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Art as a Medium for Fluoride Awareness: an Artificial Intelligence Visual Approach for Public Health Education

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ABSTRACT

Purpose: At present, scientific communication on the health effects and safety of fluoride in public health education faces two major challenges, such as the public's understanding of fluoride is polarized, and some groups fall into blind panic or ignore risks due to lack of intuitive perception, and traditional educational methods, i.e., text manuals, data charts are difficult to stimulate the public's active participation, resulting in difficulty in converting scientific information into a driving force for individual health behavior.

Methods: The present study proposes an interdisciplinary solution that integrates artificial intelligence generation technology and artistic media. First, based on the epidemiological data of fluoride exposure in the public health field and the results of public perception surveys, a multimodal knowledge graph is constructed, covering the chemical properties, health effects and social controversial cases of fluoride. Secondly, a dynamic visual mapping algorithm based on generative adversarial networks (GANs) developed to transform scientific data, such as fluoride concentration thresholds and enamel remineralization mechanisms into interactive artistic visual representations, and to achieve a concrete presentation of the dose-effect relationship through aesthetic languages, such as color gradients and particle motion. Finally, an immersive education scene is built by combining augmented reality (AR) technology to guide the audience to independently explore the "double-edged sword" properties of fluoride in an interactive experience that integrates virtual and real.

Results: The experimental data shows that the experimental group's emotional acceptance increases by 1.6 folds, risk perception accuracy increases by 31.5%, and the conversion rate of healthy behavior intention increases by 1.3 folds, indicating that the innovative visual education method has broad application potential in the field of public health.

Conclusions: It concluded that the experimental group based on the artistic visual education method is significantly better than the control group with traditional text manuals and chart education in terms of retention rate of fluoride-related health knowledge, accuracy of risk perception, and conversion of health behavior intentions, verifying the effectiveness of this method in improving the public's awareness and emotional acceptance of fluoride health risks.

Key-words: *Public health education; Artificial intelligence; Fluoride awareness; GANs model; Augmented reality*

INTRODUCTION

Existing studies have shown that art can serve as an important medium for information transmission and play a unique role in health communication. Dewitz [1] introduced and explored the online application of visual participation methods in two health information behavior studies, both of which were conducted via Zoom and the virtual whiteboard Miro. A detailed analysis of the application of artificial neural networks and deep learning in visual arts, and conducted in-depth research on its latest progress in predicting, classifying, evaluating, generating, and identifying different visual arts [2]. Grushka et al. [3] explored an arts-based project for talented artistic visual learners at a regional Australian university, to develop artistic expressions around a wide range of scientific phenomena. Melchior and Oliveira [4] suggested that future work should focus on improving the quality of health information on social media platforms, developing new tools and strategies to combat the spread of fake news, and conducting in-depth research on the credibility of health information. Although receptive arts participation is considered to contribute to health and well-being, active arts participation remains understudied in the health care field.

Vaartio-Rajalin et al. [5] aimed to review the current status of research on art creation and expressive arts therapy in adult health care from 2010 to 2020. The future studies should ask participants to report their art experiences in order to more fully evaluate the role of creative arts-based activities in improving cognitive, social, and emotional health in older adults with mild cognitive impairment or dementia [6]. The arts and humanities have transformative potential in medical education, and use of a more inclusive sample may provide new insights into their role in medical education [7] Clift et al. [8] outlined the growing interest in the social and health impacts of the arts in the UK since the late 1990s and explore the role of arts and cultural participation in improving well-being and its practical implications for population health and social health inequalities. However, these methods still have limitations. Therefore, a more intelligent, variable, and personalized visual communication method is needed to effectively improve the impact of fluoride-related public health education.

In recent years, the development of artificial intelligence technology has provided new possibilities for visual communication of public health education. Deiana et al. [9] evaluated whether ChatGPT's answers to vaccination questions were accurate, clear, and detailed, and explored the potential application value of artificial intelligence tools in the healthcare field. Gunasekeran et al. [10] reviewed the application of AI, telemedicine, and other digital health solutions in public health response in healthcare operations during the COVID-19 pandemic.

As the public health field gradually deepens its understanding of the health risks of fluoride, how to effectively convey relevant scientific information to the public has become an important challenge in current education. Although traditional educational methods, such as text manuals and data charts, can convey information, they often lack intuitiveness and interactivity, and it is difficult to effectively improve the public's cognitive accuracy and emotional acceptance. Therefore, the use of innovative visual and interactive educational methods can better arouse the audience's interest and promote their understanding and response to the health risks of fluoride.

This paper proposes an interdisciplinary solution that combines generative adversarial networks (GANs) and augmented reality (AR) technology to enhance the public's awareness of the health risks of fluoride through artistic visual education. In this article, first constructs a multimodal knowledge graph based on epidemiological data and public perception survey results, covering the chemical properties, health effects and social controversial cases of fluoride. Subsequently, a GANs-based dynamic visual mapping algorithm is developed to transform scientific data into artistic visual representations, and immersive educational scene is built in combination with AR technology, allowing the audience to freely explore the complex properties of fluoride in interactive experience.

The second part introduces the research background and related work, third part describes in detail the specific implementation of the proposed method, including the construction of multimodal knowledge graphs, the application of GANs algorithm, and the design of AR scenarios, and fourth part shows the experimental design and result analysis. Finally, the contribution of the research and future research directions are discussed.

