaraderie, peer support, and networking opportunities that physical classrooms provide. Social isolation can affect mental well-being and contribute to a sense of disconnect from the learning community [58].

In addressing these challenges, educational institutions and e-learning providers need to adopt strategies that bridge the digital divide, promote learner engagement, ensure inclusivity, establish quality assurance standards, and offer opportunities for social interaction. Additionally, investing in training and support for both educators and learners in the use of e-learning tools can mitigate these challenges and enhance the overall e-learning experience.

8. Conclusion

In conclusion, e-learning has the potential to significantly impact the management and understanding of Alzheimer's Disease (AD). The benefits of e-learning in this context are vast, ranging from providing accessible education and training for caregivers and healthcare professionals to disseminating the latest research findings and supporting individuals affected by AD. Online resources, webinars, MOOCs, and virtual rooms are among the e-learning modalities that have contributed to raising awareness, improving care, and advancing research related to Alzheimer's Disease.

However, it is essential to acknowledge the existing challenges and limitations associated with e-learning in the context of AD. These challenges include technology barriers, issues related to learner engagement and motivation, concerns about equity and inclusivity, the need for quality assurance, and addressing the potential social isolation of learners. Addressing these challenges is crucial to maximize the benefits of e-learning and ensure that it remains an effective tool for enhancing the understanding and management of Alzheimer's Disease.

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References

- [1] I. A. Mastan, D. I. Sensuse, R. R. Suryono, and K. Kautsarina, "Evaluation of distance learning system (e-learning): a systematic literature review," *Jurnal Teknoinfo*, vol. 16, pp. 132-137, 2022.
- [2] M. Liu and D. Yu, "Towards intelligent E-learning systems," *Education and Information Technologies*, vol. 28, pp. 7845-7876, 2023.
- [3] B. Prahani, J. Alfin, A. Fuad, H. Saphira, E. Hariyono, and N. Suprpto, "Learning management system (LMS) research during 1991-2021: How technology affects education," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 17, pp. 28-49, 2022.
- [4] V. Bakonyi, Z. Illés, and T. Szabó, "Real-time interaction tools in virtual classroom systems," in *Recent Innovations in Computing: Proceedings of ICRIC 2021, Volume 2*, ed: Springer, 2022, pp. 625-636.
- [5] L. Ramos and P. C. Soliven, "Rise of webinars: An impact assessment of online seminar learning from the students' perspective," in *Rise of Webinars: An Impact Assessment of Online Seminar Learning From the Students' Perspective: Ramos, Laurence | uSoliven, Paolo Carl*, 2022.
- [6] M. Abduljawad and A. Ahmad, "An analysis of mobile learning (M-Learning) in education," *Multicultural Education*, vol. 9, pp. 145-152, 2023.
- [7] F. M. Evans, A. A. Krotinger, M. Lilaonitkul, H. F. Khaled, G. A. Pereira, S. J. Staffa, *et al.*, "Evaluation of open access websites for anesthesia education," *Anesthesia & Analgesia*, vol. 135, pp. 1233-1244, 2022.
- [8] A. N. Saleem, N. M. Noori, and F. Ozdamli, "Gamification applications in E-learning: A literature review," *Technology, Knowledge and Learning*, vol. 27, pp. 139-159, 2022.
- [9] G. N. Bhadri and L. R. Patil, "Blended learning: An effective approach for online teaching and learning," *Journal of Engineering Education Transformations*, vol. 35, 2022.
- [10] N. Voudoukis and G. Pagiatakis, "Massive open online courses (MOOCs): practices, trends, and challenges for the higher education," *European Journal of Education and Pedagogy*, vol. 3, pp. 288-295, 2022.
- [11] A. S. Alam, L. Ma, A. Watson, V. Wijeratne, and M. Chai, "Transnational education and e-learning during a pandemic: Challenges, opportunities, and future," *E-learning and digital Education in the twenty-first century*, pp. 1-26, 2022.
- [12] Y. Zhang, "Classification of Alzheimer Disease based on structural magnetic resonance imaging by kernel support vector machine decision tree," *Progress in Electromagnetics Research*, vol. 144, pp. 185-191, 2014.
- [13] J. Rayen and N. Malalaseena, "AlzhCare: A cognitive therapy application for Alzheimer's Patients with smart results, and a safety tool to support their Caregivers."
- [14] E. Dincelli and A. Yayla, "Immersive virtual reality in the age of the Metaverse: A hybrid-narrative review based on the technology affordance perspective," *The Journal of Strategic Information Systems*, vol. 31, p. 101717, 2022.
- [15] O. Cohavi and S. Levy-Tzedek, "Young and old users prefer immersive virtual reality over a social robot for short-term cognitive training," *International Journal of Human-Computer Studies*, vol. 161, p. 102775, 2022.
- [16] K. Zhu, Q. Zhang, B. He, M. Huang, R. Lin, and H. Li, "Immersive virtual reality-based cognitive intervention for the improvement of cognitive function, depression, and perceived stress in older adults with mild cognitive impairment and mild dementia: pilot pre-post study," *JMIR Serious Games*, vol. 10, p. e32117, 2022.

