Review

Teaching art via digital technology for the elderly applying with inclusive design: A review

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Abstract: Art studies and activities for older adults have received significantly less attention as a result of prohibitively expensive materials that are unfit for commercial use, and research utilizing digital technology to investigate artistic activities for older adults is extremely limited. The purpose of this article is to analyze and review recent research in these fields to summarize the current trends. The literature review comprised 108 articles from databases that included Scopus, ScienceDirect, and Google Scholar. The papers were subjected to a thorough examination by the VOSviewer program and researchers, who utilized content analysis to classify them into four themes: 1) inclusive design; 2) accessibility; 3) digital art therapy and 4) digital technology environments. Further investigation and development are necessary to propose a novel approach to instructing senior-level art utilizing cutting-edge technologies, which could be enhanced by the findings of this review article.

Keywords: teaching; art; digital technology; older adults; elderly; inclusive design

1. Introduction

The United Nations states that by 2030, the population of adults aged 60 and above is projected to exceed that of children aged 0 to 9 years (Tyler et al., 2020). In addition, it is estimated that over 250 million elderly individuals are afflicted with a severe to moderate disability (MacNeil et al., 2023). Considerable emphasis has been placed on enhancing the quality of life for older adults in light of the global population aging (Shang and Zuo, 2020). According to a 2002 statement by the World Health Organization, active aging can be accomplished via three distinct determinants: health, security, and participation (Ahmad et al., 2022).

Furthermore, it is noteworthy that the percentage of older adults who utilize digital technology has increased significantly in recent years, from 14% in 2000 to 73% in 2022 (Ahmad et al., 2022). The involvement of senior citizens and the implementation of information and communication technology (ICT) have the potential to improve their overall quality of life and state of being. Regarding education, educators should provide and design all areas of educational activities, including art, for this group utilizing the most recent technological devices (Lai, 2020). As a result, they were consequently able to adapt, learn, and implement these technologies in their daily life in order to enhance their standard of living.

In relation to art-related activities (education, therapy, amusement), they may potentially facilitate healthy aging in light of the aforementioned considerations (participation, well-being, and security), as they have been linked to a variety of personal advantages, including improved health, enhanced well-being, and a higher standard of living (Bennington et al., 2016; Imran et al., 2020)

However, numerous studies from the past to present point out that art studies, classes, and activities that apply inclusive design for seniors have received considerably less attention because participation by older adults in artistic endeavors necessitates special care and attention, resulting in higher costs that are unsuitable for commercial purposes in comparison to those in younger age groups. Moreover, research on older individuals engaging in artistic activities using digital technology is considerably limited (Datlen and Pandolfi, 2020; Diggs et al., 2015; Helvacioglu and Karamanoglu, 2012; Hickman et al., 2007; Olgunturk and Dermikan, 2009; Ostroff, 2011; Seo et al., 2022). Consequently, this article aims to fill that gap by examining recent research in these domains to summarize the current trends and set up a research question as "How could inclusive design be applied to teach art via digital technology for older adults?" Future research could apply this review and propose a novel approach to instructing senior-level art using cutting-edge technologies that require additional research, investigation, and development.

2. Literature review

2.1. Inclusive design in digital art education for older adults

By applying inclusive design (ID) principles, designers can gain a more precise comprehension of the needs and demands of various user groups, including disabled individuals and older adults, without the need for adaptations (Waller et al., 2015). The fundamental goal is to establish social equality by eliminating social exclusion (Clarkson and Coleman, 2015). Additionally, ID seeks to enhance the usability of products for a broader demographic (Dong et al., 2004). Inclusive design can address the unique requirements of various populations, including those with disabilities and advanced age, where physical and cognitive declines hinder older users from performing concurrent tasks.

The achievement of ID within an industrial setting is contingent upon the education issue (Dong et al., 2015). Nonetheless, despite the extensively documented social and economic benefits of ID, there is a scarcity of universities and schools that implement it, particularly in the realm of art education (Vavik, 2011).

According to Ostroff (2011), ID or design for all is implemented in instruction at only a limited number of universities, classes, or institutions worldwide. This designation does not even apply to electives. Moreover, the incorporation of ID principles into art and design education has been relatively unexplored because it does not pertain to commercial applications (Helvacioglu and Karamanoglu, 2012; Olgunturk and Dermikan, 2009).

Scott et al. (2018) present a novel approach to implementing ID as a pedagogical method when it comes to instructing older individuals in the arts along multiple dimensions, including the following: 1) user-centered design through the creation of age-friendly environments; 2) community engagement projects and co-design workshops are examples of innovative pedagogies; 3) extending the reach of art education through its positive impact on students' social integration and overall welfare. To summarize, the integration of ID principles into art education underscores the significance of community involvement, user-centric methodologies, inventive teaching approaches, and an all-encompassing outlook on art education that integrates

the principles of ID.

2.2. Different types of arts for older adults

Noice et al. (2014) point out that senior art education should emphasize art creation rather than art observation. Additionally, they advocate for senior art to incorporate the following theories: 1) wellness studies, encompassing cognitive, emotional, physical, or psychological well-being, and 2) treatment studies, such as the therapeutic application of art by individuals coping with illness, trauma, or life's difficulties.

Visual arts: Using observation, surveys, self-reports, and semi-structured interviews, Greer et al. (2012) evaluated the effectiveness of free on-site painting lessons for senior citizens. As indicated by the findings, these forms of visual arts improved psychological health, social engagement, and a sense of empowerment. Reynolds (2010) also conducted an aesthetic, non-functional study of 32 retired women engaged in visual art, including pottery, textile art, and painting. According to the findings derived from the interviews, art participation enriched the mental lives of the participants, presented them with new challenges, fostered the development of new skills, increased their awareness of nature, and safeguarded their identities.

Dance: Social dancing was the only physically taxing leisure activity for seniors that had a significant negative association with Alzheimer's disease, according to Verghese et al. (2003). In addition, Kattenstroth et al. (2010) surveyed 38 non-dancers and 62 experienced amateur ballroom dancers. According to the findings, the dancers exhibited significantly improved health and well-being and superior performance on standard cognitive and physiological assessments. In support of this, Kimura and Hozumi (2012) examined the effects of a freestyle dance regimen and discovered that participants performed considerably better on attentional control and physiological measures. Research has established that dancing serves the same purpose as participating in sports in promoting the health and well-being of older adults (Noice et al., 2014; Verghese et al., 2003).

Expressive writing: De Medeiros et al. (2007) conducted a study involving retired individuals who had participated in an eight-week autobiographical writing workshop. The workshop offered a variety of narrative forms, including memoirs, letters, journals, poetry, and more. Significant progress was observed across all established criteria, including attention, verbal learning, and memory. Chippendale and Bear-Lehman (2012) administered an eight-week program to senior citizens utilizing a writing life review course with the intention of reducing depression or the risk of depression among older adults. The findings indicated that engaging in expressive writing reduces depressive symptoms.