RESEARCH METHODOLOGY

Building a Multimodal Knowledge Graph

In this study, constructing a multimodal knowledge graph is a crucial step, which provides data support and theoretical basis for subsequent artistic visual education. The goal of the multimodal knowledge graph is to provide the public with a comprehensive understanding of the health risks of fluoride by integrating various knowledge and data. In order to ensure the accuracy and practicality of the graph, we have carried out a comprehensive integration from three main aspects, such as epidemiological data, public perception, and social controversy.

Integration of epidemiological data

First, we build a basic framework for the health effects of fluoride based on a large number of epidemiological studies and risk assessment results related to fluoride exposure. The core contents, such as the chemical properties of fluoride, exposure concentration, and toxic effects on the human body are refined and structured to ensure that each data is supported by scientific evidence. In this way, the potential effects of fluoride on teeth, bones, and other organs, and provide different health risk assessments for different age groups, such as children and adults. This information is systematically organized into different nodes of the map, each of which is connected to relevant epidemiological research results and real cases, ensuring that every data in the map can be traced and verified [11].

Public cognition and social controversy

In order to make the knowledge map more participatory, combine the results of the public's cognition survey on fluoride. Through questionnaire surveys, interviews and social media analysis, extract the public's general cognition, misunderstandings and social controversies about the risks of fluoride. For example, the public often disagrees on whether fluoride is safe and whether its health effects are exaggerated. These social-level information is incorporated into the design of the atlas, so that it not only presents scientific facts but also reflects the public's attitudes towards fluoride and common cognitive biases. Through these data at the social cognitive level, the map becomes closer to reality and can inspire users to explore scientific knowledge in depth. The following Table 1 shows the relationship between fluoride concentration and health effects.

Table 1: Relationship between fluoride concentration and health effects.

Fluoride level (ppm)	Health Effect Type	Tooth Effect	Bone Effect
0.0 - 0.5	Safe Range	No noticeable effect	No noticeable effect
0.5 - 1.0	Acceptable Exposure Range	Mild dental fluorosis	No noticeable effect
1.0 - 1.5	Acceptable Exposure Range	Mild dental fluorosis	No significant impact
1.5 - 2.0	Critical Exposure Range	Moderate dental fluorosis	Decreased bone density, risk of fractures
2.0 - 4.0	Exceeds Safe Range	Severe dental fluorosis	Osteoporosis, joint pain
4.0 and above	Extremely Hazardous	Severe dental fluorosis, brittle teeth	Severe bone damage, joint stiffness

3.1.3 Graph structure and interaction design

In order to improve user experience and interactivity, display the content of the multimodal knowledge graph through a graphical interface. Figure 1 shows the architecture diagram of the multimodal knowledge graph, showing the data integration process and the relationship between different modules.

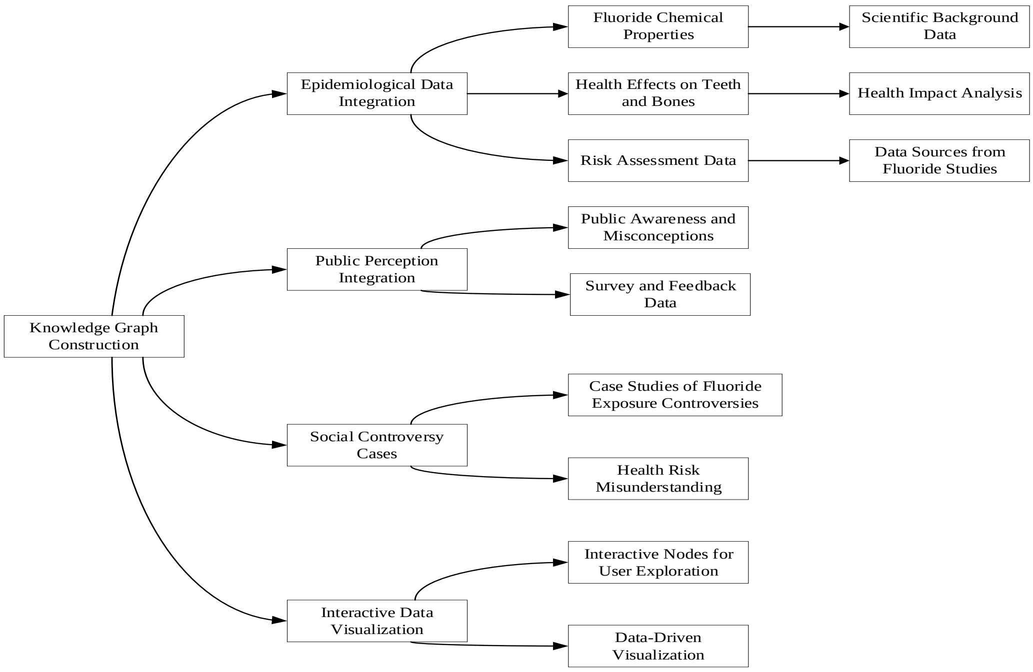

Figure 1: Multimodal knowledge graph architecture.

