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A Study on the Correlation between Functional Optimization of Special Education School Buildings and the Improvement of Teachers' Professional Competence

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Abstract This study selected 16 teachers from two special education schools as research subjects, employing questionnaire surveys and regression analysis to focus on the optimization of spatial planning and functional layout in school buildings. It explored the close correlation between the optimization of architectural functions in special education schools and the enhancement of teachers' professional competence. The main findings indicate that the optimization of spatial planning in special education school buildings exhibits a significant positive correlation with five dimensions—professional competence, personal skills, thinking patterns, personal knowledge, and team building—at the 0.01 significance level. At the 0.01 level, functional layout optimization in special education schools exhibits significant positive correlations with four dimensions: personal skills, thinking patterns, personal knowledge, and team building. Professional competence and functional layout optimization are significantly correlated at the 0.05 level, effectively promoting the enhancement of teachers' professional competence.

Index Terms questionnaire survey, regression analysis, correlation, building functional optimization

I. Introduction

With the development of the economy and culture, special education has gradually gained attention. Providing everyone with equal access to education is a manifestation of the concept of human rights. Continuously improving the special education system and prioritizing compulsory education for individuals with various disabilities have become key focuses of education in many countries [1], [2]. Under the support of national policies, the promotion by various government departments, and the active cooperation of local governments, special education has experienced rapid development, with its coverage and educational quality continuously improving [3]-[5]. Special education schools are the primary venues where school-age children, adolescents, and adults with disabilities learn cultural and life skills. The teaching facilities and educational environment of special education schools should also develop and improve accordingly. A well-designed special education school building, centered on student needs, is a prerequisite for providing high-quality compulsory education to students with disabilities [6], [7]. The campus and functional development of special education schools have gradually received the attention they deserve, undergoing a process of establishing industry standards from scratch [8].

Teachers' professional ethics refer to the moral principles and basic behavioral norms that teachers should adhere to in their professional lives when interacting with others and society, as well as the ideological awareness and behavioral qualities manifested on this basis [9]. The level of professional competence directly impacts the quality and efficiency of professional activities [10]. Since students receiving special education constitute a special group with certain physical or intellectual impairments, they require greater care and attention. Therefore, compared to general educators, special education teachers face greater pressure and must possess higher levels of knowledge and professional competence. Teachers' professional competence is a key factor in improving the quality of special education [11]-[14]. Currently, there is still a significant shortage of full-time teachers with special education professional competence, especially in grassroots special education institutions, leading to a widespread phenomenon where most teachers in special schools lack professional competence yet are still assigned to teach [15], [16]. To facilitate the career development of special education teachers, efforts to enhance their professional competence are urgently needed.

Literature [17] points out that the design of facilities (ramps, pathways, restrooms, etc.) in special education schools that do not meet standards can impair students' mobility and communication, thereby affecting their academic performance. Currently, major functional areas in special education schools are severely compartmentalized, leading to limited student interaction and hindering teaching effectiveness. Literature [18]

utilized the Kano model, analytic hierarchy process, axiomatic design theory, matrix analysis, and computer-aided design to create interactive spaces for schools serving children with intellectual disabilities. Literature [19] combines the educational and rehabilitative needs of special children to provide a school design methodology for an autism education and rehabilitation center. Additionally, literature [20] summarizes the severe shortage of educational facilities such as furniture and physical infrastructure for special populations in current Pakistani special education, as well as the insufficient availability of teaching aids, professional teachers, and non-teaching staff. Literature [21] investigated the challenges faced by special education teachers in Malaysia when teaching students with multiple disabilities, with professional teaching aids and classroom environments identified as key issues. Literature [22] mentions that initial training, onboarding training, onboarding guidance, professional development, peer interaction, and teacher evaluation experiences are effective pathways to enhance teacher competence. Existing literature often isolates studies on architecture or teacher development, failing to adequately address the mutual influence between classroom space configuration and teaching strategies, as well as the impact of changes in architectural space environments on teacher professionalism.

This paper approaches the topic from two aspects: spatial planning and functional layout optimization for the functional optimization of special education school buildings. By thoroughly analyzing the goals and concepts of enhancing teacher professional competence, it employs variance analysis, correlation analysis, and regression analysis to comprehensively examine the relationship between teacher professional competence, personal skills, thinking patterns, personal knowledge, team building, and other dimensions, and the functional optimization of special education school buildings.

