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Generational Differences - A Study of Digital Art Generation for Student Health Data

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Abstract. As academic competition between students becomes more intense, the physical health and psychological and emotional perceptiveness stability of students before exams is particularly important. Surveys have shown that students' physical and psychological health is related to their guardians' emotions, and this paper uses student health data to generate digital art to provide an evaluation solution for such issues. We used a combined subjective and objective evaluation method to allow guardians and students rate their digital artwork simultaneously and determine its association with changes in student achievement. We selected participants, 50 students and their guardians from Licheng Middle School aged from 15 to 19 years old, and asked them to rate the health data-generated digital artwork daily to examine the association between the difference in rating values between the two parties and changes in student test scores by comparing and analyzing the results. Finally, we found that the scoring difference was associated with test taker performance ($R^2 = 0.9837$). The results of the analysis showed the discriminative validity of the digital art generated from the supporting health data, with 76% of the guardians being able to perceive the student's health and emotional status from the digital artwork. Among them,63% of the test takers and guardians had a difference value of 5% or less between their scores, and the value of the change in performance of this category of students was also within 10%; 18% of the test takers and guardians had a difference value of 30% or more, and the value of the change in test performance of this category of students was more than 40%. The problem of intergenerational differences in guardians' influence on students can increase the instability of students' test scores. The closer the values of the guardians' and students' scores on digital artworks, the more stable the candidates' scores will be, and conversely the larger the scores the more their candidates' scores will fluctuate.

Keywords. Intergenerational Differences, Health Data Visualization, Digital Art

1. Introduction

In today's competitive academic world, academic examinations are a common and important source of stress for students, which can trigger physical and psychological problems [1]. Studies have shown that academic stress is positively associated with guardian stress and psychiatric problems, while test-related anxiety is also positively associated with psychiatric problems [2]. Anita Chandra et al [3] discussed that poor

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mental health of guardians can affect students' ability to function properly in school, such as school engagement and academic performance. Therefore, it is essential to help guardians understand the emotional state of their students and it is useful to study the relationship between generation gap of guardians and students and students' performance in exams.

With the increasing role of human-computer interface applications, the importance and requirements of automatic emotion recognition are growing, and emotion recognition can be accomplished from data visualization [4]. Andreas Holzinger et al [5] designed and developed a mobile software for interactive visualization of physiological data, and the results suggest that leading psychologists can provide appropriate insight into the data to provide stress prevention support. Dave Putwain et al [6] evaluated the effectiveness of multi-modal and information technology (IT) for prevention of test anxiety, students with high test anxiety showed a reduction in anxiety after approaching these methods. Kouroubali et al [7] reported a use of a novel digital health equipment developed from virtual reality (VR) and information and communication technologies (ICT) in the care process where the digital health tools showed positive impacts in the prevention of preoperative anxiety and improved patients' emotion and health status.

We would like to figure out the opportunities for visual digital art to be used in the expression and seek an intuitive visual metaphor to validate the correlation between generation gaps and students' performance on exams.

2. Related Jobs

We investigated the work of other scholars in data visualization, as well as research into generating digital art using digital algorithms, to provide feasibility for the idea of generating digital art for health data.

In terms of health data visualization research, an innovative approach for health data visualization is the publicly available health graph (HGraph) from MITRE [8]. HGraph shows a static overview of a person's health, being able to track the trajectory of different parameters, how fast they change, and how they respond to events such as medical care actions and interventions [9]. With the advances in digital medicine [10], data visualization has been used as an important tool for gaining insight into healthcare datasets, in addition to the electronic health records that are increasingly replacing paper records in hospitals and clinics around the world.

In the context of digital art algorithm research, designers can use software programming languages for modeling to meet digital visualization needs. Rita Francese et al [11] describe a signature language called MicroApp for modeling ubiquitous mobile applications directly on mobile devices. MicroApp uses generic icons to assemble mobile applications: services are represented by icons and consist of employing colors to represent data streams, and also qualitatively evaluates the visual environment for implementing this iconic language. Cottingham, Marci et al [12] use the examination of audio diaries as a means of accessing emotions and selves, in conjunction with the software program Audacity, using waveform or spectrogram output from audio software can provide sound visualization.

