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Data-driven Construction of the Regional Study Tour 4.0 Model Research

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Abstract In recent years, the innovation and development of regional study tours have received increasing attention, especially the combination with local culture and the application of technology. The core purpose of study travel is to enhance students' comprehensive literacy through field learning and exploration, and with the advancement of information technology, the modern study travel model is developing towards digitalization, interactivity and visualization. This paper proposes a regional study tour 4.0 development model based on the ArcGIS Online platform, combining geographic information technology innovations and designing three main phases applicable to study tours: the preparatory phase, the implementation phase, and the summary phase. In the preparatory stage, teachers use the geographic data provided by the platform to screen the study sites and formulate the study plan; in the implementation stage, students improve their ability to discover and analyze geographic issues through geographic observation and practical activities from multiple perspectives; and in the concluding stage, students summarize and share their knowledge by organizing the data and making story maps. The study evaluates the spatial effect and competitiveness of study tours through spatial pattern and competitiveness analysis, using hierarchical analysis and "deviation-share" analysis, and concludes that the competitiveness of study tours in Guangxi presents spatial clustering characteristics, especially in Nanning, Guilin and other cities. Through the analysis of these data, this paper proposes countermeasures to optimize the competitiveness of study and learning travel, and provides theoretical support for cultural innovation.

Index Terms ArcGIS Online, study tour, development pattern, spatial pattern, competitiveness, cultural innovation

I. Introduction

As a new type of comprehensive practical activity course, study travel is an effective carrier for cultivating students' core literacy in geography, which is widely supported by teachers and students [1]. However, at present, the study tour products on the market are mainly launched by various institutions or travel agencies, the quality of the products varies, and even under the guise of "study tour", simply stacking attractions, and ultimately turning the study tour into a sightseeing tour [2], [3]. With the continuous development of the study travel course, the study travel course has also been iterated from the 1.0 era of "visiting the flowers" to the 4.0 era of customized research study centered on the "theme" [4]. Customized research travel products are more important than general research travel products to consider the educational objectives, the difference in the age level of students, the difference in demand and other educational factors, which can better ensure the quality of research travel products [5]-[7]. This new type of study tour curriculum design emphasizes student-centeredness and allows students to participate in the real-world problem-solving process using innovative thinking, critical thinking and problem-solving skills [8], [9]. At the same time, since regional culture is a part of China's excellent traditional culture, local college teachers' exploration and dissemination of regional culture is an effective means of promoting Chinese traditional culture, improving students' sense of identity with the Chinese nation, and enhancing students' cultural self-confidence [10]-[13]. Therefore, combining the excellent regional culture with the curriculum design method to innovate the practical teaching mode, carrying out college students' study trip education, and guiding college students to enhance their cultural self-confidence is an effective way for colleges and universities to realize practical education.

This paper proposes a regionalized research and study trip 4.0 development model. Through the support of ArcGIS Online platform, a framework of study and learning travel based on data analysis and technological innovation is constructed. This model covers the whole process of study travel, from the preliminary preparatory work to the exploratory learning in the implementation process, and then to the reflection and sharing in the concluding stage, which seeks to improve the teaching effect of study travel through technological means. Especially with the promotion of cultural innovation, how to integrate geography, culture and education among different regions has become an urgent problem. Therefore, this paper will focus on exploring how to make study tours better serve the dissemination and innovation of regional culture through the intervention of technology.

II. Design of ArcGIS Online-based Study Tour 4.0 Development Model

ArcGIS Online is a public-oriented, Internet-based Web GIS cloud platform that can realize geographic mapping and information processing, which has functional modules such as Living Atlas, Map Viewer, Scene Viewer, Survey123 and StoryMap, and can facilitate the development of study tours. This paper combines ArcGIS Online to realize the design and cultural innovation of regional study travel 4.0 development mode.

The process of study tour is mainly divided into three stages: preparation stage, implementation stage and summary stage, and the function modules of ArcGIS Online will play different roles in different stages.

II. A.Preparatory phase

(1) Selecting the content of study tours and screening the places for study tours

The geography textbook is the basis for selecting the content of the study tour, and teachers should establish a horizontal connection between the content of the geography textbook and the study tour, and expand and sublimate the content of the textbook by using various types of tourism resources. According to the content of the study trip, teachers should screen the geographic data provided in Living Atlas, identify suitable study areas and obtain information on the location, scope and topography of the areas, and then sort out and simplify the study areas in a targeted way to come up with typical study locations.