- [17] C. J. Mills, D. Tracey, R. Kiddle, and R. Gorkin, "Evaluating a virtual reality sensory room for adults with disabilities," *Scientific Reports*, vol. 13, p. 495, 2023.
- [18] Y. Zhang, "Detection of Alzheimer's disease and mild cognitive impairment based on structural volumetric MR images using 3D-DWT and WTA-KSVM trained by PSOTVAC," *Biomedical Signal Processing and Control*, vol. 21, pp. 58-73, 2015.
- [19] R. Ochi, S. Saito, K. Hiromitsu, Y. Shigemune, N. Shinoura, R. Yamada, *et al.*, "Sensory hypo-and hypersensitivity in patients with brain tumors," *Brain Injury*, vol. 36, pp. 1053-1058, 2022.
- [20] T. Laukkanen, N. Xi, H. Hallikainen, N. Ruusunen, and J. Hamari, "Virtual technologies in supporting sustainable consumption: From a single-sensory stimulus to a multi-sensory experience," *International Journal of Information Management*, vol. 63, p. 102455, 2022.
- [21] M. Matsangidou, F. Frangoudes, T. Solomou, E. Papayianni, and C. Pattichis, "Free of walls: Participatory design of an out-world experience via virtual reality for dementia in-patients," in *Adjunct Proceedings of the 30th ACM Conference on User Modeling, Adaptation and Personalization*, 2022, pp. 326-334.
- [22] A. Gómez-Morales, D. W. Coon, A. Glinka, R. Stirling, T. Pipe, R. P. Joseph, *et al.*, "Training alternatives for Alzheimer's disease and related dementia caregivers: Assessing economic and environmental benefits of internet of health things," *Journal of Cleaner Production*, vol. 418, p. 138206, 2023.
- [23] Y. Zhang, "Detection of Alzheimer's disease by displacement field and machine learning," *PeerJ*, vol. 3, Article ID: e1251, 2015.
- [24] N. Song, S. Sun, K. Chen, Y. Wang, H. Wang, J. Meng, *et al.*, "Emerging nanotechnology for Alzheimer's disease: From detection to treatment," *Journal of Controlled Release*, vol. 360, pp. 392-417, 2023.
- [25] S. Wang, "Detection of Alzheimer's Disease by Three-Dimensional Displacement Field Estimation in Structural Magnetic Resonance Imaging," *Journal of Alzheimer's Disease*, vol. 50, pp. 233-248, 2016.
- [26] D. He, S. Cao, Y. Le, M. Wang, Y. Chen, and B. Qian, "Virtual reality technology in cognitive rehabilitation application: bibliometric analysis," *JMIR Serious Games*, vol. 10, p. e38315, 2022.
- [27] X. F. Lin, Z. M. Liang, K. K. Chan, W. Li, and X. Ling, "Effects of contextual interactive healthcare training on caregivers of patients with suspected COVID-19 infection: Anxiety, learning achievements, perceived support and self - efficacies during quarantine," *Journal of Computer Assisted Learning*, vol. 38, pp. 731-742, 2022.
- [28] N. E. Werner, J. C. Brown, P. Loganathar, and R. J. Holden, "Quality of mobile apps for care partners of people with alzheimer disease and related dementias: mobile app rating scale evaluation," *JMIR mHealth and uHealth*, vol. 10, p. e33863, 2022.
- [29] Y. Zhang, "Three-Dimensional Eigenbrain for the Detection of Subjects and Brain Regions Related with Alzheimer's Disease," *Journal of Alzheimer's Disease*, vol. 50, pp. 1163-1179, 2016.
- [30] S.-H. Wang, "Alzheimer's Disease Detection by Pseudo Zernike Moment and Linear Regression Classification," *CNS & Neurological Disorders - Drug Targets*, vol. 16, pp. 11-15, 2017.
- [31] D. X. Marquez, A. Perez, J. K. Johnson, M. Jaldin, J. Pinto, S. Keiser, *et al.*, "Increasing engagement of Hispanics/Latinos in clinical trials on Alzheimer's disease and related dementias," *Alzheimer's & Dementia: Translational Research & Clinical Interventions*, vol. 8, p. e12331, 2022.
- [32] S. KV, V. Ravi, M. Almeshari, Y. Alzamil, and S. K. DS, "A New Deep Learning Model based on Neuroimaging for Predicting Alzheimer's Disease," *The Open Bioinformatics Journal*, vol. 16, 2023.
- [33] O. A. Dara, J. M. Lopez-Guede, H. I. Raheem, J. Rahebi, E. Zulueta, and U. Fernandez-Gamiz, "Alzheimer's Disease Diagnosis Using Machine Learning: A Survey," *Applied Sciences*, vol. 13, p. 8298, 2023.
- [34] Y. Zhang, "Feature Extraction of Brain MRI by Stationary Wavelet Transform and its Applications," *Journal of Biological Systems*, vol. 18, pp. 115-132, 2010.