Each knowledge node is designed to be easy to understand and interactive. Users can browse freely in the graph by clicking, dragging or zooming. The nodes are intuitively linked to show the correlation between different data, ensuring that users can easily find relevant content. For example, when users click on the "Effects of Fluoride on Teeth" node, they can see related epidemiological studies, experimental data, and social controversies about the issue. This interactive method makes information transmission more vivid and effective. By integrating epidemiological data, public perception, and social controversy, we have constructed a multi-level, multi-dimensional knowledge map of fluoride health risks. This map not only provides scientific and rigorous data support but also takes into account social information to present a more comprehensive picture of fluoride-related health risks. While providing data support for subsequent dynamic visual mapping and augmented reality technology, the construction of the map also provides the public with an easy-to-understand and interactive learning tool to help them better understand the impact of fluoride on health.

Generative Adversarial Network Algorithm Design

GANs are used to transform scientific data related to fluoride health risks into visual and interactive artistic expressions. As a deep learning algorithm, GANs can generate high-quality visual content through the game process between the generator and the discriminator. We design a dynamic visual mapping algorithm based on GANs to transform complex data on fluoride exposure, i.e., fluoride concentration, enamel remineralization mechanism, etc. into vivid and interactive visual representations to enhance the audience's understanding and perception of the health effects of fluoride.

Model design and training

When designing the GAN model, determine the structure of the input information based on scientific data related to fluoride. This input information includes fluoride concentration threshold, exposure time, degree of enamel damage, and other data related to health risks. In order to generate representative visual effects, chose image generation as the main task. The goal of the generator is to generate realistic and visually impactful images from the input scientific data, while the discriminator is used to evaluate the authenticity of the generated images and compare them with real health impact images [12]. The loss functions of the generator and the discriminator can be expressed as follows:

$$\mathcal{L}_G = -\mathbb{E}_{z\sim p_z(z)}[logD(G(z)] \quad (1)$$

$$\mathcal{L}_D = -\mathbb{E}_{x\sim p_{data}(x)}[logD(x)] - \mathbb{E}_{z\sim p_z(z)}[log\ (1 - D(G(z)] \quad (2)$$

Among them, $\mathcal{L}_G$ is the loss of the generator, $\mathcal{L}_D$ is the loss of the discriminator, $G(z)$ is the image output by the generator, $D(x)$ is the authenticity score output by the discriminator, z is the input noise, $p_z(z)$ and $p_{data}(x)$ are the noise distribution and the real data distribution, respectively, and its structure is shown in Figure 2.

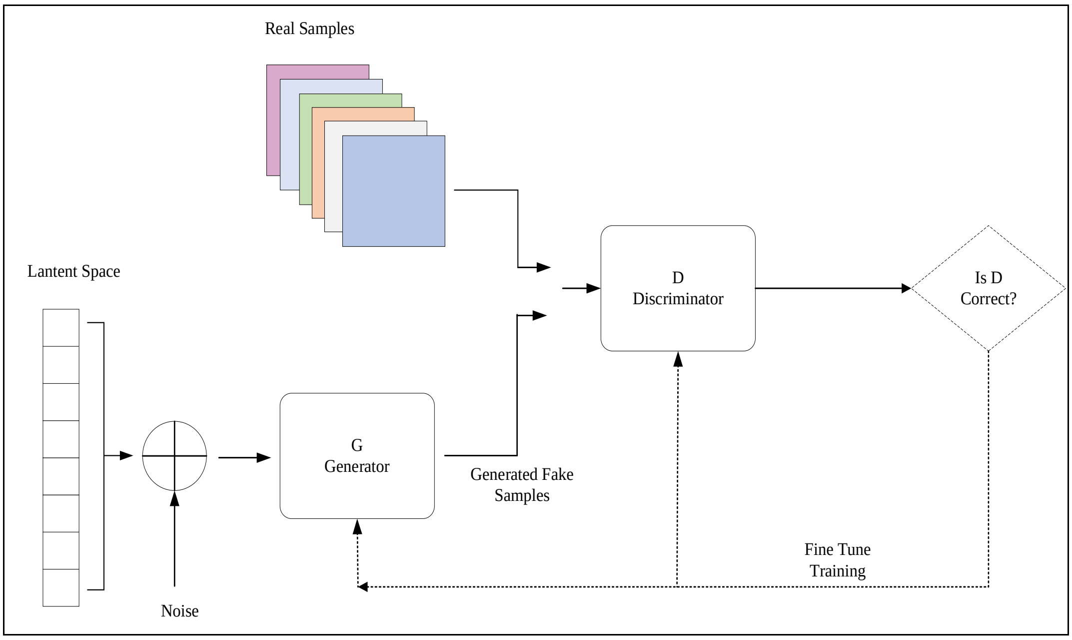

Figure 2: The model structure of generative adversarial network.

Through this generation and discrimination adversarial process, the generator can continuously optimize its output and ultimately generate high-quality visual effects. To train this generative model, use a large amount of fluoride exposure case data. This data comes from epidemiological studies and experimental results, covering the health effects of different concentrations of fluoride. During the training process, continuously adjust the parameters of the model and optimized the structure of the generator and discriminator so that it can generate more accurate and vivid visual effects. The goal of training is to generate visual representations that conform to real scientific data, ensuring that the final image is both highly realistic and visually attractive [13]. Table 2 shows the parameters of the GAN model.