(2) Formulate a study program and prepare prior knowledge

When teachers formulate the study plan before the class, they should analyze the fit between the platform service function and the study content, commit to constructing a nearly real geographic environment through ArcGIS Online, and design the corresponding practical activities from the three aspects of knowledge acquisition, technical practice and innovation, and team cooperation. After the study plan is determined, the teacher assigns relevant pre-study tasks, and students collect relevant information through the Internet, books and textbooks and familiarize themselves with the operation of ArcGIS Online, so as to complete the preliminary knowledge preparation.

II. B.Implementation phase

The implementation process of study tours should be based on learning as the purpose, research as the means, activities as the carrier, skills training as the grip, exploration and doubt as the breakthrough, and the cultivation of core literacy as the goal, so as to promote the overall development of students. The detailed implementation of the links are mainly divided into entering the geographic situation, discovering geographic problems, analyzing geographic problems and transferring and applying them, which are progressive, and the cultivation of geographic core literacy is implemented in the process of the progressive development of students' thinking.

(1) Entering the geographic context and forming regional cognition

Geographic things are generated by the integrated effect of various elements in the region, and the basis for understanding geographic things is to be based on the region and to comprehensively recognize the characteristics of the geographic environment of the region from a macroscopic point of view. Students use the three-dimensional visualization function of Scene Viewer to observe the basic conditions of regional geographic location, topography, landforms and water features from near and far, and locate the specific study site through the location search tool to recognize the location of the study site in the region, and form a preliminary spatial cognition and regional cognition of the geographic environment in which the study site is located.

(2) Discovering geographic problems and practicing geography

Understanding geographical things is a process of seeing the essence through appearances, and it is necessary to guide students to obtain geographic information through "seeing" and "doing", and then discover geographical problems. "Seeing" refers to observing geographical things in an all-round and multi-angle way, and forming a perceptual understanding of geographical things. Students can drag the 3D globe to observe the specific forms of geographical objects from different angles. "Do" means that students obtain geographic data and geographic information on the Internet according to the tasks assigned by the teacher. For example, students can use the "Survey" tool to obtain information such as the length, area and location of geographical objects, or use Survey123 to conduct online surveys to explore the hidden factors behind human phenomena. In the process of "seeing" and "doing", teachers should start from students' existing knowledge and experience, learning gaps and perceptual needs, and based on the teaching objectives of the research trip, raise questions or guide students to ask questions in a timely manner, so that students can observe and measure in a targeted manner. Practice is the first channel to obtain geographic information, ArcGIS Online exercises students' ability to use information technology to obtain geographic information, and also allows students to "ask questions" in personal experience and practice, so as to arouse students' interest in exploring geographical problems.

(3) Analyzing geographic problems and developing integrated thinking

Students organize the data and information collected in Map Viewer, then use the “Analyze” tool to explore the process of the emergence, development and evolution of geographic things, and finally visualize the results of the analysis and create thematic maps to show the results. There are various types of “analysis” tools in Map Viewer, which can help students analyze geographic problems from different dimensions, and are conducive to the development of students' comprehensive thinking.

(4) Transferring and applying to cultivate the concept of human-earth harmony.

On the basis of practice and analysis in the early stage, students have a basic understanding of the regional overview and the causes of geography, and the next step is the process of transferring and applying the principle knowledge. Teachers select typical cases from life, guide students to correctly and dialectically view the impact of the geographic environment on human beings and the role of human beings on the geographic environment, and cultivate students' ability to analyze and solve the contradictions in human-land relations. Through the discussion of “human-land relations”, the transition from geographic knowledge to geographic emotions, so that students realize that the natural environment is the basis for human survival and development, and that they should follow the laws of nature and establish the geographic thinking and values of adapting to local conditions and coordinating the development of people and the land.

II. C.Summary phase

Study tours should not be a formality, ending in the implementation stage, to summarize the knowledge and feelings formed in the process of study in a timely manner after class, deepen and consolidate the knowledge and experience of study in reflection and practice. Students independently organize the data, images and text collected during the study trip, carefully make the study roadmap or write the study tips, and finally exchange their feelings with classmates and teachers in the form of study report. In StoryMaps, students can make story maps according to browsing routes or in the form of chapters, linking the maps with pictures, videos and website links to give the stories a stronger spatiality.

