

Application of Transdisciplinary Practice in the Design of Intergenerational Interaction Products in Public Spaces for Dong Elderly People

1 Overview

With the development of society and the aging of the population, the design of public spaces for the elderly of the Dong nationality has become the focus of social attention. As a local ethnic group with rich culture and tradition, the design of public spaces for the elderly of the Dong nationality should not only meet basic functional needs, but also integrate the cultural characteristics and traditional values of the Dong nationality. However, traditional design methods often ignore the integration and coordination between different disciplines, resulting in many problems in the actual application of design solutions, such as poor cultural adaptability, imperfect functions, and insufficient intergenerational interaction. Therefore, the application of transdisciplinary research (TD) in the design of intergenerational interaction products in public spaces for the elderly of the Dong nationality is particularly important.

In this study, transdisciplinary theory was applied, hoping to combine theories from multiple disciplines such as sociology, semiotics, and service design to fully understand and design the public space products and service design for the elderly of the Dong nationality. Transdisciplinary theory emphasizes the joint participation and collaboration of experts from different disciplines, community

members, and stakeholders in the research process. The study uses participatory design methods to ensure that both the elderly and the younger generation can participate in the design process and express their needs and ideas. In addition, transdisciplinary theory can provide a framework to help identify and solve complex problems in the design of public spaces for the elderly of the Dong nationality, such as cultural inheritance, intergenerational interaction, and social participation. Transdisciplinary innovation emphasizes reflexivity and evolutionary perspectives, which means constantly reflecting on and adjusting research directions and methods during the research process to adapt to the changing social and technological environment. By integrating knowledge and methods from different disciplines, new understandings and theories are created, providing new ideas for the development of transdisciplinary research . It is helpful to increase social attention to the design of public spaces for the elderly of the Dong nationality and promote the protection and inheritance of Dong culture in society. Through a transdisciplinary approach , we design spaces that are in line with the cultural traditions of the Dong ethnic group and meet the needs of both the elderly and the younger generation, promote intergenerational interaction, improve the quality of life of the elderly, and help build a harmonious social environment.

2 Overview of Transdisciplinary Research

2.1 Definition of Transdisciplinary Research

Transdisciplinary Research (TDR) is a concept proposed by Romanian philosopher Basarab Nicolescu, which aims to solve complex real-world problems by integrating knowledge and methods from different disciplines. Nicolescu believes that transdisciplinary research is not just a simple combination of disciplines, but a higher level of integration, which requires researchers to establish new connections and dialogues between different disciplines. This research method emphasizes the comprehensiveness and integrity of knowledge, aims to break the boundaries of traditional disciplines and form a new knowledge production model. In relevant literature, TDR is considered to be an effective means to strengthen collaborative research, especially in the fields of sustainability and education. In the book *Transdisciplinary Theory, Practice and Education: The Art of Collaborative Research and Collective Learning*ⁱ, the authors explore in depth how transdisciplinary thinking can enrich academic and social experiences by promoting collaborative learning and action. The book emphasizes the importance of diverse knowledge systems and points out that a reflective and action-oriented approach is necessary in research and education. The chapters in this book discuss in detail multiple aspects of transdisciplinary collaboration, including the role of flexibility and transversality in addressing issues of planetary health and the evolution of universities towards sustainable development. In addition, the article "Managing the Tensions of Transdisciplinary Research: A Review and Agenda for the Future of Knowledge Co-production in the Anthropocene"ⁱⁱ explores in detail the many challenges facing

transdisciplinary research, including institutional barriers and the soft skills required to form effective teams. SI Kalinin and LV Pankratova (2022) ⁱⁱⁱ point out that adopting a transdisciplinary scientific approach can significantly improve problem-solving capabilities and promote the transformation to sustainable development. In addition, the article discusses the possibility of implementing a transdisciplinary approach in future mathematics teacher training, arguing that this approach can enrich educational practice and cultivate students' capabilities. This is consistent with Nicolescu's This is consistent with the vision proposed by the Institute to transcend disciplinary boundaries to gain a more comprehensive understanding of complex problems.