Music: In their study, Cohen et al. (2006) enlisted 166 older adults who shared similar demographic characteristics. An invitation was extended to 90 senior citizens to participate in a chorale led by a professional while the remaining 76 continued with their routine pursuits. Positive progress was observed on the standard measures by the chorale group after a duration of 12 months. Additionally, the self-reports revealed reductions in the frequency of medical consultations, falls, and over-the-counter medication usage, while improvements were observed in the overall health rating and

quantity of engaged activities. The results indicated that these seniors continued to be monitored and reassessed for an additional twelve months (Cohen et al., 2006). In addition, Bugos et al. (2007) investigated the effects of six months of piano instruction on the working memory and executive function of older adults. As a result, the findings indicated that instruction on the piano improved cognitive functions, including focus, concentration, and strategic thinking. In conclusion, the benefits of arts participation among older adults are readily apparent. Lower depression is a result of the intrinsically rewarding and self-motivating nature, cognitive ability, and social support that are all attributes of group arts instruction.

3. Method

The present study employs a systematic literature review approach following the PRISMA (Liberati et al., 2009) flow diagram by O'Brien and Guckin (2016). The methodology comprises three fundamental components, as depicted in **Figure 1**.
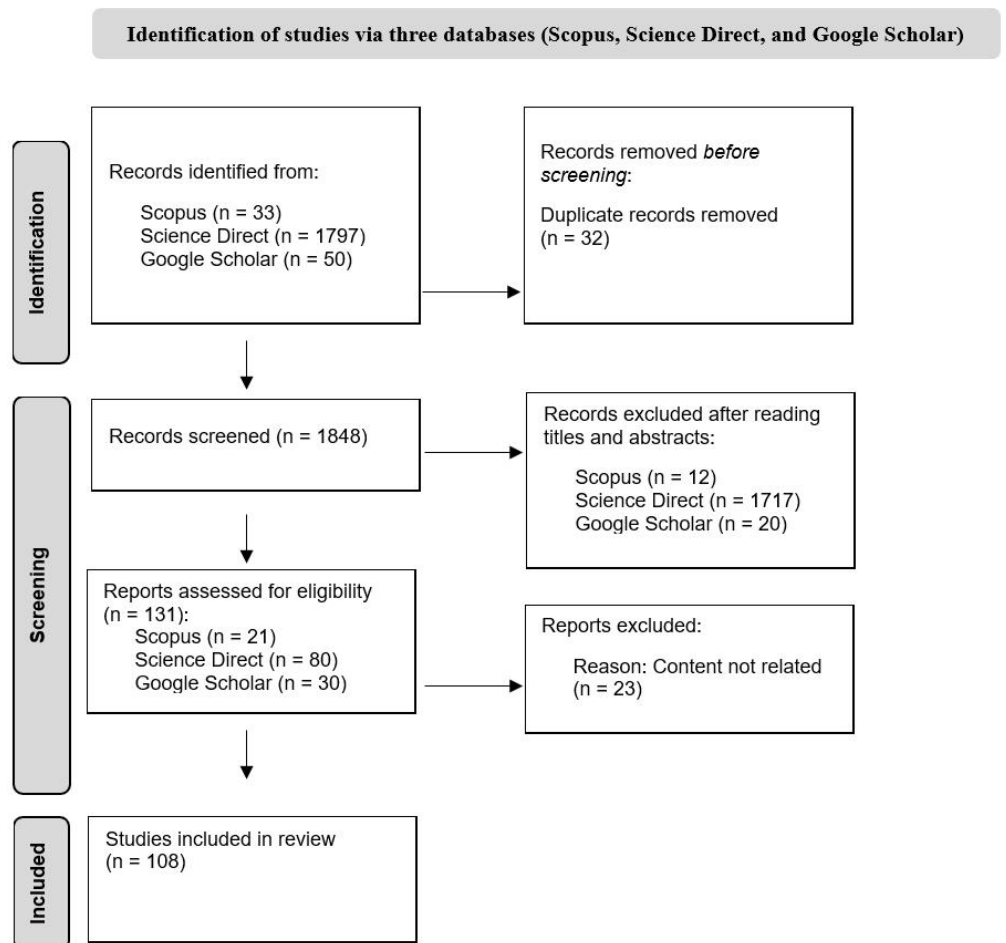

Figure 1. PRISMA (Liberati et al., 2009) flow diagram.

3.1. Developing inclusion and exclusion criteria

The inclusion and exclusion of this article were selected with the aim of presenting trends in teaching older adults about art with digital technology. They are illustrated in **Table 1** below.

Table 1. The criteria for inclusion and exclusion in the literature reviews.

Inclusion	Exclusion
Peer review studies in English	Non-English studies
Publication in the 2010–2023 period	Publications outside the time frame were not selected
Journals, conference proceedings, textbooks	Working papers, conference abstracts, book chapters, organization websites
Categories: Computer sciences, health profession, design studies, arts and humanities, social sciences	Categories: Business, management and accounting, agriculture, economics, econometrics and finance

3.2. Systematic searches in different databases

At this stage, researchers looked for studies from two major databases: Scopus and ScienceDirect; Google Scholar was used as a secondary database (when the information was not available on Scopus or ScienceDirect, Google Scholar was used). This combination of three databases covered academic literature from journals and conference proceedings. The search keywords were "older" AND "adults" AND "study" AND "digital" AND "art" from 2010 to 2023 in order to gather updated information. Next, the search terms were used for titles, abstracts, and keywords from the databases mentioned. In Google Scholar, researchers searched for the top 500 articles out of 18,100 hits by reading only topics and abstracts of all 500 articles and selecting only 50 related articles matched to the keywords and themes of this review article. Additionally, the results from searching keywords are illustrated in **Figure 2**.

Figure 2. The keyword co-occurrence in 108 articles.
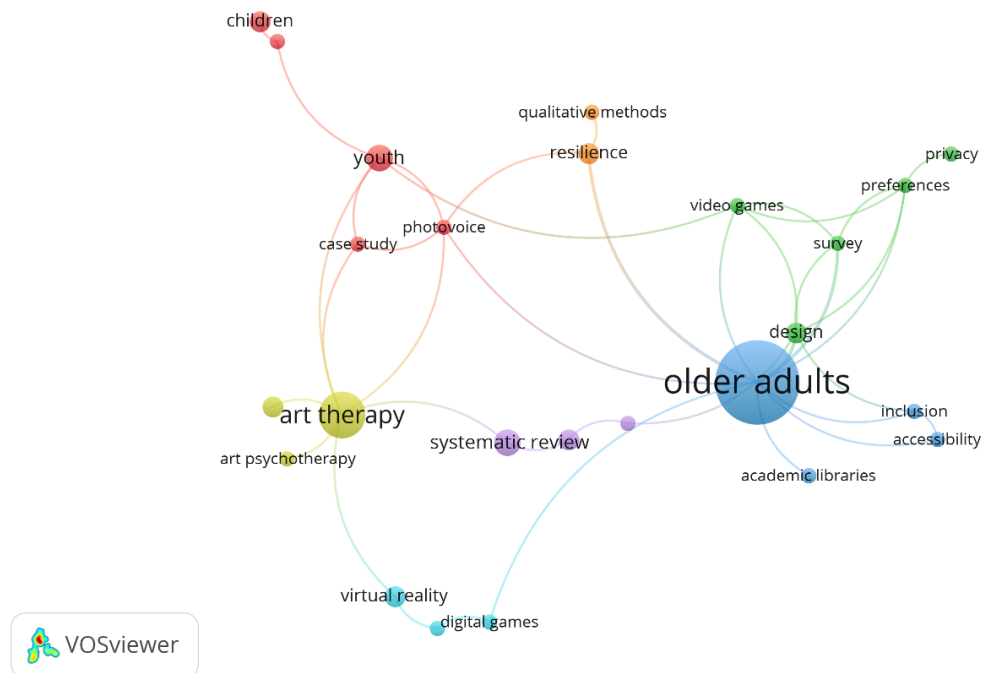
3.3. Importing search results into individual bibliographic software, documenting the search, and the deletion of duplicates

The search results from all databases (Scopus totaled 33; there were 1797 from ScienceDirect and 50 from Google Scholar) were imported into Endnote 20, a bibliographic software. Researchers imported them by selecting "Import into duplicate

library" from the menu to exclude duplicated articles into another folder. As a result, 32 articles were found to be duplicates and were removed from the software. The remaining articles totaled 1848.

