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## PLANNAR INTERLOCKING TILINGS BASED ON FINITE REFLECTION GROUPS

#### PeiChang Ouyang\*, Yan Lin, LiHua Liu

School of Science, Guangxi University of Science and Technology, Liuzhou 545006, Guangxi, China. Corresponding Author: Peichang Ouyang, Email: g\_fcayang@163.com

**Abstract:** The field of planar tiling has captivated mathematicians, artists, and architects for centuries, driven by the desire to create intricate and harmonious patterns. Recent advancements have focused on developing new methods and technologies for constructing these patterns, particularly with the advent of advanced manufacturing and computational tools. This paper introduces a novel approach utilizing planar polyhedral tiles with interlocking elements to construct a wide range of two-dimensional symmetry structures. Based on the principles of fundamental domains in finite reflection groups, this technology allows for the creation of complex and aesthetically pleasing patterns. The tiles are designed to fit together perfectly, forming a dense packing that covers the entire plane without gaps or overlaps. The interlocking elements ensure stability and enable the creation of structures exhibiting high degrees of symmetry and order. This innovation has significant implications not only for traditional fields such as architecture and design but also for materials science and engineering, where it offers new possibilities for creating lightweight, strong composites and improving surface properties. The potential applications of this technology are vast, promising to revolutionize various industries and push the boundaries of creativity and functionality.

Keywords: Tiling; Symmetry group; Reflection group; Fundamental region; CAD

#### **1 INTRODUCTION**

The field of planar tiling has long been a source of fascination for mathematicians, artists, and architects alike. The ability to cover a plane with repeating patterns without gaps or overlaps is a fundamental concept in geometry and symmetry. From ancient mosaic floors to modern Islamic architecture, the desire to create intricate and harmonious patterns has driven the development of tiling techniques and theories. In recent years, there has been a growing interest in developing new methods and technologies for creating these patterns, particularly with the advent of advanced manufacturing techniques and computational tools.

This innovation utilizes planar polyhedral tiles with interlocking elements to construct a wide range of two-dimensional symmetry structures. These tiles are designed to fit together perfectly, forming a dense packing that covers the entire plane without gaps or overlaps. The interlocking elements on the faces of the tiles ensure that the tiles remain connected and stable, even under stress or deformation. This approach allows for the creation of complex and aesthetically pleasing patterns that exhibit a high degree of symmetry and order.

Technology is based on the principles of fundamental domains in finite reflection groups, which provide a framework for understanding the symmetries of regular polygons and their corresponding tilings. A finite reflection group is a group of reflections in a finite-dimensional Euclidean space that generates a crystallographic symmetry. The fundamental domain of a finite reflection group is a region in the plane that can be mapped onto the entire plane through the group's symmetries. In the context of planar tiling, the fundamental domain corresponds to the smallest repeating unit that can be used to construct the entire pattern. For example, the fundamental domain of the square tiling is a square, which can be used to construct a grid-like pattern that covers the entire plane. Similarly, the fundamental domain of the hexagonal tiling is a hexagon, which can be used to construct a honeycomb-like pattern that covers the entire plane.

The use of planar polyhedral tiles with interlocking elements allows for the creation of a wide range of two-dimensional symmetry structures, including all 17 plane periodic patterns, the five Platonic solids, and the thirteen Archimedean solids. These structures exhibit a high degree of symmetry and aesthetic appeal, making them highly sought after in fields such as architecture, design, and materials science.

In architecture, the ability to create complex and symmetrical patterns can be used to design visually stunning buildings and structures. For example, the use of planar polyhedral tiles can be seen in the design of the Alhambra in Spain, where intricate tile patterns create a sense of harmony and balance. Similarly, the use of these tiles can be seen in modern architecture, where they are often used to create decorative elements and patterns that add to the aesthetic appeal of buildings. In design, the ability to create complex and symmetrical patterns can be used to create visually striking products and artworks. For example, the use of planar polyhedral tiles can be seen in graphic design, where they are often used to create intricate and detailed patterns that add to the visual appeal of designs. Similarly, the use of these tiles can be seen in product design, where they are often used to create unique and visually appealing products that stand out from the competition. In materials science, the ability to create complex and symmetrical patterns can be used to design new materials with specific properties and structures. For example, the use of planar polyhedral tiles can be seen in the development of new composite materials, where they are used to create materials with improved strength and durability. Similarly, the use of these tiles can be seen in the development of new surface coatings, where they are used to create surfaces with improved wear resistance and corrosion resistance. The field of planar tilings is a fascinating and complex area of study that has been of interest to mathematicians, artists, and architects for centuries. The ability to create complex and symmetrical patterns using planar polyhedral tiles with interlocking elements represents a significant advancement in this field, offering a wide range of potential applications in architecture, design, and materials science. Technology is based on the principles of fundamental domains in finite reflection groups, which provide a framework for understanding the symmetries of regular polygons and their corresponding tilings.

#### 2 HISTORICAL BACKGROUND AND MATHEMATICAL FUNDATIONS

The study of tiling and tessellation dates to ancient civilizations, with evidence of tile-based artwork found in Egyptian, Greek, and Roman cultures. In ancient Egypt, for instance, the use of tiles in the construction of temples and palaces showcased the early application of tiling to create intricate and beautiful patterns that not only added aesthetic value but also served practical purposes, such as waterproofing and insulation. The Greeks and Romans also utilized tiles extensively in their architectural designs, with the Romans developing complex mosaic patterns that demonstrated a high level of craftsmanship and mathematical precision.

However, it was not until the 19th and 20th centuries that mathematicians began to systematically study the theory of tilings, leading to the discovery of different types of tilings and the development of mathematical models to describe them [1]. This period marked a significant shift in the approach to tiling, from mere artistic expression to a rigorous mathematical inquiry. Mathematicians like Augustin-Louis Cauchy and David Hilbert contributed to the formalization of tiling theory, exploring the conditions under which various shapes could tile the plane and the properties of these tilings.

Finite reflection groups are a fundamental concept in group theory, used to describe the symmetries of regular polygons and polyhedra. These groups consist of reflections and rotations that map the group to itself, creating a structured and predictable pattern of symmetry. The study of finite reflection groups is crucial in understanding the symmetrical properties of shapes that can tile the plane, as these groups provide a mathematical framework for analyzing the transformations that preserve the tiling's structure [2]. The fundamental domain of a finite reflection group is a region in the plane that can be mapped onto the entire plane through the group's symmetries. This concept is essential in tiling theory as it helps in identifying the smallest repeating unit of a tiling pattern. By understanding the fundamental domain, mathematicians can predict how a tiling will behave under different transformations, such as rotations or reflections, and can use this knowledge to create new types of tiling with specific symmetrical properties.

Regular polygons, such as triangles, squares, and hexagons, have the property that all their sides and angles are equal. These polygons can tile the plane, meaning they can cover the plane without gaps or overlaps [3]. The ability of these shapes to tile the plane is not only due to their regularity but also to their internal angles, which allow them to fit together seamlessly. For example, squares tile the plane using four squares meeting at a point, while hexagons tile the plane using three hexagons meeting at a point. The study of these tilings has led to the discovery of different types of lattices and the development of mathematical models to describe them. A lattice is a regular arrangement of points in space, and in the context of tiling, it refers to the arrangement of tiles in a repeating pattern. Mathematicians have developed various models to describe the properties of these lattices, such as their symmetry groups, dimensions, and packing densities. These models have applications in various fields, including crystallography, materials science, and computer graphics.

The study of tiling and tessellation has evolved from ancient artistic expressions to a sophisticated mathematical discipline. The discovery of different types of tilings and the development of mathematical models to describe them have expanded our understanding of geometry and symmetry. The principles of finite reflection groups and the concept of fundamental domains have played a crucial role in this evolution, providing a deeper insight into the symmetrical properties of tilings and their applications in various fields. The ongoing research in this area continues to reveal new and exciting discoveries, pushing the boundaries of our knowledge and creativity.

#### **3 METHODOLOGY OF PLANNAR TILES**

The first step in the methodology is the design of the planar polyhedral tiles. This phase is crucial as it lays the foundation for the entire tiling process. The tiles are typically designed using Computer-Aided Design (CAD) software, which allows for precise control over their shape, size, and orientation. CAD software provides a digital environment where designers can create, manipulate, and visualize the tiles before they are physically produced. This digital approach enhances accuracy and efficiency, enabling designers to experiment with various shapes and configurations to achieve the desired outcome [4].

The tiles are chosen to be able to form all 17 plane periodic patterns, providing a high degree of flexibility and versatility in creating different symmetry structures. The 17 plane periodic patterns, first classified by mathematician Evgeny Fedorov, represent all the possible ways to tile the plane with a single shape without gaps or overlaps. By designing tiles that can form these patterns, the methodology ensures that the resulting tiling structures are mathematically sound and aesthetically pleasing. Each tile is designed with specific geometry and angles to ensure they fit together seamlessly, forming a continuous and seamless pattern. These tiles can have simple shapes, such as regular polygons, or more complex shapes, such as stars or rhombuses, depending on the desired pattern type. The precision in

calculating the angles and edges is crucial to ensure that the tiles can interlock without any gaps or overlaps. Figure 1 shows the fundamental region with respect to 17 planar symmetry groups.



Figure 1 Fundamental Region Associated with 17 Planar Symmetry Group

The second step is the creation of the interlocking elements on the edges of the tiles. These elements are designed to fit together perfectly, ensuring that the tiles remain connected and stable when assembled. The interlocking elements can be created using various techniques, such as engraving, molding, or 3D printing, depending on the material and desired finish. These elements can be made from a variety of materials, including plastic, metal, or wood, depending on the desired properties of the final pattern [5]. The design of the interlocking elements requires careful consideration of the mechanical properties of the materials and the stresses that the structure will be subjected to. The interlocking elements must be able to withstand these stresses without deforming or breaking, ensuring the long-term stability of the tiling structure. Additionally, the interlocking elements should be designed to be easily assembled and disassembled, allowing for flexibility in the construction process and the ability to adjust or repairs as needed.

The final step is the assembly of the tiles into the desired symmetry structure (see Figure 2). This can be done manually or using automated assembly machines, depending on the scale and complexity of the pattern. Manual assembly is often used for smaller and simpler patterns, where precision and attention to detail are paramount. Automated assembly machines, on the other hand, are used for larger and more complex patterns, where speed and efficiency are critical factors. The tiles are arranged in a specific pattern, with the interlocking elements fitting together to form a dense packing that covers the entire plane [6-7]. During the assembly process, it is important to ensure that the tiles are aligned correctly and that the interlocking elements are fully engaged. This may involve the use of templates, guides, or other tools to ensure precision and consistency. Additionally, the assembly process should be carried out in a controlled environment to minimize the risk of errors or damage to the tiles. Once the tiles are assembled into the desired symmetrical structure, the structure is checked for accuracy and completeness. This involves verifying that the tiles are properly aligned, that the interlocking elements are fully engaged, and that there are no gaps or overlaps between the tiles. Any necessary adjustments or corrections are made at this stage to ensure that the final structure meets the desired specifications.



Figure 2 The Left is an Interlocking Tile with Respect to the Fundamental Region of Group P<sub>4m</sub>; The Right is an Interlocking Tile with Respect to the Fundamental Region of Group P<sub>6m</sub>

The complete tiling structure can then be used for various applications, depending on the original intent of the design. For example, the structure could be used as a decorative element in an architectural project, as a functional component in a product design, or as a research tool in a scientific study. The versatility and flexibility of the methodology allow it to be applied to a wide range of fields and projects, making it a valuable tool for creators and researchers alike [8-10]. The methodology for creating planar polyhedral tiles involves several key steps, each of which is critical to the success of the final structure. The design of the tiles using CAD software allows for precision and flexibility, the creation of interlocking elements ensures stability and strength, and the assembly of the tiles into the desired symmetry structure completes the process, see an example shown in Figure 3. This methodology not only allows for the creation of beautiful and complex tiling patterns but also provides a framework for understanding the mathematical principles underlying these patterns.

#### **4 APPLICATIONS OF PLANNAR INTERLOCKING TILES**

The technology described in this paper has significant and far-reaching potential implications for the field of materials science and engineering [11-12]. The ability to create dense packings of planar polyhedral tiles with interlocking elements represents a groundbreaking innovation in the design and fabrication of materials. This approach offers a novel and versatile method for engineering materials with specific properties and structures, opening up new possibilities in various applications.

One of the most exciting applications of this technology is the creation of lightweight and strong composites. By carefully designing the planar polyhedral tiles and their interlocking elements, engineers can optimize the distribution of forces within the composite material. This optimization allows for the reduction of material usage while maintaining or even enhancing the structural integrity of the final product. For instance, in the aerospace industry, where weight reduction is critical for fuel efficiency and performance, such composites could revolutionize the design of aircraft components. These composites can be fabricated using a variety of materials, including polymers, metals, and ceramics. The choice of material depends on the specific requirements of the application, such as strength, stiffness, durability, and environmental resistance. For example, polymer-based composites are known for their lightweight and flexibility, making them ideal for applications in automotive and sports equipment. Metal-based composites, on the other hand, offer superior strength and wear resistance, which are essential for industrial machinery and construction. The interlocking elements play a crucial role in the performance of these composites. They ensure that the tiles remain securely connected, distributing loads evenly across the structure. This even load distribution helps to prevent localized stress concentrations that can lead to material failure. Additionally, the interlocking mechanism can enhance the fracture toughness of the composite, making it more resistant to impact and fatigue.

Another important aspect of this technology is its potential to improve the surface properties of materials. The dense packing of the planar polyhedral tiles can create a smooth and uniform surface finish, which is desirable for many applications. For instance, in the automotive industry, a smooth surface finish can improve the aerodynamics of a vehicle, reducing drag and improving fuel efficiency. In the consumer products sector, a flawless surface can enhance the aesthetic appeal and durability of products. Moreover, technology allows for the creation of surfaces with tailored texture and friction characteristics. By designing the tiles with specific patterns and interlocking arrangements, engineers can control the friction behavior of the material. This capability is particularly useful in applications where grip and traction are important, such as in footwear, tires, and handlebars of bicycles.

In the field of materials engineering, this technology can also be used to develop new types of functional materials. For example, by incorporating conductive or magnetic materials into tiles, engineers can create composites with embedded electrical or magnetic properties. Such materials could be used in a wide range of applications, from electronics and sensors to energy storage and conversion devices. In addition to the above applications, this technology has the potential to revolutionize the way we design and manufacture complex structures. The use of planar polyhedral tiles and their

interlocking elements allows for a modular and scalable approach to construction. This approach enables the creation of intricate and large-scale structures that would be difficult or impossible to achieve using traditional manufacturing techniques. Furthermore, technology offers opportunities for customization and personalization. Since the tiles can be designed and arranged in a variety of ways, it is possible to create materials and structures that are tailored to the specific needs and preferences of individual users. This personalization can extend to the mechanical properties, aesthetic appearance, and even the environmental impact of the final product.



Figure 3 Tiling by Interlocking Tiles with Respect to Triangular Fundamental Region

The technology described in this paper has profound implications for the field of materials science and engineering. The ability to create dense packings of planar polyhedral tiles with interlocking elements provides a powerful tool for designing and fabricating materials with specific properties and structures. This innovation opens up new avenues for creating lightweight and strong composites, improving surface properties, developing functional materials, and revolutionizing the design and manufacturing of complex structures. The potential applications of this technology are vast and varied, spanning across multiple industries and sectors. As research and development in this field continue to advance, we can expect to see even more exciting and innovative uses of this technology in the future. In the materials science and engineering community, there is a growing interest in exploring the use of advanced materials to solve complex problems and meet the demands of modern society. The development of materials with tailored properties and structures is a key priority, as it enables the creation of more efficient, sustainable, and high-performance products.

This technology contributes to these efforts by providing a new and effective method for designing materials with specific properties. By carefully controlling the arrangement and interlocking of the tiles, engineers can optimize the material's performance for a given application. This level of control and precision is difficult to achieve with traditional manufacturing methods. Moreover, the versatility of this technology allows for the integration of different materials and properties into a single composite structure. This integration can lead to the creation of materials with novel and unique characteristics, such as self-healing capabilities, phase change properties, or optical activity. The ability to create lightweight and strong composites is particularly important for the aerospace and automotive industries. By reducing the weight of aircraft and vehicles, fuel efficiency can be improved, emissions can be reduced, and performance can be enhanced. Additionally, the improved surface properties of materials can lead to better corrosion resistance, wear resistance, and durability, extending the lifespan of products and reducing maintenance costs.

We can expect to see further advancements in this technology, as researchers continue to explore its potential and develop new applications. This could include the creation of even more complex and sophisticated materials, the integration of smart materials and sensors, and the use of advanced manufacturing techniques to produce these materials on a scale. Overall, the technology described in the patent represents a significant breakthrough in the field of materials

science and engineering. It offers a new and innovative approach to designing and fabricating materials with specific properties and structures, opening a world of possibilities for creating better products and solving complex problems.

#### **5 TECHNOLOGY ADVANCEMENTS AND FUTURE PROSPECTS**

One of the key areas for future development is the advancement of design and fabrication techniques for planar polyhedral tiles. Currently, the process of creating these tiles involves specific steps for both design and assembly. In terms of design, computer-aided design (CAD) software plays a crucial role. It allows for precise control over the shape, size, and orientation of the tiles. However, as the complexity of the desired patterns increases, the limitations of traditional design methods become more apparent.

Advanced manufacturing technologies such as 3D printing, laser cutting, and CNC machining hold great promise for revolutionizing the fabrication of planar polyhedral tiles. 3D printing, for example, enables the creation of tiles with complex internal structures and intricate geometries that would be difficult or impossible to produce using conventional methods. It can build the tiles layer by layer with high accuracy, allowing for more sophisticated interlocking mechanisms between tiles. Laser cutting is also highly precise and can be used to create sharp edges and fine details on the tiles. This is especially useful for creating tiles with unique shapes that contribute to complex overall patterns. CNC machining offers the advantage of being able to work with a wide range of materials and can produce tiles with high dimensional accuracy.

The use of these advanced technologies could provide greater precision and control over the final product. With 3D printing, designers can easily make changes to the tile designs and quickly prototype new ideas. Laser cutting ensures clean and accurate cuts every time, which is essential for the proper interlocking of the tiles. CNC machining allows for the mass production of identical tiles with consistent quality. This precision is crucial for creating more complex and intricate patterns. As technology continues to advance, we can expect to see even more sophisticated tools that will further push the boundaries of what is possible in terms of tile design and fabrication. Another potential area for future development is the integration of planar polyhedral tiles with smart materials and systems. Smart materials could respond to various external stimuli such as temperature, light, or electrical signals. By incorporating these materials into planar polyhedral tiles opens for dynamic and interactive designs.

Imagine tiles that can change color in response to the time of day or the surrounding light levels. This could be used to create dynamic displays or artworks that adapt to the environment. Tiles that change shape in response to pressure or touch could enable the creation of interactive surfaces or even smart furniture. For example, a floor made up of such tiles could sense where people are walking and change its texture or pattern accordingly to provide different sensory experiences. The integration of smart materials also opens opportunities for creating tiles with self-healing properties. If a tile is damaged, the smart material could trigger a healing mechanism to repair itself without the need for external intervention. This would enhance the durability and longevity of the tiling structures. To achieve these integrations, research needs to focus on developing compatible materials and systems. The interfaces between the planar polyhedral tiles and the smart materials need to be carefully designed to ensure proper function. Additionally, the control systems that regulate the behavior of smart tiles also need to be refined to achieve precise and reliable responses.

Finally, there is potential for expanding the technology to 3-dimensional structures. The principles of fundamental domains in finite reflection groups, which form the basis of the current planar tiling technology, can be extended to three dimensions. In three dimensions, the possibilities for creating complex and aesthetically pleasing symmetry structures using polyhedral tiles are immensely increased.

#### 6 CONCLUSION

The development of planar polyhedral tiles with interlocking elements represents a significant advancement in the field of tiling and tessellation. By leveraging the principles of finite reflection groups and advanced manufacturing techniques, this technology allows for the creation of complex and symmetrical patterns with unprecedented precision and control. The ability to construct dense packings of tiles that cover the entire plane without gaps or overlaps opens up new possibilities for architectural design, graphic and industrial design, and materials science.

In architecture, this technology can be used to create visually stunning and structurally sound buildings and structures. The intricate and harmonious patterns created by the tiles add a touch of elegance and sophistication to any space, while the interlocking elements ensure stability and durability. In design, this technology provides a versatile tool for creating unique and eye-catching products and artworks. The ability to create intricate and detailed patterns and textures adds to the visual appeal of designs, making them stand out from the competition.

In materials science, this technology offers new possibilities for creating lightweight and strong composites with specific properties and structures. The interlocking elements between the tiles can be designed to distribute forces evenly throughout the material, optimizing its strength and durability. Additionally, the dense packing of the tiles can improve the surface properties of materials, such as wear resistance and corrosion resistance.

Looking ahead, there are several areas for future development. One potential area is the advancement of design and fabrication techniques, which could further enhance the precision and control over the final product. Another area is the integration of smart materials and systems, which could enable the creation of dynamic and interactive designs that respond to external stimuli. Finally, there is potential for expanding the technology to three-dimensional structures, which could open a whole new realm of design possibilities and push the boundaries of both art and engineering.

Overall, the technology described in this paper represents a significant breakthrough in the field of tiling and tessellation. Its potential applications are vast and varied, promising to revolutionize various industries and push the boundaries of creativity and functionality. As research and development in this field continue to advance, we can expect to see even more exciting and innovative uses of this technology in the future.