- [35] A. Scerbe, M. E. O'Connell, A. Astell, D. Morgan, J. Kosteniuk, I. Panyavin, *et al.*, "Digital tools for delivery of dementia education for caregivers of persons with dementia: A systematic review and meta-analysis of impact on caregiver distress and depressive symptoms," *Plos one*, vol. 18, p. e0283600, 2023.
- [36] T. Brown, L. Robinson, K. Gledhill, M. L. Yu, S. Isbel, C. Greber, *et al.*, "Learning in and out of lockdown: A comparison of two groups of undergraduate occupational therapy students' engagement in online - only and blended education approaches during the COVID - 19 pandemic," *Australian Occupational Therapy Journal*, vol. 69, pp. 301-315, 2022.
- [37] B. M. Demaerschalk, J. E. Hollander, E. Krupinski, J. Scott, D. Albert, Z. Bobokalonova, *et al.*, "Quality frameworks for virtual care: Expert panel recommendations," *Mayo Clinic Proceedings: Innovations, Quality & Outcomes*, vol. 7, pp. 31-44, 2023.
- [38] S. Wang, "Magnetic resonance brain classification by a novel binary particle swarm optimization with mutation and time-varying acceleration coefficients," *Biomedical Engineering-Biomedizinische Technik*, vol. 61, pp. 431-441, 2016.
- [39] A. L. Martínez, J. Brea, M. Castro, Á. García, E. Santamaría, Ó. Lestón, *et al.*, "An Experience of Using a Canvas-Based Template for Blended-Learning in a Master in Drug Discovery," *International Journal of Emerging Technologies in Learning*, vol. 17, 2022.
- [40] M. Farrow, H. Fair, S. Z. Klekociuk, and J. C. Vickers, "Educating the masses to address a global public health priority: The Preventing Dementia Massive Open Online Course (MOOC)," *Plos one*, vol. 17, p. e0267205, 2022.
- [41] M. Senevirathne, D. Amaratunga, R. Haigh, D. Kumer, and A. Kaklauskas, "A common framework for MOOC curricular development in climate change education-Findings and adaptations under the BECK project for higher education institutions in Europe and Asia," *Progress in Disaster Science*, vol. 14, p. 100222, 2022.
- [42] Q. Zhou, "A Survey of Deep Learning for Alzheimer's Disease," *Machine Learning and Knowledge Extraction*, vol. 5, pp. 611-668, 2023.
- [43] P. Cederberg, "Accessibility in Design Education," Carnegie Mellon University, 2022.
- [44] R. Sztramko, A. J. Levinson, A. E. Wurster, R. Jezrawi, B. Sivapathasundaram, A. Papaioannou, *et al.*, "Online educational tools for caregivers of people with dementia: A scoping literature review," *Canadian Geriatrics Journal*, vol. 24, p. 351, 2021.
- [45] M. Poole, N. Davis, and L. Robinson, "Massive open online courses: enhancing caregiver education and support about dementia care towards and at end of life," *Age and ageing*, vol. 49, pp. 171-174, 2020.
- [46] M. Pleasant, V. Molinari, D. Dobbs, H. Meng, and K. Hyer, "Effectiveness of online dementia caregivers training programs: A systematic review," *Geriatric Nursing*, vol. 41, pp. 921-935, 2020.
- [47] C. Giebel, H. Tetlow, T. Faulkner, and R. Eley, "A Community of Practice to increase education and collaboration in dementia and ageing research and care: The Liverpool Dementia & Ageing Research Forum," *Health Expectations*, 2023.
- [48] V. Gruss, "Enhancement of Geriatric Care for All: Resources for Older Adults with Intellectual and Developmental Disabilities," 2021.
- [49] L. Walker, *Resources on Alzheimer's Disease for Ministers and Parishioners: Roadmap Alzheimer's Disease Awareness Toolkit*: California State University, Long Beach, 2022.
- [50] N. S. Koufacos, E. M. Gottesman, E. Dorisca, and J. L. Howe, "Supporting Caregivers of Veterans with Dementia," *Journal of Social Work in End-of-Life & Palliative Care*, vol. 19, pp. 12-22, 2023.
- [51] I. Hoxhaj, F. Beccia, G. E. Calabrò, and S. Boccia, "A web screening on training initiatives in cancer genomics for healthcare professionals," *Genes*, vol. 13, p. 430, 2022.
- [52] J. Kiss, G. Edwards, R. Bouserhal, E. Champagne, T. Belleguic, V. Psyché, *et al.*, "Harnessing Artificial Intelligence for Early and Evolution of Alzheimer's Disease Detections and Enhancing Senior Mental Health through Innovative Art-Singing Therapies: A Multidisciplinary Approach," *Journal of Community Medicine and Health Solutions*, vol. 4, 2023.