3.4. Organization of relevant and irrelevant articles

This stage consisted of three main steps. First, two researchers read all 1848 titles and abstracts and excluded 1749 articles as non-related topics. As a result, only 131 articles were eligible. Next, two researchers read full articles focusing about aims, literature reviews, factors, results and excluded 23 articles that were not related in contents and themes of this review article. Therefore, the total number of final articles was 108.

3.5. Keyword co-occurrence analysis

Applying this technique, researchers could clearly understand the trends, clusters, and relationships between keywords of all selected studies. A total of 108 remaining articles from Section 2 were imported into the VOSviewer software. Researchers imported all articles into the program and set up the keywords so that a frequency of more than two appearances could be recognized by the program The result of the screening was 34 qualified and ranked keywords from the VOSviewer software (with a frequency of more than two appearances) from a total of all 466 keywords from 108 articles, as presented in **Figure 2** and **Table 2** below.

Through the co-occurrence of all keywords from 108 articles (**Figure 2** and **Table 2**), it could be recognized that most keywords in this area, not including the main keyword "older adults" are about "art therapy" (eight occurrences), which appeared the most. This was followed by "design", "resilience", "mental health", "virtual reality", "artificial intelligence" (three occurrences), and "inclusion", "digital technology" and "digital games" (two occurrences each).

Table 2. The top 10 keywords from 108 articles.

	Keywords	Occurrences	Total link strength
1	Older adults	17	13
2	Art therapy	8	7
3	Design	3	7
4	Resilience	3	4
5	Mental health	3	2
6	Virtual reality	3	2
7	Artificial intelligence	3	2
8	Inclusion	2	3
9	Digital technology	2	2
10	Digital games	2	2

4. Content analysis and discussion

Results from the VOSviewer software represent four clusters (with four main colors) of keywords with their link strength, as presented in **Figure 2**. This review

utilized a theory-based review methodology (Paul and Criado, 2020) to analyze the importance of a specific theory in the context of technology-based art instruction for the elderly. By synthesizing and reviewing theory, this category of review articles contributes to the advancement of the literature (Paul and Criado, 2020). Following this, a content analysis was performed on each of the 108 articles. The procedure involved thematic coding, in which the categorization was based on the meaning of the complete sentence or paragraph rather than the text as a whole. The results of the reliability assessment were reassessed and classified by a pair of researchers who engaged in deliberation regarding the final coding.

- Cluster 1: Inclusive design
- Cluster 2: Accessibility
- Cluster 3: Digital art therapy
- Cluster 4: Digital technology environments

4.1. Cluster 1: Inclusive design

4.1.1. Understanding physical limitations

All stakeholders are a critical component considered by ID. According to Scott et al. (2018), within the realm of environmental design, there is an assumption that through user involvement in the design process, the resulting products, services, and environments will more effectively cater to the varied needs and interests of individuals. In the realm of art education, the physical limitations of senior participants give rise to several challenges; however, psychological barriers frequently pose a more substantial obstacle. For seniors, a lack of confidence, frustration, a defeatist attitude, anxiety, and feelings of inadequacy are all possible manifestations of these building obstacles (McGinley and Dong, 2011; Ostroff, 2011).

Regarding teaching art with digital technology, research suggests that it is crucial to guarantee that digital art platforms and tools are accessible to older adults who have cognitive, visual, auditory, or motor impairments of varying severity. The accessibility features encompassed in this category consist of customizable user interfaces, support for screen readers designed for visual impairments, adjustable text sizes, high-contrast visuals, hearing aids, and audio instructions (Burke et al., 2011; Coelho et al., 2015; Kasemsarn and Nickpour, 2017). In order to cater to the physical limitations of this demographic, photography tools and techniques should be modified (Cristofovici, 2022). Utilizing software that is accessible to individuals with visual impairments, supplying tripods or monopods for stability, and employing cameras with larger buttons and displays are a few examples.

Design that comprehends physical limitations addresses more than just ergonomic or sensory impairments—it considers the full user experience. By ensuring digital art tools are physically accessible, researchers implicitly affirm the value of older adults' creative expression, potentially elevating their sense of agency and belonging. The implications are profound: it not only facilitates the creation of art but also serves to dignify the users by acknowledging their right to participate fully in the digital realm. The challenge is to integrate adaptability without drawing attention to the impairments themselves, thereby subtly empowering users rather than highlighting their limitations.

4.1.2. Designing a lifelong learning class

In 2000, the notion of "lifelong learning," which posits that valuable and enjoyable knowledge can be gained in various contexts (family, leisure, public, and professional life), is beginning to gain traction. This concept suggests that learning can occur at any stage of life, especially for seniors. This concept is employed synonymously with "adult education", "further education" and "permanent education" (Guler, 2012).

Lifelong learning is in accordance with both sustainability and the social progress of communities, particularly with regard to the needs of older adults in various nations (Elfert, 2019; Guler, 2012). This paradigm complements and integrates the three distinct learning modalities: formal, informal, and non-formal. Formal learning is delineated as an educational system that is formally organized; non-formal learning pertains to distinct forms of learning experienced by particular subgroups of the population; and informal learning encompasses the acquisition of knowledge, skills, attitudes, or aptitudes through everyday activities (Jarvis, 2004).

The study "Art for All Ages: A Lifelong Desire and Hard Work" (Guler, 2012) provides beginning-level painting lessons for the elderly for two years. Consequently, the majority of participants found lifelong engagement in the visual arts to be a rewarding experience that contributed to their sense of purpose and fulfillment. Moreover, this research demonstrates the beneficial effects of art on older adults' psychological well-being, self-control, collaboration, and resolve, all of which are critical attributes in the visual arts. Additionally, elderly individuals assert that their lives will be imbued with purpose and motivate them to continue living when they visualize it in the future.

Lifelong learning as a design principle transcends the simple act of education; it is a commitment to the ongoing intellectual vitality of older adults. The implication here is that learning through art is not only a recreational activity but also a cornerstone of cognitive health and social engagement. In this light, designing for lifelong learning is designing for the continuity of identity and purpose well into older age. There is a clear opportunity for research to map out the long-term benefits of sustained engagement in the arts on cognitive reserve and neuroplasticity in older populations.

4.1.3. Supporting well-being

Research on the impact of arts participation on the quality of life for older individuals has primarily concentrated on a specific well-being outcome, encompassing social, psychological, clinical, and even spiritual dimensions (Fancourt and Finn, 2019; Groot et al., 2021; Thompson, 2009). According to Groot et al. (2021), active art participation (e.g., singing, dancing, and photography) improves the emotional state of older people; having fun and laughing have a direct effect on the body and state of mind. Experiencing a sense of liveliness and vitality and being completely engrossed in a joyful moment makes one feel truly alive.

