ISSN 2522-6398 Vol. 6, Issue 26: 106-111, DOI: 10.25236/FER.2023.062618

An empirical study: Is there a correlation between empathy ability and design innovation quality?

Chao Jiang[1,a,*], Jingting Pan[1,b], Zhen Jiang[1,c]

[1]College of Art, Anhui University of Finance and Economics, Bengbu, Anhui, China
[a]99708744@qq.com, [b]PJT082800@163.com, [c]320210771@aufe.edu.cn
[*]Corresponding author

Abstract: *In teaching practice, empathy ability has long been recognized as enhancing product design quality. In order to clarify the relationship between empathic ability and design innovation quality, a quantitative empirical research method was used to study 900 students from five universities. First, the empathy ability of the samples was quantified by the Interpersonal Reactivity Index scale; second, the design innovation ability of the students was quantified by the design evaluation; and finally, the quantitative results were analyzed using Pearson's correlation coefficient and multiple linear regression. The results show that empathy ability correlates positively with design innovation quality, and empathy ability significantly impacts design innovation quality. Based on this conclusion, three suggestions are made to improve the current teaching.*

Keywords: *empathy; design innovation quality; Pearson correlation analysis; multiple linear regression; design teaching*

1. Introduction

Since the nineteenth century, empathy has been an essential concern in philosophy, aesthetics, and psychology. In early studies, empathy was understood as "the sharing of emotions between two individuals[1]" or "the passive and intuitive response of an observer to the feelings of an object[2]".In 1909, the American psychologist Edward Titchener in In 1909, American psychologist Edward Titchener argued in his "Lectures on the Experimental Psychology of Thought Processes" that empathy is not only a direct intuition of another's activity but also an active reconstruction of another's sensory experience by using imagination [1]. Although subsequent scholars have continued to discuss the details of the definition of empathy due to different research focuses [2-5], the academic community widely recognizes Edward Titchener's definition of empathy. It is also the understanding of the concept of "empathy" in this paper. Therefore, the empathy ability that we consider in this paper is a personality trait [6] and the behavioral ability of the observer to use imagination to reconstruct the sensory experience of others actively.

In applied psychology research, both at home and abroad, the effect of empathy ability on individual occupational ability is popular research. For example, in the study of the relationship between empathy and medical service quality, empathy is considered essential to promote doctor-patient communication and increase patient satisfaction, effectively improving the doctor-patient relationship [7] and reducing medical disputes. Hojat M et al. [8] believe that "rapid updating of medical technology" and "marketization of health care" have led to "information asymmetry" between doctors and patients (patients do not understand or comprehend the doctor's treatment plan), which has led to "reduced trust" of patients in health care professionals. Reduced trust" in healthcare professionals. He found that healthcare professionals with higher empathy are more patient and willing to "spend more time" explaining the treatment plan and purpose to patients, thus "increasing patients' recognition and trust in healthcare professionals." André B et al. [9] verified that empathy positively affects the quality of nurses' services in stressful and non-stressful situations and that empathy is more pronounced in stressful situations. In the study of teachers, corporate employees, and other professional empathy, Good T L et al. [10] found that empathy can promote "positive interaction" between teachers and students, helping teachers better to understand the learning needs and feelings of students, thus improving the effectiveness of teachers' teaching. Fu Huachun et al. [11] affirmed the above view from a localized perspective, believing teachers "must empathize with students" in their teaching practice. He found that teachers with higher empathy can create a more positive learning atmosphere and

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harmonious classroom relationships, providing a better environment for student's growth and development. Miao Yang [12] found that empathy enables staff to better communicate and collaborate with their colleagues, which helps to alleviate occupational stress and tension, enhance individual resilience, and improve the quality and stability of work. In addition, Wood T [13] and Cottingham M D [14] found through comparative experiments that, due to "stronger empathy between the same sex [13-14]", female prison guards, compared with male prison guards, can more effectively help female inmates establish a positive and constructive psychological state, and improve the effectiveness of supervision and the quality of rehabilitation; male nurses, compared with male prison guards, can more effectively help female inmates establish positive and constructive psychological state, and improve the effectiveness of supervision and the quality of rehabilitation.

Furthermore, regarding the quality of rehabilitation, male nurses are likelier to establish a good doctor-patient relationship with male patients than female nurses. More notably, Tapus A has even extended empathizers from humans to robots. He found that even if the empathizer is a robot, the subject's ability to empathize is still positively related to service quality [15].