II. Directions for improving teachers' professional competence

In the context of new-era education, teacher education students, as the backbone of the future education sector, play a crucial role in shaping educational quality and student development. Labor education, as an integral component of the comprehensive education system, is closely intertwined with the cultivation of teacher education students' professional competence. Exploring the interconnections between the two is of significant importance for establishing a scientifically sound and reasonable teacher education model and advancing the progress of the education sector. Therefore, we should place importance on pre-service teachers' learning and practice in labor education, using it to enhance their sense of responsibility, cooperative spirit, and innovative awareness. Additionally, labor education can help pre-service teachers better understand societal needs and cultivate their ability to solve practical problems, which is crucial for them to become qualified educators in the future. Furthermore, the implementation of labor education should be integrated with pre-service teachers' curriculum design, teaching methods, and evaluation systems to form an organic whole, thereby more effectively enhancing their professional competence [23].

(1) Professional ethics

As future educators, teacher education students must cultivate and possess high professional ethics, which include, but are not limited to, deep care for students, love and dedication to the teaching profession, a focus on cultivating students' comprehensive qualities in the teaching process, and demonstrating a good teacher image in their daily behavior. These qualities require teacher education students to respect the individual differences of each student in educational practice, to engage in educational and teaching work with enthusiasm and a strong sense of responsibility, and to set a positive moral example for students through their own words and actions.

(2) Personal Skills

Solid subject-specific knowledge is the foundation for teacher education students. They need to thoroughly master the basic concepts, principles, and knowledge systems of the subjects they teach and be able to accurately convey knowledge. Additionally, teacher education students should possess the ability to integrate theoretical knowledge with practical application to better adapt to changes in the educational environment and diverse learning needs of students.

(3) Thinking Patterns

To achieve the construction of innovative thinking patterns in elementary school classrooms, elementary science teachers must first undergo self-reform and become pioneers with innovative thinking and capabilities. Teachers should dare to innovate, boldly experiment with new teaching methods, challenge traditional teaching models, and continuously explore and learn educational paths suitable for the development of students' scientific literacy.

(4) Team Building

When organizing and implementing labor education projects, teacher education students need to carry out a series of instructional design tasks, including developing detailed activity plans, reasonably allocating personnel responsibilities, and coordinating various resources.

(5) Personal Knowledge Management

Personal knowledge management encompasses seven core knowledge management competencies: retrieval, evaluation, organization, analysis, expression, security, and collaboration. From a narrow definition, it refers to the process by which individuals use various tools or methods to establish and continuously refine a knowledge system, thereby engaging in the collection, assimilation, and innovation of knowledge.

III. Planning of architectural space and optimization of functional layout for special education schools

At the overall planning level, a systematic and forward-looking approach should be adopted. First, based on the principle of separating quiet and noisy areas, teaching areas, administrative areas, and other relatively quiet zones should be reasonably separated from sports areas, club activity zones, and other noisy zones. Greenery, walkways, or auxiliary buildings can be used to create natural barriers to reduce mutual interference. Optimize campus traffic flow by planning clear vehicular loops and pedestrian main thoroughfares to achieve separation of pedestrians and vehicles, ensuring the safety of faculty and students. Sufficient parking lots and drop-off zones should be established at campus entrances to avoid congestion during peak commuting hours. Considering the future development scale and functional expansion needs of special education schools, a certain proportion of open space or adaptable areas should be reserved to facilitate future additions of teaching buildings, laboratories, or improvements to other functional facilities, ensuring the sustainability and scalability of the campus building layout.

The layout of teaching spaces can adopt flexible and diverse design concepts. The concept of modular teaching units is introduced, with each unit equipped with standard classrooms, small seminar rooms, teacher offices, and shared resource rooms and equipment rooms. These units can be combined or divided according to subject characteristics or grade levels, facilitating tiered teaching and interdisciplinary collaborative teaching. Create shared teaching spaces, such as a large multi-purpose hall in the center of the teaching building, which can be used for school-wide activities like academic lectures, open classes, and cultural performances. Set up open learning and exchange areas between floors, equipped with comfortable seating, electronic devices, and book resources, for students to engage in group discussions and self-directed learning during breaks or study periods. This breaks the traditional closed limitations of classrooms and promotes knowledge exchange and the stimulation of innovative thinking.

