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Article

Intelligent collaboration and artistic co-creation: a study on the enhancement mechanism of social well-being through AI-enabled intergenerational integration

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ABSTRACT

This study investigates how AI-enabled intergenerational artistic co-creation enhances Social well-being through a mixed-methods approach involving 120 participants across younger (15-25) and older (65+) age cohorts. The findings reveal a novel "triangulated collaboration model" wherein AI functions as both creative catalyst and communicative bridge between generations. Empirical results demonstrate statistically significant improvements: technological engagement convergence increased from 62% to 79% among older adults ($p < .001$), bidirectional knowledge transfer showed 28.7-point gains in cultural knowledge and 32.5-point gains in technical proficiency, and creative innovation scores improved by 47.2% in intergenerational groups compared to 22.9-28.6% in age-homogeneous groups. We identify multilevel enrichment mechanisms: at the individual (psychological well-being, self-efficacy, creativity), relational (communication, empathy, social capital), and community (inclusive behavior, community participation, cultural heritage preservation) levels. The Intelligent Collaborative Enhancement Model (ICEM) is a theoretical model that outlines how technological adaptability, creative co-construction, and mutual learning form "generative integration spaces." Policy implications from this research are for educational, cultural, and social welfare policies, considering how the utilization of technological mediation can foster strong intergenerational relationships within a more age-diverse society.

1. Introduction

The convergence of artificial intelligence (AI) and artistic practice has created unprecedented opportunities for cross-generational collaboration. Baas (2024) examines how AI serves as a creative mediator, revealing new artistic possibilities while challenging traditional notions of authorship and creative agency [1]. Along with such technological advancements, Campbell et al.'s (2024) systematic review has demonstrated increasing interest in the significance of intergenerational relationships to social welfare, with intergenerational contact being identified as having the potential to bring positive outcomes for children's and young people's mental and psychosocial well-being [2]. The convergence of AI-facilitated creativity and intergenerational engagement does hold some potential to foster social welfare through co-created art forms. Davis and Ogbanufe (2024) recognize the "looming disruption of creative industries brought about by generative AI" as a double-edged sword—disrupting current creative habits while bringing new opportunities for innovative co-creation activities outside the boundaries of convention [3]. They are convinced that their work marks the potential for bridging technologies grounded in generative AI to enable reconciling conflicting knowledge structures, even those alienated by intergenerational divergence. Moreover, this disruptive promise is also teased apart with sophistication in a number of cultural spaces, as one sees in Duester's (2024) deconstruction of artificial intelligence and digital art as the new paradigm transforming the world of work in contemporary China's world of art [4]. The disruptive effect of AI on creative industries extends much beyond the fairly mundane issue of artistic production, inserting itself into deeper issues of cultural work and the welfare of the creative industries' workers. Frost and Stack (2024) talk about the interdependent relationship between practitioner well-being, cultural practice, and the development of AI, acknowledging both potential and anxieties created as technological systems become increasingly embedded in work streams of a creative kind [5]. Their argument is that properly designed AI systems can maximize potential for collaboration and repress negative effects on the autonomy and job satisfaction of employees—a domain of sheer importance in cross-generational creative project management. This research project draws on these intersecting strands of inquiry to examine how AI-enabled artistic collaboration can act as a catalyst for successful intergenerational blending and social welfare enhancement. We believe that AI technologies, if properly designed and deployed, can act as successful go-betweens for the artistic collaboration of the young and the old. Contrary to the anxiety in certain discourse that AI will take the place of human creativity, AI applications can amplify humans' capacity for creative expression and, in the process, offer points of entry that are open to a wide variety of participants, irrespective of their technical experience or artistic qualifications. This capacity to democratize the creative process positions AI-augmented art as especially apt for intergenerational collaborations, in which participants will unavoidably possess different degrees of digital literacy and creative confidence.

The current study employs a mixed-methods methodology to explore mechanisms by which artistic co-creation facilitated by AI promotes social well-being in intergenerational situations. Through the dual examination of the technological affordances that enable creative synergy and the social dynamics that evolve through such collaborative interactions, we aim to build a comprehensive framework for understanding and promoting healthy intergenerational relationships in a more interconnected world with AI. This study adds to the increasing discourses on the social effects of AI in artistic environments, the effects of technological integration on well-being in cultural work [5], and the possible advantages of intergenerational activities in fostering community cohesion and individual growth. This study develops and validates a triangulated collaboration model explaining how AI facilitates intergenerational creative engagement, identifies specific mechanisms through which AI-enabled artistic co-creation enhances social wellbeing at individual, relational, and community levels, provides empirical evidence for the effectiveness of AI-mediated intergenerational programs, and offers policy recommendations for implementing such programs in educational, cultural, and social welfare contexts.

2. Literature review

2.1 Intergenerational integration and social well-being

The intergenerational solidarity concept has come to receive important attention in modern social science debates as nations are faced with demographic change and social fragmentation. Giarrusso and Putney [6] highlight the key role played by social workers in enhancing intergenerational ties, claiming that organized contact between generations significantly supports community resilience and well-being for individuals. This approach is consistent with research supporting more professional intervention in developing positive cross-generational relationships, especially where natural intergenerational contact has declined. Empirical evidence is highly in favor of the value of intergenerational programs. Whear et al. [7] conducted a systematic review with extensive research establishing strong positive effects of intergenerational programs on the mental health and social integration of older adults. Their meta-analysis of 21 intervention studies revealed significant psychological well-being improvement, reduced loneliness, and enhanced purpose among older individuals receiving systematic intergenerational interventions. These are complemented by the World Health Organization's Global Intergenerational Week initiative [8], which emphasizes the worth of organized intergenerational contact to public health benefit, situating such contacts as central to well-functioning healthy communities and thriving social systems. The environmental dimension of intergenerational relationships also complicates this landscape. Mallick and van den Berg [9] discuss how environmental concerns are a source of intergenerational solidarity, in this case among women with climate-driven migration opportunities. Their mixed-methods research concludes that shared environmental concerns can initiate successful cross-generational dialogue and joint problem-solving, creating space for technology-supported innovative environments to mitigate environmental problems. This research outlines how existential concerns can be catalysts in the creation of intergenerational relationships founded on shared purpose and activity.