#### **COMPETING INTERESTS**

The authors have no relevant financial or non-financial interests to disclose.

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## ASSESSING THE IMPACT OF ADVANCED EDUCATIONAL STRATEGIES ON LEARNING OUTCOMES IN RURAL COMMUNITIES: A CASE STUDY OF CHIUNDA PONDE IN LUVUSHIMADA DISTRICT

Stephen Kelvin Sata

ICOF Global University, Lusaka, Zambia. Corresponding Email: stephensata@gmail.com

**Abstract**: This research focuses on the effects of innovative learning and teaching methodologies on achieving educational goals and objectives in rural communities through a case study of Chiunda Ponde School in Luvushimada District, Zambia. Education in Zambia, as with other rural counterparts around the world, is a challenge due to limited resources, few and scarcely qualified teachers and socio-economically related factors. This research assesses the applicability of new strategies, including technology-integrated education, communal support structures, and culturally sensitive teaching strategies, to these challenges.

The methods used in the super-vice learning study include qualitative interviews with individual teachers and other members of the community. The quantitative analysis used student performance data obtained over two consecutive years. Findings suggest that high-level approaches, such as the facilities of learning technologies in literacy and numeracy and advanced teacher training, enhanced students' achievement. However, the participation of the communities in the education advancement enhanced parental participation and promoted the creation of an appropriate learning atmosphere for the students.

Regarding the principle of targeted educational approaches, this case displays the optimistic opportunity of bridging the education divide in the rural and urban sectors. It focuses on policies concerning resource distribution, teacher professional development, and culturally responsive approaches in the teaching system in rural areas. In this regard, the results enrich the global conversation about the negations of inclusive education and co-enlightenment for sustainable development in such resketching areas as Chiunda Ponde.

Keywords: Advanced educational strategies; Learning outcomes; Rural communities; Teacher development

#### **1 INTRODUCTION**

As shown in Figure 1, the significance of education in supplementing social and economic development, especially in rural regions, cannot be downplayed, given the limited stock of teaching and learning resources available. For years, it has been well understood that education can effectively reduce poverty and social and economic development, especially in poor regions [1]. Like any rural district in Zambia, Lavushimanda also needs help with concerns about school infrastructure, qualified teachers, and few teaching/learning resources. Such barriers lead to poor academic performance and high dropout rates and retard the development of rural areas [2]. Nevertheless, there is a growing awareness that enhanced educational practices work in these groups to enhance learning outcomes when strategies are appropriate to the local context and factors. This study seeks to examine how such strategies are practised in Chiunda Ponde, a rural area in Lavushimanda District, and the resulting effects of such practices on learning outcomes. The empirical literature shows that context-sensitive interventions like mobile technology, teacher development and community-initiated education reforms are instrumental in a positive change for rural schools [3]. This case study will lay down the best practices for integrating education in rural areas by examining localized strategies in technology use, communal participation in school, and curriculum adjustments. Different researchers have suggested that using the community's participation in education raises enrollment levels and increases the significance of the learning content to students [4]. The study will also outline the effectiveness of these strategies in supplementing education deficiencies within rural and urban areas. A significant area of focus when it comes to changing and improving education systems in Zambia is to meet the goals of raising quality.



Figure 1 Land 1 ande

Rural schools match urban schools, giving rural students an equal chance of success as urban students. Thus, through this study, the challenges and possibilities, as well as how these strategies can be adopted in other rural areas in Zambia, will be elucidated and afford a valuable contribution to the general discussion about increasing the efficiency of education systems in developing countries. These studies from Chiunda Ponde may assist in negotiating policies and strategies that close the education gap among rural students in Zambia so that no kid is left behind in obtaining quality education.

Chiunda Ponde is a rural village in the Lavushimanda District in the Muchinga Province of Zambia. Like most remote villages, the common logistical factors hinder most of the peasants in rural areas of Zambia from wanting improved infrastructure, poor health centres, and few schools. Farming in this area is mainly for food security since the majority of the people in the village depend on agriculture. This has a bearing on the extent and rate at which the growth and development of the economy and sociability in the area transpires [5]. As with other rural areas of Zambia, education in Chiunda Ponde has its share of challenges, including poorly resourced schools, limited professional growth of teachers, and students with limited access to instructional materials. They influence poor education results such as dropouts, poor performance in the national examination and lowest educational standards. However, proactive steps have been taken recently to enhance access and quality to education in Zambia, with the participation of the local community and the Government having a central role.

#### **2** LITERATURE REVIEW

#### 2.1 Introduction to Rural Education Challenges

Hindrances to effective learning are rife and continue to afflict those in rural areas, resulting in the worst form of poverty and underdevelopment. Some hurdles teachers face include infrastructure, lack of teachers' qualifications, and general want of education material. The African country's infrastructural decay, especially in the rural regions, shows off in the dilapidated school structures, inadequate and unreliable water and sanitation facilities for educators and students, and poor electricity infrastructure affecting teaching-learning environments [6]. Analyzing the data, it was found that combined with infrastructural facilities, teaching materials such as textbooks, and the absence or inadequate access to educational technologies, it is difficult for students to follow the curriculum and develop essential skills. Most rural schools are staffed with a critical shortage of qualified teachers.

Literature review indicates that rural school stakeholders support inadequate working conditions, high teacher attrition and poor teacher quality, with only a tiny percentage of teachers in rural schools being professionally trained teachers [7]. For example, most teachers teaching in the rural areas of Zambia lack proper qualifications. Zambian schools are overcrowded and cannot afford to employ enough qualified teachers, which gives each student adequate attention [6]. Therefore, the quality of effectiveness and access to instruction and educational resources decline, and students' performance in remote areas is comparatively poor compared to that of students from urban areas. Moreover, access to teaching resources remains a big problem in rural areas. Schools need more government funding and cannot purchase primary education needs such as textbooks, desks and computers. Sometimes, the learners are allowed to share the learning materials, which minimizes the chances of learning. However, due to poor internet connection as well as a scarcity of technology devices in rural areas, student exposure to International, as well as national learning resources and opportunities, is scaled down; thus, they have difficulty being endowed with skills that help them/her fit in the current economy. These are the systemic factors that affect learning achievements.

It is sad that, in sub-Saharan Africa, in Zambia specifically, several rural students fail to display high performance, especially in literacy, numeracy and critical thinking tests. This is attributed to the fact that it is not only a result of resource constraints but also other exogenous factors that prevail within the rural agrarian-based society, such as poverty and scarcity of additional resources such as educational assistance. Opine that low academic achievements among rural students are associated with inadequate parental involvement in education since these parents struggle to find employment to pay extra tuition. Ponde of Luvushimada District in Zambia is one such case, as it mirrors several issues typical for rural education. These include inadequate and poor facilities such as proper classrooms, few schools and colleges, and inadequate library and other learning resources. There remains a critically chronic shortage of teachers, and the local schools typically employ inexperienced teachers or teachers with little instruction in current teaching methods. These challenges, therefore, lead to low literacy and numeral understanding among students; children in this part of the world need help to meet the national education performance indicators.

Consequently, schools in such regions as Chiunda Ponde must catch up to other regions regarding educational attainment. This fact has implications for social mobility and economic growth in the future. Mitigating these factors mostly requires a total overhead approach, a strategy that involves, among other things, the provision of facilities, teacher training, curriculum enhancement, and community involvement. Those educational interventions intended to enhance access and quality in rural Zambian schools, such as using ICT in schools, can provide solutions to such barriers to enhance learning achievements, as indicated. However, these solutions must be unique to the Chiunda Ponde context, sustainable, feasible and culturally acceptable.

#### 2.2 Advanced Educational Strategies: Definitions and Relevance

Current education theories are highly developed and based on flexibility, integration, and correspondence to the necessities of the contemporary learning process. These strategies include using new teaching methods, multi-media technologies, a community-based approach and a context-based curriculum. Collectively, as they seek to achieve educational equity and quality, particularly in transforming lip service, urban-centred and privileged school environments reflect the resources scarce in rural or marginalized settings; the teaching-learning approaches focus on learner engagement and achievement through activities such as inquiry-based learning and project-based learning and problem-based learning or the flipped classroom teaching strategies. These approaches move away from memorization and encourage the adoption of a more critical view of the content being taught. Technology increases the effectiveness of these methods through the use of innovative content delivery channels such as artificial teachers, intelligent learners, learning analytics for student performance tracking, and other ICT applications considered e-learning, mobile learning, and virtual classrooms, among others technology-facilitated teaching and learning has been very effective in reaching out to the unreached regions of the world. For example, mobile-based education tools educate learners in rural areas since they need help accessing well-trained teachers or everyday learning materials [8]. Such innovations spread education and digital literacy among students, which are requisite for the prevailing world economy. Community-based approaches also enhance the learning experiences by using local content, area expertise, and local culture to deliver education pertinent to the students.

These strategies go further by engaging stakeholders, for example, parents, local authorities, and NGOs, in an effort to fashion a positive learning environment for the learners and foster a sense of shared responsibility on the part of all stakeholders. Curriculum contextualization also supports such initiatives since it develops curricula that reflect the learners' social, economic, cultural and geographical context. This means that besides equal education opportunities for all students, it is also relevant for students to know how they can meet challenges within their context after joining colleges or universities. In combination, each of these approaches embodies revolutionary change in how education can be provided relatively and in a manner that respects the needs of the world's students.

#### 2.3 Technology Integration in Rural Education

Various literature evidence has supported the adoption of ICT within rural education as a positive social change in the learning achievement of learners. Research and experimental projects, including OLPC and mobile learning applications for education, have revealed enhanced learners' literacy and numeracy in a restricted-resource environment [9]. These initiatives offer learners content, learning tools, and collaboration capabilities while enabling them to access otherwise unattainable elements under conventional learning systems. More so, using ICT is essential in enhancing independent learning, critical thinking, and problem-solving skills, which are marked in the advanced knowledge-based economy. Using ICT tools in classroom teaching and learning, especially in rural areas like Chiunda Ponde, can enhance education equity by incorporating ICT-based teaching aids in addition to traditional methods. Education aids like e-learning platforms allow students to receive multiple resources related to the curriculum and use them as a means of differentiated instruction to meet students' needs.

Moreover, ICT supports teachers' professional growth by providing online access to training in information and communication technologies, lesson planning resources, and networks for teachers' cooperation. Moreover, there are considerable obstacles to integrating ICT in rural contexts [10]. One central imperative is the infrastructure's uncertainty, where most stable electricity and Internet connection chemistry cases were missing. They affect the practicality of ICT tools, hindering project efficiency or making them unsustainable in the areas in question. However, the educators' ability to incorporate technology into their practices is the crucial factor that determines the success of the ICT initiatives.

The lack of better training for the teachers and lack of exposure to the use of ICT enhances the challenges experienced in places like Chiunda Ponde. A lack of ICT technical skills and achieving the necessary pedagogical change to leverage ICTs effectively are two chief problems for teachers, suggesting that continual capacity development efforts must be addressed. Also, combined with institutional and infrastructural challenges, the disparity in the ownership of smart devices and the high cost of data perpetuates the digital divide in rural areas. Addressing these challenges requires a multistakeholder approach that includes technological and policy solutions. However, global implementations of ICT need support from the government, private sectors, and NGOs to provide funding and respond to local education needs [11].

As such, there is a need to complement these interventions with the cultivation of infrastructure, subject-sensitive teacher training, population sensitization, and participation. The organization of ICT education has shown great potential for increasing education delivery and achievement in rural areas, but its full potential can only be attained in the following manner: infrastructural, technical, and human resource capacities. Therefore, if such an integrated approach is adopted, one may easily see regional education improvement, such as that of Chiunda Ponde, offering Equitable Quality Education for All [8]. Technology integration in rural education can be seen in Figure 2.



Figure 2 Technology Integration in Rural Education

#### 2.4 Teacher Professional Development

Teacher quality is generally accepted as one of the most potent predictors of student academic performance and other educational success [12]. In these studies, it has been established that teacher's factors, including knowledge, pedagogical content knowledge and teacher strategies, have the closest and most influential relationship on students achievement, especially in developing countries and global rural areas where such issues as qual, large classes and availability of resources and levelled learners' needs. As noted, there is a pressing need to focus on professional development programmes that facilitate improvements in teaching practices to culminate in better student learning outcomes. Professional development initiatives suggest the potential for the development of capacities to support improvement in teaching and learning in rural areas, especially given the general observation that inequality in the delivery of quality education and provision of quality teaching and learning resources is usually more acute in rural centres than in urban ones.

These programs aim to prepare educators for adopting effective instruction based on current research practices and the challenges likely to be faced in rural teaching environments. One solution is using active learning teaching practices and differentiated instruction for teachers. Active learning occurs using teaching practices that enhance student participation,

including collaborative learning, inquiry, and problem-solving activities. Differentiated instruction, on the other hand, is a teaching approach that allows the teacher to accommodate the students' diverse learning styles, student preferences, learning capacities and other differences within classroom teaching.

Altogether, the provision of Mulenga, D. K.[10]such environments fosters learning that is meaningful and reasonably non-contextualized, which is almost mandatory for managing the weaknesses of rural schools encompassing multifaceted and often low-resource settings. Dank bare studies speaking to the application of such interventions in Sub-Saharan Africa. For instance, implementing professional development seminars, which included hands-on workshops, peer coaching, and model lessons in classrooms in flat package programs in literacy and non-formal education in Malawi, positively impacted teacher capacity and learners' performance. Learner-centred approach Teachers claimed that they felt more confident while conducting classes with the learner-centred approach. The learners, on their part, improved in areas such as Mathematics and reading. Likewise, in Tanzania, students' in-service training was focused on the end user's continual development and monitoring. It resulted in a significant rise in literacy and numeracy skills [5]. They also concentrated on low-cost, authentic teaching learning resources to overcome the resource limitation factors with the rationale that a teacher who undergoes professional development can apply the acquired skills in a classroom with limited resources. Other success factors include the following: it highlighted continuous professional development instead of learning interventions such as a one-off session because professional learning is required to enhance teaching quality. Second, encouraging collaboration among teachers to exchange ideas and learn from one another also benefits the continuance of the training practices over long periods.

Furthermore, using technology like mobile learning platforms and radio instruction has increased the delivery of professional development programmes, where physical access to training might be challenging [13]. Efforts to institutionalize teacher professional development in the broader teacher management systems that central governments have promoted in Malawi and Tanzania have supported such increases. This involves making teacher training a precondition for promotion, providing the teachers with incentives t to stay put in these rural areas. Together with such policy frameworks and the investment in teacher development, it implies improvement in the effectiveness of education quality in rural areas. The paper has established that teacher quality directly affects students' performance, especially in rural areas where such factors hinder effective education. Essentially, active learning approaches, differentiation, and contextual teacher practice and equally important in dealing with structural bias in school. These are potential solutions for improving educational performance in settings where resources are badly needed if backed by sound policies and proper ways of implementation with a sharp focus on improving educational systems. The scaling up of such interventions augurs well for the teaching workforce and consequently increases equity for students in rural areas. Teacher professional development methods can be seen in Figure 3.



Figure 3 Teacher Professional Development Methods

#### **3 METHODOLOGY**

The current study used qualitative and secondary analysis research instruments to examine the effectiveness of conceptual learning innovations in Lavushimanda District, Chiunda Ponde, Zambia. The qualitative employed various

strategies to obtain broader information about educational problems, communities, and other interested parties. Secondary data was collected through structured interviews with teachers, school administrators, parents, and community leaders, who gave elaborate accounts of using innovative strategies. Participants' impressions of the relevancy of education and the need for curriculum changes were further discussed with the help of FGDs among students and parents. Class observations also made it possible to assess various teaching processes, students' learning processes, and conceivable technology-enhanced learning aids. These qualitative methodologies provided a clear and quantitative grasp of rural education's socio-cultural aspects [8].

The first secondary data source was the government reports of Zambia, education journals, and institutional publications focusing on rural education in Zambia. The critical documents reviewed were performance measures, enrolment files, and policy briefs from the Ministry of Education and its partners. This secondary data helped examine historical trends, provide the context for education difficulties, and confirm the first qualitative data results [14].

Qualitative data analysis entailed identifying code patterns and themes related to educational results, teachers, preparation, and other stakeholders in the community. Secondary data in the form of quantitative data were used, and with the help of statistical tools, the difference in performance pre- and post-intervention was made. This triangulation was reliable, and the results included empirical evidence and contextual information.

This research design integrates various data types, providing an overall view of the effectiveness and prospects for testing advanced educational concepts in rural environments.

#### **4 RESULTS**

#### 4.1 Enhanced Academic Performance

Effective educational technology used in Chiunda Ponde likely contributed to improved student performance. Overall, students' performance on literacy and other numeracy assessments rose by an average of 25% within the first academic year. There was an improvement in understanding, analysis, and resolution, especially in crucial subjects such as Mathematics, Science, and English [6].

#### 4.2 Increased Student Engagement

Teachers' and students' participation during lessons, using computers and other gadgets, and group and project work greatly enhanced students' participation. Overall class attendance also rose by 40%, and attendance truancy lowered by 30%, also implying that students had gained interest in classroom learning.

#### 4.3 Community Involvement

Increased participation by parents and community members in education activities was also clearly witnessed. The formation of PTAs and community education committees made the school environment much more supportive. More than 70% of the parents interviewed said they perceived themselves as more involved in their children's education, thus enhancing students' motivation and orderliness. Some measures, such as providing scholarships to girls and adopting gender-sensitive syllabi, narrowed the disparity in education. Female enrolment was up by 20%, and the girls' dropout rate was down by 15%, meaning more girls were allowed to attend school [3].

#### 4.4 Infrastructure and Resource Utilization

The introduction of advanced learning tools, e-learning, textbooks, and science equipment improved the quality of education. Though interruptions in the electricity supply made laptops less useful, solar-powered resources made it possible for learners to use digital learning resources for continuing learning.

#### 4.5 Challenges and Limitations

Some challenges remained apparent, though they constituted barriers to implementing sophisticated learning approaches in Chiunda Ponde and comparable rural areas. These challenges include:

#### 4.6 Teacher Retention

The rural postings remained unappealing to many educators mainly because of a lack of basic facilities and professional development and the substandard living conditions they offered. This led to some gaps in their ability to find qualified teachers, which affected the level of consistency and the quality of teaching each semester. They could have been more beneficial to maintaining consistency in the teaching and learning program and faculty development plans. It was noted that more than half the pre-service teachers from rural schools in Zambia applied for transfers to urban schools within 2 years of their posting, recording isolation and lack of resources as some of their reasons. As long as the country does not introduce policies that would improve the satisfaction of rural teachers – housing benefits, mobility opportunities, and support, this problem will continue.

#### 4.7 Limited Access to Technology

Although active steps had been taken to address the digital divide, more devices, steady network connections, and electricity supply needed to be made, some of the schools in Chiunda Ponde had few or no functional computers or tablets, which restricted the students' access to digital knowledge. Moreover, other technical challenges, such as software maintenance and the shortage of IT specialists, also impacted the expansion of technology-based approaches. This forestalled equal distribution of quality education and further alienated the rural student from their urban counterparts. only 15% of Zambian rural schools have functional internet connections, 75% of Zambian urban schools have the same [5], just like Figure 4.



Figure 4 Free Education Policy in Zambia: Context and implementation

#### **5** CULTURAL BARRIER

Traditional beliefs about education sometimes obstructed the complex, innovative developmental approaches to education due to resistance to change. In some situations, people decide that having new teaching approaches or using technologies is optional or even culturally appropriate. For instance, some leaders in local institutions have not embraced teaching materials such as digital content on gender issues local institution leaders. Such resistance resulted from ignorance on the part of the Traditional rulers about the value of modern education and the resultant cultural assimilation. Issues should be treated based on cultural relations that are rewarding and empowering to ensure the people of the community embrace these educational changes in the long run.

This Pie chart shows Advanced Educational: Cultural barriers to its development. The numbers represent each segment's estimated impact, and the segment's size reflects this impact.

#### 5.1 Addressing the Challenges

This section presents measures that can be taken to decrease the above challenges; it can be noted that a combination of measures will be needed. Teacher training could mean offering specialized incentives, including rural hardness allowance, instructional advancement programs, and support structures for enhancing the living and working environment for the teachers. Closing this technology gap requires cooperation with governmental and non-governmental institutions to finance infrastructure and necessary equipment, offer inexpensive devices to purchase, and inform and train teachers and students. Finally, engaging the community requires policies that respect cultural diversity and admit the support of parents and other community members in developing reforms that acknowledge the roles of ethnic culture and present their effectiveness in development. Several barriers must be overcome for rural education to be sustained and for progress to be built in our future tour. This is a child's right regardless of whether they attend school in the town or the village [14].

#### 6 LONG-TERM OUTCOMES

Early longitudinal findings indicate that students who experience these advanced instructional strategies are more likely to transfer to postsecondary education and technical training institutions. Furthermore, quasi-synchronous positive changes in the graduates' daily communication skills and awareness of other people's issues indicate that the intervention has more social benefits. From this research, by embracing the new educational approaches seen in Chiunda Ponde, the fundamentals for changing the learning outcomes in rural areas have started to emerge. However, these measures are critical in the long term, including sustainability, capacity support, and a favourable policy environment.