Student activity and living spaces should prioritize human-centered and engaging design. In addition to standard sports fields and gymnasiums, student activity spaces can include specialty areas such as outdoor adventure zones, creative workshops, and music rehearsal rooms to cater to diverse interests. Integrating these spaces with campus landscapes—such as outdoor stages in gardens or reading corners in wooded areas—creates a vibrant and culturally enriching campus environment. For student living spaces, dormitory areas can be designed with different room types, such as single rooms and multi-person rooms, to meet students' personalized accommodation needs. Dormitory facilities should be improved, including private bathrooms, shower facilities, study rooms, and common activity rooms, while strengthening safety management and landscaping in dormitory areas.

IV. General form of regression analysis

The relationship between variables may be either a functional relationship or a correlation relationship. A functional relationship indicates a one-to-one, deterministic relationship between variables, while a correlation relationship indicates that variables are related but cannot be precisely expressed by a functional relationship, such as the relationship between a father's height and his children's height. Correlation analysis primarily describes the degree of closeness in the correlation between variables, while regression analysis not only reveals the extent of mutual influence between variables but also enables estimation and prediction through the establishment of a regression equation.

Regression is a statistical method. Regression analysis is a computational method and theory used to study the relationship between one or more independent or predictor variables and a (continuous-valued) dependent or response variable. That is, when the variable $X=\{x_1, x_2, ..., x_n\}$ and the random variable y, we can use a mathematical formula to characterize this relationship, namely:

$$y = f(x) + \varepsilon \tag{1}$$

In this context, X represents the independent variable, y represents the dependent variable, ε represents the random error, and $f(x)$ represents the deterministic functional relationship between the independent and dependent variables. When the values of the random variable X are determined, we can use the correlation model to obtain the probability distribution of the dependent variable y. Equation (1) accurately describes the characteristics of both connection and uncertainty in the correlation between variables. By treating the relationship

between the independent variable and the dependent variable as a random equation with random error, we can use methods from random mathematics to study the relationship between the independent variable X and the dependent variable y [24].

V. Empirical evidence on the relationship between building function optimization and teacher professional competence improvement

V. A. Specific circumstances of the survey subjects

To validate the aforementioned hypothesis, this paper summarizes previous research findings and combines them with teachers' work environments, characteristics, and current contexts to design interviews and questionnaires. The behavioral event interview method is proposed to determine competency characteristics, which is currently recognized as an effective method for constructing competency models. To obtain teachers' competency characteristics, an interview outline that meets the requirements of the behavioral event interview method was designed. In accordance with the subject requirements of the BEI method, both high-performing and average-performing individuals were selected for interviews to gather competency-related information. This study involved 16 teachers from two special education schools, including 8 who received excellent performance evaluations in the previous year and 8 who were average. Their gender, age, and educational background varied, with specific details shown in Table 1.

Table 1: Sample specific condition

Item name	Specific information	N	Percentage (%)
Group	Excellent group	8	50.00%
	General group	8	50.00%
Gender	Male	9	56.25%
	Female	7	43.75%
Age	Under 25	4	25.00%
	25-30	3	18.75%
	30-35	2	12.50%
	36-45	4	25.00%
	Over 45	3	18.75%
Educational background	Under junior college	1	6.25%
	Junior college	5	31.25%
	Undergraduate	6	37.50%
	Master	4	25.00%
Working life	Under 1 year	4	25.00%
	1-3	5	31.25%
	3-5	3	18.75%
	5-10	4	25.00%
	Over 10		

Some of the options in the questionnaire for this survey were directly sourced from relevant domestic and international studies, while others were compiled based on interviews. The validity and scientific rigor of the questionnaire have not been verified. To ensure the accuracy of the large-scale survey questionnaire, a preliminary survey was first conducted on a small scale. Considering regional differences and difficulties in distribution and collection, the survey participants were limited to teachers at special education schools near their residences. A total of 70 questionnaires were returned, with 62 deemed valid. The questionnaire was subjected to reliability and validity analysis, with the specific results shown in Table 2.