2.2 AI in creative contexts and artistic production

The integration of artificial intelligence technology into the art-making process represents a paradigm shift in the creative industries, challenging traditional notions of authorship, creativity, and beauty. Latikaa et al. [10] employed a two-wave survey study to reveal complex public opinion regarding AI art, whose perception was influenced by demographic traits, prior exposure to AI, and personal concepts of creativity. Their findings indicate that public acceptance of AI art remains in flux, with both enthusiasm and scepticism existing among different population groups, which points to the importance of cautious implementation strategies when introducing AI art into intergenerational contexts. Theoretically, Messingschlager and Appel [11] demonstrate that the degree to which people attribute mental capacity to AI systems matters in terms of how much they value AI-generated art. Their experimental research indicates that anthropomorphic framing of AI systems increases audience engagement with and aesthetic appreciation of the resulting art—a finding of considerable relevance for intergenerational contexts, in which participants can have varying assumptions about AI capabilities and limitations based on generational experience with technology. This research suggests that properly constructed narratives concerning AI's contribution to creative activity can increase participant engagement across generations. The environmental sustainability of AI-supported artistic creation is worth exploring in the context of growing environmental concerns. Núñez-Cacho et al. [12] explore AI in art from the viewpoint of a circular economy, suggesting that technological creativity can help with more sustainable artistic creation when coupled with environmental principles.

Their systematic review highlights new paradigms for reducing the environmental impact of digital art practice and maximizing social and cultural value—a focus that aligns with intergenerational values of responsibility and environmental stewardship. This sustainability aspect intersects with broader social initiatives, such as MIT's Responsible AI for Social Empowerment and Education program [13], which develops guidelines for AI applications based on social good and ethics. Policy analyses of culture provide additional insights into the institutional conditions for healthy AI integration into the arts sector. Herndon and Dryhurst [14] demand arts-led models of AI innovation, placing cultural values on par with technical innovation. Their comparative policy analysis suggests that meaningful integration of artistic inputs into the processes of technological development can lead to AI systems better aligned to human creative imperatives and cultural contexts. This alignment of cultural values is particularly relevant in the application of AI to heritage environments, as explored by Oates [15] in their examination of the impact of AI on heritage institutions. Both studies emphasize the importance of leadership in the cultural sector to steer AI development pathways that respect diverse artistic traditions and practices.

2.3 AI in organizational and collaborative contexts

Beyond artistic domains, AI technologies are reshaping organizational practice and collaborative processes in intergenerational terms. Przegalinska [16] conceives of AI as a complement to human creativity, not a replacement, formulating theoretical models for thinking through how technological capabilities can augment human creative expression. This vision offers a fertile ground for AI-enabled intergenerational collaboration that extends rather than cuts short human agency and creative contribution, opening up options for technology-mediated extension of creative work between and across generations. To accompany this theoretical work, empirical investigations by Murire [17] investigate the impact of AI on organizational work habits and cultural processes, with attention to the importance of congruence between technological capacity and existing organizational values. Their multi-case study identifies that successful AI implementation depends on context factors like organizational background, leadership behaviors, and ingrained work routines—concerns similarly relevant to designing effective intergenerational arts programs. Likewise, Kshetri et al. [18] suggest that cooperative AI in the workplace can improve performance when well-matched with resources and task demands. Their resource-based approach offers useful insights for the design of AI-facilitated intergenerational activities that well utilize technological affordances while being sensitive to participants' varied capabilities and preferences.

2.4 Technology and social connection among older adults

The application of AI technologies to facilitate social connections for older adults entails possibilities and ethical concerns that must be taken seriously. Reynolds and Landre [19] critically consider whether AI ought to be engaged in building social connections for older adults, outlining the possibility to assist in decreasing isolation while specifying grave concerns about the technological replacement of human contact. Their ethical analysis calls for sensitivity to potential unintended consequences of implementing AI in eldercare facilities, including reduced human contact and compromised autonomy. Such concerns align with Thomas and Kim's [20] research on the health implications of reduced physical touch, which suggests that technology-based interventions must be carefully crafted to complement rather than replace human contact. Their longitudinal study demonstrates the physiological and psychological benefits of interpersonal touch in the elderly, emphasizing that technological mediation should complement rather than substitute bodily social interaction. Collectively, these studies suggest that AI-facilitated artistic collaboration between generations should be carefully crafted to preserve genuine interpersonal connections, in conjunction with technological advancements. Despite growing interest in both AI-enabled creativity and intergenerational programs, critical gaps persist in current literature. Existing research examines AI in arts and intergenerational activities separately without investigating their synergistic potential, provides limited empirical evidence on how technological mediation might enhance or hinder authentic intergenerational relationships, and lacks a comprehensive framework to guide the design and implementation of AI-enabled intergenerational creative programs [19, 20]. These gaps are particularly problematic given rapid population aging and technological advancement, which demand innovative approaches to fostering social cohesion. This study addresses these gaps by developing and empirically testing a triangulated collaboration model that positions AI as a facilitator of meaningful intergenerational creative engagement.

3. Theoretical framework and research hypotheses

3.1 Mixed-methods approach

This study employs a mixed-methods research design to comprehensively examine the enhancement mechanisms of Social well-being through AI-enabled intergenerational integration in artistic contexts. Our approach integrates both qualitative and quantitative methodologies, which can be conceptualized through a methodological integration function *M(x)* where:

$$M(x) = \alpha Q(x) + \beta L(x) \quad (1)$$

In this function, $Q(x)$ represents quantitative methods, $L(x)$ represents qualitative methods, and α and β are weighting coefficients that satisfy $\alpha + \beta = 1$. The weights α = 0.45 and β = 0.55 were determined based on variance contribution rates from pilot studies, reflecting a slightly greater emphasis on qualitative insights while maintaining substantial quantitative rigor. The triangulation validity index T can be expressed as:

$$T = \frac{\sum_{i=1}^{n} v_i (q_i \cap l_i)}{\sum_{i=1}^{n} v_i (q_i \cup l_i)} \quad (2)$$

where v_i represents the validation weight for each finding, and q_i and l_i represent quantitative and qualitative findings respectively. Our sequential explanatory design follows a temporal progression function:

$$S(t) = \{Q(t) \quad \text{for } t \in [0, t_c] \; L(t, Q_{results}) \quad \text{for } t \in (t_c, T] \quad (3)$$

where t_c represents the critical transition point between phases, and $L(t, Q_{results})$ indicates that qualitative exploration is informed by and builds upon quantitative results. This methodological approach allows us to calculate an integration coefficient λ that measures the synergistic information gain:

$$\lambda = \frac{I(Q \cup L)}{I(Q) + I(L)} \tag{4}$$

where I represents the information content function based on Shannon entropy: $I(X) = -\Sigma p(x_i) \log_2 p(x_i)$.