Therefore, through a case study of Chiunda Ponde in Luvushimada District, the interaction between advanced educational strategies and learning outcomes in rural areas can be understood. Due to the quality education delivery strategy, increased student-environment interaction increases students' morale and improves academic performance. For example, when the pedagogical approach adopted in the classroom involved learner-centred activities based on cooperative learning and problem-solving, students' engagement and critical thinking were enhanced, as revealed using technology in the classroom, like e-learning and other materials, also gave students more comprehensive information sources in classrooms than information-deficient rural schools received from urban schools. These advancements increased academic achievement levels and better academic performance than other districts in Chiunda Ponde in primary necessities such as mathematics and English [5].

Despite the positive developments experienced above, various challenges continued to prevail in areas of resource and infrastructure and socio-economic challenges. Lack of electricity and internet and several learners per classroom reduced the effectiveness of the new approaches to education. Also, due to fatal economic challenges, families in rural areas dropped out of school, easily defaulted or were out of school, hindering the sustainability of learning improvement. These observations are consistent with other emerging concerns in rural education in that systemic issues continue to represent significant obstacles to change [5]. For both these educational approaches to succeed, one needs more than resources: the engagement and the willingness of the local community. To positively impact the child's learning environment, teachers, parents, and the government should come together and collaboratively help one another.

Teachers in Chiunda Ponde showed that implementing new approaches requires professional training and development with insights into the community setting [11]. Another aspect found here is intended to enhance parents' hope, school ownership, and accountability resulting from parents' involvement in school activities, enhancing educational achievements. Policy attention and funding are requisite to fill infrastructure deficits and to facilitate the implementation of needed instruments for rural schools. In the next phase, the advanced strategies that were successfully discussed need to be implemented and scaled to a sustainable level within rural schools. This encompasses the training of teachers, infrastructure development, and partnership in management and resource mobilization. The scenario realized at Chiunda Ponde learning institution best captures why it is possible to embrace innovation in the use of technology in teaching while at the same time planning for a technological adoption process that keenly involves the community. This approach should be appropriate to address the problems of rural schools in a range considering the context sensitivity of proposed solutions. Finally, sustaining the rural educational expenditure is essential for averting the vicious cycle of educational disadvantage and supporting the long-term development of natural communities.

To establish a systematic long-term follow-up mechanism for monitoring the impact of educational strategies on students' future development, it is essential to create a robust data collection and tracking framework. This framework should focus on key indicators such as enrollment rates, graduation rates, academic performance, and the development of practical and soft skills. Regular follow-up methods, including alumni surveys and employment status tracking, are vital for evaluating the long-term effects of education reforms. A centralized database can store data on student progress and career outcomes, while integrating data from sectors such as employment, health, and social welfare to offer a holistic view. Key long-term impact indicators to monitor include employment and income levels, entrepreneurship, social mobility, and community development. To ensure continuous improvement, annual reports, community feedback, and regular evaluation of data will help refine education strategies and inform policy adjustments. Collaboration with government bodies, research institutions, and private sector partners is crucial for sustaining this mechanism and ensuring that data collection remains accurate and comprehensive. Finally, securing continuous funding and building local capacity for long-term monitoring are essential for maintaining an effective system that can evaluate the ongoing impact of education reforms on rural communities like Chiunda Ponde in Lavushimanda District.

#### 7 RECOMMENDATIONS

The government should focus on those policies that will enable the implementation of advanced educational approaches in rural schools. Enough commitments for the staff development of teachers, construction of learning amenities, and the purchase of such texts appropriate for rural settings.

#### 7.1 Investment in Infrastructure

Invest more in important social facilities like electricity, Internet connection, and other roads in rural-speaking regions. This will enhance the provision of a technology-based education development plan and ensure that rural educational institutes remain relevant to the modern technological era.

#### 7.2 Teacher recruitment and incentives are vital aspects of the teaching course.

They are posting qualified personnel to hard-to-fill schools, particularly in rural areas, and providing incentives like free housing, hardship allowances, and promotions that will ensure their retention in these schools. Teachers remain critical factors in the delivery of any complex educational approach.

#### 7.3 How Local Content can be Incorporated into Curriculum

See to it that there are components of local knowledge, languages, and culture so as not to distance the curricula offered by schools to rural populations. This will provide even more engagement and productivity for and amongst the learners.

#### 7.4 Research and Development

Promote and finance research to estimate the efficiency of different innovative educational approaches in rural environments. Cohort with Universities and Research Institutions jointly to formulate theories-based Intercessions.

#### 7.5 Improving Public-Private Partnership Facility

Engage private organizations and NGOs in order to launch effective educational initiatives. Such collaborations may offer the technological help, the capital, and the ideas appropriate for rural issues.

#### 7.6 Enabling Technology for Education and Digital Learning

Initiate rollout programmes to supply affordable information communication technology teaching tools to rural schools and train the teachers to teach their learners using the gadgets. Offer offline alternatives when there is a problem with the internet; for instance, preinstalled educational applications on tablets.

#### 7.7 Participation and Sponsorship

Involve the parents, political leaders in the country, the Headteachers and other social organizations on the positive impacts of improved teaching techniques. Promote people's participation in order to achieve ownership and indefatigability of projects.

#### 7.8 They include Monitoring, Evaluation and Reporting

Create a national register to observe and assess the successes in applying and realizing progressive approaches in rural educational systems. Always employ empirical evidence to improve policies and programs to the next level.

#### 7.9 Budgetary Prioritization

The government should raise the education sector budget and commit at least some extra funds to improving rural education. Ensure that the funds are equitably distributed to cater to the needs of rural schools to close the gap between urban and rural schools. By actualizing these recommendations, the government will facilitate an appropriate environment for the development of enhanced educational approaches to enhance the learning outcomes of Chiunda Ponde and other rural communities.

#### **COMPETING INTERESTS**

The authors have no relevant financial or non-financial interests to disclose.

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## ECONOMIC HARDSHIP AND STUDENTS' ATTITUDE TOWARD MATHEMATICS LEARNING IN SECONDARY SCHOOLS IN OYO METROPOLIS, OYO STATE, NIGERIA

Kamoru Abiodun SABITU<sup>1\*</sup>, Olubiyi Johnson EZEKIEL<sup>2</sup>, Oluwafunmike Oyenike EZEKIEL<sup>1</sup>, Taofeek Oyesola LAMIDI<sup>1</sup>, Akinlolu SOLADEMI<sup>3</sup>

<sup>1</sup>Department of Science Education, School of General Studies Education, Federal College of Education (Special), Oyo, Oyo State, Nigeria.

<sup>2</sup>Department of Integrated Science, School of Secondary Education (Science Programmes), Federal College of Education (Special), Oyo, Oyo State, Nigeria.

<sup>3</sup>American Christian Academy, Ibadan, Oyo State, Nigeria.

Corresponding Author: Kamoru Abiodun SABITU, Email: sabitu.kamoru1584@fcesoyo.edu.ng

**Abstract:** This study is focused on how economic hardship influences the attitude of students towards mathematics learning in secondary schools Oyo metropolis, Oyo state, Nigeria. The study was carried out among secondary school students. The study adopted a descriptive survey research design in which six hundred and ninety-nine (699) from the population of six thousand five hundred and fifty-five (6,555) SS2 students in 33 public secondary schools in the three Local Government Areas of Oyo metropolis, Oyo State, Nigeria were randomly selected using Slovin's Formula. The instrument used for data collection was a self-structured questionnaire validated by experts. A reliability coefficient of 0.88 was established. The study was driven by three research questions and data collected were analysed using mean and standard deviation. The study revealed that the attitudes students exhibit toward mathematics learning as a result of economic hardship are negative and the extent to which economic hardship influences students' learning in mathematics is very high. Based on the findings it was recommended among others that mathematics teachers should make mathematics classes livelier by making the class activities based.

Keywords: Economic hardship; Students' attitude; Learning; Mathematics

#### **1 INTRODUCTION**

The economy is a determinant of the wealth or resources of a country notably in terms of the production and consumption of products and services. In the past decade, Nigeria's economy was seen and ranked as one of Africa faster faster-expanding economies until lately when the economy plunged into recession. The economic situation in Nigeria is very tough which may contribute to unfavourable attitude towards learning especially mathematics. Most pupils cannot afford the basic demands of life which may generate an unsettled mind and this in turn may hamper learning. Economic hardship is considered as the inability to meet fundamental demands of life such as food, shelter, and clothing. According to the Cambridge Business English dictionary [1], economic hardship is said to be trouble caused by having too little money or too few resources. There is an economic recession in Nigeria which impacts all sectors including the educational sector [2]. Christian Association of Nigeria (CAN) published a communique following her National Executive Meeting (NEC) which says the difficult economic circumstances in the country have caused mass poverty and hunger among millions of Nigerians. It also read that, prices of food and basic products are on the increase regularly and that many families can hardly get one meal in a day [3]. In an economic crisis, the economy is dramatically slowed down which is characterized by a reduction in wage rate, scarcity or insufficiency of funds, unemployment and poverty. The aforementioned variables affect students' educational results in terms of school enrollment, attendance, attainment and performance. Most institutions in Nigeria are encountering economic limitations and this slows down the pace of achieving the institution's tasks [4]. Economic difficulties may force some pupils to drop out of school completely. Also, economic adversity influences children's labour actions whether in the household or the labour market. Economic hardship produces a reduction in adult income which makes it harder for parents to fully compensate for the cost of education such as tuition fees, purchasing of educational materials like books, uniforms, private lessons and so on. Many of them depend on their parents for their income and the parents are also going through hard times economically. This may also encourage child labour to supplement the household income. Recently, the cashless policy in the nation has brought tremendous pain to the population in which pupils are included. Some pupils lose concentration in the classroom easily since some of the students trek great distances to school which may lead to tiredness and they may exhibit little enthusiasm in learning. This may warrant the loss of interest in academic activities considering the nature of mathematics as a subject and may expose the student to spending more time in labour or hawking more than studying and this may cause truancy, and lack of concentration in school which may eventually reduce academic performance or drop out of school [5]. The present incidence of economic crisis has caused

enormous hardship on the scholastic accomplishment of kids in mathematics. For example, the provision of infrastructure in the development of education by the government cannot be guaranteed any longer; inadequate laboratory equipment and instructional materials for mathematics precipitated by high cost made effective teaching so difficult in mathematics. Many mathematics classes consequently are not carried out due to the absence or poor instructional resources [6]. Poor funding, according to Aina [7], is another major and key factor militating against mathematics education in Nigeria. The researcher further concluded that the Nigerian government in this moment of economic crisis does not provide appropriate funds to make way for a congenial and enabling atmosphere to support the successful mathematics teaching and learning process. The relationship between the educational system and the national economy cannot be overemphasized. The school system is part of the wider macro-economy so whatever happens in the system will undoubtedly affect the schools. The school system cannot compromise standards and quality based on insufficient funding [6].

The progress of any nation can be sustained if mathematics is employed as a parameter for change. [7] argued that sustainable development may be attained if the economy supports the requirements of people living in a country. Sustainable development is nothing other than the ability of a government to provide a conducive atmosphere that promotes production and design programs that boost economic advancement that alleviates poverty. But in Nigeria reverse is the case our youths are not gainfully employed and the few that are hired loss focused because they were not endowed with mathematical, scientific and technical skills that could enable them to think critically and logically. The benefit of any citizen living in a nation may be realised when the resources of that nation are well explore and utilize to the highest level to reflect the operation of industries with efficient technology.

Mathematics is a pyramid of concepts and information that support and raise economic activities to optimal proportions. It promotes logical reasoning and critical thinking of individuals and enables them to operate effectively in the exploration of country resources that support economic improvement [6]. Mathematics is the backbone of the economy through which government and people decide on how the nation's resources could be efficiently utilized. [1] opined that the economic activities of a nation continually diminish if there is the low income per capita, low productivity and underutilized of workers. Mathematics is the airbag of intellect, a pillar on which each field and source of enlightenment to human critical thinking lies [6]. Mathematics is a cornerstone of science, technology, economy and engineering. It expands philosophical principles that are utilized to solve economic difficulties.

The concept of attitude is often stated as positive or negative feelings and thoughts associated with a given social entity such as individuals, objects, facts or events [8]. Attitude is a state of mental or neurological preparedness both as the foundation and the consequences of conduct as a result of inclinations of emotions, thoughts and feelings owing to previous experiences [8-9]. Attitudes are not directly experienced but can be observed through behaviours. They give direction to human behaviours, they are a phenomenon that can impact decision-making, problem-solving processes and all other interactions. Therefore, the attempt of the student to display the expected behaviours in terms of teaching objectives, as a positive or negative attitude towards learning, is viewed as a predictor of the academic achievement of the student. A student shows sentiments and thoughts in terms of the learning environment and learning processes with appropriate or inappropriate behaviours by the expectations of the environment. He or she prefers to describe ones' self with positive or negative attitudes [8,10-11].

Learning is a function of intelligence, it is the working mind that has transported the primitive human to the modern human, causing change and progress and distinguishing human beings from other living things (Agir, 2019). Learning is a generally enduring change in behaviour arising from learned experience. It is the acquisition of information, knowledge, and abilities. Learning is not restricted to formal education which takes place within the four walls of any school, but it is a continuing process that takes place throughout life [12]. Learning occurs as a result of experience. The learning process begins when you have a new experience, whether that be reading a new term, listening to someone explain an idea, or attempting a new way of solving an issue. Once you have tried a new approach for boiling eggs or an alternative route to work, you may assess whether it works for you and then employ it in the future which shows that learning has taken place. Olson [13] believes that the learning process begins when you have a new experience, whether that is reading a new term, listening to someone explain an idea, or trying a new way of solving a problem. The process of learning is not always the same, learning can happen in a broad range of ways. Access to learning opportunities and elements of the learning environment plays a role in how people learn.

Olson [13] further explains that learning can impact attitudes, knowledge, or behaviour. There is significantly more to learning than "book learning." Yes, you can learn new words, concepts, and facts. But you can also learn how to accomplish things and how to feel about things. It is crucial to remember that learning can involve both helpful and bad behaviours. Learning is a natural and ongoing component of life that takes place consistently, both for better and for worse. Sometimes learning means being more knowledgeable and enjoying a better life. In other circumstances, it entails learning practices that are damaging to health and well-being. This study tends to examine the influence of economic hardship on students' attitudes to the learning of mathematics in Oyo Metropolis, Oyo State, Nigeria.

#### **2 STATEMENT OF THE PROBLEM**

The economic hardship faced in Nigeria bears its toll on individuals, families, firms, society and social institutions of the nation. Individuals, firms and the community at large are required to make fundamental changes to cope in the face of economic hardship. However, these economic and lifestyle shifts may have a painful effect on individuals, society and the nation at large. In the face of poverty, young age in the society nationwide could be experiencing considerable difficulties to cater for them. As a result, some youths of secondary school could find it difficult to pay for transportation, be absent from classrooms and have no means of paying for educational materials needed as a result of the hardship facing their parents in the society. The effect of economic hardship on the educational attainment of students has received the attention of numerous academics and experts. Despite various works on hardship and students' attitudes to learning, no research has been specifically carried out on the influence of economic hardship influences the attitude of secondary school students towards learning mathematics in Oyo metropolis, Oyo State, Nigeria.

#### 2.1 Purpose of the Study

The main purpose of this study is to find out how economic hardship influences the attitude of students towards learning mathematics in Oyo metropolis, Oyo States, Nigeria. Specifically, it sought to determine;

- 1. the attitudes students exhibit to learning mathematics as a result of economic hardship.
- 2. To what extent has students' attitude in economic hardship affected students' learning in mathematics?
- 3. The probable remedies to economic hardship.

#### **2.2 Research Questions**

The following research questions guided the study;

- 1. What is the attitudes students' exhibit to mathematics as a result of economic hardship?
- 2. To what extent has students' attitudes in economic hardship affect students' learning in mathematics?
- 3. What are the probable remedies to economic hardship?

#### 2.3 Methodology

The research design adopted for this study is descriptive research design. This study's population consists of 6,555 SS2 students in 33 public secondary schools in the three local government Areas of Oyo metropolis, Oyo State, Nigeria. These Local Government Areas are Oyo West, Oyo East, and Atiba. The class was taken into consideration because SSS 2 students are not transitioning into senior school like SSS 1 students do, nor are they getting ready for external exams like SSS 3 students do. Compared to the other two classes, they are steadier in the senior class.

A sample of six hundred and ninety-nine (699) senior secondary school II (SSS2) students was selected using the Multistage sampling procedure. At the first stage, the Simple random sampling technique was used to select two schools in each of the local government areas in Oyo. At the second stage, the Simple random sampling technique using Slovin's Formula was also used to select the six hundred and ninety-nine (699) male and female senior secondary school II (SSS2) students in the six schools. Thus in order to maintain the consistency in the selection process and to further ensure true representation of the sample, purposive sampling was used to select two schools in each of the three local government areas that met the following criteria in considering the sample school. The school must;

- Be a public co-education school.
- School with highest population in each local government.
- Have been graduating students for at least ten years.
- Be in good location with high population.

The instrument used to collect data for this study was a self-structured questionnaire constructed by the researchers titled "Economic Hardship and Mathematics Education Questionnaire" (EHMEQ). The questionnaire comprised of two sections, A and B. Section A elicited demographic information such as name of school, age, class, sex etc. Section B consists of the question items which were drafted to elicit response from the respondents in the sampled schools. 4-point likert scaling rating which are Strongly Agree assigned 4, Agree assigned 3, Disagree assigned 2 and Strongly Disagree assigned 1 was used. The instrument for this study was given face and content validity by experts in the field of educational evaluation. The reliability of the instrument was established using Cronbach Alpha. The reliability coefficient of 0.88 was obtained which was adjudged high enough for the study. Copies of the questionnaire were administered to the selected students in the schools. The respondents filled out the questionnaires and returned them. The administered copies were collated. Descriptive statistics was employed to analyze the data generated. Mean and standard deviation were used in result presentation.

#### **3 RESULTS**

**Research Question 1:** What are the attitudes students' exhibit to mathematics as a result of economic hardship?

S/N	Items	Mean	Std. Deviation
1	I can endure economic hardship.	1.58	.963
2	I come late to mathematics class always for lack of transport fare.	2.76	.952
3	I do not pay attention in mathematics class when I do not have money.	1.62	.871
4	I am always aggressive because of economic hardship.	2.82	1.093
5	I do not like relating with anyone because I do not have money.	1.68	.971
6	I do not submit school assignments on time for lack of money and hung school.	ger in the 2.52	.946
	Weighted Mean	2.16	

Table 1 Students' Attitude to Mathematics Learning During Economic Hardship

The above table 1 reveals a weighted mean of 2.16 out of the maximum obtainable score of 4.00 which is lower than the standard mean of 2.5. This reveals that the attitudes students' exhibit to mathematics learning as a result of economic hardship is negative.

Research Question 2: To what extent has students' attitude in economic hardship affect students' learning in mathematics?

S/N	Items	Mean	Std. Deviation	
7	I am living with someone not my parent because he or she provides my needs	3.18	.386	
8	I have been involved in internet fraud because of economic hardship	3.01	.643	
9	I have involved in drug abuse to prevent thinking about lack of money	3.37	.485	
10	I have been forced to join bad gang to sponsor my education	3.05	1.067	
11	I have involved in illicit sexual activities to get money	3.02	.619	
12	I have missed examination before because I did not pay school fees on time	3.19	.394	
13	I sleep in class often because of tiredness as a result of long trekking	3.22	.416	
14	I cannot read and assimilate when there is little or no money	3.01	.659	
15	I have difficulty in getting Mathematics textbooks for my studies	3.11		
	Weighted Mean	3.13		

2 Extent of Students' Attitude to Math

The above table 2 reveals a weighted mean of 3.13 out of the maximum obtainable score of 4.00 which is higher than the standard mean of 2.5. This implies that extent at which students' attitude in economic hardship affect students' learning in mathematics is very high.

Table 2 Domodios to Economia Hardshin

Research Question 3: What are the probable remedies to economic hardship?

Table 5 Keinedies to Economic Hardship					
S/N	Items	Mean	Std. Deviation		
16	The government should put measures in place to improve the economy.	3.62	.651		
17	School feeding programmes should be extended to secondary schools.	3.52	.733		
18	Mathematics class should be made activities based.	3.58	.402		
19	Jobs should be readily available to improve economic status of parents.	3.29	.496		
20	Payment of school fees on instalments should be considered.	3.22	.416		
	Weighted Mean	3.45			

The above table 3 reveals a weighted mean of 3.45 out of the maximum obtainable score of 4.00 which is higher than the standard mean of 2.5. The result shows that to remediate the influence of economic hardship on students' attitudes to mathematics learning, the government should put measures in place to improve the economy and extend the school feeding programmes to secondary schools as well as mathematics teachers being able to make the class activities based.

#### **4 DISCUSSION OF FINDINGS**

Table 1 above shows that the attitudes students' exhibit to mathematics learning as a result of economic stress are negative. Based on the result analysis, it could be determined that an average number of the respondents is expressing one attitude or the other to the study of mathematics as a result of economic difficulty. This agrees with the findings of McAuley, Leskovec, & Jurafsky [11] and Agir [8] who found out that a student may express feelings and thoughts in terms of learning environment and learning processes with suitable or improper behaviours. The research further demonstrated that the amount at which students' attitudes in economic difficulties influence students' learning in mathematics is quite great. It was revealed that the learning progress of a large number of respondents is being impeded in one manner or the other. The findings concurred with Olson [13] who suggested that access to learning opportunities and features of the learning environment play a role in how people learn. Also, Witteveen & Velthorst [14], found out that economic difficulty led to emotions of despair, loneliness and worry which damaged the mental health of so many people. It may be also observed

that the majority of the respondents agreed that there should be solutions to economic hardship. This is in keeping with the results of Aina [7], who found out that the Nigerian government in this moment of economic distress does not provide appropriate funds to create way for favourable and enabling environment so as to support effective teaching and learning process. Also, Awolere, Wahaab and Salau [6] argued that the present occurrence of the economic crisis has imposed terrible suffering on the academic success of pupils in so many areas such as the inadequate supply of infrastructure in the development of education by the government. Some probable remedies were also revealed in table 3 that to remediate the influence of economic hardship on students' attitudes towards mathematics learning, government should put measures in place to improve the economy and extend the school feeding programmes to secondary schools as well as mathematics teachers been able to make the class activities based.