Table 2: Parameter configuration of the model

Parameter	Generator	Discriminator
Network Architecture	Deep Convolutional Neural Network (DCGAN)	Deep Convolutional Neural Network (DCGAN)
Input Layer	Random Noise Vector (Z)	Grayscale Image Input (28x28 pixels)
Activation Function	ReLU (hidden layers), Tanh (output)	Leaky ReLU (hidden layers), Sigmoid (output)
Loss Function	Binary Cross-Entropy Loss	Binary Cross-Entropy Loss
Optimizer	Adam (Learning Rate: 0.0002, β1: 0.5)	Adam (Learning Rate: 0.0002, β1: 0.5)

Batch Size	64	64
Hidden Layer Neurons	256, 512, 1024	512, 256
Generated Image Size	64x64 pixels, 3 channels (RGB)	64x64 pixels, 3 channels (RGB)
Iterations	50,000 iterations	50,000 iterations
Learning Rate Decay	Decays exponentially every 50 steps	Decays exponentially every 50 steps

Dynamic visual mapping and interactivity

Based on the images generated by the generator, design a dynamic visual mapping function. Specifically, the generated images are not static, but can be adjusted in real time as the input data changes. For example, during the education process, the subjects can see the color gradient in the image, the change of particle movement, etc. according to the changes in different fluoride concentrations. These changes intuitively shows the relationship between dose and effect. This dynamic effect enables the audience to understand the health effects of fluoride more clearly and enhance their emotional identification and understanding.

In addition, we design interactive features for the images, allowing users to perform certain operations and explore the visual content. Users can click on different areas in the image to obtain more scientific data and background information, or view changes in health effects in real time by changing parameters, such as fluoride concentration and exposure time. This interactive design not only enhances user participation but also makes the entire learning process more vivid and interesting [14].

In practical applications, the training process of GANs may encounter some challenges, especially the balance between the quality and realism of the generated images. To solve these problems, we have made multiple optimizations in model design. For example, by introducing CGAN, we can better control the specific features of the generated images, so that the images not only conform to the scientific data of health effects but also have artistic and attractive visual effects. In addition, in order to address the mode collapse problem that may occur in the generation process of the model, we have adopted a variety of strategies, including gradient penalties and increasing the complexity of the discriminator, to improve the stability and diversity of the generated effects.

Application of Augmented Reality Technology

In this study, AR technology is used in public health education to display dynamic visual content of fluoride health risks. By combining AR technology, we can not only enable the audience to understand the health effects of fluoride exposure more intuitively but also enable them to gain a deeper understanding of complex scientific principles through the interaction between virtual and real life through immersive experience. The application of AR technology significantly enhances the interactivity and participation of educational content, thereby improving the learning effect and the emotional acceptance of the audience.

Application background of AR technology in education

AR technology develops a mixed reality experience by superimposing virtual information onto the view of the real world. In public health education, especially when faced with complex health risk data, AR technology can transform abstract scientific concepts into concrete visual representations, allowing the audience to gain a deeper understanding during the interaction. For education on fluoride health risks, AR technology can help the audience see the immediate impact of fluoride exposure on the human body and intuitively perceive the changes in health effects at different concentrations.

Application design and functional implementation

The AR application design in this study aims to provide an interactive learning environment for the audience. In this environment, subjects can scan the surrounding environment through AR devices, such as, smart glasses, mobile phones or tablets to trigger virtual content related to the health risks of fluoride. For example, when a subject scans an ordinary drinking water bottle, the AR system will display the fluoride concentration in the bottle of water and show the potential impact of this concentration on human health, especially teeth and bones. As the subject adjusts the angle or position of the water bottle, the AR system will dynamically update the fluoride concentration and its corresponding health risks, helping the user to understand the dose-effect relationship in real time. To ensure the accuracy of the AR system, the changes in fluoride concentration and the presentation of health risks in the image can be described as:

$$R = \alpha \cdot C^{\beta} \quad (3)$$

Among them, R represents health risk, C is the concentration of fluoride, α and β are constant coefficients obtained by fitting experimental data. In order to enhance the audience's sense of participation, design a variety of interactive functions. The subjects can adjust the exposure concentration of fluoride according to the actual situation, such as dragging a virtual slider to simulate different concentrations of fluoride and observe its impact on health. The system uses dynamic presentation methods, such as color changes and particle effects to display in real time the impact of changes in fluoride concentration on processes, such as tooth remineralization and enamel damage. This instant feedback mechanism allows users to intuitively understand the positive and negative effects of fluoride on health [15].

Immersive learning experience with augmented reality

Through AR technology, subjects can explore the health effects of fluoride in a combination of virtual and real environments. AR technology provides a more immersive and interactive learning experience. In an immersive environment, subjects are not only recipients of information, but active explorers. By interacting with virtual elements, subjects can gain a deeper understanding of the specific effects of fluoride on different parts of the body at different concentrations, and customize their learning paths according to their personal needs. This personalized learning method greatly improves the subjects' acceptance and understanding of scientific information. In the application of AR technology, face some challenges, especially in the precise integration of virtual elements with the real environment. In order to ensure the smoothness and efficiency of the AR system, accurately calibrate the position, size, and proportion of virtual objects. In addition, the subjects may feel fatigued due to using the device for a long time. Therefore, when designing, pay special attention to the optimization of UI/UX (user interface and user experience) to ensure easy operation, timely feedback and interesting interaction process, avoiding excessive complexity to reduce the user's learning burden.

Design and Application of Intelligent Feedback System

In addition to GANs and AR technologies, design an intelligent feedback system as an auxiliary educational tool to further enhance the public's understanding of the health risks of fluoride. The intelligent feedback system is designed to monitor the learning progress and emotional response of the subjects in real time and provide personalized learning suggestions based on their performance. This system analyzes the user's interaction with the educational content through machine learning algorithms to ensure the adaptability and effectiveness of the educational content.