3. System Design

3.1. Analysis of Health Data Generation Digital Art

Combining the above theoretical and technical results, we generate digital images of the candidates' health data, which combine technologies such as electromyographic acquisition, data visualization presentation and human-computer interaction. We aim to build digital artworks from health data through a combination of algorithms and try to identify the candidates' physiological and psychological conditions in a new way.
In the system design, we build an algorithmic model and framework for generating digital art from health data and give it a set of digital visual correspondence system. In order to enhance digital image recognition, public understanding and participation, we used "plants, flowers and scenes" as the digital images for health data generation. The branches, points and leaves of plants can be symbols for presenting complex emotional relationships. With the products developed by Eight Pulse Technology, health data can be calculated based on the collected surface electromyographic signals (sEGM) of the human body.

3.2. ArtDescription of the digital system design

The conceptual framework of digital design is shown in Figure 1, and the prototypes of digital art are plants, flowers, and scenes.

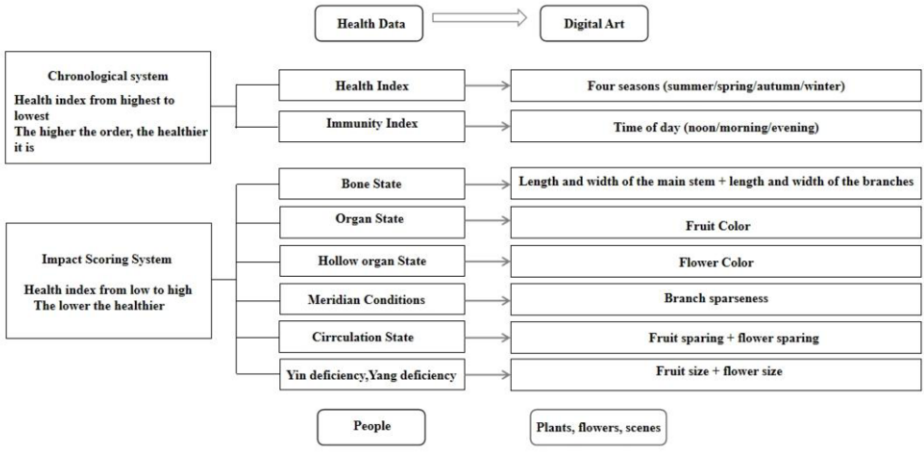

Figure 1. Conceptual Framework Diagram for Digital Design.

3.3. ArtDescription of the digital system design

The presentation of the digital algorithm comes from the 3D animation software - C4D, full name CINEMA 4D, which comes from Germany MAXON, input the corresponding health data into the corresponding software input port, then control the value of this port, the value itself will change, and the result of the generated picture will

be different. The algorithm framework is shown in Figure 2, and the software input health values are shown in Figure 3.

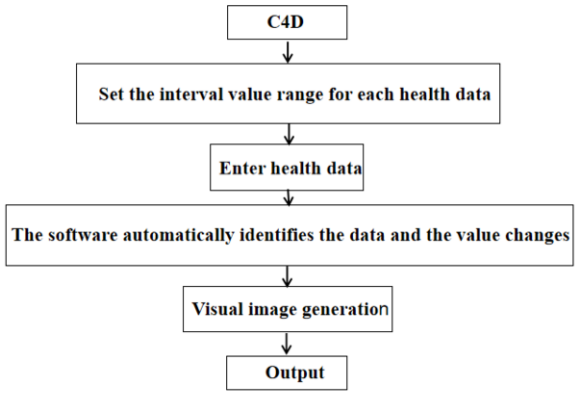

Figure 2. Conceptual flow of digital art algorithms.

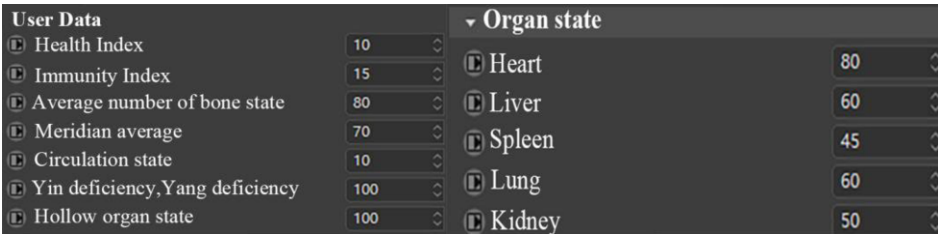

Figure 3. Software input health value chart.

3.4. Final visual effect display

Sixteen digital artworks extracted from the 100 final visual presentations and displayed are shown in Figure 5. Their corresponding input health data values are shown in Figure 6.