Art activities are characterized as well-being environments where individuals communicate in an aesthetic language, which consists of scene, sound, image, and motion, as opposed to a "linguistic" or conventional art language. Because it is a "language" that can be perceived through the body, senses, and subconscious, it does not necessarily demand "normal" cognitive functioning (Groot et al., 2021; Thompson,

2009). Regarding photography activity, experiencing natural and picturesque settings while participating in an artistic endeavor may promote the mental and emotional health of older adult learners through self-expression, social interaction, and environmental engagement.

This design principle acknowledges that the emotional and psychological dimensions of learning are as critical as the intellectual ones. Art's therapeutic potential is well-documented, but its integration into digital platforms can magnify this impact, making therapeutic art experiences more readily available. Thus, the design must cater to creating environments that are not only intellectually stimulating but also emotionally supportive. Research could explore how digital platforms can be optimized to deliver art therapy interventions, and how these interventions contribute to overall well-being and quality of life for older adults.

4.1.4. User-centered design

Don Norman introduced the concept of user-centered design in 1980 as a conceptual structure for a design methodology aimed at enhancing the acceptance and usability of a given system (Norman, 1986). User-centered design has gained significant traction within the human-computer interaction (HCI) domain. User-centered design is an assemblage of approaches that seeks to engage users in a suitable manner throughout the product development process (Carayon et al., 2020; Duque et al., 2019). In order to tailor art education with digital technology to the needs, capabilities, and characteristics of older adults, designers or instructors must involve end users (seniors) in the design process (design art class) when utilizing user-centered design to instruct art for this group. First, include older adults in the whole process of design and development of art class. Next, collect senior's feedback in order to gain insight into their preferences, difficulties, and needs. This will, therefore, be contingent on the development of an affordable, user-friendly art course that is both well-designed and centered on the elderly (Carayon et al., 2020; Duque et al., 2019; Tongsubanan and Kasemsarn, 2023).

The concept underscores a democratized approach to technology development, where the end-users—older adults—are not passive recipients but active contributors to the design process. This shifts the focus from usability to user empowerment, fostering a sense of ownership and customization. The implication is a move towards a co-creation paradigm where older adults are partners in design, potentially leading to products that resonate more deeply with their lived experiences and needs. Future research could investigate participatory design processes that engage older adults and assess how these processes affect the adoption and efficacy of digital art education tools.

4.1.5. Physical ergonomics

According to Gonzalez and Morer (2016), the work environment system with human factor ergonomic theory identifies four interrelated factors that are critical when contemplating human-computer interaction (HCI) in technology, particularly concerning the unique requirements of older adults:

1) The workstation components and tools (product): The phrase "workstation components" encompasses an extensive variety of tools, equipment, and their respective configurations, such as a chair, desk, monitor, keyboard, task lamp,

and footrest (Gonzalez and Morer, 2016).

2) For whom are they creating the design (user): When considering user-sensitive ID, it is crucial to consider the physical, cognitive, and emotional dimensions of the three branches of ergonomics (Edwards and Jensen, 2014; Gonzalez and Morer, 2016).

3) Organizational and workspace factors (context or environment): Four primary organizational considerations have been identified as influencing the design of the workspace: 1) openness, denoting the absence of barriers or partitions; 2) shareability, pertaining to the number of individuals sharing the workspace and/or workstation; 3) protocol, defining whether collaboration or concentration is permitted or expected of the users; 4) personalization, pertaining to the permitted or anticipated accessibility of individual belongings and preferences (Gonzalez and Morer, 2016).

4) The components comprising interaction (activity): The tasks and activities performed over a period of time. This factor includes work activity preceding, during, and following (Dong et al., 2015).

Ergonomics plays a pivotal role in ensuring that the physical interaction with technology is not a source of discomfort or harm. A well-designed ergonomic product can extend the duration and enhance the quality of engagement with digital art tools. By accommodating the physical needs of older adults, ergonomics becomes a gateway to prolonged and more meaningful interactions with art and technology. This has broader implications for how society designs spaces and tools for older adults and represents an opportunity for research into the development of universal design standards to make technology products more accessible to older adults. In summary, when developing digital technology and designing digital art tools for older adults, physical ergonomics should be taken into account. Designers should suggest devices that are both comfortable and accommodating for older adults and offer recommendations on how to arrange workspaces to optimize comfort and reduce physical strain.

4.2. Cluster 2: Accessibility

4.2.1. Accessibility and usability

Studies by Kasemsarn and Nickpour (2017), Portet et al. (2013) and Rodrigues et al. (2020) identify older adults as a distinct group that warrants special attention with regard to accessibility and usability concerns:

- Vision: As time passes, the eyes of individuals become less sensitive and unable to distinguish light, colors, and details. The vision changes associated with aging pose challenges for older individuals when it comes to reading from a computer screen.

- Hearing: Older adults experience progressive auditory decline, resulting in challenges in distinguishing acute sounds. Approximately 20% of individuals aged 45 to 54 have some degree of hearing impairment. This proportion escalates to 75% among individuals in the age groups of 75 to 79 years.

- Muscular abilities: The aging process gradually impairs physical performance, resulting in a deterioration of motor abilities, including diminished strength and

speed, and occasionally tremors in the hands that can impede the operation of the keyboard and mouse.

- Cognition: Cognitive decline is a characteristic feature of the aging process. This includes impairments in memory, speed of perception, comprehension of texts, ability to concentrate, and attention. The ability of older individuals to concentrate and maintain their attention on tasks for extended durations is typically compromised.

As a result, the development of supports that facilitate the creation of art activities with technology that are suitable for the elderly remains a formidable obstacle. These users do not exhibit a singular deficiency but rather a collection of constraints that impede their ability to engage with the technology.

In the area of art education utilizing technological devices for this demographic, it is imperative that the tools be user-friendly, error-resistant, and simple to master (Portet et al., 2013). According to the Digital Accessibility Team (DAT), individuals with visual, physical, or cognitive impairments will encounter significant challenges when attempting to operate equipment, particularly switches and controls. Portet et al. (2013) suggest that, with the exception of individuals with hearing impairments, the audio channel is one of the preferred modalities for technological devices. Indeed, audio processing has the capability to provide insights into the content of spoken sentences, including voice commands and distress signals. Furthermore, it is recommended that designers endeavor to incorporate hands-free capabilities for switches and controls whenever feasible and prioritize speech input over touch screens or keypads whenever feasible (Kasemsarn and Nickpour, 2016; Portet et al., 2013).

The converging sensory declines in vision and hearing, coupled with the physical challenges of muscular control and cognitive faculties such as memory and attention, manifest not simply as individual hurdles but collectively as a significant barrier to technology adoption among older adults. In brief, it is the responsibility of art educators to ensure that the technological platforms and applications utilized in art instruction for older adults possess intuitive interfaces, are user-friendly, reduce errors, support impairments, and are uncomplicated to navigate.

4.2.2. Assistive technology

According to Wargnier et al. (2018), as the number of elderly individuals requiring care increases—despite a decline in the active population—there is a growing interest in assistive technologies. These technologies offer ways to compensate for cognitive impairment, enhance quality of life, and decrease care expenses.

Within the area of older adults, assistive technology (AT) encompasses any device, product, or equipment that aids individuals in accomplishing tasks that would otherwise be unattainable or simplifies the daily lives of seniors (Sanford, 2012; Vichitvanichphong et al., 2014; Wargnier et al., 2018). According to Sanford (2012), assistive technology is distinguished from other technologies by the fact that it is personalized and typically follows the individual. As suggested by this definition, assistive technologies can manifest in a wide variety of ways, ranging from low-tech devices such as automatically igniting lights to high-tech personal robots.