The concept of transdisciplinary research has gradually developed and evolved since the mid-20th century. Initially, transdisciplinary research was mainly seen as a simple collaboration between disciplines, where researchers from different disciplines worked together on a project ^{iv}. Over time, researchers gradually realized that collaboration alone could not adequately solve complex real-world problems, so transdisciplinary research began to develop towards a deeper level of integration.

In the late 20th and early 21st centuries, transdisciplinary research was gradually incorporated into a broader social and scientific context, emphasizing collaboration with non-academic stakeholders ^v. This collaboration includes not only academic experts, but also policy makers, businesses, community members, etc., to ensure that research results can better serve society. For example, in the

field of sustainable development, transdisciplinary research is widely used to address the complexity of environmental, economic and social issues.

In addition, the methods of transdisciplinary research are also constantly enriched and improved. Modern transdisciplinary research not only focuses on the integration of knowledge, but also emphasizes interaction and feedback in the research process. Related literature also puts forward the importance of participatory action research (PAR) in promoting cooperation among stakeholders^{vi}. This method combines traditional knowledge with modern technology to show how stakeholder participation can improve the results and sustainability of local enterprises. Select sources to view detailed information and availability options. Through continuous communication and collaboration, researchers form a dynamic knowledge production process to meet the ever-changing challenges of reality.

2.2 Key Principles of Transdisciplinary Research

The core of transdisciplinary research lies in the integration between different disciplines. This integration is not just a simple superposition of knowledge from different disciplines, but a comprehensive research system formed through in-depth communication and cooperation. The integration process requires researchers to break the traditional disciplinary boundaries and combine their respective expertise and methods to solve complex problems. For example, in the cooperation between environmental science and economics,

researchers have developed a green economic model that not only considers the impact of environmental factors on economic development, but also incorporates economic principles to evaluate the cost-effectiveness of sustainable development policies ^{vii}. This interdisciplinary integration can generate new insights and solutions and promote the innovation and development of knowledge.

Transdisciplinary research emphasizes real-world problem orientation. These problems are usually complex and multidimensional, and it is difficult for a single discipline to solve them independently. For example, when dealing with global issues such as climate change and the global health crisis, transdisciplinary research provides more comprehensive and effective solutions by integrating the perspectives and methods of different disciplines ^{viii}. Involving different stakeholders can expand the range of perspectives and skills, which is crucial for developing comprehensive solutions suitable for complex socio-economic contexts. Researchers need to clarify the practical significance of research problems and ensure that the research results can have a positive impact on the real world. This problem-oriented research approach not only improves the practicality and pertinence of research, but also promotes the close integration of scientific research with social needs.

2.3 Application of Transdisciplinary Research in Product Design

The transdisciplinary principle emphasizes examining design problems from

multiple perspectives, helping designers to more fully understand user needs and the market environment. For example, when designing a smart wearable device for the elderly, it is necessary not only to consider the product's functions and technical implementation, but also to pay attention to the elderly's physiological characteristics, psychological needs, and usage habits^{ix}. By considering these factors, developers can create more effective and user-friendly solutions, thereby improving the quality of life of the elderly. By integrating knowledge from multiple disciplines such as medicine, psychology, and sociology, designers can more accurately define design problems and provide a solid foundation for subsequent design solutions.

And the transdisciplinary principle encourages designers to break the traditional mindset and draw on innovative thinking and methods from different disciplines. For example, when designing a new type of transportation, you can combine theories and technologies from multiple disciplines such as industrial design, mechanical engineering, and computer science^x. Industrial design provides guidance on the product's appearance and user experience, mechanical engineering ensures the product's structural strength and power performance, and computer science provides technical support for intelligent navigation and autonomous driving. This cross-disciplinary collision of thinking can inspire more creative inspiration and promote innovation and optimization of design solutions.