Table 2: questionnaire scale reliability analysis table

Scale	Subject matter	Alpha
The function optimization of special education school building	32	0.948
Relationship performance scale	12	0.882
Task performance scale	6	0.859
Salary incentive scale	12	0.914
Total consistency	62	0.948

The validity test of the questionnaire survey is shown in Table 3. The Alpha coefficient is an indicator of reliability, with higher values indicating higher reliability. Generally, if the reliability coefficient is above 0.9, it indicates very good reliability. If it is above 0.8, it is acceptable. If it is above 0.7, it indicates that the scale requires major revisions but can still be used for research. If it is below 0.7, it indicates that it should be abandoned. As shown in the table, all Alpha coefficients are above 0.8, with some even exceeding 0.9, indicating that the questionnaire has high reliability and can be used for research surveys.

The table above presents the results of the KMO and Bartlett tests. A KMO value greater than 0.5 indicates that the questionnaire meets the requirements for factor analysis. The closer the KMO value is to 1, the better the questionnaire is designed. From the table, we can see that the KMO values are 0.762, 0.814, 0.806, and 0.817, indicating that factor analysis can be conducted. The null hypothesis of Bartlett's sphericity test is that the correlation coefficient matrix is the identity matrix. With a Sig value of 0.001, the null hypothesis is rejected, indicating that there are correlations among the variables, making it suitable for factor analysis. In summary, all sections of the survey questionnaire have passed reliability and validity tests, indicating that the questionnaire is feasible. Therefore, this questionnaire is adopted as the tool for large-scale data surveys in this study.

Table 3: Questionnaire scale validity analysis table

	The function optimization of special education school building	Relationship performance scale	Task performance scale	Salary incentive scale
The sample is sufficient for the Kaiser-Meyer-Olkin quantity	0.762	0.814	0.806	0.817
Bartlett spherical test approximation card square	1145.289	225.618	108.986	300.48721
Df	440	56	20	28
Sig	0.001	0.001	0.001	0.001

V. B. Correlation Analysis

A correlation analysis was conducted between the optimization of school building functions (spatial planning and functional layout optimization) and teachers' professional competence. The results are shown in Table 4: The results indicate that the five dimensions of professional competence, personal skills, thinking patterns, personal knowledge, and team building are significantly correlated with spatial planning optimization at the 0.01 level. The five dimensions of personal skills, thinking patterns, personal knowledge, and team building are significantly correlated with functional layout optimization at the 0.01 level, while professional competence is significantly correlated with functional layout optimization at the 0.05 level. It is not difficult to conclude that school building functional optimization is significantly correlated with teacher professional competence. Further analysis reveals that the relationship between school building functional optimization and teachers' professional competence is relatively closer. This result is reasonable and suggests that performance can be inferred based on competence during the work process. In teacher recruitment, the level of professional competence can be used as one of the screening criteria. Teachers with knowledge and skills matching their job positions can utilize school building functionality to develop reasonable teaching plans tailored to the needs of different students. Teachers with high professional competence tend to create a harmonious, united, and relaxed work environment, where they are competitors at work but friends and confidants in life, which significantly promotes the improvement of functional layout optimization. Teaching is a rapidly developing and constantly changing profession that requires continuous self-improvement and self-enhancement, as well as a focus on collaboration, to achieve good performance. The results indicate that the five dimensions of teacher professional competence, personal skills, thinking patterns, personal knowledge, and team building are significantly correlated with spatial planning optimization at the 0.01 level. The five dimensions of personal skills, thinking patterns, personal knowledge, and team building are significantly correlated with functional layout optimization at the 0.01 level, while professional competence is significantly correlated with functional layout optimization at the 0.05 level. It is not difficult to conclude that school building functional optimization is significantly correlated with teacher professional competence.

Table 4: Correlation analysis

	Professionalism	Personal skill	Thinking pattern	Personal knowledge	Team building
Spatial planning optimization	0.620**	0.458**	0.506**	0.618**	0.522**

Functional layout optimization	0.278*	0.479**	0.412**	0.401**	0.346**

V. C. Regression Analysis

The regression results are shown in Table 5. The standard regression equations for spatial planning optimization include professional competence, personal skills, thinking patterns, and personal knowledge. The regression equations for functional layout optimization include professional competence, personal skills, and team building. The F-value tests for the regression equations are all significant at the 0.01 level, indicating that the regression effects are significant. The four dimensions of professional competence, personal skills, thinking patterns, and personal knowledge explain 17.0% of the variance in spatial planning optimization. Among these, the regression coefficients for professional competence and personal skills are significant at the 0.01 level, while those for thinking patterns and personal knowledge are significant at the 0.05 level. Professional competence, personal skills, and team building explain the variance in functional layout optimization. Among the variables entering the regression equation, professional competence is significant at the 0.05 level, while the others are significant at the 0.01 level.