Moreover, intelligent assistive technologies (IATs) are a subset of AT that

incorporate advancements in voice-activated systems, robotics, communications, and sensors (MacNeil et al., 2023). Numerous studies have classified the swiftly growing domain of IATs into the following six classifications: 1) wearables such as smart-watches, GPS necklaces, and fall monitoring devices; 2) handheld devices including tablets, GPS trackers, fitness trackers, and smartphones; 3) mobility aids like smart canes and smart wheelchairs with built-in sensors; 4) voice-activated assistants such as Siri, Alexa, and Google Home; 5) distributed systems like smart-homes with integrated sensors for light and heat; and 6) situation-specific robots for tasks like floor cleaning, soothing, and emotional response (Ienca et al., 2017; MacNeil et al., 2023; Vollmer Dahlke and Ory, 2020).

According to Coleman et al. (2015), assistive technology utilized by senior citizens or individuals with disabilities to access the art curriculum can vary in sophistication. Low-tech devices consist of inexpensive, non-electronic tools, while mid-tech tools utilize battery-powered art tools. High-tech solutions involve computerized software. As an alternative to two-dimensional materials such as paint, AT for students with visual impairments could consist of tactile materials like sandpaper and cotton, high-contrast colors, battery-operated lighted magnification devices, computers with bright backlit screens, or museum website descriptions of artwork. Assisted technology may consist of modified implements (e.g., scissors or paintbrushes with enlarged handles or spring-open mechanisms), switch-operated battery-powered devices (e.g., adapted SpinArt), or an adapted joystick utilized to operate computerized drawing software for students who have limited fine motor control.

The proliferation of assistive technologies, ranging from simple automated lights to sophisticated voice-activated systems, mirrors the increasing care demands of the aging population. The implication here is a future where assistive technology is not an adjunct but a seamless aspect of the daily lives of older adults, offering not just a way to cope with impairments but a pathway to enhanced independence and quality of life.

4.2.3. Flexible learning digital formats as e-learning

According to Pappas et al. (2019), an assortment of computerized training programs that target the cognitive abilities of older adults have emerged in recent years. Without requiring explicit instructions, these intervention programs can be implemented at any time and in any location and are regarded as more cost-effective (Kueider et al., 2012). Furthermore, older adults have been provided with expanded opportunities through the integration of ICTs in education, as e-learning has the potential to improve their overall self-development and have a positive impact on their social and political lives (Pappas et al., 2019). E-learning, applied in all classes, offers evident benefits for the elderly, including the ability to overcome physical isolation, access current and continuous learning resources, reduce the cost of educational activities, and provide students with a more personalized educational experience (Pappas et al., 2019; Quan-Haase et al., 2016).

Despite the broad scope of the term "e-learning," the inquiry emerges as to how this domain can be effectively incorporated into instructional and learning contexts. Thalhammer (2014) distinguished two types of e-learning that possess distinct characteristics. The primary emphasis of "associative e-learning" is the development

and dissemination of educational resources that utilize multimedia. "Process-oriented e-learning" organizes and guides learning processes through the use of new media.

Ahmad et al. (2022) highlight that hybrid forms of e-learning are frequently employed in practical teaching and learning settings to integrate virtual and digital components of various media with conventional teaching methods. These applications include serious games in educational institutions, virtual universities, corporate e-learning, e-collaboration, and e-training, as well as e-training programs for the elderly. This demonstrates that e-learning is implemented across all educational domains.

The expansion of e-learning offers a lifeline for continued education and engagement for older adults, potentially bridging the social divide imposed by physical limitations. When applying this concept to art classes, art educators should create e-learning and allow older adults to engage in digital art activities at their own convenience and at their own pace by providing a range of flexible learning schedules and allowing them to customize personal preferences by choosing art subjects. Finally, art educators can offer video tutorials or recorded lessons that learners may refer back to when necessary. The implication is a digital art educational model that is as flexible and adaptable as the needs of its users, providing personalized, scalable, and context-aware learning opportunities.

4.2.4. Training with digital devices

Instructing older adults on how to interact in a safe and effective manner with these technological advancements, including but not restricted to the implementation of goal-oriented training to enhance performance, the reduction of working memory demands, and the provision of self-paced training, is crucial and needs specialized procedural training (Hickman et al., 2007; Kasemsarn and Nickpour, 2017).

According to Kasemsarn and Nickpour (2017), older adults express a keen interest in art activities and technology; however, the insufficiency of training programs for older adults concerning the utilization of digital technologies presents an obstacle. To increase motivation and decrease anxiety, training should be tailored with a specialized design geared toward the objectives, experience, and capabilities of seniors exclusively (Berg-Weger and Morley, 2020; Gonzalez et al., 2015).

In addition, Hickman et al. (2007) suggest the subsequent procedures for instructing older adults in digital technologies:

- Mouse instruction: Hickman et al. (2007) conducted mouse training in order to acquaint participants with the fundamental capabilities of the mouse, including pointer movement and left mouse button activation, which were essential for the simulator system. A 90% accuracy criterion was employed to ascertain successful mouse training, and participants were provided with three opportunities to attain this level of accuracy. Participants who failed to meet this criterion were subsequently substituted.
- Training on systems: In order to elucidate the framework of the system, Hickman et al. (2007) developed two training tutorials: Guided action training and guided attention training. In each training condition, participants executed identical task trials that consisted of the desired outcome and the corresponding steps needed to achieve it. The fundamental distinction lay in the fact that individuals engaged in guided action training received explicit instructions at each stage, while those

in the guided attention condition were required to engage in more active cognitive processing of the information in order to ascertain the most suitable courses of action.

- Evaluation criteria: Hickman et al. (2007) assessed performance accuracy and task completion time during training, on the test for trained tasks, and on the test for untrained tasks.

In terms of art classes, instructors should provide older students with comprehensive training and support regarding digital tools, platforms, and programs (e.g., how to use a digital tablet, design program, digital pen, and mouse). This may encompass continuous support, workshops, and tutorials. Nonetheless, this specialized training must be tailored exclusively to seniors and not for the general class. The implication is a call for art educational methodologies that are empathetic to the learning curve and physical realities of older users.

4.3. Cluster 3: Art therapy

4.3.1. Digital tools for art therapy

Digitized technology facilitates in-person and online art therapy sessions for older adults, as evidenced by a number of studies (Datlen and Pandolfi, 2020; Diggs et al., 2015; Seo et al., 2022). According to Cornejo et al. (2016), technologies ought to facilitate adaptation ability and customization, individual needs assessment, empowerment, and simplicity. These sessions may include the use of new art media and online group therapy sessions. Art therapists may utilize digital photography (Atkins, 2007), animation (Austin, 2009), or digital collage-making on screens (Diggs et al., 2015) as opposed to pencil sketches of objects on paper by older adults. These studies demonstrated that the variety of digital media may facilitate collaborative drawing or allow art therapists to assess the emotional and psychological distress of seniors using a variety of methods (Datlen and Pandolfi, 2020).