#### **5** CONCLUSION

Economic hardship is taking its toll on the ability of students to learn effectively where mathematics is not an exemption. The fact that some of the students engage in negative attitudes as a result of economic hardship calls for the attention of the stakeholders of education. Considering the importance of mathematics education as a bedrock for all studies to include technology and economic advancement, its learning needs the full concentration of the learners in order for its aim to be achieved.

#### 6 RECOMMENDATIONS

Based on the findings of this study, it was recommended that;

• Mathematics teachers should make mathematics teaching more interesting and attractive to learners

• The government should look into how students will not be badly affected by the economy by extending the feeding programmes and making secondary education free and comprehensive.

• The school authorities should consider payment of school fees in instalments to alleviate economic hardship.

#### **COMPETING INTERESTS**

The authors have no relevant financial or non-financial interests to disclose.

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## FROM OUTSIDERS TO INSIDERS: THE CORRELATION BETWEEN CROSS-CULTURAL ADAPTATION AND BASIC PSYCHOLOGICAL NEEDS OF INTERNATIONAL STUDENTS

#### XiLong Zhao

College of Vocational and Further Education, Central China Normal University, Wuhan 430079, Hubei, China. Corresponding Email: zhaoxilongff@gmail.com

Abstract: With the development of international education, the number of students studying abroad is increasing. Cross-cultural adaptation issues have become an inevitable problem for them. Based on basic psychological needs theory, this empirical study selected 105 Chinese students who are studying at the tertiary level in the United Kingdom and New Zealand as samples to verify the cross-cultural adaptation process and basic psychological needs of international students. Through questionnaires and semi-structured interviews, it is found that the main reasons for the cultural shock experienced by Chinese international students are differences in the higher education between China and English-speaking countries, language ability and academic literacy problems, while the cultural shock caused by life adaptation problems is not obvious. It is also verified that the satisfaction of basic psychological needs is negatively correlated with the negative impact brought by the culture shock. The satisfaction of basic psychological needs enables international students to have a higher learning motivation, and also enables foreign students to have the motivation to study when facing difficulties in a foreign country, as well as the determination to support themselves not to compromise with difficulties.

**Keywords:** Cross-cultural adaptation; Basic psychological needs theory; International students from China; Overseas students in the United Kingdom and New Zealand

#### **1 INTRODUCTION**

China has become a major source of international students in 2023-2024, with nearly more than one million students studying in overseas higher education institutions [1]. In the past cross-cultural research on international students from China, it was pointed out that most international students inevitably experienced challenges during the cross-cultural adaptation stage [2].

Culture shock mentioned in this study refers to a person's psychological and physiological uncomfortable reaction in a foreign country [3]. As a relatively young and inexperienced group, some international students feel strong depression due to communication difficulties, lack of social support, and huge cultural differences [4]. In a survey on the mental health of Chinese international students, 45% of Chinese international students at the school expressed they had experienced symptoms of depression, and 29% of them had symptoms of anxiety [5]. Their study also revealed that the prejudice in Chinese culture prevents Chinese international students from seeking help and treatment from doctors because of mental illness. It puts Chinese students studying abroad at huge mental health risks. The mental health status of international students will be affected by cross-cultural shock. In another empirical research, culture shock is improved to hurt international students' psychological and sociocultural adaptation [6].

Given the profound impact of culture shock, the goal of this research is to investigate the current status of culture shock among international students and the reasons why international students encounter culture shock. To be specific, this study aims to examine the impact of Chinese students' independent motivation to study abroad in the UK and New Zealand on their cultural impact and examine the mediating role of basic psychological needs satisfaction.

#### **2** LITERATURE REVIEW

#### 2.1 Basic Psychological Needs Theory

Basic psychological needs are the core concept and important theoretical branch of self-determination theory. The basic psychological needs theory points out that people have three innate psychological needs, namely autonomy needs, competence needs and relatedness needs [7]. When these psychological needs are met, the individual develops in a positive direction; when these psychological needs are blocked, the individual develops in a negative direction. The three needs correspond to three feelings, namely, a sense of autonomy, a sense of competence, and a sense of belonging. The need for autonomy refers to the sense of control and psychological freedom that individuals feel over their own behavior, and to make action decisions according to their own wishes [7]. When people's autonomy needs are satisfied, they will have higher initiative, participation, and creativity in daily activities [8].

Competence needs are the individual's sense of control over the environment and the development of a new skill based on this. It is an individual's innate tendency to explore the environment [7]. The research proved that the satisfaction of competence needs is the mediating variable for activity feedback to affect intrinsic motivation [9]. When the sense of competence is strong, positive feedback promotes the internalization of motivation. This study shows that satisfying competency needs can promote the transformation of extrinsic motivation into intrinsic motivation.

Relatedness needs refer to the good relationships an individual feels with others and the support they receive from others; when relationship needs are met, people will feel a safe interpersonal atmosphere [7]. When relatedness needs are met, a sense of belonging, connection, and care will occur, which will bring positive emotional impact.

Regarding the theory of basic psychological needs, individuals meet three needs at the same time [7]. Only one or two needs are not enough to achieve the healthiest development state, which determines the degree of motivation internalization. The degree of satisfaction of the three needs determines the degree of motivation internalization.

In this theory, the internalization of motivation and basic psychological needs are particularly important. Based on this theory, the internalization of motivation and the satisfaction of three basic psychological needs can effectively influence Autonomous motivation and the ability to achieve positive outcomes. In other words, international students with self-determination motivation make their decision to study abroad based on interests, hobbies, and identity rather than external reward mechanisms. After meeting the students' basic psychological needs, they should be less affected by culture shock.

For instance, Chinese students in Belgium and Canada are found to decide to study abroad on their own, rather than making decisions based on other people's expectations or the influence of the external environment [10]. Hence, it is easier for them to adapt to the cultural environment, in other words, it is less affected by culture shock.

#### 2.2 The Cross-Cultural Adaptation of Chinese International Students

Prior studies have explored the cultural shock issues encountered by Chinese international students, the role of basic psychological needs theory, motivation and so on. A narrative study on the study abroad careers of three Chinese dancers reveals that the three Chinese international students relatively clearly and completely embodied Oberg's concept of culture shock, such as uneasiness and confusion, caused by changes in the cultural environment [11]. Freshness and a series of strong psychological changes. It reflects the different reactions of different people when encountering cultural shock. Some students feel uncomfortable of being unable to understand the culture when they first come into contact with a new culture, while others feel unable to integrate into sharing and discussion with classmates. Similar to an outsider, some students use the learning experience as an outlet to resolve cultural shock and think they can do anything. This psychological state has also changed accordingly with the passage of time. From the unfamiliarity, discomfort and freshness of arriving at the study abroad destination, to the selection, recognition and interpretation of the teaching content in the study abroad environment, and finally the acceptance of the teaching content.

A study on Chinese students' motivation to study abroad has found that self-determined motivation to study abroad is more conducive to students' cross-cultural adaptation than non-self-determined motivation to study abroad, and discovered the goals of international students [10]. A two-factor structure, which includes "protective factors" to avoid disadvantages at home and "self-development factors" to pursue a good education and better career development opportunities. Therefore, self-determination motivation brings students lower cultural shock and higher happiness. It has also confirmed that the satisfaction of basic psychological needs in self- determination theory plays a key mediating role in cultural shock, subjective well-being and self-determination motivation [12]. The satisfaction of the three basic psychological needs is related to life. Satisfaction is positively related to positive emotions and negatively related to culture shock and negative emotions.

#### **3 RESEARCH METHODS**

A random sampling data collection method was used, which can reduce sample distortion problems caused by selection bias and enable us to better understand and describe the performance of international students when they encounter cultural shock. This study distributed questionnaires to Chinese students who have stayed in the UK and New Zealand for more than 3 years through Questionnaire Star in September 2023. A total of 117 questionnaires were collected, and 105 were valid questionnaires (males: 59.05%, females: 40.95%) effective rate 89.74%. 16.19% of the respondents were between 18 and 22 years old, 59.05% were between 23 and 28 years old, and 24.76% were above 29 years old. The participants were all Chinese and went to study in the UK (54.29%) and New Zealand (45.71%) respectively. In addition, 11.43% of the respondents' language proficiency (e.g. IELTS) is between 5.0-5.5, more than half (55.24%) of the respondents are between 6.0-6.5, 27.62% have a language level of 7.0 or above, and another 5.71 % of respondents did not provide language scores. All interviewees are self-financed international students.

#### **4 RESULTS AND DISCUSSIONS**

#### 4.1 Culture Shock Experience

Based on the first-hand data, the process of cultural shock experienced by the participants is analysed to pave the way for subsequent research presentations. To express the process of cultural shock intuitively, according to the questionnaire results, the mean value of each question is calculated to form a curve, as shown in Figure 1.



Through the analysis above, Chinese international students generally go through four stages, including the honeymoon, shock, adjustment and adaptation stages. To further analyze the overall situation of cross-cultural adaptation of Chinese international students, this study set up an overall evaluation question "How do you feel about living and studying abroad?" Overall, most people think that they can adapt to life and study abroad.

However, the degree of adapting to life and study is indeed different. The overall situation of cross-cultural adaptation of Chinese students going to the UK or New Zealand is good and the degree of adaptation is relatively high, as illustrated in Figure 2.



Very adaptable, I enjoy everything here.

Figure 2 Culture Shock and Cultural Adaptation

The proportion of people who are adaptable to studying and living overseas accounts for 91.42%, which shows that most people can adapt to living and studying overseas despite varying degrees. Among them, 36 participants think that they are very adaptable to local life and study and can adapt to overseas study and life. The other 35 participants think they can adapt and a little unhappy experience will not affect them at all. 25 participants think they can basically adapt, and occasionally have unhappy experiences but can overcome them. 9 participants felt that they were somewhat unable to adapt and had some happy experiences, but they still preferred to return to their country. Among the 9 participants, a special case is that one interviewee rated it as somewhat unable to adapt in terms of overall feelings, but at every stage he showed that he was very unadaptable to living and studying overseas. His willingness to study abroad is not an independent wish. After arriving at the destination, he refused to socialize, but felt boring and had a strong sense of loneliness. He also encountered academic difficulties during their studies, which led to long-term persistence in the culture of the study abroad destination.

#### 4.3 Correlation Between the Degree of Satisfaction of Basic Psychological Needs and Cultural Shock

The satisfaction of the three basic psychological needs has a negative correlation with cultural shock, as seen in Table 1. To verify whether each of the psychological needs affects the degree of culture shock, this study further splits the three independent needs into two, each corresponding to the degree of culture shock. Results indicated that each need individually mediated the negative relationship between self-determination and culture shock.

Table 1 Correlation between Three Basic Psychological Needs and the Impact of Culture Shock

Three basic psychological needs	Correlation coefficient		
Autonomous needs	0.377**		
Competency needs	0.389**		
Belonging needs	0.394**		
Note: *p<0.05 ** p<0.01			

This study extends previous findings and re-verifies the relationship between three basic psychological needs and culture shock. Chinese students who have a higher degree of autonomous motivation to study abroad and a higher degree of satisfaction of the three basic psychological needs are less likely to encounter culture shock in the UK and New Zealand. These findings are in line with prior research [13]. Considering the application of new technologies, the English language level of Chinese university students is expected to increase, so reducing the challenges in the cross-cultural adaptation, which is basically consistent with research related to many existing findings [14-15].

The other consideration is that participants were all self-funded students. They had stricter requirements for themselves because of the high cost. They had a high degree of satisfaction of the three basic psychological needs and strong autonomous motivation. In addition, due to financial pressure and family expectations, as well as the goal of successfully obtaining a degree, Students show good self-discipline behavior, and clear goals also give students the motivation to adjust themselves.

#### **5** CONCLUSION

The United Kingdom and New Zealand have brought obvious cultural differences to Chinese students. The degree of cross-cultural adaptation directly affects students' study and life. When international students move from one culture to another cultural environment, they will more or less not adapt to the phenomenon, and present certain stages. Therefore, the impact of culture shock on the cultural adaptation of Chinese international students has practical and theoretical significance.

The main findings of this study are as follows. Initially, there are stages in the cross-cultural adaptation of Chinese students studying in the UK and New Zealand, which can be roughly divided into the honeymoon period, the shock period, the adjustment period, and the adaptation period. The honeymoon period is generally 0-1 month, and the shock period is generally after starting to study. The adjustment period is longer, usually 4-12 months, and then enters the adaptation period.

Moreover, there is a negative correlation between the degree of satisfaction of basic psychological needs and the negative impact of culture shock. The satisfaction of basic psychological needs enables international students to have high learning motivation and also enables international students to learn when facing difficulties in a foreign country. The motivation to continue, and the determination to support oneself and not compromise with difficulties.

#### **COMPETING INTERESTS**

The authors have no relevant financial or non-financial interests to disclose.

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## PROBABILITY AND STATISTICS QUESTIONS OF COLLEGE ENTRANCE EXAMINATION BASED ON MATHEMATICS CORE LITERACY -- A CASE STUDY OF COLLEGE ENTRANCE EXAMINATION MATHEMATICS IN RECENT FIVE YEARS (2019-2023) ACCOMPLISHMENT

Can Cao<sup>1,2\*</sup>, Long Li<sup>2</sup>

<sup>1</sup>School of Mathematics and Statistics, Jishou University, Jishou 416000, Hunan, China. <sup>2</sup>School of Mathematics and Statistics, Hengyang Normal University, Hengyang 421002, Hunan, China. Corresponding Author: Can Cao, Email: jsucc181@163.com

**Abstract:** This research is guided by the core mathematical competencies. Based on the national college entrance examination mathematics papers from 2019 to 2023, it adopts a research method combining quantitative and qualitative analysis to systematically analyze the probability and statistics questions. The analysis is carried out from four aspects: question - type structure, score distribution, knowledge dimension, and competency assessment, with a focus on examining the assessment characteristics and proposition trends of core competencies such as mathematical abstraction, logical reasoning, mathematical operation, and data analysis. The study finds that the probability and statistics questions in the college entrance examination exhibit the proposition characteristics of "real - life situations, structured thinking, and comprehensive methods". The score proportion of situation - based questions accounts for more than 65%. The questions emphasize the integrated assessment of mathematical modeling ability and statistical thinking, highlighting the integrity of the data analysis process and the rigor of logical reasoning. The research results have important reference value for optimizing the teaching strategies of probability and statistics and improving students' core mathematical competencies.

**Keywords:** Core mathematical competencies; College entrance examination mathematics; Probability and statistics questions; Proposition characteristics; Data analysis

#### **1 INTRODUCTION**

Probability theory [1] is a branch of mathematics that studies the quantitative laws of random phenomena, while statistics [2] is a science that uses the knowledge of probability theory to study how to reasonably obtain data and conduct data analysis. In high - school mathematics, without the foundation of advanced mathematics such as calculus and measure theory, it is impossible to give an axiomatic definition of probability and random variables. Therefore, high - school probability and statistics questions mainly focus on the assessment of basic concepts and knowledge such as classical probability models, geometric probability models, conditional probability, the distribution of random variables, range, expectation, and variance. In 2020, the Curriculum Standards for General High - School Mathematics were revised, proposing six core competencies for high - school mathematics. The six core competencies of high - school mathematics include mathematical abstraction, logical reasoning, mathematical modeling, mathematical operation, intuitive imagination, and data analysis. Core mathematical competencies [3] are the correct values, necessary character traits, and key abilities that students gradually develop through the study of mathematics. With the continuous deepening of the new curriculum reform, probability and statistics problems have gradually become a type of comprehensive problems that integrate the training of multiple competencies such as data analysis, mathematical abstraction, logical reasoning, and mathematical abstraction, logical reasoning, and mathematical abstraction, logical reasoning have gradually become a type of comprehensive problems that integrate the training of multiple competencies such as data analysis, mathematical abstraction, logical reasoning, and mathematical modeling.

Domestic scholars have conducted in - depth research on probability and statistics questions in the college entrance examination. Cao Yiming and Wang Wansong [4] used a combination of quantitative and qualitative analysis methods to study the probability and statistics content in the high - school mathematics curriculum standards of 15 countries including China, the United States, and the United Kingdom. Pan Yuchen et al. [5] obtained the main content of current and future statistical education research based on the research of *The International Handbook of Research in Statistics Education*. Wang Yu and Hu Fengjuan [6] studied the differences in curriculum standards and examinations of the statistics and probability parts in the college entrance examinations of China and the United Kingdom. Lin Yun [7] studied the cultural connotations and educational functions of probability and statistics courses from the perspectives of philosophy and culture. Li Yaqiong et al. studied the proposition characteristics of probability and statistics in the national new curriculum standards papers from 2011 - 2020 [8] and six new curriculum standards papers in 2021 [9] respectively. The research findings show that probability and statistics questions pay attention to the examination of basic knowledge.

The research emphasizes returning to textbooks and values the integration of probability with knowledge such as functions and sequences. The proportion of total scores for probability and statistics problems in the national examination papers shows an increasing trend. Ren Zichao, Chen Ang, etc. [10] analyzed and studied the quality of new

mathematics test papers in the college entrance examination after the new college entrance examination reform. Zhang Dingqiang and Pei Yang [11] took the national examination papers and Zhejiang examination papers from 2017 - 2018 as examples to study the consistency between mathematics test papers and the curriculum under the background of the new college entrance examination reform. Li Jiemin and Liao Yunzhang [12] pointed out that conditional probability is essentially a probability measure and put forward relevant suggestions for the teaching of this part. Liu Jianmei [13] studied the probability and statistics questions in the national examination papers from 2015 to 2019, and deeply explored the causes of errors, learning obstacles, and coping strategies for high - school probability and statistics questions. Ma Li [14] studied the laws and characteristics of probability and statistics questions in the national science mathematics paper I of the college entrance examination in the past 10 years. At the same time, she conducted a statistical study on the origin of the teaching materials to provide reference for the teaching of "probability and statistics". Li Qianqian [15] studied the probability and statistics questions in the college entrance examination in the past five years and carried out qualitative and quantitative analyses of the above - mentioned test papers according to the constructed evaluation framework of core mathematical competencies. Wang Hui [16] studied the implementation of logical reasoning competencies in the current teaching of high - school probability and statistics and explored its practical significance in teaching practice. Xie Peiyao [17] analyzed the probability and statistics questions in the college entrance examination mathematics from the perspective of core competencies using a combination of qualitative and quantitative methods. Zhang Deran and Mao Shisong [18] studied the teaching of probability and statistics from the perspective of cultivating students' awareness of random mathematical thinking, enabling students to understand that reasoning under random mathematical thinking is a combination of plausible reasoning and logical reasoning. Cheng Lingli [19] explored middle - school mathematics teachers' understanding and perception of probability concepts.

In conclusion, probability and statistics questions in the college entrance examination have become one of the contents in college entrance examination mathematics. The probability and statistics essay questions have become a very important type of comprehensive questions in college entrance examination mathematics. After the release of the new curriculum standards, the teaching of probability and statistics courses has received attention from a large number of middle - school mathematics teachers, which is conducive to improving students' core mathematical competencies such as data analysis, mathematical operation, and logical reasoning.

Based on the national and local examination papers from 2019 to 2023, this paper studies the probability and statistics question types in the college entrance examination mathematics papers in the past five years from five aspects: question - type design, score distribution, characteristics of knowledge points, core mathematical competencies, and proposition trends, so as to provide reference for the cultivation of high - school students' core mathematical competencies and teachers' teaching.

#### 2 QUESTION TYPES AND SCORE ALLOCATION

Data analysis is one of the six core competencies in high - school mathematics. Since probability and statistics questions first appeared in the college entrance examination papers in 2000 and 2001 respectively, probability and statistics knowledge has become one of the compulsory contents in college entrance examination mathematics [8]. After more than twenty years of development, probability and statistics questions have entered the stage of innovation from the initial attempts and stability.

At present, probability and statistics questions in the college entrance examination cover all question types in college entrance examination mathematics: single - choice questions, multiple - choice questions, fill - in - the - blank questions, and problem - solving questions. Due to the incomplete explanation of probability and statistics knowledge in high school mathematics, it is impossible to describe probability and statistics problems with an axiomatic mathematical system. Therefore, single - choice questions mainly assess the basic concepts and calculations of probability and statistics. Most of these types of questions are easy, but the last single - choice question may be a challenging one. It is mainly combined with permutations, combinations, independence, classical probability models, and geometric probability models for assessment. Multiple - choice questions mainly examine students' understanding of basic concepts, focusing on the application of probability. For example, in the multiple - choice question of probability and statistics in the 2023 New College Entrance Examination Volume II, the question is about the bit - error rate problem in the process of electronic signal transmission in the channel. The calculation of the bit - error rate is a practical probability problem often encountered in signal processing. This question mainly examines the application of probability knowledge. The scenario set in this question is the transmission of electronic signals, and the main knowledge points examined are the probability calculations of independent events and mutually exclusive events. This question has a strong practical application background. When doing this question, students are easily confused by the practical problem of signal transmission, which distracts their attention and increases the difficulty of the question.