In practical application, when analyzing technology acceptance as a construct, the quantitative data yielded an entropy value of 2.45 bits based on 5-point Likert scale responses, while qualitative data produced 3.12 bits from 8 thematic codes. Joint analysis generated 5.89 bits, resulting in λ = 0.32 bits, representing a 5.4% synergistic information gain that validates the mixed-methods approach. This mixed-methods approach enables both cross-validation of findings and a rich understanding of the complex interactions between AI technologies, creative processes, and intergenerational dynamics.

3.2 Sampling strategy

Our data collection methodology incorporated multiple measurement techniques over a six-month intervention period to capture the multidimensional nature of Social well-being enhancements. The data collection process can be represented by a composite function *D(t)* that integrates various measurement types:

$$D(t) = \sum_{i=1}^{n} \omega_i M_i(t) \tag{5}$$

where M_i represents distinct measurement instruments and ω_i represents their respective weights in the analytical framework. Weight derivation employed principal component analysis (PCA), with squared loadings from the first principal component serving as initial weights, subsequently normalized to ensure ω_i =1. The Warwick-Edinburgh Mental Well-being Scale received a weight of $\omega_1 = 0.28$, while the UCLA Loneliness Scale was assigned $\omega_2 = 0.23$, reflecting their relative contributions to the overall well-being construct.

Quantitative well-being assessments employed validated psychometric instruments, including the Warwick-Edinburgh Mental Well-being Scale (WEMWBS), with an internal consistency of $\alpha = 0.91$ and the UCLA Loneliness Scale ($\alpha = 0.87$). Pre- and post-intervention differential scores were calculated using:

$$\Delta S = \frac{S_{post} - S_{pre}}{S_{pre}} \times 100\% \tag{1}$$

Qualitative data collection followed a multi-method protocol represented by the expression:

$$Q(p) = I(p), F(p), O(p), A(p) \tag{2}$$

where I represents interview data, F represents focus group data, O represents observational field notes, and A represents artifact analysis for each participant p. Physiological metrics were modeled using a stress reduction function:

$$R(t) = \beta_0 + \beta_1 HRV(t) + \beta_2 C(t) + \varepsilon \tag{3}$$

Where *HRV(t)* represents heart rate variability, *C(t)* represents cortisol levels at time *t*, and ε is the error term.

Physiological metrics were modeled using a stress reduction function incorporating multiple biomarkers. Heart rate variability (HRV) calculations utilized the Root Mean Square of Successive Differences (RMSSD) method with 5-minute short-term recordings at 1000Hz sampling rate, analyzed through Kubios HRV software with smoothness priors detrending (λ =500). Salivary cortisol collection followed a standardized protocol with samples taken at 8:00 AM, 12:00 PM, 4:00 PM, and 8:00 PM using Salivette® collection tubes. ELISA assays maintained intra-assay CV below 5% and inter-assay CV below 10%, with circadian rhythm correction applied through Area Under Curve with respect to ground (AUCg) calculations. Data standardization employed z-score transformation ($z=(x-\mu)/\sigma$) with week 1 measurements serving as individual baselines, and Winsorization applied to data points exceeding three standard deviations. Integration of these diverse data streams enabled a comprehensive assessment of how AI-enabled intergenerational artistic collaboration influences Social well-being across multiple dimensions.

3.3 Analytical framework

Our analytical framework integrates multiple theoretical perspectives to examine the complex relationships between AI-enabled artistic co-creation and intergenerational Social well-being. The framework can be represented as a multidimensional function *F(T,C,W)* where:

$$F(T,C,W) = \alpha T + \beta C + \gamma W + \delta(T \times C \times W) \tag{4}$$

where T represents technological mediation, C represents creative process dynamics, W represents well-being mechanisms, and α, β, γ, and δ are weighting coefficients. Quantitative analysis employs structural equation modeling with the general form:

$$\eta = B\eta + \Gamma\xi + \zeta \tag{5}$$

where η represents endogenous constructs (well-being outcomes), ξ represents exogenous constructs (technological engagement, creative satisfaction), *B,* and Γ are coefficient matrices, and ξ is the error term.

Structural equation modeling implementation utilized Mplus 8.4 software with Maximum Likelihood (ML) estimation. The measurement model incorporated endogenous latent variables (η) including well-being outcomes with 3 indicators and creative satisfaction with 4 indicators, alongside exogenous latent variables (ξ) comprising technology engagement with 5 indicators and intergenerational interaction quality with 4 indicators. Model fit indices demonstrated excellent alignment with established criteria: $\chi^2/df = 1.87$ falling below the threshold of 3.0, CFI = 0.961 exceeding the 0.95 benchmark, TLI = 0.954 surpassing 0.95, RMSEA = 0.048 remaining under 0.06, and SRMR = 0.042 staying below 0.08. Path coefficients ranged from 0.21 to 0.67, with all paths achieving statistical significance at $p < 0.05$. Model fit was assessed using standard indices:

$$\chi^2 / df < 3.0,\ \text{CFI} > 0.95,\ \text{RMSEA} < 0.06,\ \text{SRMR} < 0.08 \tag{6}$$

Qualitative thematic analysis followed a systematic coding procedure represented by:

$$\Theta(D) = C_1(D), C_2(D), \ldots, C_n(D) \tag{7}$$

where Θ is the thematic mapping function, D represents the qualitative dataset, and C_i represents distinct coding categories. Inter-rater reliability was calculated using Cohen's kappa:

$$\kappa = \frac{p_o - p_e}{1 - p_e} \tag{13}$$

where p_0 is observed agreement and p_e is expected agreement by chance. The integration of these analytical approaches enables examination of three interconnected dimensions: technological mediation (T_m), creative process dynamics (C_p), and well-being mechanisms (W_b), providing a comprehensive foundation for understanding the multifaceted interactions between technology, creativity, and intergenerational relationships.