Furthermore, it has been stated in studies (Datlen and Pandolfi, 2020; Seo et al., 2022) that technology ought not to supplant art therapists but rather serve as a supplement to the processes of creation and sharing. Limited art therapy systems have been created with the intention of facilitating off-line interaction, including conversation, participation, and individualized support. The presence of Blank Canvas, a canvas situated in the main lounge of an assisted living community, and Video Window, a screen that projects a video of the outside environment, stimulated residents' dialogue and creativity. However, they discovered that "engagement is highly individualized" and that tools should facilitate the creation of personalized content. These systems identify a number of obstacles associated with the development of tools that facilitate digital art therapy.

Digital tools in art therapy extend beyond traditional methods, offering diverse media such as digital photography and online platforms, which enhance collaborative opportunities and allow for multifaceted assessments of older adults' emotional and psychological states. The implications here are twofold: first, digital media provide alternative avenues for self-expression and communication, which may be particularly valuable for those facing physical or cognitive challenges. Second, these tools afford therapists a more nuanced understanding of their clients' experiences, potentially

leading to more tailored and effective interventions. The direction for future research should involve developing and testing digital art therapy interventions tailored to older adults' capabilities, with a focus on the evaluation of therapeutic outcomes and the optimization of technological interfaces for this demographic.

4.3.2. Aided health and well-being

Due to a lack of intimate relationships, multiple losses, impaired communication, physical disability, loss of function, and separation from family, social isolation in older individuals results in loneliness (Bennington et al., 2016; Imran et al., 2020). Nevertheless, Stephenson (2006) found that art therapy yielded a greater number of advantages than other recreational activities in the same time period. Art has the potential to serve as a "visual conduit through which one can delve into previous and current experiences" (Stephenson, 2006). Activation of autobiographical memories has been associated with health (Bennington et al., 2016), which makes this a particularly crucial point.

By presenting a dynamic learning opportunity that engages the cognitive, motor, and social abilities of older individuals, art therapy and art education, which include painting, sculpture, sketching, and aesthetic analysis, enhance cognition in the elderly. In addition, individuals with dementia experience a sense of belonging and the ability to recall memories, which contributes to an improvement in mood, structure, and normalcy (Bennington et al., 2016).

Art demonstrates tremendous promise in the direction of a sustainable future, and art therapy is a beneficial form of expression (Shrivastava et al., 2012). Artistic approaches and methods can foster emotional bonds in numerous domains, including healthcare, thereby providing long-lasting benefits and outcomes for groups, organizations, and individuals.

Engaging in public awareness and discourse regarding mental illness in order to reduce stigma constitutes an additional opportunity for art therapy in a museum to promote the health and well-being of older adults, with topics such as dementia, Alzheimer's, and lifelong learning for older adults. Future research should therefore examine the longitudinal effects of regular art therapy on mental health and cognitive function, identifying which approaches yield the most significant health outcomes. There is also a need to explore how art therapy can be implemented within public health initiatives to improve societal understanding and reduce the stigma associated with aging and mental health conditions.

4.3.3. Virtual art therapy

Virtual Reality (VR) is an environment created by computers that provides users with a surrogate sensory environment in which to interact and experience themselves. It is utilized extensively for artistic creation and entertainment (Hacmun et al., 2021).

Studies proposed that the distinctive attributes of the VR medium in art therapy, such as artistically tailored environments, could potentially enhance and supplement the clinical application of traditional art therapy (Hacmun et al., 2018; Hacmun et al., 2021). Furthermore, research has established that the integration of digital media, including artistic VR, is essential for the development of the art therapy field (Hacmun et al., 2018; Kaimal et al., 2020; Lohrius and Malchiodi, 2018).

A recent qualitative study identifies a number of favorable VR art therapy

experiences, including play, exploration, and positive emotions. In addition, the researchers concluded that virtual reality art therapy may improve psychological health and well-being via problem-solving, interactivity, creativity, and enhanced imagination; it also produced positive changes in tension, self-efficacy, and anxiety (Kaimal et al., 2020).

There is speculation that adopting the perspective of an older adult and attempting to see the world from their point of view could strengthen the therapeutic alliance, foster greater intimacy, and increase empathy (Hacmun et al., 2018; Lohrius and Malchiodi, 2018). The potential for one to manipulate the dimensions of environments and objects in accordance with their physical presence, as offered by the VR space, could elicit affective responses. As an illustration, senior citizens have the ability to adjust the size of an object to suit their therapeutic requirements (Hacmun et al., 2018; Kaimal et al., 2020; Smriti et al., 2022). These VR tools enable older adults to experience new viewpoints and perspectives in the artwork and contribute to the self-observation process, which is fundamental to psychotherapy.

VR introduces an immersive dimension to art therapy, potentially enhancing traditional therapeutic practices by providing environments tailored to the psychological needs of older adults. The capacity of VR to induce play, exploration, and positive emotions presents a significant opportunity for enhancing well-being and reducing anxiety and tension among older adults. Future research should explore how VR environments can be designed to meet the unique therapeutic needs of this demographic and measure the effects of such interventions on psychological health. Additionally, the potential of VR to enhance empathy in the therapist–client relationship could be a fascinating avenue for future investigation—examining how VR experiences shared between therapists and clients might strengthen their therapeutic alliance.

In conclusion, the analysis of Cluster 3: Art therapy underscores the transformative potential of digital tools, both as mediums for art therapy and as instruments for the psychological and emotional enrichment for older adults. The role of technology in art therapy presents an innovative frontier that has the potential to redefine therapeutic practices and enhance the quality of life for older adults, warranting further exploration and investment in research and development.

4.4. Cluster 4: Digital technology environments

4.4.1. Behavior and attitude for digital technology

Research on the relationship between older adults and computer usage often shows that this group consists of keen and motivated users. Both seniors and disabled people would like to learn the basics and consider digital skills significant in this age if someone encourages them (Juznic et al., 2006; Kasemsarn and Nickpour, 2017). However, Wagner et al. (2010) suggest that the common belief that the cost of a technological device is a major barrier, followed by a lack of benefit, motivation, knowledge, access, cost, fear, and physical limitations. This is because technology in every category (e.g., learning, living, and entertaining) does not support or meet the needs of this group. As a result, they do not understand how technology is related to them and are scared about their privacy or being scammed. Therefore, researchers and

teachers must address these issues before using technology in teaching older adults.

Training older adults how to use digital technology in learning art is an interesting and difficult topic. Therefore, art educators must create and design the proper environments, including hardware, software, user interfaces, usability, class training, locations, interior building, and furniture, to support this group both in traditional and online classes. Furthermore, training older adults requires additional support and examples from special staff (Wagner et al., 2010).

Older adults exhibit a readiness to engage with technology, albeit with support and encouragement. Contrary to the common belief that cost is a barrier, it is the relevance of technology to their lives, along with privacy concerns and fear of scams, that are the primary obstacles. There's a profound need for research that develops training and educational programs specifically designed to bridge this gap in technology usage. Future research should also investigate strategies to enhance the perceived relevance of technology for older adults, addressing fears and building confidence in using digital tools for art education.

4.4.2. Privacy

A number of studies focusing on technology for older adults in all categories (e.g., learning, working, and entertainment) state that privacy is the major barrier for this group and should be considered and solved. Older adults have extremely restrictive goals when using digital technology due to the possibility of their privacy being hacked. They still prefer traditional communication since they feel unsafe to use technology. However, literature reviews suggest the following points will make older adults feel more secure when using technology: Teach how and what information can be shared (Gibson et al., 2010), teach details about privacy settings (Coelho et al., 2015), and ensure privacy setting menus are simple and clear to use (Coelho and Duarte, 2016). As a result, this point is about how to design user interfaces that are appropriate for older adults. Regarding teaching art with digital devices, privacy protections should be included in the default settings, and seniors can reach only their family or friends. Therefore, they can feel that their personal information is available for only contacts and not strangers.