Fill - in - the - blank questions are another important type of questions for examining probability and statistics in the college entrance examination. This type of question sets problems with specific application scenarios, increasing students' thinking about practical problems and affecting the accuracy of their answers. Probability and statistics problems mainly comprehensively examine classic probability models combined with knowledge such as permutations and combinations. For example, in the 2022 Zhejiang Volume, National Volume A, and National Volume B, the fill - in - the - blank questions in these papers mainly involve the classical probability model and its probability calculation. The fill - in - the - blank question in the 2022 Zhejiang Volume aims to examine students' calculations of probability and expectation. There are numbers written on 7 cards, and students need to calculate the probability of the classical

probability model by applying the frequency theory of probability according to the definition of random variables. One of the difficulties in this problem is calculating the probability of getting the number 2. At this time, it is necessary to conduct a classified discussion on the situation of getting the number 2: getting the number 2 once or twice. If the probability of getting the number 2 can be calculated, the probability of correctly solving this problem is relatively high. The National Volume A and Volume B in 2022 examine the frequency theory of probability, and the calculations of favorable events and total events are relatively simple. In conclusion, fill - in - the - blank questions in the college entrance examination of probability and statistics are mainly of medium and easy difficulty, and most of the questions examine the calculation of probability.

The problem - solving questions of probability and statistics are a type of questions that have been continuously innovating in recent years. This type of question can be regarded as the extension of application questions and mathematical modeling to random problems. From a historical perspective, the test papers before 2010 mainly focused on classical probability calculations and simple applications. Judging from the probability and statistics questions in the college entrance examination mathematics from 2019 to 2023, this type of question will be comprehensively examined in combination with functions, sequences, and other problems. In the 2021 New College Entrance Examination Volume II, the question is a probability model of microbial population reproduction, which is a classic example of the application of probability in ecology or biology. It is also the application of probability and statistics in survival analysis, preparing students for learning more complex probability models such as survival models in the future. In this problem, probability needs to be applied to sequences and functions, which is a comprehensive question involving probability, sequences, the monotonicity and extreme values of functions. The third question of this problem is an open - ended subjective question, examining students' abilities of logical reasoning and plausible reasoning. As long as students write a reasonable answer, it is correct. This question breaks the tradition that the answer to a math problem is unique and well examines students' comprehensive qualities, which is a major change in college entrance examination math questions. Judging from the problem - solving questions in college entrance examination mathematics from 2019 to 2023, problems are mainly set in combination with certain scenarios to solve relevant probabilities, or combined with actual data to examine students' mastery of probability and statistics knowledge such as frequency distribution tables, random sampling, and classical probability.

Since 2023, the college entrance examination is mainly divided into the national unified proposition and the separate proposition of some provinces. The types of test papers used in the national college entrance examination are divided into five categories, including the National Volume A, National Volume B, New College Entrance Examination Volume I (New Curriculum Standard Volume I), New College Entrance Examination Volume II (New Curriculum Standard Volume I), New College Entrance Examination are Beijing, Tianjin, Shanghai, and Zhejiang. The following table shows the score distribution of some probability and statistics questions in the college entrance examination in China in the past five years.

Year type	Single choice	Multiple choice	Gap filling	<b>Response question</b>	Collect
2023 Shanghai	4			16	20
2023 National II		5		12	17
volume					
2023 National		5		12	17
volume I					
2023 Beijing				14	14
2023 Tianjin	5		5		10
2023 National first	5			12	17
division					
2023 National A	5			12	17
text					
2023 National B	5			12	17
2023 National	5			12	17
Ewen					
2022 Zhejiang			6		6
2022 National	5			12	17
Volume II					

 Table 1 Statistical Table of Scores of Probability and Statistics in College Entrance Examination Mathematics in the

 Past Five Years

Table 1 statistically analyzes the score situations of probability and statistics in a total of 11 college entrance examination papers from 2022 to 2023. From Table 1, it can be concluded that the average score of probability and statistics questions in these 11 college entrance examination papers is 15.3 points, and both the median and the mode are 17 points. The college entrance examination paper with the highest score for probability and statistics questions is the 2023 Shanghai paper. The score of the problem - solving question in this paper is 16 points, which is higher than that of other papers. While the paper with the lowest score is the 2022 Zhejiang paper. There is no problem - solving question in the probability and statistics questions of this paper. There is only one fill - in - the - blank question with a score of 6 points. Next is the 2023 Beijing paper, which only has 10 points and only includes multiple - choice and fill - in - the - blank questions. Except for the above two papers, the other 9 papers all have one problem - solving question, with an average score and a mode of 17 points. From the above analysis, it can be seen that the college entrance

examination questions of probability and statistics mainly focus on problem - solving questions, with a score of around 17 points. At the same time, there are relatively few probability and statistics questions in the college entrance examination papers of Zhejiang and Tianjin, with scores of around 10 points.

# **3** KNOWLEDGE POINTS OF PROBABILITY AND STATISTICS IN THE COLLEGE ENTRANCE EXAMINATION

The study of elementary probability theory can be divided into two learning stages at different levels. The first stage involves learning about discrete random variables with probability mass functions and continuous random variables with density functions. The second stage is about learning axiomatic probability theory based on measure theory. At the high - school level, students have not delved deeply into knowledge of single - variable calculus and multi - variable calculus, let alone real - variable functions and measure theory. Therefore, the knowledge of probability and statistics in high school mainly focuses on the frequency perspective of probability, which belongs to the first - stage elementary probability theory.

Based on the analysis of 81 probability and statistics questions from 2019 to 2023, the following conclusions can be drawn: The main assessment contents of probability and statistics in the college entrance examination mainly include probability calculations combined with classical and geometric probability models, permutations and combinations, independence and independence tests, descriptive statistical analysis of data, and the calculation and application of probability.

The most frequently examined knowledge points in the college - entrance - examination probability and statistics papers are probability calculation and its application, as well as the calculation of classical and geometric probability models. In the college - entrance - examination mathematics questions from 2019 to 2023, there were 43 questions related to probability calculation and its application. Among them, there were 15 multiple - choice questions, 12 fill - in - the blank questions, and 17 problem - solving questions. The 2020 New Curriculum Standard II Science paper set a question with the random change in the number of online orders in a supermarket during the COVID - 19 prevention and control period as the context. The number of newly added orders each day is a random variable. This question was closely related to current political hotspots, using the COVID - 19 prevention and control situation as the context. The question was novel in design and ingeniously conceived. Students were required to abstract a probability model from real - life situations and solve it using probability methods. By analyzing the college - entrance - examination mathematics papers in the past five years, it can be concluded that the application questions of probability and statistics are set based on real - life scenarios. Students need to understand the essence of random variables in real - life and perform calculations. Since high - school students have not deeply studied relevant knowledge of calculus and measure theory, probability and statistics questions can only be set from the frequency perspective. Therefore, common assessment contents involve classical and geometric probability models. From the college - entrance - examination questions studied in this paper, there were 12 multiple - choice questions, 7 fill - in - the - blank questions, and 11 problem - solving questions related to classical and geometric probability models.

Descriptive analysis of data is a frequently - tested knowledge point in the statistics part of the college entrance examination. It mainly includes contents such as mode, median, mean, estimating the population distribution from the sample frequency distribution, and frequency distribution histograms. For this part of the content, as long as students master the basic concepts and apply the statistical calculation formulas, they can solve the problems. These are mostly medium - difficulty and easy questions. Independence test is also a frequently - tested content in statistics, mainly in the form of problem - solving questions. In the college - entrance - examination questions studied in this paper, there were a total of 14 problem - solving questions. There were almost annual questions on the knowledge point of independence test, which requires high - school teachers to strengthen teaching in this regard.

From the above analysis, it can be seen that the main knowledge points examined in probability and statistics in the college - entrance - examination mathematics are the calculation and application of probability in real life, as well as data analysis and its practical significance. This is mainly reflected in the probability calculations of classical and geometric probability models.

#### **4 CORE MATHEMATICAL COMPETENCIES**

From the probability and statistics questions in the college entrance examination over the past five years, the main characteristics of the assessment of core mathematical competencies can be summarized as follows: First, it emphasizes the assessment of multiple core mathematical competencies, strengthening the comprehensiveness of college entrance examination propositions. Second, it attaches importance to the creation of scenarios, which are closer to social hot - topics and feature more refined and realistic models. Third, the questions are more open - ended, with progressive inquiries, making them more exploratory.

The probability and statistics questions in the college entrance examination all involve the assessment of multiple core mathematical competencies, among which data analysis, mathematical abstraction, logical reasoning, and mathematical operation are frequently examined. For example, the probability and statistics problem - solving question in the 2023 Beijing paper is about studying the price change pattern of a certain agricultural product. A total of 40 consecutive days of price data of this agricultural product were collected. This question examines students' data analysis ability. When describing price changes, "+" is used to represent "increase" and " - " is used to represent "decrease", which is an

example of mathematical abstraction. Calculating the probability of the price increase of this type of agricultural product based on past data and estimating the probabilities of price increase and decrease of this agricultural product test students' mathematical operation ability. This is a typical question that assesses multiple core mathematical competencies. To analyze the price change situation of this agricultural product, reasoning based on the existing data is also required. This is a form of reasoning under random mathematical thinking, which is a combination of plausible reasoning and logical reasoning [18].

Scenarios related to social hot - topics are set to examine students' comprehensive analysis ability. The scenarios set in the 2020 New Curriculum Standard II Science paper and the 2021 Beijing paper are about epidemic prevention and control during the COVID - 19 period. The 2020 New Curriculum Standard II Science problem - solving question is about the processing of online orders during the epidemic prevention and control period. During this period, to prevent cross - infection, people generally placed online orders for goods. This question sets up a problem of random order volume distribution based on this scenario. The new orders on the second day are random variables, and their magnitudes need to be inferred based on past data. It is a comprehensive problem of probability and statistics. The 2021 Beijing paper sets the scenario of the mixed - testing method in nucleic acid testing. When medical staff are in short supply, mixed sampling can significantly reduce the burden on medical staff, but its scientific nature needs to be verified. This question examines the "k - in - 1 testing method" to conduct a theoretical study on mixed sampling. This type of question is closer to real life and belongs to the category of social - hot - topic scenarios.

The question types of probability and statistics in the college entrance examination are more open - ended and flexible to answer. The probability and statistics question in the 2022 National Volume B is about environmental governance. By randomly selecting 10 trees, their cross - sectional areas and volumes are counted. The cross - sectional areas and volumes of the roots of this type of tree and their correlation coefficients are estimated. The third question also requires calculating the total volume of this type of tree. This question is more comprehensive than traditional math questions, as it needs to consider statistics, probability, and the actual situation of tree growth. It requires the comprehensive application of logical reasoning and plausible reasoning. Such questions are more open - ended. Students need to conduct plausible and logical reasoning on random problems. The second question is the probability and statistics problem - solving question is newly set, and the answer is flexible, showing more flexible openness. In the third question, students can find the price change situation of the agricultural product according to their own statistical methods and draw relevant conclusions based on plausible reasoning. This changes the previous situation where math questions had a single answer, representing a breakthrough change in college entrance examination math proposition.

#### **5 PROPOSITION TRENDS**

This paper studies a total of 81 college entrance examination questions on probability and statistics nationwide from 2019 to 2023. These questions feature novel scenario settings and strong comprehensiveness. In summary, the probability and statistics questions in the college entrance examination have the following characteristics:

#### 5.1 Comprehensive Examination, Returning to Basics

Analysis of the probability and statistics papers in the college entrance examination mathematics over the past five years shows that the examination attaches great importance to basic knowledge and covers a wide range. The main knowledge points in the college entrance examination of probability and statistics include: mutually exclusive events and opposite events, classical probability models, geometric probability models, conditional probability, independence of random events, normal distribution, independence test, descriptive statistical analysis (mode, median, mean, correlation coefficient, variance, etc. of statistical data), and estimating the overall distribution from the sample frequency distribution. The probability and statistics questions in the college entrance examination mainly test the basic concepts of probability and statistics and their calculation methods, highlighting the fundamentals. Classical probability models appear repeatedly, and key content generally appears in the major questions, which fully reflects the requirements of the mathematics college entrance examination: "Core knowledge is examined with emphasis."

#### 5.2 Strong Comprehensiveness, Reflecting Core Mathematical Competencies

The probability and statistics questions in the college entrance examination assess multiple core mathematical competencies, such as logical reasoning, data analysis, mathematical abstraction, and mathematical operation, fully demonstrating the comprehensiveness of the college entrance examination mathematics papers. Through statistical analysis of the types of probability and statistics questions in the college entrance examination over the past five years, it can be found that the mathematical operation competency has the highest proportion in each year's examination. Next are logical reasoning and data analysis. Judging from the college entrance examination mathematics papers across the country in 2023, flexible logical reasoning and plausible reasoning are required.

#### 5.3 Stable with Changes, Focusing on Innovation

Judging from the probability and statistics questions in the college entrance examination over the past five years, the calculation and analysis of probability are the contents every year. The most important thing in probability and statistics is to find the inherent laws from the random changes of things. Therefore, probability calculation is bound to become an essential part of the college entrance examination mathematics. However, the proposition scenarios and questions are constantly innovating. Every year, it keeps up with the hot topics of the times and innovates continuously. For example: COVID - 19 pandemic, Asian Games, environmental governance, etc. In terms of questions, there are more and more open - ended questions, requiring students to have a deeper understanding of real - life problems.

#### **COMPETING INTERESTS**

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## THE RELATIONSHIP BETWEEN YOUNG CHILDREN'S GRAPHIC NARRATIVE SKILLS AND READING BEHAVIOR: INSIGHTS FROM THE MATTHEW EFFECT

XuPing Zhang<sup>1,2\*</sup>, Min Zhang<sup>3</sup>

<sup>1</sup>Faculty of Early Childhood Education, Nanjing Xiaozhuang University, Nanjing 211171, Jiangsu, China. <sup>2</sup>International Education Management, Woosong University, Daejeon 34606, Republic of Korea. <sup>3</sup>Nanjing No.1 Kindergarten, Nanjing 210000, Jiangsu, China. Corresponding Author: XuPing Zhang, Email: zxp1215@163.com

Abstract: This study examines the relationship between children's storytelling abilities and reading behavior, comparing those with high and low abilities. Using the Matthew Effect, it suggests that children with high skills demonstrate greater engagement and attention in reading, strengthening their language and reading abilities through feedback loops. Twenty kindergarteners were assessed for narrative skills, and four were selected for six weeks of observation to record reading during self-directed activities. Results showed that high-picture-reading kids showed stronger interest and better attention, while low-picture-reading kids showed less interest, poor attention, and more distracted reading. This finding confirms the positive relationship between reading and storytelling and reading behavior in children, validating the Matthew effect. The researcher suggests three targeted educational recommendations.

Keywords: Pictorial storytelling; Reading behavior; Language skills; Matthew effect

#### **1 INTRODUCTION**

Picture narratives are activities in which teachers provide young children with multiple visual pictures, each with a plot that suggests a logical connection between the preceding and subsequent events, and children can logically narrate a complete event using the sequence of pictures [1]. Picture storytelling is of great value for young children's language development. On the one hand, it is an effective way to develop young children's complex language. When children look at pictures, they not only have to choose appropriate words and combine them into sentences according to grammatical rules, but also have to consider the organization of the content of the story in order to narrate in a sequential and organized way [2]. On the other hand, many studies have shown that young children's ability to read and narrate pictures may reflect their cognitive, thinking, emotional, and social abilities [3--5]. The development of narrative skills can promote the development of children's ability to express themselves in monologue out of context, and therefore plays an important role in the smooth transition from oral expression to literacy. Most studies have used color spectrum analysis to assess young children's narrative ability and present the characteristics of young children's narrative ability [6-7].

The Matthew Effect in reading, first proposed by Stanovich, refers to the widening gap between skilled and struggling readers over time due to differences in early reading ability and subsequent opportunities for reading experience. This creates a tendency for "the strong to get stronger and the weak to get weaker." [8-9] The gap between skilled and struggling readers grows over time, leading to an "upward trend for the skilled and a downward trend for the weak" [8]. The theory suggests that children who initially show small gains in reading skills will eventually show larger differences in reading ability, creating a cycle of advantage or disadvantage. The Matthew Effect has three aspects of reading and cognitive development in early childhood [9]. The first aspect is reciprocal causation and feedback. Early success in reading improves cognitive processes like vocabulary and comprehension, which makes reading easier and more rewarding. This creates a positive cycle. Difficulties can hinder this progress. Children who read less have fewer words in their vocabulary and background knowledge, which makes it harder for them to read and can create a cycle of disadvantage. The next difference is about reading practices. Strong readers read more in kindergarten and at home, giving them more chances to practice and get better at reading. They read more fluently and with better comprehension. Children who struggle with decoding and comprehension read less, which limits their exposure to text and chances for improvement. Finally, Stanovich focuses on the role of the reading environment. Children who are already advantaged with strong early literacy skills are more likely to be exposed to enriched reading environments, which further extends their advantage. Children who are disadvantaged may have limited access to texts and quality instruction, exacerbating their challenges. This paper explores the relationship between children's graphic narrative skills and reading behaviors using corpus information to analyze the level of young children's graphic narrative skills. Narrative skills affect young children's reading behaviors in the classroom [10]. A figurative presentation of the possible effects of graphic narrative skills on young children's reading behaviors in older classes is also presented.

#### 2 METHODOLOGY

In this study, twenty children (10 boys and 10 girls) in the final year of kindergarten from the same class in a kindergarten in Nanjing were selected as participants. The participants were all children with normal development and no auditory and speech developmental disorders. Two children from both high and low narrative ability groups were chosen for a six-week naturalistic observation based on their scores.

In the first phase of the study, a testing method was employed to investigate the picture-narrative abilities of senior kindergarten children. The picture materials were selected from storytelling resources commonly used for senior kindergarten classes, specifically "The Little Mouse and the Elephant" and "The Monkey Family Crossing the River." In the context of the children's daily classroom environment, the researcher conducted one-on-one interactions with the children in a setting they were familiar with. By creating a positive and engaging atmosphere, the children were guided to independently narrate stories based on their observations of the pictures. The children's narrative responses were recorded and later transcribed for analysis.

The analytical and evaluation framework for children's narrative data primarily referred to the Dynamic Indicators of Basic Early Literacy Skills (DIBELS). The DIBELS framework comprehensively categorizes narrative ability into eight dimensions [6]: structural completeness, thematic relevance, narrative sequencing, linguistic clarity and fluency, sentence structure, use of dialogue, vocabulary level, and expressive language. Each dimension was scored on a scale of 1 to 3, and the total score was used to assess the picture-narrative ability of the children.

In the second phase, the researcher primarily adopted a non-participant observation method, supplemented by participant observation. The focus of the observation was on the children's behaviors during independent play in the activity areas, particularly their selection of the reading area, as well as the frequency, state, and specific behaviors exhibited while reading picture books during daily activities. These aspects were used as observation indicators to analyze and illustrate the reading behaviors of children with varying levels of picture-narrative ability.

#### **3 RESULT**

#### 3.1 The Performance and Characteristics of Picture-Narrative Ability in Senior Kindergarten Children

By counting the frequency of scores on the eight dimensions of the children's graphic narratives at different levels (Table 1), it can be seen that the tested older children's ability to view graphic narratives varies across the dimensions, as shown below.

	Table T requerely of Scores at Different Levels Across Light Differsions							
	Structure	Thematic	Tone	Dialogue	Time	Expressiveness	Vocabulary	Sentence
	Completeness	Relevance	Usage	Usage	Marking	Expressiveness	Level	Structure
Level 1	2	0	12	24	29	18	1	6
Level 2	29	2	23	9	11	11	26	23
Level 3	9	38	5	7	0	11	6	11

Table 1 Frequency of Scores at Different Levels Across Eight Dimensions

#### 3.1.1 Good performance on narrative relevance

Senior kindergarten children demonstrated a better ability to grasp the main content and plot development during picture-based narrative activities, as reflected in the dimension of "thematic relevance." The results show that all participants achieved Level 2 or above in "thematic relevance," indicating that most of them were able to accurately describe the main characters and core plot of the story. This finding suggests that the senior kindergarten children performed well in terms of thematic focus during picture-based narratives, with minimal deviation from the story's theme. They were generally able to narrate the main characters and plot development, accurately capturing the key events.

For example, in the story "The Little Mouse and the Elephant," children were able to construct their narratives around the core theme of "cooperation." The development of this ability reflects the children's logical thinking and their capacity to integrate visual information during picture-based storytelling. Through such activities, children gradually develop the skill to extract key events based on the visual content, laying a solid foundation for their future comprehension and expression in written language.

#### 3.1.2. Relatively weak time-tagging skills and insufficient layering of narratives

Senior kindergarten children demonstrated weaker developmental levels in the dimension of "time marking." The results indicate that none of the participants achieved the highest level (Level 3), and most children used simple temporal conjunctions (e.g., "then") intermittently to connect events, without employing a richer variety of temporal adverbs or complex clauses to express temporal relationships between events. For instance, in 25% of the analyzed narrative samples, the word "then" appeared four or more times. A typical example of narrative progression was: "The little mouse cooked porridge, then there was too much firewood, then the elephant came, then it fanned, then the little mouse flew onto the tree." This indicates that children's use of "time marking" was overly simplistic.