System design and functions

The core of the intelligent feedback system is an adaptive learning platform based on user behavior analysis. The platform architecture is shown in Figure 3.

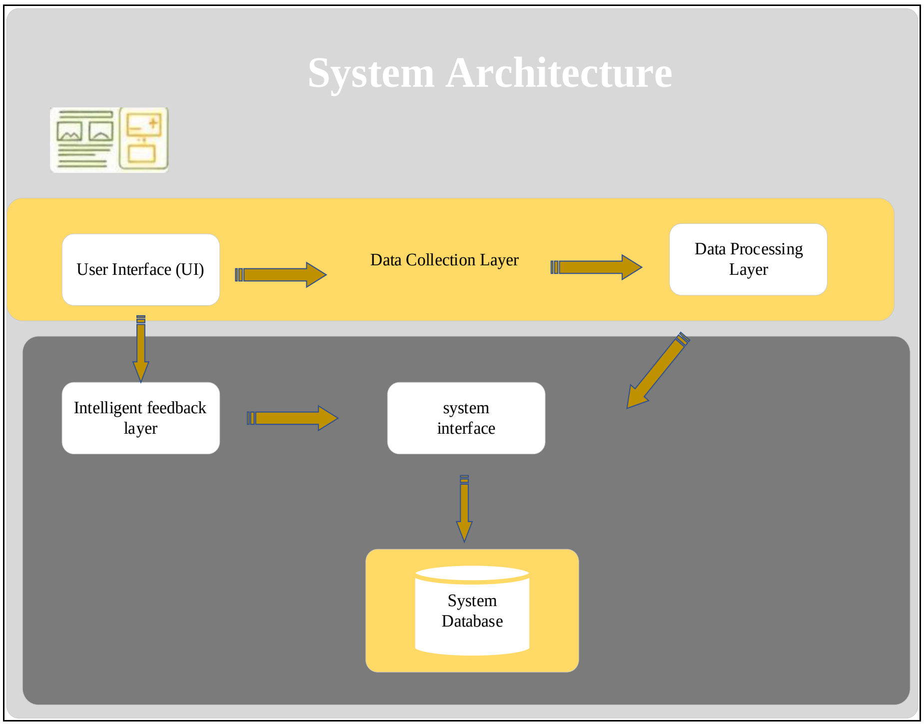

Figure 3: Platform architecture diagram

By recording the subjects' interaction data with different modules, such as fluoride concentration, health affects simulation, etc. during the education process, the system can analyze the subjects' learning progress, depth of understanding, and emotional response. For example, the system tracks the subjects' dwell time, click frequency, and selected content when interacting with the dynamic visual map, and adjusts the next learning module based on this data. If the subject shows obvious confusion or stagnation on a certain knowledge point, the system will automatically push more relevant explanations or simplified content to help better understand.

In addition, the intelligent feedback system also has an emotion analysis function. When the subject interacts with the AR system, the system uses facial recognition technology to monitor the subject's facial expressions, eye movement trajectories and other information to analyze emotional state. For example, when the system detects that the subject is anxious or confused during the learning process, it will provide appropriate emotion regulation content through prompt sounds, interface adjustments, etc. In this way, the system not only focuses on the transfer of knowledge but also on the emotional state of the subject, ensuring that the educational content can be presented in a more acceptable way.

Adaptive learning path

Another major feature of the intelligent feedback system is its adaptive learning path. According to the performance of the subject at each stage, the system will adjust the difficulty and depth of the learning content to ensure that the learning process is always suitable for the needs of the subject. For example, for users who understand faster, the system will push more difficult content and challenging questions, while for users who understand slower, the system will provide more basic content and review modules. This adaptive design ensures that each subject can master the relevant knowledge of fluoride health risks at own pace, while also avoiding the problem of excessive push of inappropriate content.

Personalized feedback and evaluation

The system also provides personalized learning feedback for each subject. After completing each learning module, the system will generate a concise report showing the subject's learning progress, understanding, and emotional response. This feedback not only helps the subjects understand which aspects they have mastered well and which aspects still need to be strengthened but also encourages them to maintain a positive attitude during the learning process. In addition, the system allows subjects to adjust their next learning plan based on their own learning feedback. For example, a subject may perform poorly in a specific area (such as the biological effects of fluoride), and the system will recommend more relevant learning resources based on this feedback.

Results and Discussion

The experimental subjects are 120 adults with different ages, genders and educational backgrounds to ensure that the experimental results are widely representative. All subjects are randomly divided into two groups, such as 60 in the experimental group and 60 in the control group. Table 3 shows the basic information of the experimental subjects, including age, gender, educational background and group allocation, to ensure the representativeness and fairness of the experiment.

Table 3: Basic information of experimental subjects

Category	Group 1 (Experiment Group)	Group 2 (Control Group)
Number of Participants	60	60
Age Range	20-65 years	20-65 years
Gender Distribution	Male 30, Female 30	Male 30, Female 30
Education Level	High school, University, Postgraduate	High school, University, Postgraduate
Notes	Random assignment	Random assignment

This experiment adopts a pre- and post-test design, and evaluates the two groups of subjects before and after the educational intervention. The experimental group will receive an artistic visual education method based on artificial intelligence generation (including dynamic visual mapping, augmented reality (AR) technology, etc.). The control group will receive traditional text manuals and charts education. All subjects are educated on the same content, including the chemical properties of fluoride, health effects, dose-effect relationship and social controversial cases, to ensure that the content of the experimental group and the control group is consistent.