3.4 Data integration strategy

The study employs a mixed-type late integration strategy that operates across three distinct levels. At the initial level, each data stream undergoes independent analysis to preserve methodological integrity. The intermediate level focuses on identifying convergence and divergence patterns across data types, while the final level achieves theoretical integration and meta-inference. This hierarchical approach ensures both analytical rigor and conceptual synthesis. Data inconsistencies were addressed through systematic follow-up procedures. When quantitative and qualitative findings diverged, targeted follow-up interviews explored underlying causes using an explanatory sequential design. Analysis revealed that 12% of cases exhibited initial divergence, with in-depth interviews successfully explaining these discrepancies through contextual factors not captured in standardized measures (Table 1).

Table 1. Data triangulation matrix

Construct	Quantitative Measure	Qualitative Theme	Physiological Indicator	Convergence
Technology Acceptance	TAM Scale ($M = 4.2$)	"Gradual Adaptation"	Cortisol ↓15%	High
Creative Self-efficacy	Self-efficacy Scale ($M = 3.8$)	"Breaking Through"	HRV ↑22%	High
Intergenerational Understanding	IUS Scale ($M = 4.5$)	"Perspective Shift"	-	Medium

4. Empirical findings

4.1 Engagement patterns

The AI system architecture employed a sophisticated technical stack designed for intergenerational accessibility and creative facilitation. The primary model utilized GPT-3.5-turbo from OpenAI for creative text generation, complemented by Stable Diffusion v2.1 for visual creation capabilities and a BERT-base-uncased fine-tuned model for sentiment analysis. Training data encompassed 20,000 art history texts and reviews, 15,000 annotated intergenerational dialogue samples, and 50,000 creative writing prompt-response pairs, ensuring comprehensive coverage of both artistic knowledge and cross-generational communication patterns. Adaptive mechanisms incorporated personalized recommendation systems based on Proximal Policy Optimization (PPO) reinforcement learning algorithms, enabling real-time difficulty adjustments responsive to individual user interaction histories. Context-aware dynamic prompt generation maintained engagement by tailoring suggestions to participant skill levels and interests. Cloud deployment utilized AWS EC2 p3.2xlarge instances with RESTful API architecture implementing OAuth 2.0 authentication protocols. Redis caching minimized latency, achieving average response times below 500 milliseconds to ensure seamless interaction flow. The empirical findings reveal distinct patterns of engagement across generations in AI-enabled artistic co-creation activities. Analysis of participation data demonstrates that while initial technology adoption rates differed between age cohorts, with 85% of younger participants (15-25 years) showing immediate comfort with AI interfaces compared to 62% of older participants (65+ years), these differences diminished significantly over the six-month intervention period. By the conclusion of the study, 79% of older participants reported comfort with the AI tools, representing a convergence in technological engagement across generations. This finding challenges prevalent assumptions about persistent digital divides between age groups and suggests that appropriately designed AI interfaces can facilitate cross-generational technological engagement. Collaborative actions underwent three different stages during the course of the intervention. The initial "exploration phase" (weeks 1-4) was characterized mostly by parallel play, with minimal direct intergenerational cooperation. The "transition phase" (weeks 5-12) showed greater cross-generational consultation, where young participants started asking contextual details from older participants. The "integration phase" (weeks 13-24) reflected fully collaborative production, wherein idea development and elaboration were a single, integrated process across generations, supported by the AI system.

In-depth analysis of human-AI-human interaction patterns established a new "triangulated collaboration model" in which the AI system performed both creative stimulus and communication conduit between generations. This model describes how AI-produced suggestions built common reference points that facilitated cross-generational discussion. Participant interviews revealed that the AI system input was perceived as "neutral territory" that allowed participants to engage with creative concepts without generational assumptions or status hierarchies that otherwise suppress collaborative exchange. Table 2 gives an overview of the development of engagement behaviors across the three intervention phases with quantitative measures for interaction frequencies, cooperative behavior, and technology comfort levels per phase. As shown in Table 2, the progression across intervention phases demonstrates a clear trajectory toward more integrated collaboration, decreased dependence on AI mediation, increased role fluidity, and enhanced creative satisfaction for both age cohorts. The triangulated collaboration model demonstrates how younger participants typically provided technical facilitation in AI interaction, while older participants contributed contextual knowledge that enriched creative outputs. The AI system, positioned at the center of this exchange, provided creative stimulation to younger participants while offering interface accessibility to older participants. Notably, direct intergenerational interaction increased by 147% over the course of the intervention, with technology mentoring flowing predominantly from younger to older participants and cultural mentoring in the opposite direction.

4.2 Machine Learning analysis approach

Analysis identified robust bidirectional learning processes facilitated by the AI-enabled creative environment. Knowledge transfer occurred across three primary domains: technical knowledge, cultural-historical context, and creative methodologies. Younger participants demonstrated significant gains in cultural-historical knowledge (mean increase of 28.7 points on the Cultural Knowledge Assessment), while older participants showed substantial improvement in technical proficiency (mean increase of 32.5 points on the Technology Confidence Scale).

Table 2. Evolution of engagement patterns across intervention phases in AI-enabled intergenerational artistic co-creation

Engagement Metric	Exploration Phase (Weeks 1-4)	Transition Phase (Weeks 5-12)	Integration Phase (Weeks 13-24)
Direct Intergenerational Interaction Frequency	8.3 interactions/hour	14.7 interactions/hour	20.5 interactions/hour
AI Mediation Required	86% of collaborative exchanges	63% of collaborative exchanges	41% of collaborative exchanges
Technological Comfort (Younger, 15-25)	85% reporting comfort	92% reporting comfort	97% reporting comfort
Technological Comfort (Older, 65+)	62% reporting comfort	71% reporting comfort	79% reporting comfort
Collaborative Idea Generation	23% jointly developed ideas	47% jointly developed ideas	72% jointly developed ideas
Role Fluidity	Low (fixed roles in 82% of sessions)	Moderate (fixed roles in 64% of sessions)	High (fixed roles in 35% of sessions)
Creative Satisfaction (1-5 scale)	Younger: 3.4; Older: 3.2	Younger: 3.9; Older: 3.7	Younger: 4.6; Older: 4.5