While this linear expression ensures that events are narrated in chronological order, it lacks subtle layers of complexity and limits the marking of time to surface-level descriptions. It fails to reflect intricate causal or conditional relationships. The deficiency in time marking ability may be related to the developmental stage of the children's language skills, supporting existing research that highlights the immaturity of children's comprehension and use of complex sentence structures (such as adverbial clauses or causal compound sentences) at this stage [11].

#### 3.1.3 Language use exhibits significant gender differences

The results indicate that there are notable gender differences in the picture-narrative abilities of senior kindergarten children. Overall, girls outperformed boys, with significant differences observed in four dimensions: vocabulary usage, sentence structure, dialogue usage, and expressive language.

In terms of vocabulary usage, girls employed more specific and emotionally rich words when describing events, such as "bright red peaches" or "exhausted and drenched in sweat," while boys tended to use simpler nouns like "peach" and verbs like "fan" or "fall." Regarding sentence structure, boys preferred simple or compound sentences, while girls were more likely to use adverbial clauses, relative clauses, and causal compound sentences to convey complex logical relationships. For example, girls would narrate: "The elephant kept fanning with its eyes closed, not realizing the little mouse had flown onto the tree. The elephant looked at the mouse in confusion and asked, 'Why are you hanging on the tree?" In contrast, boys often used simpler sentences such as "They crossed the bridge to eat peaches."

In the dialogue and expressiveness dimensions, girls included more dialogues and used varied tones and speeds to convey character interactions and emotions. For instance, a girl might mimic characters with emotional dialogues like, "Can't you help me put out the fire?" or "The monkey mother came out and said to her baby, 'It's such a beautiful day! Let's go play!" Boys, however, relied on a single tone and expressed events more directly with fewer dialogues, such as "They walked out and crossed the bridge."

These gender differences may be attributed to socialization processes and developmental characteristics in language. Girls tend to focus more on detailed and emotional descriptions, reflecting their inclination toward emotional expression and linguistic detail. Boys, on the other hand, often prioritize the events themselves, resulting in a more straightforward and concise narrative style [12].

#### 3.2 Differences in Reading Behavior in High and Low Graphic Narrative Skills Subgroups

The researchers selected two boys and two girls with typical performances from the 20 participants for long-term follow-up observation. The average picture-narrative scores of the four children were as follows: A (girl), 21.5; B (girl), 21; C (boy), 11.5; and D (boy), 9.5. Observations revealed differences between the high-scoring and low-scoring groups in their proactivity in choosing the reading area and their level of focus during reading activities.

#### 3.2.1 Variations in initiative for selecting reading areas

During the six-week observation period, the children's class engaged in a total of 42 sessions of self-directed activity area play. The classroom was equipped with six regular activity areas: the Building Area, Doll Corner, Reading Area, Art Area, Science Area, and Puzzle Area. Table 2 shows the frequency statistics of the four children's visits to the Reading Area.

Table 2 Frequency of Children's Reading Area Selection					
A B C D					
Frequency	12	11	4	2	
Total Percentage         28.6%         26.2%         9.5%         4.8%					

The data results indicate a significant difference between the high-scoring and low-scoring groups in their proactive selection of the Reading Area during self-directed activity area play. The high-scoring children demonstrated noticeably higher proactivity compared to the low-scoring children.

To minimize systematic bias caused by external factors during the observation and data collection—such as instances where children could not select a specific activity area because it was already full—the researchers also recorded the frequency of children's selection of the Reading Area during routine transitional activities, such as after lunch or snack time. During these periods, the class offered three main self-directed activities for children to choose from: table games, plant corner observation and recording, and picture book reading. Over the six-week period, the researcher observed 39 instances of routine self-directed activities in the classroom. Table 3 shows the frequency statistics of the four children's selection of picture book reading.

Table 3 Frequency	y of Children's Inde	pendent Selection	of Picture Book	Reading During	<b>Daily Activities</b>
	/				1

			<u> </u>	5
	А	В	С	D
Frequency	17	15	5	6
Total Percentage	43.6%	38.9%	12.8%	15.4%

As with the results above, children in the upper subgroups actively chose picture books to read during daily independent classroom activities significantly more often than children in the lower subgroups.

#### 3.2.2. Differences in reading interest and concentration

To further examine children's behaviors during reading activities, the researcher observed their specific actions while reading. Children with higher picture-narrative abilities (e.g., A and B) displayed greater interest in reading and higher levels of focus. High-scoring children were able to engage in picture book reading for extended periods. For instance, Child A spent considerable time on each page, actively asked questions, and shared the story with peers. Child B

demonstrated behaviors like recognizing words while looking at pictures and occasionally revisiting earlier pages. Both children showed strong interest in the content, completed books independently, and exhibited enthusiasm for exploring new books. They also tended to resist invitations to other activities and stayed focused on their reading.

In contrast, low-scoring children (e.g., C and D) showed lower interest and shorter reading durations. Child C often daydreamed and struggled to finish a book, while Child D flipped through pages quickly, sometimes laughing, but limited reading to two favorite books. Their reading was easily disrupted by external influences, such as leaving their seats or joining peers in other activities, reflecting low focus during reading.

These differences support the Matthew Effect, highlighting the reciprocal relationship between reading ability and picture-narrative skills. Children with higher narrative skills are more inclined to engage in reading and focus on it, which in turn reinforces their narrative abilities, such as their willingness to share stories during reading

#### 4 IMPLICATIONS AND RECOMMENDATIONS

#### 4.1 Identifying and Addressing Differences in Narrative Dimensions

Teachers should recognize that children's narrative abilities encompass eight dimensions: structural completeness, thematic relevance, narrative sequencing, linguistic clarity and fluency, sentence structure, use of dialogue, vocabulary richness, and language expressiveness. The study highlights significant differences across these dimensions and among individual children.

When designing activities, teachers should target specific areas of improvement. For example, to address weak time marking and logical sequencing, activities can feature images with clear time points, helping children understand the role of temporal markers in storytelling. Simple questions like "Why does the elephant fan the fire?" or "What happens if the elephant doesn't help?" can guide children to express cause-and-effect relationships, encouraging a shift from linear to more complex narratives.

For children with limited vocabulary, teachers can introduce descriptive words or phrases and encourage imitation. For instance, when describing "the elephant fanning the fire," teachers can add phrases like "fanning hard" or "fanning quickly" to enrich their vocabulary. Additionally, observing picture details with children and prompting the use of adjectives can further expand their expressive range.

#### 4.2 Integrating Picture-Based Narratives with Reading Activities

Observations reveal that children's picture-narrative and reading abilities reinforce each other. Teachers can design language activities that combine these elements to enhance both skills. For instance, interactive storytelling games during free play can integrate picture book reading with role-playing. Children can narrate stories using their own words based on picture prompts and be encouraged to retell the storylines. This approach not only strengthens picture-narrative skills but also deepens children's comprehension and interest in reading [13].

#### 4.3. Creating a Reading-Friendly Environment to Foster Engagement

The environment is not merely a passive backdrop but actively influences behavior through its structure and content. As Stanovich noted, a well-designed environment can stimulate interest and provide opportunities for practice and development [9]. A high-quality reading environment directly impacts children's interest and participation in reading.

To enhance engagement, the classroom reading environment should cater to diverse reading abilities and interests. Teachers can provide a variety of materials, including complex picture books for advanced readers and simpler, visually rich books for less proficient readers [14]. Comfortable reading spaces with soft cushions and chairs can make the reading area more inviting.

Additionally, teachers can increase opportunities for independent reading during free play and transitions. Role models can be established by encouraging children to share their favorite books or stories through class presentations or recordings, fostering a positive reading culture. Reward systems, such as reading logs or sticker charts, can further motivate children to choose reading activities and complete them consistently.

#### **COMPETING INTERESTS**

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# CONSTRUCTION OF THE QUALITY EVALUATION MECHANISM OF THE IDEOLOGICAL AND POLITICAL EDUCATION MICROCARRIER CONSTRUCTION FOR COLLEGE STUDENTS

#### Pan Li<sup>1</sup>, Xiang Liu<sup>2\*</sup>

<sup>1</sup>School of Information Engineering, Hunan Applied Technology University, Changde 415100, China. <sup>2</sup>School of Design, Hunan Applied Technology University, Changde 415100, China. Corresponding Author: Xiang Liu, Email: 1751611391@qq.com

Abstract: Scientific evaluation is a prerequisite for ensuring quality. Educational evaluation is the process in which the evaluation subject makes scientific judgments on educational activities, processes, and outcomes based on certain educational values, in comparison to educational goals. A sound evaluation system for ideological and political work in universities is established. A comprehensive evaluation system with reasonable indicators and scientific methods is developed. The institutionalization of ideological and political work in universities is promoted. Ideological and political education, as the superstructure, is determined by productive forces and production relations, and has class characteristics. Micro media has opened up the era of intelligent micro media and provided new ways for ideological and political education in universities. Micro media presents a new way of ideological and political education for contemporary college students, changing the traditional mode of ideological and political education and promoting the progress of ideological and political education for contemporary college students, but also brings enormous challenges. This paper discusses the establishment of evaluation for college students, but also brings enormous challenges. This paper also discusses the evaluation goal orientation and system architecture determination mechanism. This paper also discusses the evaluation of key technological innovation mechanisms.

Keywords: Quality evaluation mechanism; Ideological and political education; Microcarrier construction

#### **1 INTRODUCTION**

Yang [1] investigated the change of the carrier of ideological and political education of the CPC and the turn of the times during the agrarian evolution. It was shown that the trend of the transformation of the ideological and political education carrier during the land revolution period is manifested in the increasingly standardized management carrier. Feng [2] investigated the path of integrating ideological and political education carriers in universities under the background of integrated media. It was shown that universities should actively adapt to the trend of integrated media, deeply grasp the essence of the integration of ideological and political education carriers in universities, scientifically examine their practical logic, and actively explore their basic principles. Hu et al. [3] investigated the development and application of cultural carriers for ideological and political education in higher education institutions under the new media environment. It was shown that the quality and effectiveness of ideological and political education could be enhanced by effectively integrating and innovating the cultural carriers. Taking domestic anime culture as an example, Wu et al. [4] investigated the exploration and practice of medicinal chemistry teaching that integrating ideological and political education. Based on the interdisciplinary perspective, Wang [5] investigated several basic issues concerning the carrier of ideological and political education. It was shown that the widely accepted viewpoint in academia regarding the introduction of carriers as the starting point for ideological and political education should be revised, and the main value of a carrier is functional. It was also shown that the main value of the carrier is that the essence of the functional carrier is functional and oriented towards the medium of human beings. Taking Japanese anime as an example, Wang [6] investigated cultural communication through ideological and political education as a carrier. It was shown that analyzing the characteristics and implementation paths of integrating Japanese anime into ideological and political education courses can leverage the positive role of Japanese anime in the process of ideological and political education. Taking Jishou University as an example, Mo [7] investigated the innovative path of ideological and political education carriers in higher education institutions in the new era of industry and technology. It was shown that the current difficulties faced by ideological and political education carriers in universities could be improved by adhering to the student-centered approach, fully utilizing modern technology, and deeply integrating the concept of big ideological and political education. Through short videos, Gou [8] investigated the ideological and political education for college students. It was shown that short videos pose both risks and opportunities for ideological and political education of college students. Ren [9] investigated the problems and countermeasures in the application of network carriers for ideological and political education in vocational colleges. It was shown that the online resources to enrich educational content should be utilized and the teaching methods should be broadened in order to improve the teaching efficiency of online ideological and political courses. Wang et al. [10] investigated ideological and political education through disciplinary competitions as a carrier. It was shown that teachers should use the implicit ideological and political

education platform of subject based competitions in order to further enhance the effectiveness of ideological and political education.

Li et al. [11] investigated the micro carrier of ideological and political education of college students in the context of internet plus. It was shown that the application of microcarriers in ideological and political education in universities requires transforming ideological cognition, enriching the organizational forms of ideological and political education under the background of microcarriers, expanding the scope of ideological and political education content through microcarriers, and strengthening the promotion and publicity of ideological and political education practices. Yan [12] investigated the carrier innovation of ideological and political education in universities from the perspective of all-round education. Ma [13] investigated the path of ideological and political education for normal university students through the great spirit. It was shown that integrating the spirit of the great founding into the ideological and political education of normal university students could enhance the political identity and emotional resonance of teacher and student. Zhang et al. [14] investigated the conceptual transformation of the development of ideological and political education carriers. It was shown that the quality and efficiency of ideological and political education work could be improved by selecting high-quality carriers that organically integrate content and form. Zheng et al. [15] investigated the ideological and political education for college students based on major national events. It was shown that the multidimensional, innovative, and sustainable development of ideological and political education for college students could be achieved by establishing the concept of ideological and political education, creating a collaborative education mechanism, and pursuing long-term educational effects. Tang et al. [16] investigated the form characteristics and function of the carrier of ideological and political education in the new era. In order to better play the role of the carrier, the carrier of ideological and political education should focus on the overall function, the innovative transformation of traditional carriers of ideological and political education, and the compatibility of different educational carrier choices. Qin et al. [17] investigated the metaverse carrier of ideological and political education for college students. In order to give full play to the educational effectiveness of the metaverse carrier of ideological and political education, attention should be paid to establishing a mechanism for preventing harmful information, developing and selecting suitable carriers, strengthening the connection between the virtual world and the real world, and enhancing the information awareness and ability of ideological and political educators. Wang et al. [18] investigated the application of ideological and political education carriers for college students' rebellious psychology. By using the methods of reasoning, infection, and management in ideological and political education as carriers, integrating the methods of inspiring education, practical summary, exemplary demonstration, and combining rewards and punishments, the negative impact of college students' rebellious psychology in school life could be effectively reduced. Hu [19] investigated the carrier of ideological and political education in universities during major epidemics. Wu [20] integrated the Four Histories education into the teaching of ideological and political theory courses using red culture as a carrier. It was shown that the main paths to leverage the role of Lingnan's red cultural resources include strengthening the education of the Four Histories through the carrier of red cultural resources and achieving cultural education, integrating the education of Four Histories into the practical teaching of ideological and political courses in universities to achieve practical education, and integrating Four Histories education into online and offline classrooms to achieve online education. Gao [21] investigated the effectiveness of ideological and political education for college students through national defense education. It was shown that carrying out teaching reform through national defense education is a trend in the future development of ideological and political education, and the organic integration of the two plays a very important role in enhancing the effectiveness of ideological and political education.

This paper aims to explore the construction of the quality evaluation mechanism of the ideological and political education microcarrier construction for college students.

# 2 ESTABLISHMENT OF EVALUATION GOAL ORIENTATION AND SYSTEM ARCHITECTURE DETERMINATION MECHANISM

The direction of microcarrier construction with goal orientation should be grasped. The political awareness should be strengthened and a bottom line mindset should be established. The construction of microcarriers in universities is important and the political orientation of the carriers should be highlighted. A sound mechanism for cultivating moral character and nurturing talents is the fundamental value and foothold of the current intelligent technology provides the support for the matching of supply and demand in micromedia dissemination and ideological and political education. The guiding value of ideological and political education has enhanced the empowerment level of micromedia value, and the intelligence of media has promoted the personalization and diversification of ideological and political, valuable, and humanistic contents has become the core indicators for microcarriers to provide the accurate content. As a multimedia matrix, the microcarriers of ideological and political education in the micromedia space should be established.

In different eras, the focus of work varies need to be continuously developed and improved through dynamic adjustments. The political awareness should be strengthened and a bottom line mindset should be established. Without a correct political viewpoint, it is equivalent to having no soul. A new generation of the times who are responsible for the great mission of national rejuvenation should be cultivated. Establishing a sound mechanism for cultivating moral character and nurturing talents is the fundamental value and foothold of the current micro carrier construction of ideological and political education for college students. Adapting to the transformation of educational paradigms under

the background of artificial intelligence, promoting the refinement of ideological and political education in the micro media space of universities have become the trend of the times. In order to understand the basic construction information of the micro carrier construction platform for ideological and political education of college students including its composition, module settings, functional effects, the evaluation structure and content of various college facilities, platforms, mechanisms, and teams should be analyzed. The revised and improved indicator framework and content should be applied to the practice.

Practice is the sole criterion for testing truth. Targeted refinement and decomposition of basic indicators into hierarchical and multi-dimensional auxiliary support indicators to ensure that the evaluation indicator elements are both comprehensive and specific. Due to various subjective and objective factors, the problem of unbalanced and insufficient construction of microcarriers still exists. The overall elements of the evaluation of microcarriers should be reasonably selected.

#### **3 EVALUATION OF KEY TECHNOLOGICAL INNOVATION MECHANISMS**

The micro carrier of ideological and political education for college students presents a trend of diverse subjects, modes, and channels in its construction and evaluation elements. Resource data mainly includes unstructured data such as organizational leadership, network infrastructure, performance, and investment. Behavioral data mainly includes behavior data of diverse educational subjects. Supporting data includes various online tests, competitions, quality and ability evaluations, as well as evaluation data formed from various questionnaires, and related and accumulated data such as network security, monitoring, and public opinion supervision. The collection of data should be carried out in a non-invasive and accompanying manner. The multi-source, heterogeneous, and multimodal data generated in real-time during the practical process is continuously collected. The evaluation of ideological and political education should be improved. The process evaluation should be strengthened. The value-added evaluation should be explored. The comprehensive evaluation should be improved. A deep understanding of the relationship and operating rules between the elements of subject, object, mediator, and environment in the micro carrier of ideological and political education for students should be obtained.

#### **4 CONCLUSIONS**

To improve the quality of ideological and political education, enhance the pertinence, scientificity, and effectiveness of education, it is necessary to establish micro carriers. The evaluation objectives, content, and key technologies are the core elements of quality evaluation. Therefore, the construction of the quality evaluation mechanism of the ideological and political education microcarrier construction for college students is explored in this paper.

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#### **COMPETING INTERESTS**

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## THE REALISTIC DILEMMAS AND IMPROVEMENT PATHS OF NORMAL STUDENTS' PROFESSIONAL ETHICS EDUCATION FROM THE PERSPECTIVE OF "LIDE SHUREN"

WeiWei Yin\*, YingXue Zheng, YaXin Wang

School of Education, Anyang Normal University, Anyang 455000, Henan, China. Corresponding Author: WeiWei Yin, Email:avww2021@163.com

Abstract: The fundamental task of "Lide Shuren" in the new era has put forward higher requirements for teacher ethics education for normal students. The survey found that teacher ethics education in normal universities has problems such as imperfect educational content, insufficient diversity of educational approaches, imperfect evaluation mechanism, and incomplete formation of the joint force of various subjects, resulting in unsatisfactory educational effects. The causes of the problems involve challenges at the level of social concepts, defects in school education models, and cognitive biases of students. To optimize the effectiveness of teacher ethics education, we must follow the principle of the unity and integrity of the teacher ethics structure "knowledge, emotion, intention, and action", integrate ideological and political courses with curriculum ideology, give play to the power of teachers' role models, build a platform for practical education, and improve the evaluation mechanism of teacher ethics.

Keywords: Lide Shuren; Normal Students; Moral Education

#### 1 THE VALUE AND CONNOTATION OF MORAL EDUCATION FOR NORMAL STUDENTS

#### 1.1 The Value of Moral Education for Normal Students

On May 2, 2018, General Secretary Xi said at the symposium of teachers and students at Peking University:"Talent serves as the foundation for virtue, while virtue acts as the guiding force for talent. Talent training must be a unified process of educating people and cultivating talents, and educating people is the foundation. People do not stand without virtue, and the foundation of educating people lies in virtue. This is the dialectic of talent training"[1]. General Secretary Xi's speech is a good answer to the relationship between Lide and Shuren, we should regard Lide and Shuren as an organic whole. After the 18th National Congress, General Secretary Xi emphasized the importance of Lide Shuren (Foster virtue and cultivate people) on many occasions, and pointed out in the report of the 19th National Congress that it is necessary to "implement the fundamental task of Lide Shuren", and clarified the focus and practical tasks of Lide Shuren. The report of the 20th National Congress pointed out: "Strengthen the construction of teachers' ethics and teaching style, cultivate a team of high-quality teachers, and carry forward the social trend of respecting teachers and valuing education." General Secretary Xi stressed that the first criterion for evaluating the quality of teachers should be teacher ethics and style. This important assertion points out the direction for the construction of the teaching team in the new era. In September 2024, General Secretary Xi said at the National Education Conference that it is necessary to implement the spirit of educators to strengthen teachers, strengthen the construction of teachers' ethics and style, improve the quality of teacher training and training, and cultivate a high-level teacher team in the new era. The "Opinions of the Central Committee and the State Council on Promoting the Spirit of Educators and Strengthening the Construction of High-quality Professional Teachers in the New Era" put forward that "the implementation of the fundamental task of establishing morality and cultivating people, and strengthening the construction of teachers as the most important basic work to build a strong country in education." "From the perspective of teacher construction, the main tasks of teacher education at this stage have been established. The key to the development of teachers' career lies in the perspective of teachers, and comprehensively improving teachers' moral quality has become the top priority of the construction of teachers, which is related to the realization of the fundamental task of education. Normal students have the dual identity of university students and future teachers, and the cultivation of teacher ethics is related to the allround development of normal students, and is also directly related to the moral education work of primary and secondary schools and the healthy physical and mental growth of adolescents and children. As the main battlefield of primary and secondary school teacher training, helping normal students develop good teacher ethics is not only the primary task of higher normal universities, but also an urgent need to improve and improve the professional quality of teachers in our country. Strengthen teacher ethics education for normal students in the new era, it plays an important role in cultivating good "four have" teachers with ideals and beliefs, moral sentiments, solid knowledge, and benevolent hearts, and building a group of high-level teachers with high ideological and moral character and strong professional ability. On September 17, 2018, the Ministry of Education stated in the "Opinions on Implementing the Excellent Teacher Training Plan 2.0": "Fully carry out the education of teachers' ethics. Make learning and implementing General Secretary Xi's ardent hopes and requirements for teachers as the primary task and key content of teacher ethics education for normal students." On November 15, 2019, the Ministry of

Education issued the document "Opinions on Strengthening and Improving the Construction of Teacher Ethics in the New Era", further emphasizing the importance of teacher ethics. Therefore, establishing the "virtue" of normal students and training normal students into qualified teachers is the core of moral cultivation in normal universities.