The fear of privacy breaches significantly affects their willingness to engage with digital platforms, including digital art education. Future research needs to develop user interfaces and privacy settings that are intuitive and straightforward, reducing the complexity of privacy management. The goal is to create environments where older adults can feel secure, focusing on designs that simplify privacy controls and emphasize transparency in data handling.

4.4.3. Offering offline mode

Although technology and innovative devices could be mostly connected to online or virtual modes, especially when synced with social media or the internet, there is still an issue in proposing an off-line mode for seniors. Morris (2005) points out that designers and teachers should put older adults in the center of a solar system, like the sun surrounded by their family and friends, leading them to feel comfortable. Moreover, studies suggest that teaching art with high-technology devices should support or offer them the option of face-to-face meetings or interactions with real people, locations, and activities, not only online mode (Coelho et al., 2015; Garattini

et al., 2012). For example, an art class should be set up in an area that provides opportunities for older adults to connect with their communities through art activities (Coelho et al., 2015). This could boost offline interaction between members living in the same community by encouraging activities with different art forms (Harley et al., 2014). Last and most significantly, if older adults need instant offline mode in case of an emergency, designers or teachers should set up easily accessible offline shortcut keys, icons, or buttons (Michailidou et al., 2015).

While there is a push towards an increasingly connected world, the importance of offline modes cannot be overlooked for older adults. The option for offline engagement is essential for those who may feel overwhelmed by persistent connectivity or when online access is not possible. Research should focus on how to balance digital and physical experiences, integrating art therapy into community settings and enhancing face-to-face interactions that foster community and a sense of belonging.

4.4.4. Personalization and customization

This group suffers from several impairments, e.g., motor, cognitive, sensory, and social concerns, and worries about using new technology. In studies from 2009 until now, researchers found that offering customization and personalization is appreciated by older adults. For example, when learning art with digital devices, they would like to adjust profile presentation, information, and features by themselves (Burke et al., 2011; Coelho et al., 2015). Moreover, regarding interaction, older adults prefer custom interface adaptations, such as text-to-speech, voice commands, or any technology using augmentative alternatives that could help make their studies easier. This point is very significant since it could lead to an interest in using technology. In brief, this group needs special care and unique solutions due to their different impairments. Therefore, adapting the interfaces and contents that older adults can personalize is the key to success. This group has a variety of needs, from physical and cognitive impairment to social and cultural characteristics (Kasemsarn et al., 2023)

Regarding customizing the user interface, Coelho et al. (2015) recommend that the interface of digital devices for this group must consist of minimal changes geared to this age group. However, in real-life situations, seniors still complain if an interface is too complex, has too many options or buttons, is not for older users, or is not supported for users with physical impairments. The user interface in digital devices or social media is a major issue. Several studies have focused on suggesting alternative interfaces (Chen, 2009) or how to simplify them (Hayes et al., 2015; Kasemsarn, 2022) for older adults. Several studies suggested that user interfaces for older adults must be personalized and as simple as possible. Older adults are not the only group who can benefit from this simplicity since a simple interface could be applied and be safe for every group of users.

In terms of art activity, seniors should be able to select digital tools that provide customization options, including brush size, color schemes, and canvas dimensions, in addition to having the curriculum tailored to their individual interests and skill levels. Following this, artistic assignments ought to be customized in order to mirror unique personal experiences, cultural heritage, and aesthetic preferences (Kasemsarn and Nickpour, 2017). In conclusion, art educators ought to provide individualized

feedback on each participant's artwork through the utilization of small-group discussions or one-on-one sessions.

Customization and personalization of digital tools are crucial in addressing the varied impairments and needs of older adults. Research here should focus on interface and content adaptability, ensuring that technology serves as an enabler rather than a barrier. There is a need for studies that develop adaptable user interfaces, which accommodate a range of physical, cognitive, and sensory impairments, while also respecting the social and cultural nuances of this demographic.

In terms of art activity, older adults should be able to select digital tools that provide customization options, including brush size, color schemes, and canvas dimensions, in addition to having the curriculum tailored to their individual interests and skill levels. Following this, artistic assignments ought to be customized in order to mirror unique personal experiences, cultural heritage, and aesthetic preferences (Kasemsarn and Nickpour, 2017). In summary, the focus of Cluster 4: Digital Technology Environments requires a holistic understanding of the barriers and facilitators affecting older adults' engagement with technology. Future research must tackle these challenges head-on, designing digital environments that are secure, customizable, and finely tuned to the diverse needs of older adults. By doing so, technology can be transformed from a source of concern into a portal for creative expression and lifelong learning.

5. Interrelation of each cluster

The content analysis facilitated through VOSviewer software revealed four pivotal clusters, which, when considered collectively, illuminate the multifaceted approach required for effective technology-based art instruction for older adults. The interaction between these clusters: 1) inclusive design; 2) accessibility; 3) digital art therapy, and 4) digital technology environments—highlight the comprehensive framework necessary for the holistic development of art education tailored for older adults presented in **Figure 3**.
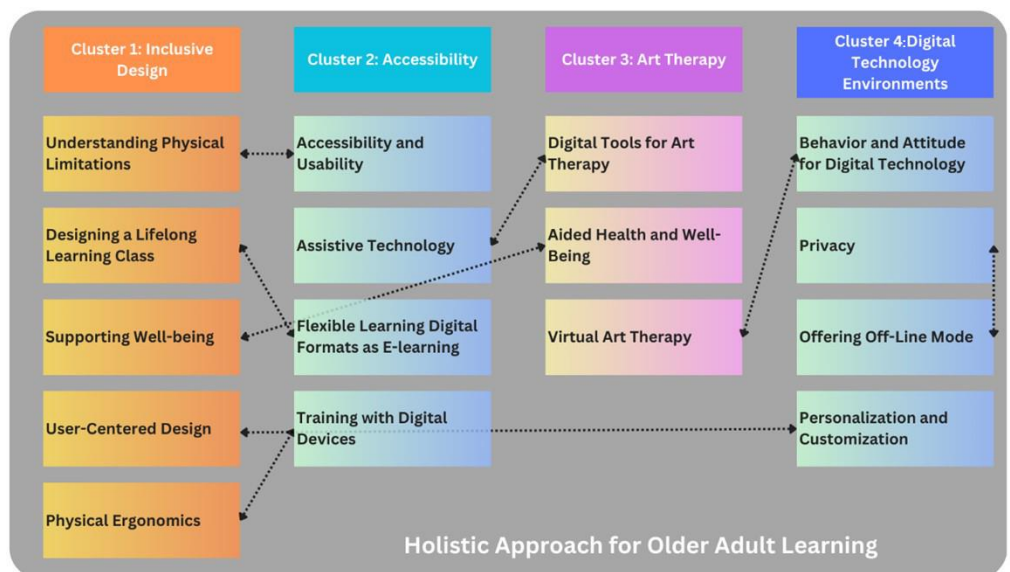

Figure 3. Interrelation from four clusters.