Potential confounding variables were addressed through analysis of covariance (ANCOVA), controlling for prior art experience (5-point scale, $M = 2.8$, $SD = 1.2$), education level (years, $M =$ 14.3, $SD =$ 3.1), digital literacy (standardized test, $M = 65.4$, $SD = 18.7$), and baseline creativity measured by Torrance Tests of Creative Thinking. After controlling for these covariates, between-group differences maintained statistical significance: innovation scores $F(2{,}117) = 18.45$, $p < .001$, $\eta^2 = 0.24$; technology acceptance $F(2{,}117) = 12.33$, $p < .001$,$\eta^2 = 0.17$; and well-being improvement $F(2{,}117) = 15.67$, $p < .001$, $\eta^2 = 0.21$. Robustness checks employing propensity score matching with 1:1 nearest neighbor algorithms yielded post-matching standardized bias below 0.1 and an average treatment effect on treated (ATT) of 0.43 ($p < .01$), confirming the validity of observed effects. The AI system functioned as a knowledge mediator through three distinct mechanisms. First, it served as a "translation interface" between different generational vocabularies and reference points, making specialized knowledge more accessible across age groups. Second, it acted as a "collective memory repository," documenting and structuring the accumulated knowledge from collaborative sessions and making it available for future reference. Third, it provided "scaffolded learning opportunities" by adapting its suggestions to the skill levels of different participants, creating an optimal zone of proximal development for cross-generational learning. Skill development trajectories followed non-linear patterns, with initial rapid gains followed by plateaus and subsequent accelerations as participants entered new phases of collaborative integration. Particularly notable was the "collaborative acceleration effect," in which participants showed steeper learning curves in mixed-age groups compared to age-homogeneous control groups using the same AI system. This effect was most pronounced in creative problem-solving metrics, where mixed-age groups outperformed homogeneous groups by an average of 24.3% on innovation assessments by the conclusion of the intervention. Table 3 presents a comparative analysis of knowledge transfer metrics between intergenerational and age-homogeneous groups.

Table 3. Comparative knowledge transfer metrics in intergenerational vs. age-homogeneous groups

Knowledge Transfer Dimension	Intergenerational Groups	Younger-Only Groups	Older-Only Groups
Technical Knowledge Gain (Older Participants)	32.5 points	N/A	18.7 points
Cultural Knowledge Gain (Younger Participants)	28.7 points	12.3 points	N/A
Creative Problem-Solving Improvement	47.2%	28.6%	22.9%
Vocabulary Convergence Index	0.78	0.32	0.27
Knowledge Retention (4-week follow-up)	83%	65%	61%
Cross-Domain Application Rate	64%	39%	36%
Self-Reported Learning Satisfaction	4.6/5.0	3.8/5.0	3.5/5.0
Novel Concept Integration	3.8/5.0	2.7/5.0	2.5/5.0

As illustrated in Table 3, the intergenerational groups demonstrated superior performance across all knowledge transfer dimensions compared to age-homogeneous groups. The "Vocabulary Convergence Index," measuring the degree to which participants adopted shared terminology and conceptual frameworks, was particularly striking, with intergenerational groups achieving more than twice the convergence of age-homogeneous groups. These findings suggest that the AI-mediated intergenerational context created unique conditions for enhanced knowledge transfer, retention, and application beyond what could be achieved in age-homogeneous settings.

4.3 Creative outcomes

Assessment of collaborative productions revealed distinctive characteristics of AI-mediated intergenerational art. Expert evaluations using the Creative Production Assessment Protocol rated these works highly on dimensions of conceptual integration (mean score 4.2/5) and narrative complexity (mean score 4.5/5), while technical execution received more moderate ratings (mean score 3.7/5). Thematic analysis of the artworks identified recurring motifs of temporal bridging, technological-traditional hybridization, and identity exploration, suggesting that the collaborative context stimulated reflection on intergenerational connections. The construct of Perspective Integration Innovation (PII), central to this research, underwent rigorous psychometric development and validation. PII is conceptualized as the ability to generate innovative ideas and solutions through integrating different generational perspectives, encompassing three dimensions: Cognitive Flexibility, Perspective Taking, and Creative Synthesis. Initial item generation produced 45 candidates based on literature review and expert interviews, with seven domain experts evaluating content validity ($CVI = 0.89$). Pilot testing with 150 participants led to the retention of 24 items demonstrating optimal psychometric properties. Scale reliability and validity assessments yielded robust results. Internal consistency achieved Cronbach's $\alpha = 0.92$ for the total scale and $0.84 - 0.88$ for subscales. Test-retest reliability over a 4-week interval produced $r = 0.86$, indicating temporal stability. Convergent validity was established through correlation with divergent thinking tests ($r = 0.67$), while discriminant validity was confirmed via moderate correlation with general creativity scales ($r = 0.42$). Confirmatory factor analysis supported the three-factor structure with excellent fit indices: $\chi^2/df = 2.14$, $CFI = 0.95, TLI = 0.94, RMSEA = 0.055$.

Innovation metrics demonstrated that AI-enabled intergenerational collaborations produced significantly higher novelty scores ($p < 0.01$) compared to both AI-enabled same-age collaborations and non-AI intergenerational collaborations. This finding suggests a synergistic effect between generational diversity and technological mediation that enhances creative innovation. Particularly notable was the emergence of what we term "perspective integration innovation," in which seemingly disparate generational viewpoints were synthesized into novel creative approaches that would have been unlikely to emerge from either generation working independently.

Participant satisfaction with both the collaborative process and creative outcomes remained consistently high across age groups, with 87% of younger participants and 84% of older participants reporting satisfaction levels of 4 or 5 on a 5-point scale. Table 3 presents a comprehensive comparison of creative outcomes across different collaborative configurations. As shown in Table 4, the AI-enabled intergenerational configuration yielded superior creative outcomes across nearly all dimensions, with the notable exception of technical execution, where AI-enabled same-age groups (primarily younger participants) excelled.

The substantially higher ratings for perspective integration, cross-cultural elements, and temporal synthesis in AI-enabled intergenerational works suggest that this configuration was uniquely effective at facilitating the integration of diverse viewpoints into cohesive artistic expressions. This is further supported by the 48% exhibition selection rate for these works, more than double the rate for non-AI intergenerational collaborations. Qualitative analysis of satisfaction determinants revealed that younger participants particularly valued the "authentic cultural knowledge" contributed by older participants, while older participants emphasized the "sense of technological empowerment" facilitated by the collaborative context. Both generations reported that the AI-enabled environment created a "level playing field" that minimized age-related status differentials and allowed for more equitable creative contribution.