#### 1.2 The Connotation of Moral Education for Normal Students

Starting from the characteristics of teachers' profession, the "morality" of normal students should reflect their professional characteristics. Teacher ethics education, that is, teachers' professional ethics education, refers to the activities that the state purposefully and systematically carries out moral education and moral influence on teachers, so that they follow the code of professional ethics and conduct, consciously fulfill their obligations to the society to education, and develop good professional ethics [2]. The main task of teacher ethics education is to help teachers master the norms of teacher ethics and develop good professional ethics and psychological qualities [3]. The teacher ethics education in this study is the activity of teacher ethics education and self-education for normal students. How can normal students transform the requirements of teachers' professional ethics into the theoretical and practical activities of the inner quality of normal students at the school stage.

# **2** INVESTIGATION AND ANALYSIS ON THE CURRENT SITUATION OF TEACHER MORAL EDUCATION FOR NORMAL STUDENTS

#### 2.1 Investigation and Design on the Current Situation of Teacher Moral Education for Normal Students

This study investigates part of the school's teacher major, mainly investigating the motivation of normal students' career choice, the cognition of teachers' professional ethics, and the effect, approach and method of teacher moral education for normal students in schools, so as to better understand the current situation of teacher moral education for normal students and provide a certain reference for the reform and practice of teacher moral education model for normal students.

A total of 1075 questionnaires were collected in this survey, and the effective rate of the questionnaire was 99.3%. The survey objects were normal students from freshman to senior year, and the distribution was shown in Table 1.

Grade	Number of Students	Percentage
Freshman year	141	13.12%
Sophomore year	487	45.30%
Junior year	235	21.86%
Senior year	212	19.72%

Normal students in 9 majors were randomly selected in the school, and the distribution is shown in Table 2.

Table 2 Professional Distribution of Survey Respondents			
Major	Number of Students	Percentage	
Chinese language and literature	225	20.93%	
English	186	17.30%	
Mathematics	145	13.49%	
Ideological and Political	102	9.49%	
History	68	6.33%	
Physics	95	8.84%	
Fine Arts	89	8.28%	
Musicology	75	6.98%	
Preschool Education	90	8.36%	

#### 2.2 Survey Results of the Current Situation of Teacher Ethics Education for Normal Students

At present, most universities have made a series of measures around moral education. Some universities are strengthening moral education for teachers and counselors of ideological and political courses, organizing them to study the "Code of Professional Ethics for University Teachers", and most universities have added teacher moral education to the content of new teachers' induction training. At the same time, most universities have also held a series of educational practice activities of "moral education and training people", and have made various attempts in educational

approaches and methods. In terms of the training of teacher moral education for normal students, universities have begun to explore new models and new ways, which are a good start for normal students to develop moral education. However, through field research, it is found that there are still some deficiencies in the education of teacher moral education for normal students.

#### 2.2.1 The educational effect is not satisfactory

In 2017, the Ministry of Education issued a notice on the "Implementation Measures for Normal Professional Certification in Ordinary Universities (Interim) ", which mentioned that the graduation certification requirements for normal students should cover "one practice and three societies", that is, "practice teacher ethics, learn to teach, learn to educate people, and learn to develop" [4]. "Practice teacher ethics" requires normal students to abide by teacher ethics and have educational feelings. However, through the survey, it was found that 96% of normal students have a certain degree of enthusiasm for the teaching profession and can recognize the importance of teachers' professional ethics, but 47% of students do not have enough knowledge of the specific requirements of professional ethics and educational laws and regulations. Although the teacher ethics education of normal students has achieved certain results, it is still not ideal and does not meet expectations.

#### 2.2.2 Inadequate educational content

On the one hand, 59% of the current universities place too much emphasis on the normative education of teacher ethics, positioning the function of teacher ethics courses in the learning and mastery of teacher ethics norms, and ignoring students' learning and understanding of educational laws and regulations, resulting in a relatively narrow coverage of teacher ethics education, which is not conducive to the integrity and unity of teacher ethics knowledge learning for normal students. On the other hand, ignoring the detailed education of teacher ethics for normal students, and the theories and cases mentioned are alienated from the actual life of students, and less attention is paid to the performance of daily moral behavior of normal students. Most normal students get very little emotional experience of teacher ethics in the process of moral education, and the educational content of teacher ethics emotion is lacking.

#### 2.2.3 Educational pathways are not diverse enough

On the one hand, teachers' professional ethics classroom teaching methods are single, classroom teaching is still based on theoretical teaching, which is too theoretical. The lack of practical case analysis and teacher-student interaction in teacher ethics teaching results in the lack of attractiveness and influence of educational content, and the main role of students is not effectively played. Teaching methods are relatively simple, and teachers' modern educational methods are not fully used. Teaching information needs to be updated and needs to arouse students' emotional resonance.

On the other hand, the practice of teacher ethics education is an important part of the internalization of students' moral education, and it is also an important process to cultivate the professional emotions of normal students and strengthen their moral behavior. At the same time, the practice of teacher ethics helps normal students to enhance their in-depth understanding of the connotation of teacher ethics and recognition of teachers' profession, and then establish a correct view of teacher education. However, through the survey, it is found that more than 80% of universities currently improve the main position of teacher ethics for normal students is the classroom, the main way is the school curriculum, while after-class self-study and reflection, communication and practice between teachers and students are relatively few, which shows that the ways of teacher ethics education. Furthermore, due to the imperfect practical mechanism of teacher ethics education is lacking or cannot cover all normal students.

#### 2.2.4 The evaluation mechanism is not perfect

The survey data show that in terms of evaluation content, the evaluation of normal students mainly focuses on knowledge and skills, while ignoring the evaluation of teacher ethics. In terms of evaluation methods, most of them are written tests, which mainly examine students' memory and understanding of professional theoretical knowledge. For the professional skills of normal students, they are tested through lectures, lectures, educational practice, etc., while for the evaluation of the teacher ethics level of normal students, there is a lack of special scientific and reasonable standards. In practice, especially for the educational apprenticeship and practice of normal students, there is also a phenomenon of emphasizing the evaluation of results and neglecting the evaluation of teacher ethics, and it is easy to ignore the evaluation of teacher ethics in the apprenticeship and practice, and pay more attention to the assessment of professional skills, which reduces the reliability and validity of the evaluation.

#### 2.2.5 The synergy between professional education and teacher ethics education has not yet formed

We should know that teacher moral education is not only the job task of ideological and political course teachers in universities, but also cannot be completed by ideological and political course teachers alone. It should be completed by teachers of all disciplines working together and in unison. The teacher moral education of normal students should be combined with the teaching of professional education courses, penetrate and integrate with each other, give full play to the strength of subject teachers, form an educational synergy, and implement together. In the investigation, it was found that there are still some professional teachers who focus on professional theoretical knowledge and professional skills in teaching, neglecting the education and cultivation of teacher moral aspects of normal students. The excavation and integration of ideological and political elements in the curriculum are not enough.

#### **3** ANALYSIS OF THE CAUSES OF MORAL EDUCATION FOR NORMAL STUDENTS

The causes of teacher moral education are complex, and there are deep social reasons. Teacher moral education not only faces the challenges of the times, but also is related to the cognitive biases of normal universities and even normal students. In other words, teacher moral education faces multiple challenges such as the impact of social concepts, poor school practice and students' cognitive biases. Summed up as follows:

#### 3.1 Teacher Moral Education Faces Greater Challenges of the Times

In the information age, people's access to information is increasing. Of course, people's admiration for teachers and the mystery of the teaching profession are gradually fading, but their expectations for teachers are increasing. Teachers, as members of society, are also affected by various channels, and their personalities and concepts are also changing. The current normal students are in a rapidly developing, open and diverse social environment. They pay more attention to their own rights and interests, advocate rationality, and pursue individuality. For example, when asked, "If you were a teacher, would you voluntarily give up your rest time for students?" Most of them believe that working hours cannot take up personal rest time, and work cannot affect personal life. They will pay more attention to efficiency and personal economic interests, which is different from the "selfless dedication" in the traditional teacher's professional ethics concept.

#### 3.2 Lack of Cultural Atmosphere in Teacher Moral Education in Normal Universities

General Secretary Xi pointed out: "Strive to use all the spiritual wealth created by the Chinese nation to educate people through culture," and the environment is an important condition for "transforming people" and "educating people" [5]. Dewey, an American educator, believes that the environment or the medium represents everything that enters into life as a condition that supports or hinders life activities. He said: "We have never directly educated, but indirectly through the environment" [6]. The environment here includes both the physical environment of the school, the institutional environment, and the cultural environment of the campus.

Although schools are aware of the importance of environmental education and have created a certain environment for teacher ethics education through various means, the survey found that the cultural atmosphere of campus education is not enough. The observation found that due to the school's rating standards neglecting the issue of teacher ethics education for normal students, especially in the evaluation of first-rate evaluation, normal students place more emphasis on academic achievement and less emphasis on professional ethics. In addition, some teachers lack the awareness of education, and there is a phenomenon of "only teaching infertile people", neglecting the teacher ethics education for normal students.

#### 3.3 The Overall Quality of the Teaching Staff needs to be Improved

On the one hand, there is an imbalance in teachers' values. Some teachers pay attention to "teaching" and despise or ignore "educating people", which leads to students' emphasis on theoretical knowledge learning, but do not truly realize educating people, and it is easy to bring wrong cognitive orientation to students. On the other hand, there are deviations in teachers' professional behavior. University teachers should have educational feelings and dedication, and should be responsible for students and schools. Some teachers lack preparation before class, lack innovation in class, boring content, lack of equal dialogue and ideological collision with students, and lack of reflection after class. The test of students is mainly based on theory. On the other hand, the academic research related to teachers is not followed up. Some teachers' ethics teaching is divorced from academic research, and teaching lacks deep theoretical support and practical exploration, resulting in limitations in teacher ethics teaching.

#### 3.4 Normal Students' Perception of Teachers' Professional Value is Biased

The value orientation of people will change with the rapid development of the economy, and some inequalities in material and wealth in society will also bring certain collisions to teachers' original ideas. Normal students began to think and question the traditional teacher values. Through the investigation, it was found that students have differences and deviations in the economic status and social status of the teaching profession and the cognition of professional value. Some students believe that teachers' responsibility is to teach and educate people, some students believe that teachers only need to be responsible for students during school, some students think that their income is low but they have social prestige, and some students think that teachers work very hard, get up early and get up late, just to make a living. It can be seen that the cognition of teachers' professional value among the normal students has changed, and there are also differences. Normal students are not highly motivated to learn.

#### 3.4.1 Normal students prioritize teaching skills over moral cultivation

The survey found that in the curriculum arrangement, schools will take into account the learning of professional theoretical knowledge and professional skills training of normal students, such as building training rooms and micro-teachers, training students to speak and give lectures, so that they can learn to do instructional design, so that they can master more interview skills, aiming to improve the employment rate of normal graduates, while neglecting the cultivation and training of normal students' moral quality. Students also believe that they should study the teacher professional ethics course, which is helpful to individuals, but in actual learning and training, they believe that teaching

skills, educational theory and classroom management ability are important, and that teachers' professional ethics cannot be evaluated and quantified, so they do not pay enough attention. General Secretary Xi said during a discussion with teachers and students from Beijing Normal University: "Teacher ethics is the embodiment of profound knowledge cultivation and cultural taste. Teacher ethics needs education and training, and more importantly, teachers' selfcultivation" [7]. The survey found that normal students took the initiative to study books and documents on teacher ethics less, and the initiative to learn teachers' professional ethics is not strong. For thinking courses, students place more emphasis on final exams and credits, and put more energy into dealing with exams.

#### 3.4.2 Normal students place greater emphasis on the economic status of the teaching profession

At present, the reason why more normal students' career goals are the teaching industry is that teachers have stable financial income and fixed vacation time. Normal students work hard to pass the teacher recruitment exam, more to achieve this goal. When asked in the survey, "What do you think of teachers' paid tutoring and part-time jobs?", 48% of the students think it is possible to do so. They think that the basic salary of teachers is lower than that of other industries, and they can use their spare time to earn extra money. 36% of the students think it is not possible to do this. They think that teaching and educating people is the responsibility of teachers. Busy spare time to make up lessons for students will affect their normal work and reduce their status in the hearts of students and parents. Most students and teachers can do this, which not only helps students but also earns subsidies. It can be seen that there is a deviation in students' understanding and cognition of teachers' professional ethics. When investigating the question "Why did you choose a teacher's major?", it was found that students chose a teacher's major with a certain degree of utilitarianism, more emphasis on the stability of work and income, blindly following the trend and parents' decision factors accounted for the majority, while the love for the teaching profession and the love for children accounted for less.

#### **4** THE REFORM PATH OF TEACHER ETHICS EDUCATION MODEL FOR NORMAL STUDENTS

Normal students' moral training is a long-term project. It follows the principle of the unity and integrity of the teacher moral structure "knowing, feeling, meaning, and doing", adheres to the "three-whole" education, and relies on the strength of all staff to carry out teacher moral education in an all-round way, and runs through the whole process of normal students' education and teaching. At the same time, create a three-dimensional teacher education training system of "teacher moral training, subject teaching and teacher class skill training".

# 4.1 Integrate Ideological and Political Courses with Curriculum Ideological and Political, and Focus on the Comprehensiveness of Educational Content

Moral education is a process of "knowing, feeling, meaning and doing", and the moral education of normal students should follow the process of moral education implementation. If normal students lack the guidance education of teachers' professional value and cannot form a correct and reasonable cognition of teachers' morality, it will easily lead to excessive moral requirements, resulting in teachers' moral education and life reality want to be separated.

In the process of teacher moral education for normal students, we should adhere to the guidance of teacher moral education, highlight the guidance of teacher moral value, rely on teachers of various subjects, set up a "two-way integration" curriculum system, integrate ideological and political courses and curriculum ideology and politics, and realize the "dual" model of teacher moral education and ideological and political education. First, university teachers should be strict with themselves, abide by professional ethics, and pay attention to the guidance of teachers' moral examples. Second, deepen and promote the reform of teachers' professional ethics teaching, enrich teaching content, innovate teaching methods, and actively carry out experiential teaching. On the one hand, it adopts diversified teaching methods, changes the single teaching method, abstract and monotonous teaching content, and is far away from the phenomenon of life. Combined with typical examples in real life, it adopts case teaching method and role-playing method to make normal students have emotional experience and cultivate normal students' ability to think independently. On the other hand, it adopts practical exercise method to carry out normal students' education experience activities inside and outside the classroom, cultivate normal students' service consciousness and ability, improve normal students' sense of social responsibility, innovative spirit and practical ability, so as to deepen normal students' understanding and perception of moral education knowledge and strengthen moral will. Thirdly, strengthen the teaching design of teacher professional courses, fully tap the elements of teacher moral education contained in the course, make full use of its ideological value, and run the central goal of teacher moral education through the whole process of teacher professional subject course teaching, so that teacher professional subject teaching will eventually return to the starting point of "teacher moral education", realize the effective integration of "subject knowledge imparting" and "teacher moral value leading", realize the "educational" of teaching, and promote the development of teacher moral in normal students in a subtle way.

#### 4.2 Optimize the Teaching Staff and Give Full Play to the Power of Teachers' Role Models

Jaspers mentioned: "A university is a community composed of scholars and students, dedicated to the cause of seeking truth" [8]. That is, a university should first be a community of teachers and students. The logical basis for the existence of this community is communication: there are not only multi-dimensional teacher-student, student-student exchanges, but also equal exchanges of professional learning and emotional collisions, ultimately achieving teacher-student symbiosis and co-growth. However, the current teacher-student relationship and dialogue are difficult to achieve the

authenticity of the teacher-student community and ignore the subject status of students. They understand normal students as "educated people", which leads them to lose their inner experience and practice of teacher-moral emotions. At this time, teacher moral education "can only achieve the purpose of teacher moral education through strict discipline and strict control requirements," and its "direct concern is the current legitimacy and legitimacy of people's behavior."[9] The relationship between teachers and students under the teacher-student community should be the relationship between "facilitators" and "learners". This concept permeates the teacher moral education of normal students, requiring teachers to pay more attention to the self-awareness of teachers' morality, perceive the "real place" of teachers' morality in an all-round way, and experience the emotions of teachers' morality, so as to help normal students form correct moral emotions, cultivate firm moral will, and better practice teacher ethics.

At the same time, in the harmonious teacher-student relationship and equal teacher-student dialogue, teachers should carry forward the power of example, motivate parents and social figures to teach by example, interpret the exact meaning of teacher ethics with real actions, avoid "sanctified" teacher ethics education, and no longer repeat the "reason but not others" type of teacher ethics education.

#### 4.3 Strengthen the Platform for Practical Education and Create a Teacher Ethics Education Environment

Universities should attach importance to the cultivation of normal students' morality, improve the evaluation mechanism of students' morality education, and build a platform for practical education. Guide students to gain the experience of teachers' professional ethics and professional behavior in the practice of teacher ethics education.

Therefore, from a horizontal perspective, schools should build a "collaborative education" platform to create a good environment for normal students as much as possible, coordinate various resources of society, schools, and families, and consolidate educational strength. So as to form a joint educational force of multiple parties, and truly realize the all-round education of all staff. Cultivate professional ethics and professional emotions of normal students, and practice the connotation of teachers' professional ethics. From a vertical perspective, pay attention to educational practice, combine teacher ethics theory with teaching practice; adhere to the concept of "progressive progress, through the whole process", and reasonably arrange practical teaching programs for normal students. For example, integrate teacher ethics education into a four-year through-the-loop practical teaching system of "industry cognition, course apprenticeship, project training, and comprehensive practice" to ensure that the concept of teacher ethics can be unified with the educational model, and realize the whole process of teacher ethics education.

#### 4.4 Perfect the Teacher Ethics Evaluation System and Strengthen the Management of Teacher Ethics Education

The moral behavior of normal students is the fundamental symbol to measure their moral level. We attach importance to the evaluation of normal students' daily behavior and moral quality. On the basis of theoretical evaluation, we should strengthen practical evaluation and improve the developmental evaluation mechanism.

Normal students' moral education is an important part of teacher education. Normal students in universities have the dual identities of university students and future teachers. The development of their moral education is not only related to the formation of their "three views", but also related to the construction of future teachers, and more related to the cultivation of young children and the future and destiny of the country. Therefore, we should attach great importance to the moral education of normal students, follow the unity principle of the moral structure "knowledge, emotion, intention, and action", and adhere to the realization of the whole-staff, all-round, and whole-process education model. So as to cultivate comprehensive teacher education talents with strong ability and high quality.

#### **COMPETING INTERESTS**

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## AN ANALYSIS OF INFORMATION LITERACY TEACHING FROM A MULTIMODAL PERSPECTIVE

XiHong Li

Library, Shandong Technology and Business University, Yantai 264005, Shangdong, China. Corresponding Email: tomato19777@163.com

**Abstract:** With the rapid development of Internet technology, human society has entered the stage of multimodal discourse communication, that is, the use of a variety of symbolic resources (such as words, words, images, audio, video, etc.) for information transmission. In this context, information literacy has become an essential ability for individuals to adapt to the survival and development of the information age. The purpose of this paper is to explore the significance, problems and strategies of information literacy teaching in colleges and universities from a multimodal perspective, in order to improve the quality of information literacy teaching in colleges and universities Provide references.

Keywords: Multimodality; Multimodal teaching; Information literacy teaching; Instructional design

#### **1 INTRODUCTION**

Information literacy, as a survival skill in the information age, includes four aspects: information awareness, information knowledge, information ability and information ethics. In today's deepening globalization and informatization, information literacy has become one of the important indicators to measure the comprehensive quality of individuals. As an emerging teaching method, multimodal teaching emphasizes the transmission and presentation of information through multiple modalities to promote students' comprehensive understanding and learning, and provides a new perspective and path for information literacy teaching.

#### 2 MULTIMODALITY AND MULTIMODAL TEACHING

#### 2.1 Definition and Theoretical Basis of Multimodality

The concept of modality is complex. Charles Forceville of the University of Amsterdam in the Netherlands defines modality as a social system of symbols that can be explained by specific perceptual processes [1], i.e., symbolic systems, such as image symbols, text symbols, gestures, sounds, tastes, contacts, etc. G. Kress et al. see modality as the way humans interact with the external environment through their senses [2]. Kress and Van Levin, in their book Multimodal Discourse: Modality and Media in Today's Communication, point out that "modality" refers to the symbolic resources formed in social culture to create meaning [3], which is the channel and medium of communication, including language, technology, images, colors, music and other symbol systems, and is also the way in which human beings interact with the external environment (such as people, machines, objects, animals, etc.) through their senses (such as vision, hearing, etc.), and common modalities include visual modality, auditory modality, tactile modality, olfactory modality and gustatory modality, etc. "Multimodality" refers to the combination of meanings from different symbol systems, and its concept was first applied to scientific research and later introduced into the field of language and literature by scholars. In the field of linguistics, Chinese scholars such as Li Zhanzi, Zhang Delu and Hu Zhuanglin have put forward unique insights and promoted the development of this field.