Transdisciplinary principle requires designers to work closely with experts in

different fields to jointly solve technical problems and realize design intentions. For example, when developing a wearable health monitoring device, designers need to form a transdisciplinary team with electronic engineers, biomedical experts, software developers, etc. ^{xi}Electronic engineers are responsible for the design of hardware circuits and the integration of sensors, biomedical experts provide methods for collecting and analyzing human physiological data, and software developers develop data processing algorithms and user interfaces. Through the collaboration of a transdisciplinary team, the technical feasibility and functional integrity of the product prototype can be ensured.

The transdisciplinary guides designers to adopt diversified testing methods and evaluation criteria to comprehensively test product performance and user experience. For example, when testing a smart home product, it is necessary not only to test the stability and compatibility of the product from a technical perspective, but also to examine the user's experience and acceptance from a psychological and sociological perspective ^{xii}. By collecting and analyzing user feedback information and combining analytical tools and models from different disciplines, designers can discover problems and deficiencies in the product and make targeted optimizations and improvements accordingly.

3 Innovative methods for product design

3.1 Advantages of a Transdisciplinary Approach

A transdisciplinary approach can significantly enhance innovation

capabilities by integrating knowledge and perspectives from different disciplines. Researchers from different disciplines bring diverse ways of thinking and methodologies, and this diversity can inspire new ideas and solutions. For example, in the development of medical imaging technology, the combination of X-ray principles in physics and medical clinical needs has greatly improved the accuracy and efficiency of medical diagnosis ^{xiii}. In addition, transdisciplinary research can also give rise to new research fields and disciplines. For example, the intersection of international politics and economics, psychology and linguistics gave birth to international political economics, international political psychology and international political linguistics respectively ^{xiv}. This kind of transdisciplinary innovation not only promotes the generation of knowledge, but also provides theoretical guidance for solving new problems.

Transdisciplinary approaches have significant advantages in solving complex problems. Many real-world problems involve knowledge and skills from multiple subject areas, and it is often difficult for a single discipline to provide a comprehensive solution. Through transdisciplinary collaboration, researchers can deeply analyze problems from multiple perspectives to find more effective solutions. For example, when dealing with the global issue of climate change, researchers combine climate models from natural sciences with policy research from social sciences to better understand the social impacts of climate change and develop practical response strategies ^{xv}. In addition, transdisciplinary methods can also improve the practicality and sustainability of research and help

researchers combine theoretical research with practical applications. For example, in the field of environmental science, transdisciplinary research can more comprehensively assess the impact of environmental policies by integrating knowledge from ecology, economics, and sociology ^{xvi}. This integrated approach is critical to addressing today's pressing sustainability challenges.

3.2 The impact of transdisciplinary research on personal knowledge and work

Transdisciplinary research significantly improves one's understanding of complex issues by integrating knowledge and methods from different disciplines. First, it enables individuals to look at problems from multiple angles, thereby gaining a more comprehensive perspective. For example, when studying the impact of environmental changes on society, environmental science provides data and theory about changes in the natural environment, while sociology helps understand the impact of these changes on human social structure and behavior ^{xvii}. This multi-perspective understanding helps individuals gain deeper insight into the nature of the problem and potential solutions. Secondly, transdisciplinary research promotes the development of critical thinking. In transdisciplinary teams, individuals need to constantly communicate and collaborate with colleagues from different disciplinary backgrounds, which requires them to reflect on and question their own views and assumptions ^{xviii}. Through this kind of critical thinking exercise, individuals can better identify and

solve problems in the research process and improve their problem-solving abilities. In addition, transdisciplinary research also enhances personal innovation awareness and capabilities. The combination of different disciplines can often inspire new ideas and creativity. For example, in the intersection of artificial intelligence and psychology, psychologists' understanding of human emotions is combined with computer scientists' machine learning techniques to develop intelligent systems that can recognize and analyze human emotions^{xix}. This kind of innovation not only promotes the development of related fields, but also enables individuals to come up with more innovative solutions at work.