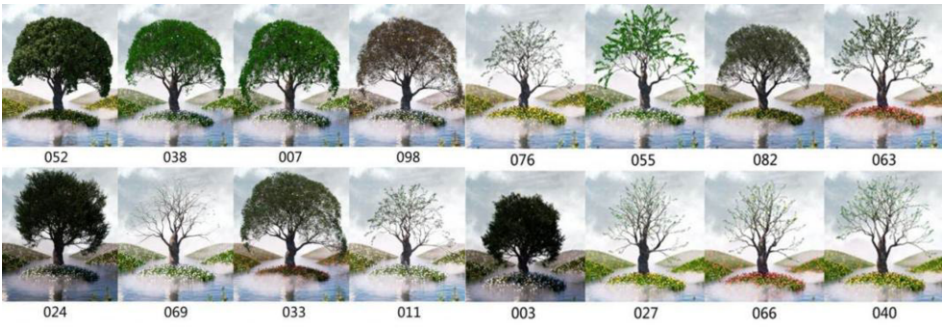

Figure 4. Digital visual effects display.

Sequence	Health Index	Immunity Index	Bone State	Mean Meridian Index	Circulation State	Yin Deficiency And Yang Deficiency	Hollow Organ State	Organ State				
								Heart	Liver	Spleen	Lung	Kidney
052	72.00	90.00	13.00	50.00	5.00	1.00	80.00	2.00	5.00	32.00	0.00	17.00
038	82.00	70.00	15.00	10.00	6.00	40.00	20.00	15.00	54.00	1.00	0.00	2.00
007	80.00	62.00	18.00	10.00	3.00	1.00	4.00	5.00	5.00	5.00	4.00	16.00
098	50.00	80.00	12.00	5.00	10.00	6.00	3.00	10.00	20.00	50.00	31.00	0.00
024	60.00	60.00	2.00	20.00	10.00	20.00	0.00	10.00	20.00	15.00	60.00	50.00
069	80.00	69.00	15.00	42.00	3.00	1.00	4.00	5.00	4.00	5.00	6.00	7.00
033	63.00	70.00	12.00	8.00	13.00	54.00	100.00	30.00	20.00	50.00	31.00	0.00
011	65.00	90.00	28.00	50.00	13.00	1.00	80.00	2.00	11.00	24.00	5.00	4.00
076	65.00	90.00	28.00	50.00	13.00	1.00	2.00	2.00	11.00	24.00	5.00	4.00
055	80.00	75.00	10.00	60.00	20.00	15.00	23.00	3.00	45.00	1.00	12.00	12.00
082	70.00	63.00	38.00	10.00	10.00	52.00	50.00	2.00	5.00	6.00	8.00	2.00
063	72.00	90.00	13.00	52.00	5.00	1.00	80.00	2.00	5.00	32.00	0.00	17.00
003	72.00	90.00	13.00	28.00	5.00	1.00	80.00	2.00	5.00	32.00	0.00	17.00
027	80.00	90.00	10.00	40.00	5.00	1.00	60.00	3.00	4.00	50.00	12.00	2.00
066	85.00	75.00	10.00	40.00	5.00	1.00	80.00	3.00	1.00	6.00	8.00	9.00
040	85.00	90.00	2.00	40.00	10.00	20.00	80.00	10.00	10.00	5.00	1.00	2.00

Figure 5. Corresponding data health values

4. Research Content

4.1. Research Methodology

The participants we selected were candidates from the age group of 15-19 at Lixing High School, and we randomly selected a sample of 20 candidates from each age group, for a total of 100. The health data was divided into two groups, healthy and sub-healthy, with 50 samples in each group. The health data were calculated by the surface electromyographic signals (sEGM) of the human body that can be collected by Eight Pulse Technology, and the experiment was carried out in two groups using the subjective and objective detection method.

The subjective test method is mainly to establish the connection between the digital artworks generated from the health data and the health condition and emotional experience of the human body. The chi-square test was used to count the ratings of the digital artworks by their guardians and students in different health groups, who scored the digital art images according to the seasons, hours, length of the main stem, size of the fruit, etc., and calculated the overall average score from 1 to 10. Then four rounds of experiments were done to score the emotional condition of the digital art images, classifying emotions into 2 criteria: positive and passive; 6 types of emotions (excitement, joy, contentment, anger, sadness, and decadence) are measured separately. the intensity of emotions is expressed on a scale from -5 to 5, with positive emotions taken as positive scores and passive emotions taken as negative scores, to obtain their emotional perceptions when viewing the works. Finally, the difference between the guardians' and students' emotional scores is then summarized and counted. The objective test method was used to verify the association between the difference in scoring and the change in students' test scores by using linear regression analysis against the difference in scoring between guardians and students.