- [53] M. V. Lourenco, W. V. Borelli, C. Duran-Aniotz, E. R. Zimmer, and S. S. de Castro, "Promoting diversity and overcoming publication barriers in Latin American neuroscience and Alzheimer's disease research: A call to action," *Alzheimer's & Dementia: Translational Research & Clinical Interventions*, vol. 9, p. e12378, 2023.
- [54] N. Hannache-Heurteloup and K. Moustaghfir, "Exploring the barriers to e-learning adoption in higher education: A roadmap for successful implementation," *International Journal of Management in Education*, vol. 14, pp. 159-182, 2020.
- [55] S. L. Gares, J. K. Kariuki, and B. P. Rempel, "CommUnity matters: Student–instructor relationships foster student motivation and engagement in an emergency remote teaching environment," *Journal of Chemical Education*, vol. 97, pp. 3332-3335, 2020.
- [56] B. Žmuk, F. Hussain Qureshi, and S. Khawaja, "Inequality in E-Learning in European Union Countries: Role of Gender, Education and Urban Development," *Interdisciplinary Description of Complex Systems: INDECS*, vol. 21, pp. 441-457, 2023.
- [57] C. Troussas, A. Krouska, and C. Sgouropoulou, "Towards a reference model to ensure the quality of massive open online courses and e-learning," in *Brain Function Assessment in Learning: Second International Conference, BFAL 2020, Heraklion, Crete, Greece, October 9–11, 2020, Proceedings 2*, 2020, pp. 169-175.
- [58] M. Azmat and A. Ahmad, "Lack of social interaction in online classes during COVID-19," *Journal of Materials and Environmental Science*, vol. 13, pp. 185-196, 2022.