Inclusive design and accessibility: The foundational elements of Inclusive Design directly influence the parameters of Accessibility. Inclusive Design addresses the broad spectrum of user needs, especially considering older adults varied physical and cognitive capabilities. When these design principles are effectively implemented, they enhance the accessibility of digital platforms and tools, ensuring that art educational materials are within reach for all older adults, regardless of their physical or cognitive conditions. This underscores the notion that art education for this group should not only accommodate physical limitations but also embrace a wide range of learning styles and accessibility needs.

Interconnection with digital art therapy: Both Inclusive Design and Accessibility serve as the bedrock for effective Digital Art Therapy. The tailored digital environments and tools, designed with older adults' specific needs in mind, provide a safe and accessible space for therapeutic artistic expressions. The application of art therapy principles in digitally inclusive settings allows for a broader engagement, catering to older adults with diverse needs and promoting their psychological well-being and social connectivity.

Synergy with digital technology environments: The integration of Inclusive Design and Accessibility principles within Digital Technology Environments facilitates an ecosystem where older adults can seamlessly engage with art therapy. This environment fosters an interactive and engaging platform for learning and therapeutic expression, leveraging technology to enhance the artistic experience and making it more engaging and beneficial for these users.

Holistic approach: The synergy among these clusters' advocates for a holistic approach for developing art educational programs for older adults. It emphasizes the importance of creating accessible, user-centered digital platforms that support art therapy's therapeutic goals, thereby fostering a comprehensive learning and healing environment.

The following analysis presents an interaction between each element across the four clusters. Each interaction between these clusters' elements highlights the complexity and interdependence in designing digital art education for older adults.

- Understanding physical limitations (Cluster 1: Inclusive design) and accessibility and usability (Cluster 2: Accessibility): These elements intersect to ensure that digital art tools and platforms are designed with older adults' physical limitations in mind, thereby enhancing overall accessibility.
- Designing a lifelong learning class (Cluster 1: Inclusive design) and flexible learning digital formats such as e-learning (Cluster 2: Accessibility): Lifelong learning concepts must be integrated with flexible digital formats to cater to the varied schedules and learning paces of older adults, enhancing engagement and inclusivity.
- Supporting well-being (Cluster 1: Inclusive design) and aided health and well-being (Cluster 3: Digital art therapy): The design of digital art platforms can significantly impact therapeutic outcomes by supporting the psychological and emotional well-being of older adults, highlighting the need for well-being-focused designs in therapeutic contexts.
- User-Centered design (Cluster 1: Inclusive design) and personalization and customization (Cluster 4: Digital technology environments): Engaging older

adults in the design process helps ensure that the digital environments are tailored to their preferences and needs, enhancing user satisfaction and effectiveness.

- Physical ergonomics (Cluster 1: Inclusive design) and training with digital devices (Cluster 2: Accessibility): Ergonomic considerations inform the development of training programs for digital devices, ensuring that older adults can use them comfortably and effectively.
- Digital tools for art therapy (Cluster 3: Digital art therapy) and Assistive Technology (Cluster 2: Accessibility): Integrating assistive technologies into digital art therapy tools can enhance accessibility for older adults with varying abilities, enabling more inclusive therapeutic experiences.
- Virtual art therapy (Cluster 3: Digital art therapy) and behavior and attitude towards digital technology (Cluster 4: Digital technology environments): The implementation of virtual art therapy should consider older adults' attitudes towards technology to ensure high engagement levels and effective therapy sessions.
- Privacy (Cluster 4: Digital technology environments) and offering offline mode (Cluster 4: Digital technology environments): Protecting privacy while offering offline modes respects user autonomy and security, encouraging trust and continuous use of digital platforms by older adults.

6. Conclusion

As stated in the introduction, art studies and activities for older adults have received considerably less attention due to their need for special care, attention, and understanding of their preferences and limitations that, result in higher costs and are unsuitable for commercial purposes. Moreover, research on older individuals engaging in artistic activities using digital technology is considerably limited. To answer the research question "How could inclusive design be applied to teach art via digital technology for older adults?". As a consequence, 108 articles were ultimately chosen, as illustrated in **Figure 1**. The researchers then used VOSviewer software to group them into four main clusters and read the articles with content analysis to match each theory into four primary categories to answer the research question:

Inclusive design: Art educators have to understand physical limitations, from environments to digital equipment, for this special group. Next, art educators should consider lifelong learning concepts, focusing on every stage of life, and frequently collect feedback from this group in every process and develop art classes by understanding their preferences, difficulties, and needs, resulting in a user-friendly art course. Next, designers should understand their ergonomic limitations in the area of HCI with the unique requirements of older adults (workstation, users, environment, and activity).

Accessibility: Due to their impairments (vision, hearing, mobility, and cognition), older adults are a distinct group that warrants special attention concerning accessibility and usability concerns. Therefore, the tools and technology to teach art activities must be user-friendly, error-resistant, and simple. Additionally, assistive technologies (e.g., voice-activated systems, GPS, robotics, and sensors) should be applied, offering ways to compensate for cognitive impairment. Moreover, training older adults about digital

devices is necessary before teaching or practicing art activities. Last, flexible formats or hybrid forms should be offered to accommodate schedules and preferences.

Art therapy: It has the potential to serve as a visual conduit through previous and current experiences, activating memories, increasing health and movement (e.g., sculpture, dancing), and reducing loneliness and isolation. Studies recommended using new digital art media and online group therapy sessions, such as digital photography, animation, or digital collage-making on screens. Currently, VR therapy enables older adults to experience new viewpoints and perspectives in the artwork and contributes to the self-observation process, which is fundamental to psychotherapy.

Digital technology environments: Art educators should set up the proper environments covering all hardware, software, interface, usability, class training, locations, interior building, and furniture to support this group in both traditional online classes. Moreover, there are some serious issues such as privacy—the major barrier for seniors, offering off-line mode—if older adults need instant off-line mode, designers or teachers should set up easily accessible off-line shortcut keys, icons, or buttons, and personalization and customization because older adults prefer customized interface adaptation.

6.1. Practical implications

If researchers, designers, and art educators wish to design art activity classes via the use of digital technology, this review article could be applied in different ways:

- On-site digital art classes: prepare all methods of accessibility, including digital devices and interiors matched to older adults' impairments (details in clusters 1 and 2).
- Virtual online art: Designing user interfaces, privacy settings, and digital tools, as well as understanding preferences and allowing older adults to customize and share with their family or friends (details in clusters 3 and 4).
- Digital art therapy: Apply VR tools to present new perspectives of the artwork and contribute to the self-observation process (details in cluster 3).

6.2. Directions for future research

Long-term studies: Future research should undertake studies to assess the long-term impact of digital art education on older adults' well-being, social inclusion, and cognitive preservation.

Interface and experience design for older adults: There is a clear need for further exploration into the design of user interfaces that cater to the physical and cognitive needs of this group, including studies that explore the balance between technology's complexity and usability.

Therapeutic efficacy of digital art: Empirical research, specifically tailored to the mental health and cognitive needs of older adults, is needed to understand the therapeutic effects of digital art and virtual reality art therapy.

Privacy and security in learning digital art: As privacy concerns are paramount for this group, future works must focus on creating clear, simplified privacy settings and educational programs that empower older adults to navigate digital safety (both online and offline) with confidence.

Balanced technology integration: Studies should also explore the integration of offline and online art education experiences, investigating how these blended environments impact engagement and learning outcomes for this group.

Adaptive and personalized technology: Studies should develop adaptive technology that respects the diversity of aging, allowing for personalized experiences in digital art education.

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