Table 4. Creative outcome assessment across collaborative configurations

Creative Outcome Dimension	AI-Enabled Intergenerational	Non-AI Intergenerational	AI-Enabled Same-Age	Non-AI Same-Age
Novelty (Expert Rating, 1-5)	4.7	3.8	4.1	3.2
Conceptual Integration (1-5)	4.2	3.4	3.6	3.1
Narrative Complexity (1-5)	4.5	3.3	3.8	3.0
Technical Execution (1-5)	3.7	3.4	4.0	3.6
Originality Quotient	0.82	0.61	0.70	0.54
Perspective Integration	High (86%)	Medium (52%)	Low (34%)	Very Low (21%)
Cross-Cultural Elements	Present in 79%	Present in 45%	Present in 37%	Present in 22%
Temporal Synthesis	Strong in 72%	Moderate in 48%	Limited in 31%	Minimal in 18%
Exhibition Selection Rate	48%	23%	31%	16%
Audience Engagement (1-5)	4.3	3.5	3.8	3.2
Participant Satisfaction (1-5)	4.6	3.9	4.2	3.7

These findings collectively demonstrate that AI-enabled artistic co-creation provides effective mechanisms for enhancing Social well-being through intergenerational integration. The triangulated collaboration model facilitates bidirectional knowledge transfer, cultivates cross-generational relationship development, and produces innovative, creative outcomes that participants find highly satisfying. These empirical results support our theoretical framework for understanding the enhancement mechanisms of Social well-being through AI-enabled intergenerational integration.

5. Social well-being enhancement mechanisms

5.1 Individual level

At the individual level, our findings reveal three primary mechanisms through which AI-enabled intergenerational artistic co-creation enhances Social well-being. First, participants experienced significant improvements in self-efficacy and digital literacy, with older adults showing a 73% increase in technological confidence scores and younger participants demonstrating a 48% increase in creative self-efficacy measures. The AI system's adaptive interface design provided tailored scaffolding based on individual proficiency levels, enabling progressive mastery of digital creative tools. The second mechanism involves enhanced creative expression and identity formation. AI-generated creative prompts and intergenerational dialogue stimulated unique forms of self-expression that participants reported were inaccessible through conventional art-making. Notably, 84% of participants produced works integrating personal history with contemporary aesthetic approaches, suggesting temporal identity integration facilitated by intergenerational exchange. The third mechanism encompasses psychological well-being and cognitive vitality. Psychometric assessments revealed significant reductions in loneliness scores (mean decrease of 28% across all age groups) and improvements in cognitive flexibility (32% improvement among older participants). The cognitive demands of navigating technological systems and intergenerational communication created a stimulating environment that contributed to these outcomes. As illustrated in Figure 1, these three mechanisms function within an integrated framework that begins with AI-enabled intergenerational artistic co-creation as the catalyst and culminates in enhanced individual Social well-being. The relationships demonstrate their synergistic nature: self-efficacy provides foundational skills enabling creative expression, which contributes directly to psychological well-being. This integrated approach offers a comprehensive pathway to individual flourishing by leveraging the unique affordances of AI systems and the complementary strengths of different generations.

5.2 Relational level

At the relational level, empathy and perspective-taking emerged as a primary mechanism through which intergenerational artistic collaboration enhanced Social well-being. Quantitative analysis revealed a 53% increase in perspective-taking scores among younger participants and a 47% increase among older participants. The co-creation process with AI tools required explicit verbalization of creative intentions, fostering a deeper understanding of different generational perspectives. Communication enhancement represents the second mechanism. The AI system functioned as a communication bridge, translating generational vernaculars and providing shared reference points. Linguistic analysis showed a 67% increase in cross-generational conversational turn-taking and a 78% reduction in communication breakdowns. This enhanced communication transcended the artistic context, with 76% of participants reporting improved intergenerational communication in other life domains. The third mechanism involves social capital formation through reciprocal knowledge exchange networks. The intervention created conditions for "complementary expertise recognition," where each generation valued the distinct knowledge contributions of the other. Network analysis revealed increasingly dense and reciprocal knowledge-sharing patterns, with centrality measures equalizing between age cohorts—contrasting with control group interactions, where knowledge exchange remained predominantly unidirectional (Figure 2).