Table 5: Regression analysis

Dependent variable	Independent variable	Standard regression coefficient	T value	Sig	Adj.R^2	F value
Spatial planning optimization	Professionalism	0.364	5.532	0.001	0.170	13.296**
	Personal skill	0.148	4.417	0.003		
	Thinking pattern	0.235	2.708	0.036		
	Personal knowledge	0.336	1.615	0.045		
Functional layout optimization	Constant	0.015	1.046	0.001	0.408	8.578**
	Professionalism	0.126	2.798	0.028		
	Personal skill	0.408	4.178	0.001		
	Team building	0.322	3.862	0.001		

V. D. Evaluation and feedback on the effectiveness of improving teachers' professional competence

The effectiveness of this teacher professional development program was evaluated primarily through a comparison of test scores (before and after the optimization of school building functions) and an offline questionnaire survey. The post-optimization group consisted of the classes where the teaching process took place after the optimization, while the pre-optimization group consisted of classes that were selected to be comparable in overall performance to the post-optimization group. Both groups were selected from all ninth-grade students at a certain middle school in Harbin City, Heilongjiang Province.

Based on the overall results from the questionnaire data, as shown in Figure 1, the scores after optimization were higher than those before optimization across all dimensions. This indicates that, whether from the perspective of knowledge and ability, classroom dynamics, or post-class extension, teachers' professional competence has a significant impact on classroom performance and the development of students' competencies.

In terms of knowledge mastery, since the optimized teachers emphasized the improvement of professional knowledge literacy, they conducted in-depth research and learning on the sources and application of professional knowledge. Students were able to easily grasp the essence of knowledge under the teachers' clear explanatory framework, thereby identifying key memory points. In the classroom, they could keep pace with the teachers' instructional logic, and through smooth knowledge transmission, they relatively smoothly mastered the knowledge points required for the lesson. Therefore, as evidenced by the results of questionnaires and tests, the level of knowledge mastery after optimization was higher than that before optimization.

From the perspective of ability development, teachers with higher professional competence demonstrate higher ability competence in their classes (after optimization). The reason they exhibit higher learning ability competence and better cognitive development levels is that teachers focus on their professional competence development in the classroom, continuously improving their teaching skills, accumulating experience through practice, and conveying key points and difficulties to students in an accessible manner. From the perspective of classroom learning state, when teachers possess higher professional competence, their classes exhibit better learning states. This is not only related to teachers' professional competence but also to their non-professional competence.

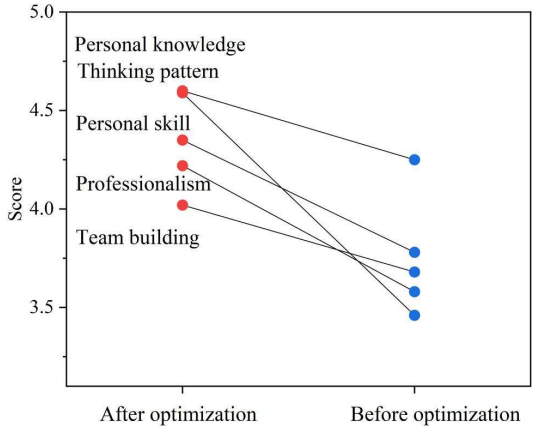

Figure 1: teaching effect comparison analysis

VI. Conclusion

This study employs questionnaire surveys and regression analysis to examine the relationship between the optimization of architectural functions in special education schools (spatial planning and functional layout optimization) and the enhancement of teachers' professional competence. The results indicate that five dimensions—teachers' professional competence, personal skills, thinking patterns, personal knowledge, and team building—are significantly correlated with spatial planning optimization. The five dimensions of teacher professional competence, personal skills, thinking patterns, personal knowledge, and team building are significantly correlated with functional layout optimization. The findings of this study provide practical guidance for enhancing teacher professional competence.

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