4.2. Study results

4.2.1 Study results

By analyzing and organizing the scale data, the results of digital artwork evaluation and emotion detection scores of their guardians and students in different health subgroups were tallied to obtain Table 1 Table 2 Table 3 Table 4, and the chi-square test was used to derive Table 5 Table 6. Subsequently, we summarized the absolute difference of emotion scoring statistics in Table 7.

Table 1. Statistics of students' evaluation of digital artworks by different health groups

Health group/ Average score	Seasons	Time	Main stem length	Fruits Color	Flower Color	Branches sparse and dense	Fruit size	Average score
Health Group	7.6	6.4	5.2	6.1	8.0	4.3	5.5	6.2
Subhealth group	3.3	4.7	4.5	2.7	3.6	2.8	3.2	3.5

Table 2. Statistics on the evaluation results of digital artworks by their guardians in different health groups

Health group/ Average score	Seasons	Time	Main stem length	Fruits Color	Flower Color	Branches sparse and dense	Fruit size	Average score
Health Group	7.9	7.1	6.7	4.2	6.9	5.8	5.7	6.3
Subhealth group	2.6	3.8	3.4	1.6	3.9	3.1	2.7	3.0

Table 3. The same digital art image and its students' emotion detection result statistics of digital art

Emotional state/ Average score	Excitement	Joyfulness	Comfortable	Anger	Sadness	Decadent	Average
Round 1	4.7	4.2	3.9	-1.0	-1.0	-1.1	1.6
Round 2	4.2	4.1	2.7	-1.0	-1.1	-0.9	1.3
Round 3	3.9	4.0	3.9	-1.0	-0.8	-1.0	1.5
Round 4	3.7	4.0	2.6	-1.1	-1.1	-1.1	1.2
Average	4.7	4.1	3.3	-1.0	-1.0	-1.0	1.4

Table 4. The same digital art image and its guardian's emotion detection result statistics for digital art

Emotional state/ Average score	Excitement	Joy	Ease	Anger	Sadness	Decadent	Average
Round 1	4.8	3.8	2.4	-1.2	-0.9	-1.2	1.3

Round 2	3.8	4.0	3.8	-1.0	-0.8	-1.1	1.5
Round 3	4.1	4.7	2.1	-1.2	-0.9	-1.2	1.3
Round 4	3.2	3.8	2.7	-1.2	-0.9	-0.8	1.1
Average	4.8	3.8	2.8	-1.2	-0.9	-1.1	1.3

Table 5. Comparison of guardians' and students' scores for different health groups (in the scoring system of the work, the median average of the total full scores of the digital artwork evaluation scale in Table 2, i.e., 5, is the passing mark, greater than is "excellent" and less than or equal to is "poor")

Items	Number	Well N(%)	Poor N(%)
Health Group	50	39(78.0)	11(22.0)
Subhealth group	50	21(42.0)	29(58.0)
X^2	15.164		
ρ	<0.001		

Table 6. Comparison of mood scores between guardians and students in different health groups (in the mood evaluation system, the mean scores are integrated in Table 2 to define mood before and after the experiment, with greater than 0 being "positive" and less than or equal to 0 being "negative")

Items	Number	Positive N(%)	Negative N(%)
Health Group	50	41(82.0)	9(18.0)
Subhealth group	50	22(44.0)	28(56.0)
X^2	13.569		
ρ	<0.001		

Table 7. Long caption. Long caption. Long caption. Long caption. Long caption. Long caption. Long caption. Long caption. Long caption

Absolute difference range (X)	X＜5%	5%≤X≤30%	X≥30%	X≥70%
Total number of samples as a percentage	63%	12%	18%	7%

4.2.2 Objective testing method

The objective test method was primarily designed to derive the relationship between the percentage of rating difference and the percentage change in student test scores. We compared the difference in ratings of guardians and students with the change in test scores, and we randomly selected a sample of 20 students with a difference value of 1% to 60%, and it compared their change between the two test scores, and their relationship between the two was initially determined by comparison in Figure 6.

Poor score (%)	Change in examination results (%)
1.2	2.0
3.4	2.5
3.9	5.6
4.3	7.1
5.9	11.2
10.2	20.8
12.9	22.4
16.7	28.7
18.1	27.9
23.1	35.8
26.0	37.9
30.8	44.3
36.1	50.4
37.9	49.1
39.7	52.4
40.3	52.8
45.2	60.2
48.6	62.1
50.4	64.8

Figure 6. Scoring Difference vs. Percentage Change in Exam Performance

We used linear regression analysis to examine the relationship between. percent rating difference and changes in student test scores. There was a linear relationship between guardian and student rating differentials and changes in test scores when rating differential percentages were used as the dependent variable and test score changes were used as the independent variable. The final linear regression constructed in Figure 7 was statistically significant ($Y = 1.2533x + 3.5863$, $R^2 = 0.9837$).