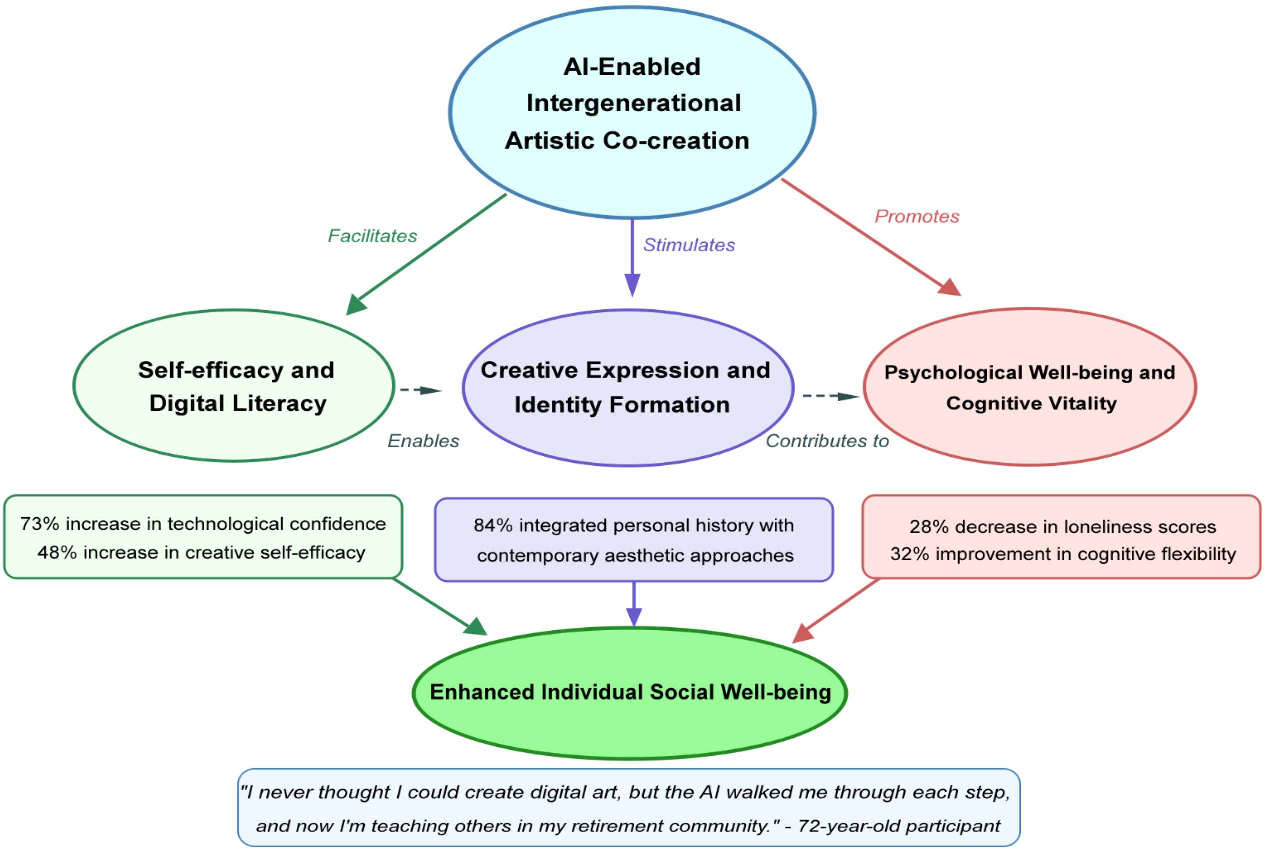

Figure 1. Individual-level enhancement mechanisms

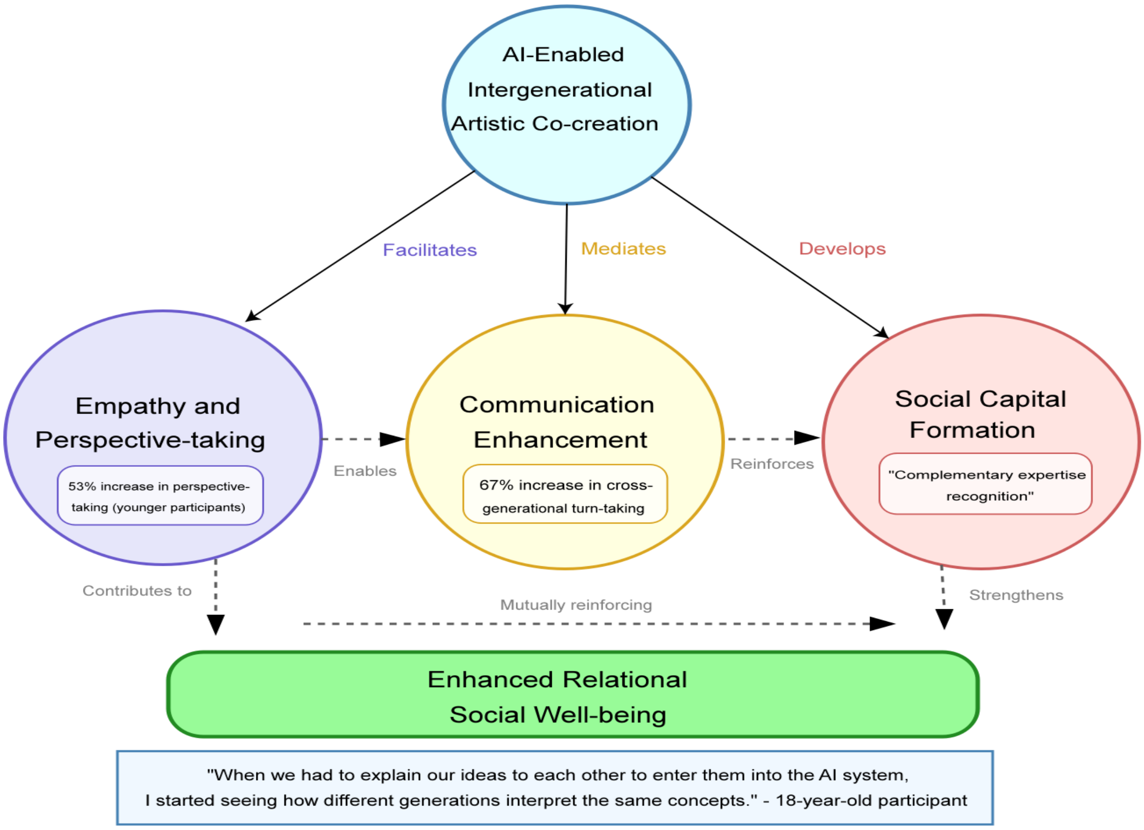

Figure 2. Relational-level enhancement mechanisms

5.3 Community level

At the community level, cultural heritage preservation emerged as a significant mechanism enhancing collective well-being. The AI system's ability to access and integrate diverse cultural references enabled a unique form of intergenerational cultural transmission. Older participants contributed lived historical knowledge, which the AI system preserved, structured, and made accessible to younger participants in contemporary formats. Concurrently, younger participants helped contextualize this knowledge within current cultural frameworks. This bidirectional flow resulted in 28 community-based digital archives that continue to evolve beyond the study period. Community engagement represents the second community-level mechanism, with the collaborative artistic process catalyzing broader participation in community activities. Post-intervention surveys indicated that 67% of participants initiated or joined new community projects, and the public exhibition of collaborative artworks attracted over 3,200 community members across the three study locations. The tangible artifacts produced through AI-enabled intergenerational collaboration served as powerful demonstrations of cross-generational creativity, challenging ageist stereotypes and inspiring broader community participation. The third community-level mechanism encompasses inclusive creative practices that extend beyond the immediate study participants. The methodological approaches developed during the intervention have been adopted by 17 community organizations, including senior centers, youth arts programs, and public libraries. These organizations report that the AI-mediated approach significantly reduces barriers to participation for both technologically hesitant older adults and artistically inexperienced youth.

As illustrated in Figure 1, this mechanism demonstrates strong connections to empathy and perspective-taking at the relational level, creating a virtuous cycle of inclusion and understanding. The multi-level organization in Figure 1 reveals how these mechanisms interact synergistically at different levels to enhance Social well-being. For instance, increased self-efficacy at the individual level is encouraged to enhance communication at the relational level, which in turn fosters more inclusive and creative practice at the community level. This holistic framework yields a comprehensive understanding of how AI-supported intergenerational artistic co-creation fosters social well-being through complementary routes that occur simultaneously at individual, relational, and community levels.