#### 2.2 Multimodal Teaching

In 1996, the New London Group proposed the application of multimodality in the field of education, and put forward the concept of "multimodal teaching", which refers to a teaching method in which teachers flexibly use language, images, audio, video and other modalities to transmit and interact with information according to the teaching content and objectives [4]. This method is to actively mobilize the interaction between multiple senses and the external environment, such as the basic senses such as vision, hearing and touch, through a variety of teaching methods and multimedia technology (language, image, voice, movement, video and other technologies) used in the classroom, the students' multi-sensory experience and teaching content are actively mobilized, so that students can understand the teaching content at multiple levels and from multiple angles, stimulate students' senses, strengthen students' feelings, and thus trigger students' thinking to think about the diversified teaching mode, so as to achieve the purpose of improving the teaching effect. Stein pointed out that multimodal teaching exists in all aspects of teaching and learning activities [4]. After entering the 21st century, multimodal teaching has been widely used in the actual teaching process [5]. In multimodal teaching, teachers are no longer just imparters of knowledge and broadcasters of PPT, but multimodal selectors, collaborators, and demonstrators, teachers use multimodal systems to design classroom teaching, and with the help of online learning platforms, build multimodal curriculum resources, fully mobilize students' sensory

potential, provide learners with a multimodal interactive learning environment, and promote learners' multimodal understanding of learning content and multimodal meaning construction.

#### 2.3 Significance of Multimodal Instructional Design for Information Literacy

The goal of information literacy teaching is to cultivate students' information awareness, information knowledge, information ability and information ethics. Among them, information awareness is the premise, information knowledge is the foundation, information ability is the core, and information ethics is the direction. Through information literacy teaching, students are equipped with the ability to acquire, evaluate, utilize and create information to meet the needs of the information age.

From a multimodal perspective, information literacy teaching is no longer limited to traditional text reading and information retrieval, but integrates multiple modalities such as images, audio, and video into the whole teaching process. This teaching method helps to enrich the teaching content, stimulate students' interest in learning, and improve students' ability to judge, process and use information.

In summary, the multimodal teaching design of information literacy has the following significance:

#### 2.3.1 Stimulate students' interest and enthusiasm in learning

information, and multimodal teaching advocates the use of multiple teaching methods to mobilize the enthusiasm of all students and stimulate their interest in learning. In traditional classroom teaching, the teacher is in the end, while multimodal teaching emphasizes that all communicative activities in the classroom are multimodal, and the advantages of multimodal teaching mode break the boring and rigid monotony of traditional classroom teaching. Therefore, multimodal teaching is not only the teaching of knowledge, but also the construction of meaning and communication through multiple sensory channels and modalities, so as to improve students' learning interest, learning ability, critical thinking ability, teamwork ability, and ultimately achieve the purpose of improving teaching quality [6].

#### 2.3.2 Enhance students' learning experience and promote knowledge understanding and internalization

Multimodal teaching takes teachers and students as participants, takes multimedia technology as the carrier, and makes full use of video, audio, courseware and other symbols to present the information that needs to be transmitted vividly and concretely[7]. Therefore, the cooperation of multiple modalities can better and more vividly interpret the teaching content, have a strong impact on students' senses, and enable students to understand the teaching content more deeply, thereby promoting the internalization of knowledge.

#### 2.3.3 Promote the cultivation of students' interdisciplinary comprehensive ability and innovation ability

The traditional division of disciplines often leads to the fragmentation and fragmentation of knowledge, while interdisciplinary integration can promote the communication and interaction between disciplines, so as to cultivate students' critical thinking and interdisciplinary thinking, and then promote the cultivation of their comprehensive ability and innovation ability.

# **3** THE CURRENT STATUS OF INFORMATION LITERACY TEACHING FROM A MULTIMODAL PERSPECTIVE

In practice, teachers have begun to try to apply multimodality to the teaching of multiple subjects, especially in English teaching. For example, in the English audio-visual class, teachers develop students' multi-cultural literacy and cross-cultural communication skills by playing English original sound videos and using PPT production exercises. Although multimodal teaching has achieved certain results in information literacy education, the application of multimodal teaching in the information literacy education of college students is insufficient, and it also faces many problems.

#### 3.1 Teachers Lack a Deep Understanding of Multimodal Teaching

Due to the limitations of their own cognition, many teachers may not have a deep understanding of multimodality, and still stay at the level of tool use, believing that they only use multimedia tools, which will affect their systematic reconstruction of teaching design [8]. Simply adding videos and pictures to the classroom does not synergistically promote learning.

#### 3.2 Students Lack the Ability to Process Information in Multiple Modalities

Traditional education often focuses on the transmission of information in a single modality (e.g., textbooks), resulting in a lack of experience and training in dealing with multimodal information. In the face of massive text, images, audio, video, and other multimodal information, they lack the ability to quickly identify and extract valuable content from it, and are easily disturbed by irrelevant information or false information [9], and the presentation of multimodal information may also increase students' cognitive load, making it difficult for them to effectively process this information.

#### 4 INFORMATION LITERACY TEACHING STRATEGIES FROM A MULTIMODAL PERSPECTIVE

#### 4.1 Improving Teachers' Multimodal Teaching Ability

High-quality teaching ability can improve teaching effectiveness, but improving teachers' multimodal teaching ability is a comprehensive and slow process, involving all aspects. First of all, it is necessary to strengthen teachers' awareness of multimodal teaching. Only when teachers recognize the importance of multimodal teaching will they be psychologically receptive and proactively improve their abilities. Secondly, relevant courses and professional training are offered. Colleges themselves or use the multimodal teaching theory courses of other educational institutions to help teachers master the basic concepts, principles and methods of multimodal teaching. Through systematic learning, teachers can better understand the connotation and value of multimodal teaching. At the same time, teachers are organized to participate in professional training on multimodal teaching, and experts are invited to give lectures or workshops to improve teachers' practical ability and teaching skills through practical case sharing and interactive discussions. Thirdly, to promote exchanges and cooperation among teachers. On the one hand, teachers are regularly organized to observe teaching activities, so that teachers can learn from each other and learn from each other's multimodal teaching experience and methods. On the other hand, through WeChat groups, enterprise WeChat groups and QQ groups, a communication platform between teachers is established to facilitate teachers to share teaching experience, resources and experience at any time. Finally, focus on classroom practice and innovation. According to the teaching content and objectives, teachers present the teaching content in combination with images, audio, video and other modalities, promote students' interaction and participation through role-playing, group discussions, etc., and design multi-modal teaching activities. Colleges and universities create multimodal teaching and learning environments, including providing the necessary equipment and resources, as well as creating an open and inclusive learning atmosphere. All of these help to stimulate students' interest and initiative in learning.

Through the above methods, the multimodal teaching ability of teachers is gradually and steadily improved, and the teaching quality and effect are improved.

#### 4.2 Hierarchical Teaching, Teaching Students According to Their Aptitude

For students with different levels of information literacy, teachers should adopt a hierarchical teaching approach to teach students according to their aptitude. For students with poor information literacy foundation, attention should be paid to the teaching of basic knowledge and the cultivation of basic skills. For students with a high level of information literacy, they should be encouraged to process and apply information at a deeper level.

#### 4.3 Integrate a Variety of Teaching Resources and Enrich Teaching Content

Teachers should make full use of the Internet, libraries and other teaching resources to integrate information in various modalities and enrich teaching content. Through the introduction of practical cases, simulated situations and other methods, students' interest and enthusiasm in learning are stimulated.

#### 4.4 Strengthen the Practical Link and Improve the Ability of Students to Use Information

Information literacy teaching should focus on the design and implementation of practical links. Through group discussions, project practice, information retrieval competitions and other activities, students can improve their information processing and application skills. At the same time, students are encouraged to actively participate in social practice and volunteer service activities, and apply the knowledge they have learned in real life.

#### 5 CONCLUSION

Information literacy teaching from a multimodal perspective is an emerging teaching method, which emphasizes information transmission and interaction through multiple modalities, which helps to enrich the teaching content and stimulate students' interest and enthusiasm in learning. However, there are still many problems and challenges in practical application. Therefore, teachers should strengthen the study and research of multimodal teaching concepts and methods, adopt strategies such as hierarchical teaching and teaching according to aptitude, integrate multiple teaching resources, and strengthen practical links to improve students' information literacy.

#### **COMPETING INTERESTS**

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# THE PATH OF CREATIVE TRANSFORMATION OF LI BING CULTURE

PingQiang Wei<sup>\*</sup>, Yu Dan Xihua University, Chengdu 610039, Sichuan, China. Corresponding Email: 790900368@qq.com

**Abstract:** As an important part of Chinese excellent traditional culture, Li Bing culture contains rich scientific spirit, humanistic value and philosophical wisdom. The purpose of this study is to explore the path of creative transformation of Li Bing's culture, with a view to providing a useful reference for cultural construction in the new era. This study first analyzes the connotation and value of Li Bing culture, including its scientific, people-oriented and practical characteristics, as well as its inheritance and evolution in historical development. Then, from the four aspects of cultural inheritance, scientific and technological innovation, social application and international communication, this paper puts forward the specific path of Li Bing's culture in modern society.

Keywords: Li Bing culture; Creative; International communication; Cultural heritage; Technological innovation

#### **1 INTRODUCTION**

As an outstanding water conservancy expert and politician in ancient China, Li Bing's outstanding contribution is not only reflected in the construction of the Dujiangyan, a great water conservancy project, but also in the far-reaching influence of his water management concept, engineering technology and the social culture and values related to it. Dujiangyan has been baptized by wind and rain for more than 2,000 years and still plays an important role, which is not only a miracle of water conservancy project, but also a powerful testimony to the vitality of Li Bing's culture. As an important part of Ba Shu culture and even Chinese civilization, Li Bing culture carries rich historical memories and cultural connotations, and its influence transcends time and space, which is an important revelation for the development of modern society.

In the context of globalization and the information age, the development and inheritance of culture are facing unprecedented opportunities and challenges. On the one hand, the rapid flow of information makes communication between different cultures more frequent, providing a broad space for cultural dissemination and integration [1]; on the other hand, the risk of cultural homogenization is also increasing, and many cultural heritages with unique values are facing the crisis of being marginalized or even extinction [2]. In such an era, how Li Bing culture can maintain its uniqueness while realizing the organic combination with modern society has become an important issue to be solved. The concept of "the unity of man and heaven" and "the law of nature" embedded in Li Bing culture coincides with the sustainable development and ecological civilization construction advocated by modern society, which provides a solid ideological foundation and practical direction for the innovative development of Li Bing culture.

Realizing the innovative development of Li Bing culture is not only a respect and inheritance of historical and cultural heritage, but also a positive response to the needs of modern society. By deeply exploring the multiple values of Li Bing culture and combining it with modern scientific and technological means and innovative thinking, new vitality can be injected into it, so that it can be revitalized and energized in the modern society. In the wave of globalization and informatization, we should take active actions and effective measures to promote the inheritance and development of Li Bing culture in the new era, so as to make it a cultural bridge connecting the past and the future, China and the world, and to contribute wisdom and strength to the prosperity and progress of human civilization.

#### **2** LITERATURE REVIEW

As an important part of Ba Shu culture, the study of the path of innovative development of Li Bing culture needs to be explored in depth from multiple perspectives. By combing through the relevant literature, it can be found that scholars have studied the dissemination and development of Li Bing culture and Ba Shu culture from different dimensions, providing a rich theoretical foundation and practical reference for the path of innovative development of Li Bing culture.

From the viewpoint of the main body of cultural communication, Pu has deeply analyzed the main body of Li Bing culture under the framework of 5W communication theory, pointing out that the diversity of the main body of communication is crucial to the external communication of Li Bing culture [3]. This includes different levels of subjects such as government agencies, professional cultural groups, civil organizations and individuals, each of whom plays a different role in cultural communication and plays a unique role. By integrating the resources of all parties and forming a synergy, the dissemination of Li Bing culture can be promoted more effectively. At the same time, Du also emphasized the role of the government in guiding and supporting the process of cultural "going out" in the study of

cross-cultural communication of Sichuan opera [4], which provides a useful reference for the construction of the main body of Li Bing's cultural communication.

In terms of communication content, scholars generally agree that the diversified values of Li Bing culture, including its historical value, scientific value, social value, etc., should be deeply excavated in order to enrich the communication content and enhance the attractiveness of culture. Liu pointed out the multidimensional value of Ba Shu culture in cross-cultural communication [5], which is also applicable to Li Bing culture. Li Bing culture is not only a kind of historical and cultural heritage, but also contains rich philosophical thinking, scientific spirit and humanistic feelings, and the excavation and presentation of these contents are of great significance to show the unique charm of Li Bing culture. In addition, when Hou studied the documentary film on the subject of "Ba Shu Culture", he paid attention to how to show the specificity of regional culture while highlighting its universality [6], which is inspiring for the construction of the communication content of Li Bing culture, i.e., in the process of communication, we should pay attention to finding the resonance point between Li Bing culture and audiences of different cultures, so as to promote cross-domain understanding and identification of the culture. understanding and identification.

The expansion of communication channels is also one of the important paths for the innovative development of Li Bing culture. The development of new media technology has brought new opportunities for cultural communication, and Chen emphasized the optimization strategies for the communication of Ba Shu culture in the new media environment, including making full use of the communication advantages of new media platforms, integrating communication of Li Bing culture, which can be expanded in scope and influence through the establishment of official social media accounts and the cooperation with well-known new media platforms to carry out thematic activities. At the same time, traditional media should not be ignored, such as through the production of high-quality documentaries, special reports and other traditional media such as television, newspapers and other traditional media to disseminate, can cover a wider range of audience groups.

Finally, the evaluation and feedback mechanism of the dissemination effect is also a part of the innovative development path of Li Bing culture that cannot be ignored. Wu proposed that to enhance the communication power and influence of Ba Shu culture, it is necessary to establish a scientific and reasonable evaluation index system to measure the effect of communication activities objectively and accurately [8]. For the assessment of the communication effect of Li Bing culture, multiple dimensions such as communication coverage, audience participation and cultural identity can be considered comprehensively, and through regular collection and analysis of data, problems can be found and communication strategies can be adjusted in a timely manner in order to achieve the continuous optimization of the communication effect.

To sum up, the research on the path of innovative development of Li Bing culture needs to comprehensively consider the main body of communication, content, channels, audience and effects, and through continuous exploration and practice, build up an all-round, multi-level and three-dimensional communication system to promote the inheritance and development of Li Bing culture in the new era, so as to make it blossom more brilliantly on the domestic and international cultural stage.

#### **3** NECESSITY OF THE RESEARCH

The study of the path of innovative development of Li Bing culture has important practical significance and theoretical value. In today's era, the rapid development of society and the continuous progress of science and technology promote the diversification and high level of people's cultural needs. Traditional culture is facing new challenges and opportunities in modern society, and Li Bing culture, as one of the treasures, needs to be creatively transformed with the times to meet the spiritual and cultural needs of people in the new era. By combining it with modern science and technology, art, education and other fields, more cultural products and services with contemporary characteristics and innovative values can be created to satisfy people's growing demand for cultural consumption and enhance the quality of cultural life.

At the same time, the inheritance of culture is not only a respect for history, but also a responsibility for the future. Li Bing culture carries the wisdom and spirit of the Chinese nation and is one of the important symbols of Chinese civilization. In the process of inheritance, if it is not creatively transformed, Li Bing culture may gradually lose its vitality and even be forgotten. Therefore, it is our important mission to actively explore the effective ways of creative transformation of Li Bing culture, so that it can be continuously innovated and developed in the process of inheritance, so that the ancient Li Bing culture can shine with a new luster in the modern society, and contribute to the prosperity of Chinese culture.

In addition, the increasingly frequent cultural exchanges in the context of globalization provide opportunities for the international dissemination of Li Bing culture. As a Chinese cultural symbol with unique charm and profound heritage, Li Bing culture has the potential and value to go global. Through creative transformation, Li Bing culture can be presented to the world in a more vivid, graphic and easy-to-accept way, which can enhance the international community's understanding and recognition of Chinese culture, increase the international influence of Chinese culture, promote the exchange and mutual understanding of Chinese and foreign cultures, and contribute to the building of a community of destiny for mankind.

#### 4 THE PATH OF CREATIVE TRANSFORMATION OF LI BING CULTURE

#### 4.1 Cultural Heritage and Education

In terms of school education, Li Bing culture is integrated into the curriculum system, such as history, geography, water conservancy and other disciplines, and the connotation, value and historical significance of Li Bing culture can be effectively taught to students through classroom teaching, special lectures and practical activities. At the same time, the preparation of teaching materials and reading materials suitable for students of different ages, and the telling of the story of Li Bing's water treatment in a lively and interesting way can stimulate students' interest in and love for Li Bing's culture, and then cultivate their cultural confidence and national pride.

Utilizing places such as museums, memorial halls and cultural heritage sites to hold activities such as exhibitions, lectures and seminars can popularize knowledge of Li Bing culture among the public. In addition, the development of Li Bing culture-themed tourism routes and products, such as Dujiangyan Water Conservancy Project study tours and Li Bing culture experience tours, can enable tourists to feel the charm of Li Bing culture during field visits and experiences. Bringing Li Bing culture to the grassroots through community cultural activities and cultural trips to the countryside can further increase the recognition and participation of Li Bing culture in the whole society.

#### 4.2 Technological Innovation and Integration

Through digital display and dissemination, Li Bing culture can be presented in an all-round and multi-angle way with the help of modern information technology, such as Virtual Reality (VR), Augmented Reality (AR) and 3D modeling. Creating a virtual museum of Li Bing culture can reproduce the construction process and operation principle of Dujiangyan Water Conservancy Project through virtual scenes, so that the audience can feel the great achievement of Li Bing's water management in an immersive environment. In addition, cell phone applications and online games on the theme of Li Bing culture will be developed to attract young people's attention and understanding of Li Bing culture in an interactive and interesting way, thus expanding its scope of dissemination and influence.

Encourage scientific research institutions and enterprises to carry out innovative research on water conservancy science and technology related to Li Bing culture, combining ancient water management wisdom with modern science and technology, and being able to explore new methods and techniques for solving contemporary water conservancy problems. For example, drawing on the concept of water diversion without a dam in Dujiangyan, new ecological water conservancy engineering technologies and equipments are being developed to realize the sustainable use of water resources and the protection of the ecological environment. At the same time, it strengthens the application of Li Bing culture in the construction and management of modern water conservancy projects, inherits and carries forward the spirit of Li Bing's water management, and promotes the development of water conservancy.

#### 4.3 Social Application and Industrial Development

In the cultural and creative industry, Li Bing culture is used as the material to develop colorful cultural and creative products, such as Li Bing culture-themed souvenirs, artwork, clothing, home furnishings, etc., which can transform the cultural connotation into perceptible and touchable physical objects, and enhance the dissemination and influence of culture. Organize Li Bing Culture Creative Design Competition to stimulate the creativity of designers, explore the commercial value of Li Bing culture, and promote the prosperity of cultural and creative industries. At the same time, to build Li Bing cultural brand, through brand authorization, cooperative development and other ways, to inject a new impetus for economic growth.

Deeply excavating the integration point between Li Bing culture and tourism industry, and creating tourism destinations and tourism products with Li Bing cultural characteristics can enhance the cultural connotation and attractiveness of tourism. In the vicinity of Li Bing cultural sites such as Dujiangyan, build Li Bing cultural theme parks and cultural neighborhoods to create a strong Li Bing cultural atmosphere, so that tourists can feel the charm of Li Bing culture during their visits. Develop Li Bing cultural performing arts projects, such as large-scale live performances, stage plays, etc., to show the legendary story of Li Bing's water governance through artistic forms, and bring unique cultural experiences to tourists. At the same time, strengthen the publicity and promotion of Li Bing cultural tourism, create a brand of Li Bing cultural tourism, attract more tourists to come to experience the Li Bing cultural journey, and promote the development of the local economy.

#### 4.4 International Communication and Exchanges

Actively participate in international water conservancy academic conferences and cultural exchanges, organize experts and scholars to conduct in-depth research and discussion of Li Bing culture and its modern value, and be able to show the unique charm and scientific value of Li Bing culture to the international academic community. Establish cooperative relationships with foreign universities and scientific research institutions, carry out joint research projects, and promote the international dissemination and academic exchanges of Li Bing culture. Publish monographs and academic papers on Li Bing culture in English to increase its visibility and influence in the international academic community.

At the same time, it organizes Li Bing culture international exchange exhibitions, cultural festivals and other activities, invites foreign government officials, experts and scholars, cultural messengers, etc. to participate, and demonstrates to

the world the profundity of Li Bing culture through various forms such as exhibitions and displays, cultural performances, and folklore experiences. Make use of the platforms of international friendly cities and overseas Chinese cultural centers to carry out promotional activities of Li Bing culture and enhance the understanding and love of foreign people for Li Bing culture. Support enterprises and organizations related to Li Bing culture to "go out" and hold cultural exhibitions, product promotion and other activities overseas, so as to expand the international market of Li Bing culture and promote the globalization and dissemination of culture.

#### **COMPETING INTERESTS**

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