In actual projects, the impact of transdisciplinary research on personal knowledge and work has been fully reflected. For example, in a research project on sustainable urban development, researchers come from multiple disciplines such as urban planning, environmental science, economics and sociology^{xx}. Urban planning experts provide professional knowledge on urban spatial layout and infrastructure construction, environmental scientists focus on the impact of urban development on the natural environment and sustainable resource utilization, economists analyze the economic benefits and costs of urban development, and sociologists study the impact of urban development on residents' quality of life and social relations. Through transdisciplinary cooperation, researchers not only gain new insights in their respective professional fields, but also integrate this knowledge to form a comprehensive model of sustainable urban development^{xxi}. This model not only takes into

account the economic and environmental factors of the city, but also pays attention to social and cultural issues, providing an important reference for urban planning and policy making. In this process, the personal understanding of the researchers has been greatly expanded. They can better understand the complexity and multidimensionality of urban development and improve their work ability and influence in related fields.

3.3 Reducing bias through transdisciplinary research

During the design process, potential biases may appear in many forms, affecting the functionality and user experience of the final product, such as user bias, data bias, cultural bias, etc. Designers may have preconceived views of the target user group based on their own background and experience. For example, when designing a health monitoring device for the elderly, the designer may assume that all elderly people are not interested in or good at using new technologies, thereby ignoring those who actively learn and use smart devices. When collecting and analyzing user data, there may be sample selection bias or subjectivity in data processing. If only data from young urban users is collected when designing a social application, the application may not meet the needs of rural or elderly users. And designers may ignore user needs and usage habits in different cultural backgrounds. For example, when designing an educational software for the global market, if only the teaching model and cultural elements of Western countries are considered, the applicability of the software in other

cultural backgrounds may be limited.

Transdisciplinary approaches provide a series of effective strategies to overcome bias in the design process by integrating knowledge and perspectives from different disciplines, such as forming a diverse team, adopting multidisciplinary analysis methods, conducting transdisciplinary user research, and continuous feedback and iteration. When team members come from different disciplinary and cultural backgrounds, they can bring diverse perspectives and ways of thinking. For example, when designing a piece of software, the team can include industrial designers, psychologists, computer scientists, and marketing experts ^{xxii}. Psychologists can help identify users' psychological needs, computer scientists are responsible for technical implementation, and marketing experts focus on the market positioning and user acceptance of the product. Secondly, combine theories and tools from different disciplines to analyze design problems and user needs. Collaborate with researchers from different disciplines to conduct comprehensive user research. For example, when designing an educational toy for children, you can work with pedagogy experts to understand children's cognitive development laws and learning needs ^{xxiii}; and work with psychologists to study children's attention and interests. During the design process, continuously collect feedback from different disciplinary backgrounds and iterate and optimize based on the feedback. For example, when developing a smart fitness device, you can invite sports science experts, nutrition experts, and user experience designers to participate in product

testing and evaluation, and continuously improve the product's functions and design based on their feedback ^{xxiv}.

Through these transdisciplinary strategies, designers can more fully identify and overcome biases in the design process, thereby creating more inclusive, adaptive, and innovative products.

4 Integration and synthesis of research results

4.1 Research Methods

Research design is the blueprint of the entire research process, which determines the direction and methods of the research. In this study, first of all, it is necessary to clarify the main goal of the research, which is to explore the application effect of transdisciplinary research in the design of intergenerational interaction products in public spaces for Dong elderly people. Specific goals include understanding the needs of Dong elderly people in public spaces, identifying obstacles in intergenerational interaction, and evaluating the innovation and effectiveness of transdisciplinary methods in product design. Secondly, around the research objectives, a series of specific research questions are proposed. For example, what are the main challenges faced by Dong elderly people in public spaces? How does intergenerational interaction occur in these public spaces? How does transdisciplinary methods promote innovation in product design? Finally, qualitative and quantitative research methods are combined to obtain more comprehensive research results. Qualitative research is

used to deeply understand the needs of Dong elderly people and the complexity of intergenerational interaction, while quantitative research is used to evaluate the effect of product design and the influence of transdisciplinary methods.