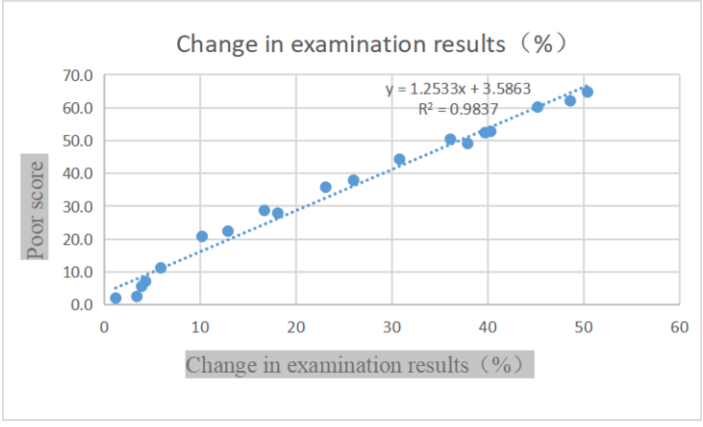

Figure 7. Linear dot plot of the relationship between percent difference in guardian and candidate scores and percent change in test scores

4.2.3 Analysis of results

The results of the subjective testing method showed that the digital artworks generated from the health data were correlated with the health status and emotional experience of the human body, and the better the health status, the better the positive rating of the artwork and the more positive emotional impact the artwork brought to the person likewise, and vice versa. From Table 5, it was found that 63% of the candidates

had a 5% or less difference in value between their scores and their guardians' scores, and 18% of the candidates showed a difference value above 30%.

The results of the objective test method indicate that 63% of the candidates and guardians with a difference value below 5% in rating exhibit that the value of change in performance of these students are within 10%; 18% of the candidates and guardians with a difference value of 30% or more showed that the value of the change in test performance of these students are more than 40%.

In summary, the problem of intergenerational differences will couple with the influence of guardians on students and it can increase the instability of students' test performance. The experiment exhibited that they are positively correlated.

4.3. User Feedback

In response to our work, we received perceptions and feedback on this experiment from candidates as well as their guardians as shown in Table 8. This feedback expanded our understanding of the possibilities of digital artwork.

Table 8. Guardians' and candidates' perceptions of the digital artwork after the experiment (n=10).

Variables	Yes	No	Object
	N(%)	N(%)	
Pre-experimental perceived state affects experimental judgment	3(30.0)	7(70.0)	Guardians, students
Experiment to understand the intention of the corresponding imagery in the painting	6(60.0)	4(40.0)	Guardians, students
Exact grasp of scoring in experiments	5(50.0)	5(50.0)	Guardians, students
Experimentation to perceive the emotions to be expressed in the paintings	7(70.0)	3(30.0)	Guardians, students
Exact grasp of emotional perception scores in the experiment	8(80.0)	2(20.0)	Guardians, students
Experiments in which the emotional changes that occur daily can be perceived	6(60.0)	4(40.0)	Guardians, students
Feel better emotional state after the experiment	7(70.0)	3(30.0)	Students
Digital art images can boost academic performance	8(80.0)	2(20.0)	Students

5. Conclusion

This study presents a data visualization based on digital art images generated from health data of students aged 15-19 to assess their physical health and psycho-emotional

status. By interpreting the digital art images, we build a complex communication bridge between students and their guardians and provide a complementary solution to improve the stability of students' test scores.

Our test method also has certain limitations, from one hand, the sample size is small and the study population is not broad enough. On the other hand, the emotional feedback and cognitive judgments of guardians and students are generated from a subjective cognitive perspective. Although the guardians and students' ability of aesthetic perceptions also affect the experimental judgments, the experimental results show that digital art can help guardians and students to perceive physical health and psycho-emotional conditions. Also, it can be used to predict changes in students' test scores by scoring differences, and its interesting visualization effects can stimulate students' interest and achieve the effect of improving academic performance. Through this research, we successfully clarified that digital art can generate its value in healthcare.

Digital visualization is a development direction of human-computer interaction, and computers have enabled the creation of digital art. It is unclear whether digital art can have any impacts on students in other domains, but we deeply believed that in the future, digital art approaches will be able to provide more health benefits for students.

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