Specifically in industrial design and product design teaching, "empathy has a positive effect on the quality of design innovation" seems to be a default and potential "consensus." Teachers usually believe that the use of various forms of teaching activities to enhance students' empathy and guide students to empathize with users can help students more deeply explore the user's functional and emotional needs of the product to design works more in line with the user's "heart" [16]. For example, organizing wind picking, research, and other activities to let students "field observation," giving students intuitive and strong experience feelings, stimulating students' creative inspiration. For example, with the help of tools such as "disability simulation equipment," "role-playing," and "storyboards," students can search for and discover users' "pain points" through simulation and imagination. "Pain points" and solve problems through design innovation. From practical experience, similar teaching activities can help students improve their empathy and enhance design innovation quality. Strictly speaking, however, due to the lack of objective tests on the relationship between "empathy" and "design innovation quality," the relevant teaching activities lack strong support, and the "enhancement of empathy" in the teaching activities is not as strong as it should be. "The legitimacy of "improving empathy" in teaching activities is still questionable. Based on this consideration; this paper aims to reveal the relationship between "empathy" and "design innovation quality" through quantitative empirical methods and put forward corresponding teaching suggestions based on the empirical results.

2. Methodology

2.1. Selection of research subjects

From March to June 2022, the research team organized seven master's degree students to conduct questionnaire research on some students majoring in industrial design and product design in five universities. The sampling method is: according to the grade division (undergraduate second to fourth year, postgraduate first to third year). Each grade randomly selected 30 people. A total of 900 questionnaires were distributed in this research, and 888 were effectively recovered, with an effective recovery rate of 98.7%. An effective recovery rate of more than 75% can be used as a basis for research conclusions.

2.2. Quantification of empathy and questionnaire design

The questionnaire design consists of two aspects: one is the collection of basic information about the research subjects, including grade, gender, age, specialty, etc., which is used for effective questionnaire screening and information registration; the second is the empathy ability test scale, which is used to quantify the empathy ability of the research subjects.

The Chinese version of the Interpersonal Reactivity Index (IRI), compiled by Davis in 1980, was used in this study (translated by Jen Chih-Yu and other scholars from Taiwan). The scale has cognitive and affective dimensions, has been well-validated in cross-cultural studies [17], and is widely used to test and quantify empathy. Its internal consistency is 0.71-0.77, and retest reliability is 0.62-0.80.

The IRI scale quantifies subjects' empathy in four dimensions, including 1) Fantasy Scale (FS), which measures subjects' ability to emotionally take in (fantasize that they are in a "fictional situation"); 2) Perspective-Taking Scale (PT), which measures subjects' ability to shift their "own perspective" to

ISSN 2522-6398 Vol. 6, Issue 26: 106-111, DOI: 10.25236/FER.2023.062618

the "perspective of others" when dealing with people. Unlike Fantasy Empathy (FS), PT is not used in hypothetical and imaginary situations but only real-life situations. 3) Empathic Concern Scale (EC), which measures the ability of subjects to shift their perspective to that of others when dealing with others. The Empathic Concern Scale (EC) measures subjects' ability to empathize with and care for others. 4) The Personal Distress Scale (PD) measures subjects' ability to perceive the negative experiences of others.

Each of the above four dimensions contains 7 items, and the entire IRI scale consists of 28 items. In terms of answer setting, the degree of conformity of the subjects was expressed on a 5-point Likert scale - "very unconformable, somewhat unconformable, uncertain, somewhat conformable, and very conformable," which corresponded to the scores "1, 2, 3, 4 5". Based on the calculation method, the score intervals of the four dimensions of the IRI scale FS, PT, EC, and PD are [-5, 23], [-5, 23], [-11, 17], and [-5, 23], and the total score interval is [-26, 86], with higher scores indicating that the subjects are more empathetic.