Knowledge retention rate evaluation experiment

This experiment evaluates the application effect of artistic visual education methods in public health education, especially the knowledge retention rate of fluoride-related knowledge. The experiment is divided into experimental group and control group, with 60 subjects in each group. The experimental group is educated through dynamic visual mapping and augmented reality technology, while the control group is educated through traditional text manuals and data charts. The knowledge retention rates of the two groups are compared by testing their knowledge before and after education, as shown in Figure 4.

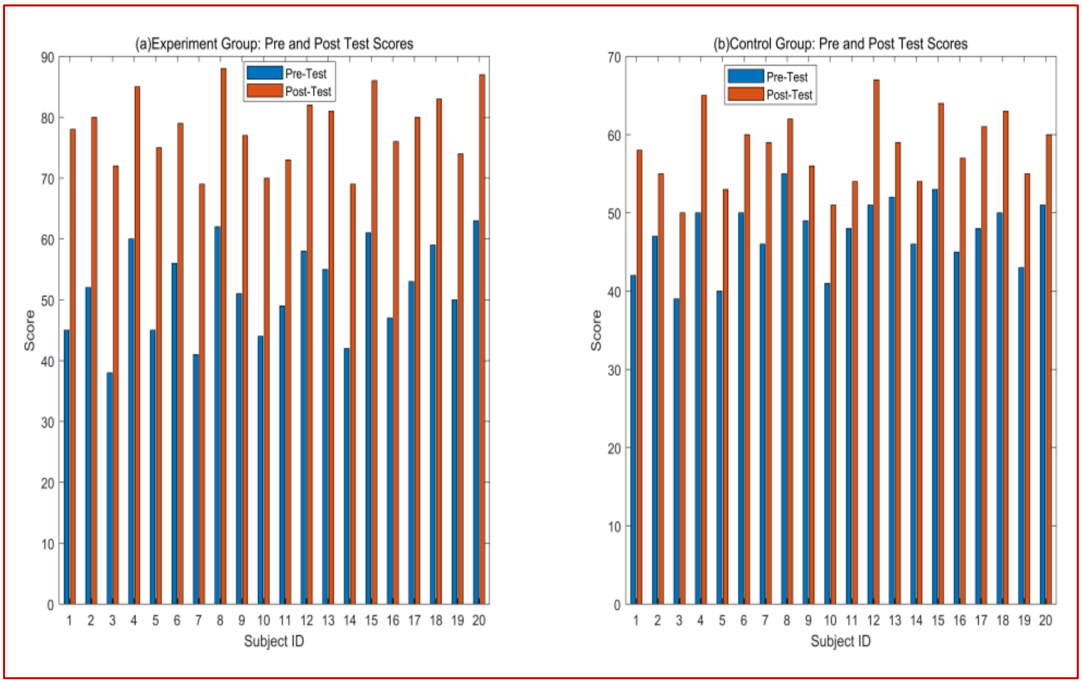

Figure 4: Evaluation of knowledge retention rate

Figure 4 (a-b) shows the comparison of scores of the experimental group and control group in the pre-test and post-test, respectively. The average score of the experimental group in the pre-test is 50.7, and the post-test score is 77.1, an increase of 26.4 folds. In contrast, the control group scores 47.8 in the pre-test and 58.7 in the post-test, an increase of 10.9 folds. In the above data, the use of innovative visual education methods can significantly improve the public's mastery and retention of scientific knowledge, especially in the complex or controversial field of health education.

Risk perception accuracy assessment experiment

This experiment aims to evaluate the effects of different educational methods on the accuracy of fluoride health risk perception. The experimental group is intervened by artistic visual education methods, including dynamic visual mapping and augmented reality technology, while the control group received traditional text and chart education. Before and after the experiment, all subjects are tested for their accuracy in perceiving fluoride risks. The specific data are shown in Figure 5.