Data collection is a key step in obtaining information during the research process. In this study, interviews and observations were mainly used for qualitative research, and questionnaires were used for quantitative research to collect data. Under the guidance of the interview method, in-depth interviews need to be conducted with the elderly, the younger generation, community workers and relevant experts of the Dong ethnic group. The interview content includes the elderly's activity habits in public spaces, the way of interaction with the younger generation, their satisfaction with existing public facilities, and their expectations and suggestions for new product designs. The interview can be semi-structured in order to flexibly guide the topic and explore the details in depth. Through field observations in the public spaces of the Dong ethnic community, the interaction behaviors of the elderly and the younger generation, the use of public facilities, and the impact of environmental factors on the interaction are recorded. The observation method can help researchers intuitively understand the actual situation and discover information that may be missed in the interview. The views and needs of the elderly and the younger generation of the Dong ethnic group on public space and product design are investigated through questionnaires. The content of the questionnaire includes the evaluation of existing public facilities, the preference for new product design, the attitude

towards intergenerational interaction, etc. The questionnaire survey can expand the sample size and obtain more representative data.

After completing the survey, the collected data needs to be sorted, interpreted and summarized. Content analysis was conducted on the interview and observation records to identify the main needs of the elderly Dong people in public spaces, the characteristics of intergenerational interaction, and the innovations of transdisciplinary methods in product design. Data were coded and thematically analyzed through Nvivo, and the data were classified and summarized to form an in-depth understanding of the research questions. The questionnaire data was statistically analyzed through SPSS to calculate the mean, standard deviation and other statistics of the elderly and younger generations' satisfaction and preferences for public space and product design. By comparing the differences between different groups, the effect of product design and the influence of transdisciplinary methods were evaluated.

Finally, the qualitative and quantitative research results were analyzed comprehensively to verify and complement each other's findings. For example, the needs of the elderly for public space safety identified in the qualitative study can be further confirmed by the satisfaction scores in the quantitative survey data. The comprehensive analysis helps to form a comprehensive and accurate understanding of the research problem and provide a reliable basis for subsequent research and practice. Through the description and analysis of the above research methods, this study was able to systematically collect and

integrate data, laying a solid foundation for the integration and synthesis of research results.

4.2 Knowledge Integration

In the research process, it is crucial to combine the research results with the existing literature, which helps to verify the reliability of the research findings and put them in a broader academic context. In the early stages of the research, through extensive literature review, understand the existing research and theoretical framework in the field of intergenerational product design. For example, when studying the application of intergenerational integration theory in product design, you can refer to the relevant literature in sociology and design to understand the understanding and application methods of intergenerational integration by different scholars. After the research results come out, compare these results with the theories and findings in the literature to find out the consistency and differences, so as to verify the innovation and contribution of the research results.

Integration of theoretical framework: Integrate the research results into the existing theoretical framework to further enrich and develop these theories. Combine theories and methods from different disciplines to interpret and analyze the research results in multiple dimensions. For example, in intergenerational product design, the user demand theory in psychology, the intergenerational relationship theory in sociology, and the user experience

theory in design can be combined to comprehensively analyze the influencing factors and optimization strategies of intergenerational product design ^{xxv}.

Through research and literature analysis, we can have a more comprehensive understanding of the differences and commonalities in the needs of users of different generations. For example, the elderly may pay more attention to the safety and ease of use of the product, while the younger generation may pay more attention to the functionality and fashion of the product. This in-depth understanding can help to better meet the needs of different users in product design and improve the market competitiveness of the product. Refinement and optimization of design principles: Combining the research results and theories in the literature, a series of principles and methods for intergenerational product design can be refined. For example, the intergenerational integration product design model can include principles such as two-way socialization, functional complementarity, and emotional connection ^{xxvi}. These principles provide designers with clear guidance to help them better balance the needs and expectations of different generations in the design process.

By summarizing existing research and practice, we can discover innovative opportunities and potential directions in intergenerational product design. For example, under the concept of smart health care, we can combine emerging technologies such as artificial intelligence and the Internet of Things to develop smart products that can monitor the health of the elderly in real time and interact

with the younger generation ^{xxvii}. This innovation can not only improve the functionality and user experience of the product, but also provide new ideas and impetus for the development of intergenerational product design.

Through knowledge integration, researchers can combine their research results with existing literature to form a comprehensive understanding of intergenerational product design, providing a solid theoretical foundation and practical guidance for subsequent research and practice.