2.3. Quantification of design innovation quality

A corresponding mature scale for quantifying design innovation quality has yet to be reached. This study quantitatively scores design innovation quality by design evaluation, and for this purpose, a team of 17 experts from specialized fields was formed. The specific process of quantitative scoring of design innovation quality is as follows: 1) Establishment of evaluation index. The keywords "innovation, design innovation, innovation performance, innovation quality" were used to collect literature from China Knowledge Network (CKNI), Web of Science, and other websites, and Nvivo software was used to analyze the word frequency of the collected literature to get the high-frequency words in related fields. Three indicators for design innovation quality evaluation were determined by expert analysis and discussion - the number of innovations, novelty, and practicality of innovations.2) Determination of indicator weights. The determination of indicator weights adopts the hierarchical analysis method: firstly, using the 1-9 scale method to determine the two-by-two relative importance between the three evaluation indicators and construct the relative importance matrix; secondly, using the SPSS software, the weight values of the three indicators are calculated to be "0.296, 0.328, and 0.376" respectively. After the test, CR = 0.002. It is generally believed that the consistency test is passed if the CR value is less than 0.1 [18].3) Indicator scoring method. The scoring of the indicators is based on the scoring method. The five grades of "fail, pass, moderate, good, excellent" correspond to the score interval of "[0, 59], [60, 69], [70, 79], [80, 89], [90, 100]", and the average score of the experts is taken as the final score for the quantification of the quality of design and innovation. The Final score for innovation quality quantification.

2.4. Statistical methods

Based on the statistical software SPSS 27, 1) the collected data were tested for normality, and the results showed that the data conformed to the normal distribution, so they are expressed in the form of "mean ± standard deviation" in the following.2) Pearson's correlation analysis was used to examine the correlation between empathic ability and its four dimensions and design innovation quality, respectively.3) Linear regression was used to analyze the predictive effect of empathic ability on design innovation quality.

3. Results

3.1. IRI and design innovation quality scores

Table 1: IRI and design innovation quality scores.

Items	scores	*t*/*F*	*P*
IRI	(54.8±5.3)	5.421	0.003
FS	(14.1±5.4)	4.746	0.004
PT	(17.7±4.1)	5.143	0.003
EC	(12.7±2.8)	4.720	0.003
PD	(10.3±5.1)	3.974	0.005
Design Innovation Quality Rating	(78.8±11.3)	6.210	0.002

ISSN 2522-6398 Vol. 6, Issue 26: 106-111, DOI: 10.25236/FER.2023.062618

The results of the IRI total score and design innovation quality score are shown in Table 1. In the table, the total IRI score was (54.8±5.3), and the design innovation quality score was (78.8±11.3). In addition, the four dimensions of FS, PT, EC, and PD scores were (14.1±5.4), (17.7±4.1), (12.7±2.8), and (10.3±5.1).

3.2. Correlation between design innovation quality score and IRI score

The results of the Pearson correlation analysis between the design innovation quality score and the total IRI score and its four dimension scores are shown in Table 2. The design innovation quality score positively correlates with the total IRI score and its four dimensions. Furthermore, among the four dimensions of IRI, the PT dimension has the highest correlation with the design innovation quality score, with a correlation coefficient of 0.218; the PD dimension has the lowest correlation with the design innovation quality score, with a correlation coefficient of 0.101.

Table 2: Correlation between design innovation quality score and IRI score.

Empathy ability and its elements	Correlation
IRI total score	0.237*
FS	0.194*
PT	0.218*
EC	0.173*
PD	0.101*

3.3. Regression analysis of empathy affecting design innovation quality

Taking the design innovation quality score as the dependent variable and the four dimensions of FS, PT, EC, and PD of IRI as the independent variables, regression analysis was carried out, and the results showed that the scores of the four dimensions of FS, PT, EC, and PD of IRI all had a positive predictive effect on the design innovation quality scores of product design majors. The results of the analysis are shown in Table 3.

Table 3: Multiple linear regression analysis.

independent variable	Unstandardized coefficient		*Beta*	*t*	*P*	R^2	R^2_{adj}
	B	*SE*					
FS	0.401	0.063	0.178	1.79	0.003	0.102	0.098
PT	0.513	0.072	0.181	2.21	0.003		
EC	0.841	0.090	0.273	3.37	0.004		
PD	0.596	0.067	0.194	2.47	0.002		

4. Teaching Suggestions

The empirical results show that empathy ability is positively related to the quality of design innovation, and empathy ability positively impacts the quality of design innovation. Research on the cultivation program of industrial design and product design majors in domestic colleges and universities found that teaching activities and related contents in the existing teaching system can enhance students' empathy. Therefore, this paper focuses on enhancing empathy in other fields, combining with the reality of industrial design and product design majors, and puts forward complementary teaching suggestions from three perspectives of "knowledge structure, mode of thinking, and project practice."