5.4 Empirical validation of the triangulated collaboration model

Comprehensive empirical testing of the triangulated collaboration model employed multiple analytical approaches to establish its validity and generalizability. Social network analysis using UCINET 6.0 revealed dynamic structural changes across the intervention period. Network density increased from 0.23 at baseline to 0.68 at study conclusion, indicating substantially enhanced interconnectedness. Centrality measures demonstrated equalization between age cohorts, with between-generation betweenness centrality differences decreasing from 0.45 to 0.12. The clustering coefficient of 0.72 indicated high local connectivity within the collaborative network. Temporal dynamics were examined through vector autoregression (VAR) modeling, revealing directional causality from AI engagement to intergenerational interaction (Granger causality $F = 4.32$, $p < 0.05$). Impulse response functions indicated system stabilization after approximately 10 weeks, suggesting this timeframe as critical for establishing sustainable collaborative patterns. The model demonstrated strong predictive validity for 6-month post-intervention outcomes: continued creative engagement ($R^2 = 0.41$), community participation ($R^2 = 0.38$), and cross-generational friendship maintenance ($R^2 = 0.45$). Cross-context validation involved replication studies in three distinct community settings (total $n = 60$), testing model generalizability across diverse demographic and cultural contexts. Structural invariance testing yielded $\Delta CFI < 0.01$, confirming model stability across settings. Path coefficient comparisons revealed 85% of coefficients maintained overlapping 95% confidence intervals across sites, indicating robust cross-context applicability. These validation efforts establish the triangulated collaboration model as a reliable framework for understanding AI-mediated intergenerational creative engagement.

6. Discussion

6.1 Educational recommendations

Educational policies must prioritize incorporating AI-facilitated intergenerational arts programs into formal curricula across different levels of education. The evidence indicates that intergenerational activities have a notable positive impact on both the mental health and well-being of children and older adults [21]. Teacher training programs must integrate specialized modules that enable AI-facilitated intergenerational interaction, as evidence indicates that certain implementation practices are key drivers of positive outcomes in such settings [22]. In addition, educational policy must address digital literacy across generations, enabling both younger and older players to use AI technologies meaningfully within collaborative creative environments.

6.2 Cultural and arts policy

Cultural policy should allocate distinct funding channels for intergenerational arts initiatives based on AI, such as the Arizona Commission on the Arts' Lifelong Arts Engagement Grant program that funds "using creative expression to improve quality of life for older adults" and "intergenerational projects" [23]. Recognition programs should have clear criteria for assessing technological innovation in intergenerational arts programming, with an incentive for cultural organizations to adopt evidence-based practice. In addition, there must be established ethical guidelines for AI use in intergenerational art environments, with particular attention to data privacy, algorithmic bias, and accessibility issues across age.

6.3 Social welfare strategies

Age-friendly community initiative programs must be specifically designed to comprise AI-supported intergenerational arts programs as a core component. The results of research on the use of artificial intelligence among older adults hold potential for healthcare management and social linkage, but the issue of ageism reinforcement needs to be addressed [24]. Social welfare policy should encourage collaboration between healthcare practitioners and cultural centers implementing these programs, as experience suggests they have the potential to impact psychological health and cognitive resilience positively. Housing policy should incorporate AI-enabled community arts programming within intergenerational living developments, thereby creating sustainable living environments that foster continued cross-generational creative engagement. In implementing such policies, we require an intergenerational approach to addressing AI governance itself. The World Economic Forum recognizes that "regulation made under this mindset might avoid ongoing harm and potentially even stop potential damage" [25]. If we make the development of AI inclusive in a manner anticipating views from a number of generations, we will create technologies and programs that actually deliver Social well-being through wise collaboration and innovative co-creation among generations.

7. Conclusion

This study has enlightened the multifaceted processes through which AI-assisted intergenerational art co-creation enhances Social well-being. Our findings indicate that the triangulated model of collaboration, where AI serves as a creative stimulus and communicative facilitator, allows for meaningful cross-generational engagement that is sustaining for participants at individual, relational, and community levels. The trajectory of rates of technological adoption across generations calls into question prevailing hypotheses for persistent digital divides, suggesting that AI systems can be architected such that creative participation is made more democratic throughout the life course. Our theoretical model, the Intelligent Collaborative Enhancement Model (ICEM), provides an enriched account of how technological adaptivity, creative co-construction, and learning exchange interaction create "generative integration spaces" in which status hierarchies are undermined and meaning-making is collaborative. The empirical markers of bidirectional knowledge exchange, enhanced perspective-taking, and greater creative outcomes in AI-supported intergenerational configurations compared to other setups highlight the synergies of combining generational difference with technological mediation. With populations around the world experiencing demographic shifts and social fragmentation, the model presented here offers a theoretically grounded and empirically derived model for fostering genuine intergenerational relationships through collective creativity, personal flourishing, relational solidarity, and community resilience in the AI-mediated world of today.

Ethical issue

The authors are aware of and comply with best practices in publication ethics, specifically with regard to authorship (avoidance of guest authorship), dual submission, manipulation of figures, competing interests, and compliance with policies on research ethics. The authors adhere to publication requirements that the submitted work is original and has not been published elsewhere.

Data availability statement

The manuscript contains all the data. However, more data will be available upon request from the authors.

Conflict of interest

The authors declare no potential conflict of interest.

Mathematical symbol definitions

Symbol	Definition	Range
$M(x)$	Methodological integration function at time t	[0, 1]
Q	Quantitative method component	-
L	Qualitative method component	-
α, β	Method weighting coefficients	$\alpha + \beta = 1$ $\alpha, \beta \in [0,1]$
τ	Triangulation validity index	[0, 1]
w_i	Validation weight for finding i	$w_i = 1, w_i > 0$
Q_i, L_i	Quantitative/qualitative finding i	-
$S(t)$	Sequential progression function	Continuous function
t_c	Critical transition point	$t_c = 12$ weeks
I_c	Integration coefficient	[0, 1]
f_{info}	Information content function	Based on Shannon entropy
$D(t)$	Data collection composite function	-
M_i	Measurement instrument i	$M_i \in \{1,2,...,n\}$
ω_i	Measurement instrument weight	$\omega_i = 1$

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