5. Addressing real-world challenges through transdisciplinary research

By using transdisciplinary research, we can effectively deal with many challenges in the real world. In terms of public space design, we face the challenge of promoting interaction between different age groups. For the elderly of the Dong ethnic group, public spaces need to meet their social needs, safety and comfort, while also providing spaces for interaction and entertainment for the younger generation. However, many public spaces have physical barriers, such as uneven ground and lack of handrails, which make it difficult for the elderly to move freely. In addition, some public spaces are too single-function and cannot meet the diverse needs of the elderly and young people. The cultural differences between different generations also require the design of public spaces to take into account the usage habits and preferences under different cultural backgrounds. To solve these problems, we can integrate urban planning and sociology. Through the cooperation of urban planning experts and

sociologists, we can design multifunctional public spaces that can not only meet the social and leisure needs of the elderly, but also provide places for entertainment and learning for young people. At the same time, we can introduce psychology and ergonomics, use psychological principles to understand the behavioral patterns and psychological needs of the elderly and young people, and combine ergonomics to optimize the layout and facility design of public spaces, such as designing ergonomic seats and barrier-free passages to ensure the safety and comfort of the elderly when using them. These transdisciplinary approaches can not only improve the quality of life of the Dong elderly, but also enhance their sense of well-being. By promoting emotional communication, products and services designed with transdisciplinary approaches can enhance the sense of belonging and well-being of the elderly. At the same time, transdisciplinary research helps the elderly better integrate into society and participate in community activities and public affairs, such as through community education projects, allowing the elderly to learn new skills or participate in volunteer services with young people, improving their social participation and sense of self-worth. These efforts to improve intergenerational interaction are of great significance to the long-term interests of the community, which can enhance the cohesion and stability of the community, promote mutual support and cooperation among different age groups, and form a more harmonious community environment. In addition, transdisciplinary approaches also promote resource sharing between different generations. The experience

and wisdom of the elderly can provide guidance to the young, and the innovative thinking and technical knowledge of the young can also help the elderly better adapt to modern society. Transdisciplinary approaches are also highly adaptable to other cultural backgrounds, emphasizing the integration of multiple disciplines and the integration of multiple cultures, and can be adjusted according to the characteristics of different cultural backgrounds.

Future research and implementation directions can further deepen interdisciplinary cooperation and explore more collaborative innovations between disciplines, such as combining knowledge from multiple disciplines such as sociology, psychology, and engineering to develop more intelligent and humane intergenerational interactive products. At the same time, attention should be paid to the concept of sustainable development to ensure that the design of public spaces and products can effectively serve the community in the long term, such as using environmentally friendly materials and energy-saving technologies to reduce the operating costs and environmental impact of public spaces. In addition, strengthening community participation is also key, encouraging community residents to participate in the design and implementation of public spaces and products, and collecting residents' opinions and suggestions through community workshops, questionnaires, etc., to ensure that the design results can better meet the actual needs of community residents.

6 Conclusion

Transdisciplinary research has important application value and significance in the design of intergenerational interaction products in public spaces for the elderly of the Dong nationality. By integrating theories and methods from multiple disciplines such as sociology, semiotics, and service design, transdisciplinary research can fully understand and solve complex problems in the design of public spaces for the elderly of the Dong nationality, such as cultural inheritance, intergenerational interaction, and social participation. The use of participatory design methods ensures the active participation of the elderly and the younger generation, making the design scheme closer to their actual needs and cultural background. Transdisciplinary research not only promotes innovation, improves the practicality and effectiveness of design schemes, but also enhances the quality of life and social happiness of the elderly. In addition, transdisciplinary research also shows great potential and broad application prospects in responding to other challenges in the real world, such as public space design, improving the quality of life of the elderly of the Dong nationality, and scalability in a cross-cultural context. Future research and practice can further deepen transdisciplinary cooperation, explore more collaborative innovations between disciplines, focus on the concept of sustainable development, and strengthen community participation to better meet the needs of community residents and promote the harmonious development of society.

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