4.1. Introducing multidisciplinary knowledge to expand empathy tools and horizons

The Introduction and expansion of disciplinary knowledge include two main modules: ① Introduction of human behavioral science and psychological knowledge. Deeping knowledge of human behavior and psychology is the basis for forming empathy [20-21]. Learning-related knowledge can provide students with tools for analyzing and interpreting user behaviors and emotions, deepen their understanding of the principles of human cognition, emotions, and behaviors, recognize individual differences, the diversity of emotional expressions and emotional experiences, as well as the motives and psychological mechanisms behind the behaviors, and more accurately understand the psychological

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processes and behavioral patterns of users to help students achieve empathy with users. In addition, learning human behavioral sciences and psychology can help students identify and understand human emotional expressions and experiences and better understand and interpret users' emotional needs to achieve better emotional connections and empathic experiences. ②Expanding knowledge of social sciences and humanities. Through the study of social science and humanities knowledge, students can understand the differences and commonalities between different cultures, grasp the impact of different cultures and social backgrounds on human behavior and values, and gain a comprehensive perspective on human behavior and socio-culture, which can help establish more effective empathic connections with users of different knowledge and cultural backgrounds. Learning-related knowledge can enable students to look at design issues from a broader perspective and improve their empathy.

4.2. Encourage critical thinking and focus on developing self-reflection skills

In terms of thinking mode, encouraging students to develop critical thinking is a meaningful way to improve their empathy with users. Among them, developing students' ability to reflect on their biases and limitations is a more critical task. First of all, the cultivation of students' ability to reflect on their own biases and limitations can help students realize the subjectivity of their viewpoints and take them into account to assess and interpret user needs in a more comprehensive and integrated way. Reflection in this thinking process involves in-depth consideration, assessment, and examination of one's own design perspectives, preferences, and ideologies, enabling students to enhance further their awareness of their own possible cognitive biases and subjective perspectives. This enables students to empathize with users by taking a more objective and neutral approach to their opinions and feedback and being more alert and conscious of not over-projecting personal preferences into their designs. Second, reflecting on one's biases and limitations helps students develop humility and open-mindedness. This humility and openness allow students to experience and understand users' feelings, expectations, and challenges and be more open to receiving users' opinions and feedback as valuable information and guidance rather than resisting or ignoring them. This enables students to meet the needs of their users better and improve the quality of their design and user experience, thereby realizing the goal of empathy.

4.3. Promote user participation in design and enhance user interaction and feedback

In design practice, it is essential to strengthen participation and interaction with users [22]. On the one hand, such participation and interaction provide designers with opportunities to reveal users' actual experiences and expectations and direct insights about their needs. Such a process of direct engagement and interaction with users involves in-depth insights into users' emotions, attitudes, and behaviors, as well as an understanding of the motivations and goals behind users' needs, which enables designers to obtain more comprehensive and accurate information about users' feedback and needs, and thus gain better insights into users' experiential sensations, behavioral patterns, and service needs. At the same time, this also enables designers to respond to users' needs with more effective design strategies, promoting the formation and strengthening of empathy with users. On the other hand, when designers have deviations in understanding user needs and experiences, continuous user participation and interaction can provide designers with real-time correction opportunities and more accurate user-oriented guidance for the design process. This real-time correction and user orientation enables designers to obtain users' feedback and opinions promptly and, at the same time, understand their perceptions and expectations of the design solutions so that they can better identify and correct their misunderstandings or deviations from users' needs, improve the accuracy, quality, and user satisfaction of the design, and promote the development of design practice in a more user-centered and personalized direction. In addition, the participation and interaction of users in design activities can help designers and users establish a closer contact and trust relationship, enabling designers to maintain close communication and collaboration with users to achieve better empathy.

5. Conclusion

This paper uses quantitative empirical methods to prove that students' empathy is positively related to the quality of product design innovation and that empathy positively impacts the quality of design innovation. Based on this conclusion, we propose three teaching suggestions to help students improve their empathy.

However, this study also has some limitations: 1) the study sample was only taken from five

ISSN 2522-6398 Vol. 6, Issue 26: 106-111, DOI: 10.25236/FER.2023.062618

universities, which is a small sample coverage, and there may be some sampling errors. 2) this paper needs to discuss the specific mechanism of the role of empathic ability on the quality of design innovation, which can be further deepened in future research.

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