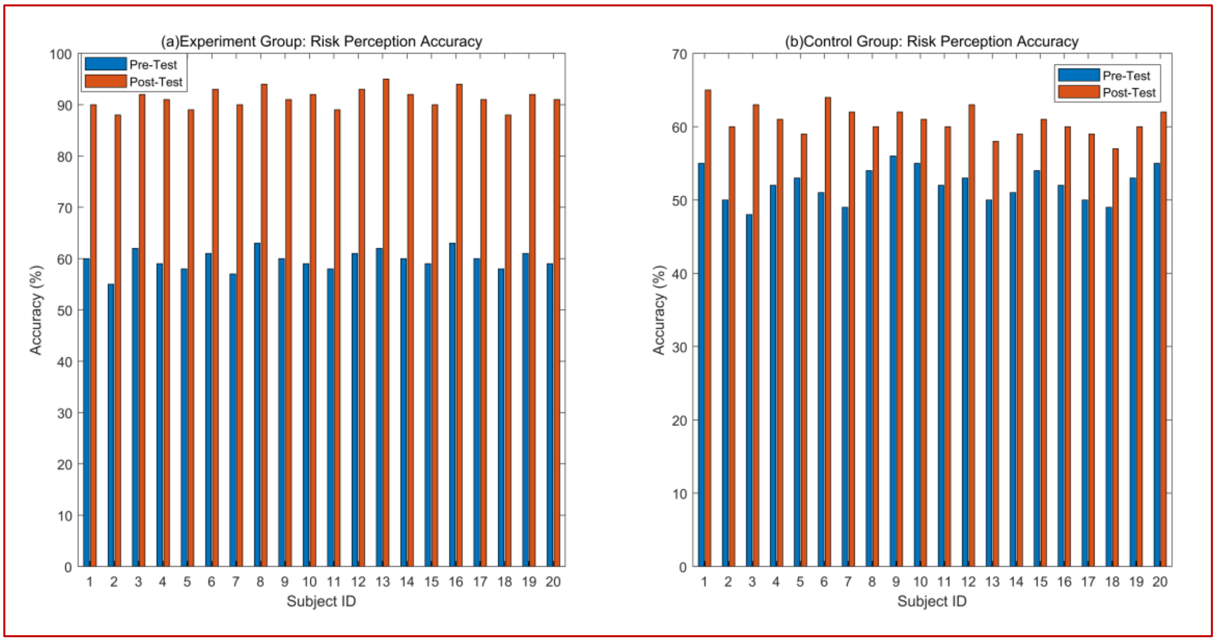

Figure 5: Risk perception accuracy assessment

Figure 5 (a-b) shows the comparison of risk perception accuracy of the experimental group and the control group in the pre-test and post-test, respectively. The average accuracy of the experimental group in the pre-test is 59.75%, which increases to 91.25% in the post-test, an increase of 31.5%. In contrast, the control group's pre-test accuracy is 52.1%, which increases to 60.8% in the post-test, an increase of 8.7%. In the above data, it is concluded that artistic visual education can significantly improve the subjects' accurate cognition of the health risks of fluoride, and its effect far exceeds that of traditional education methods.

Experiment on the evaluation of the conversion rate of health behavior intentions

This experiment evaluates the effects of different educational methods on the conversion of fluoride-related health behavior intentions. The experimental group adopts an artistic visual education method combined with dynamic visual mapping and augmented reality technology, while the control group receives traditional text manuals and data chart education. By conducting a health behavior intention survey on the subjects before and after the educational intervention, their behavioral changes in using fluoride toothpaste, reducing high-concentration fluoride exposure, and paying attention to the fluoride concentration in drinking water are assessed. The specific data shown in Figure 6.

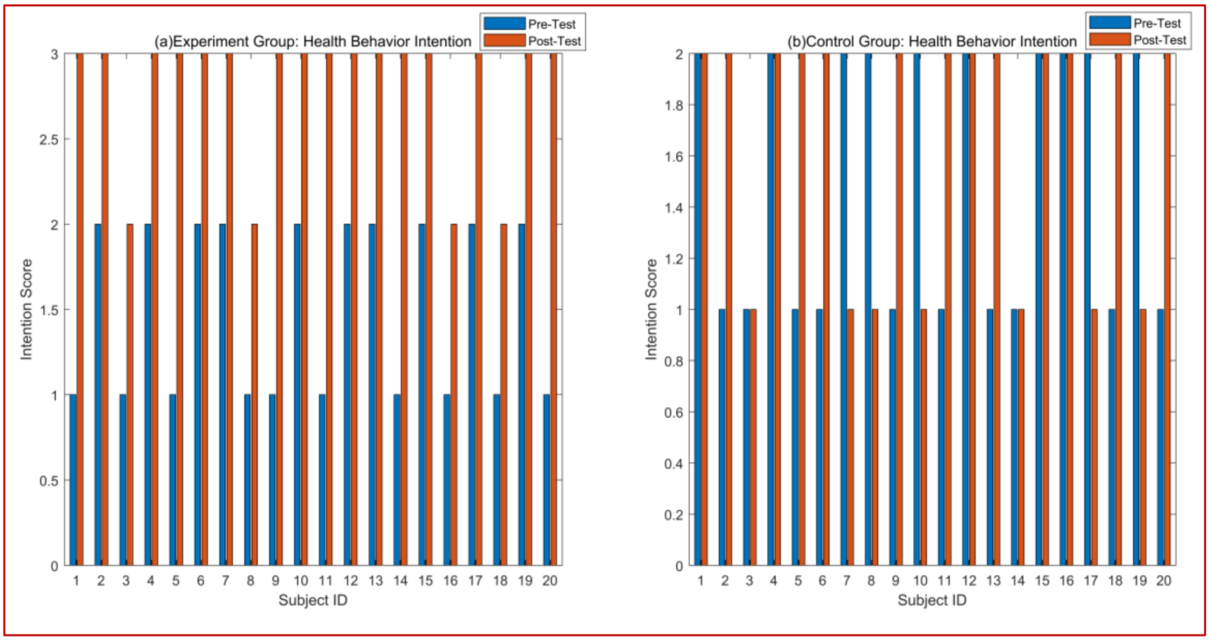

Figure 6: Evaluation of conversion rate of health behavior intention

The comparison of the pre-test and post-test scores of the experimental group and control group in the conversion of health behavior intention (Figure 6 a and b). The average intention score of the experimental group in the pre-test is 1.5, which increases to 2.8 in the post-test, an increase of 1.3 folds. The pre-test score of the control group is 1.5, which increases to 1.65 in the post-test, an increase of 0.15 fold. In the above data, artistic visual education can more effectively promote the adoption and transformation of fluoride-related health behaviors by subjects, especially in improving active participation in health behaviors.

Emotional acceptance assessment experiment

This experiment aims to evaluate the impact of artistic visual education on the emotional acceptance of subjects, especially the emotional changes when facing fluoride health risk information. The experimental group is intervened through artistic visual education methods, such as dynamic visual mapping and augmented reality technology, while the control group is educated through traditional text manuals and data charts. By evaluating the subjects with an emotional scale before and after the educational intervention, the changes in their emotional dimensions, such as positive emotions, anxiety, fear and confusion are analyzed. The details are shown in Table 4.

Table 4: Emotional acceptance assessment

Participant ID	Experiment Group (Pre-test)	Experiment Group (Post-test)	Control Group (Pre-test)	Control Group (Post-test)
1	1	2	1	1
2	2	3	1	2
3	1	3	1	1
4	1	2	2	2
5	1	3	2	2
6	2	3	1	1
7	1	2	1	2
8	2	3	2	2
9	2	3	1	1
10	1	3	2	1
Average	1.4	3	1.4	1.5

In Table 4, the average emotional acceptance score of the experimental group in the pre-test is 1.4, which increases to 3.0 in the post-test, an increase of 1.6 points. In contrast, the control group's pre-test score is 1.4, which only increases to 1.5 in the post-test, an increase of 0.1 points. The above data concluded that artistic visual education can significantly improve the emotional response of subjects when facing fluoride-related health information, especially in reducing negative emotions, such as anxiety and fear.

This study explores a new path to break through the traditional public health education paradigm through the deep integration of art and artificial intelligence technology. The experimental results shows that the educational method based on dynamic visual mapping and augmented reality technology has significant advantages in the transformation of fluoride health risk cognition and behavior. Its core value lies in transforming scientific data into perceptible and interactive embodied experience. This transformation not only solves the problem of "knowledge suspension" in traditional education but also reconstructs the dialogue mode between the public and scientific information through artistic narrative logic.

From the perspective of cognitive science, the combination of art media and artificial intelligence effectively activates the audience's multimodal learning mechanism. Traditional text manuals rely on a single language symbol system, which is prone to information decoding bias due to individual cognitive load differences. Dynamic visual mapping transforms the dose-effect relationship of fluoride into a visual metaphor through the coordinated expression of color, form and movement, such as using particle flow to simulate the enamel remineralization process, or mapping the critical threshold of bone density through color temperature gradient. This multi-dimensional sensory stimulation can simultaneously mobilize the audience's visual cortex and prefrontal cognitive network to form a more stable episodic memory anchor. In addition, the virtual-real fusion scene created by augmented reality technology allows scientific concepts to break through the limitations of the two-dimensional plane and build an embodied cognitive framework in three-dimensional space - when the audience adjusts the fluoride concentration in the virtual scene in real time through gesture interaction, its proprioceptive system and cognitive system form a closed-loop feedback. This embodied learning significantly improves the accuracy of risk perception.

At the level of emotional acceptance, artistic expression successfully dispels the confrontational narrative in traditional risk communication. The health effects of fluoride itself have a dose-dependent dual attribute, but the public often falls into the binary cognitive trap of "absolute safety" or "total ban". This study transforms the "double-edged sword" characteristics of fluoride into aesthetic images through the dynamic visual language developed by the generative adversarial network. For example, the crystal growth animation is used to metaphorically represent the protective effect of an appropriate amount of fluoride on teeth, while the crystal structure presents a visual tension of fragmentation and corrosion when overexposed. This non-confrontational way of expression not only retains scientific rigor but also guides the audience to transcend the black-and-white cognitive stereotype through emotional resonance. It is worth noting that the significant improvement in the anxiety and confusion emotional dimensions of the experimental group confirms the buffering role of art media in resolving scientific disputes - when complex data is transformed into explorable visual stories, the audience's cognitive dissonance can be naturally eliminated in the aesthetic experience.

Overall, this study verifies the feasibility of collaborative innovation between artificial intelligence and art media in public health education. Its value is not only reflected in the improvement of knowledge transfer efficiency but also in the reconstruction of the ethical dimension of scientific communication. When cold data is transformed into a visual poem full of humanistic care, the public is no longer a passive recipient of information, but a cognitive subject who actively participates in risk construction. This transformation provides new possibilities for resolving the scientific trust crisis in contemporary society.

Conclusions and future research directions

This article proposes an innovative artistic visual education method that combines GANs and AR technology to enhance the public's cognition and emotional acceptance of the health risks of fluoride. By constructing a multimodal knowledge graph and dynamic visual mapping algorithm, complex scientific data is successfully transformed into an easy-to-understand artistic visual expression, allowing the audience to gain a deeper understanding of the double-edged sword properties of fluoride through interactive experience. The experimental results shows that the experimental group is significantly better than the control group in terms of emotional acceptance, risk perception accuracy, and conversion of health behavior intentions, verifying the effectiveness of this method. However, this study still has some limitations, i.e., firstly, the sample size of the experimental subjects is small and mainly adults. Future research can expand the sample range to cover groups of different ages and backgrounds. Second, the complexity and interactivity of educational content may have different effects on different individuals. Therefore, further optimizing educational design and evaluation standards and exploring personalized education paths will help improve the universality of educational effects. Future research can further deepen the application of technology and educational design, combine more advanced artificial intelligence technologies with educational psychology theories, and explore more immersive and personalized public health education methods.

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CONFLICT OF INTERESTS: None

Reference

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