Finally, the teacher evaluates and summarizes the students' presentations based on the requirements of core literacy development.

III. Competitiveness evaluation and spatial pattern analysis model construction of study tours

In this chapter, a comprehensive evaluation index system for study and research travel was constructed, and the weights of each index were determined using the hierarchical analysis method. On this basis, the comprehensive evaluation and spatial pattern analysis of the competitiveness of regional study and learning travel was realized by using the “deviation-share” analysis method and the spatial autocorrelation analysis method.

III. A. Indicator system for comprehensive evaluation of study tours

This paper carries out the selection and establishment of indicators on the basis of the research and study travel course model, combines the series of books on research and study travel as well as research and study travel related literature to supplement and expand, and establishes a set of indicators suitable for the comprehensive evaluation of research and study travel system as shown in Table 1. The weights are obtained by using the hierarchical analysis method.

Table 1: The index system for the comprehensive evaluation of study tours

First-level indicator	Weight	Secondary indicators	Weight	Third-level indicators	Weight	Comprehensive weight
Participants in study tours	0.5495	Pre-class stage	0.1341	Independence	0.2687	0.0198
				Target clarity	0.7313	0.0539
		Mid-class stage	0.6396	Discipline	0.2805	0.0986
				Etiquette	0.0914	0.0321
				Communication and exchange	0.1489	0.0523
				Positive and focused	0.4792	0.1684
		After-school stage	0.2263	External display	0.3425	0.0426
				Internalization	0.6575	0.0818
Study tour products	0.3204	Study tour route	0.5	Typicality	0.0904	0.0145
				Safety	0.5795	0.0928
				Scientific rationality	0.3301	0.0529
		Course design	0.5	Purpose	0.1324	0.0212
				Content	0.2847	0.0456
				Implement	0.5829	0.0934
Implementers of study tours	0.1301	Sponsor	0.3456	Organization	0.1725	0.0078
				Communication	0.3061	0.0138
				Post-class acceptance summary	0.5214	0.0234
		Organizer	0.6544	Contract performance status	0.3182	0.0271
				Process implementation status	0.5768	0.0491
				Management service situation	0.1050	0.0089

III. B. "Deviation-share" analysis

The basic idea of "deviation-share" analysis (SSA) [14] is that regional growth rates are influenced by three types of factors: industrial structure, sectoral productivity, and dynamic demand and consumer preferences. The traditional "deviation-share" analysis method only uses a numerical value to examine the changes at the beginning and end of the period, and there is a possibility that the fluctuation characteristics of different years will be hidden, so the idea of dynamic "deviation-share" analysis is applied to truly reflect the fluctuations. Therefore, the idea of dynamic "deviation-share" analysis is used to truly reflect such fluctuations, and the time period of the study is further subdivided to analyze the impact of each industrial sector on economic development within each time period.

III. B. 1) Early "deviation-share" models

If the location factor is removed, a region should maintain the same level of growth as a country, provided that the sectoral composition is the same and has the same productivity, but in fact the regional growth rate is often different from the hypothetical national growth rate, if the indicator variable is expressed in terms of the growth rate of income, with y_t as the national growth rate, and y^* as the regional growth rate, then at this point:

$$y_t = y^* + S \tag{1}$$

The S, called "deviation", represents the difference in growth rates between the study and reference regions, which depends on two main effects: the structural (MIX) effect and the competitive (DIF) effect.

The MIX effect is the more pronounced sectoral dynamics within the region at the national level due to growing sectoral demand, showing the differences in the contribution of each sector to regional growth, and is given by the formula:

$$MIX = \sum_{i=1}^{n} \frac{E_{ir}^0}{E_r^0}\left[\frac{E_{in}^1}{E_{in}^0} - \frac{E_n^1}{E_n^0}\right] \tag{2}$$

where E uses employment rate or industry value added as the sectoral variable, i is the sector, n is the country, and r is the study region.

The DIF effect represents the ability of the regional economy to develop its various sectors at a higher average growth rate, which emphasizes that the same sectors in different regions have different productivity, and is expressed in public terms as:

$$DIF = \sum_{i=1}^{n} \frac{E_{ir}^{0}}{E_{r}^{0}} \left[\frac{E_{ir}^{1}}{E_{ir}^{0}} - \frac{E_{in}^{1}}{E_{in}^{0}} \right] \tag{3}$$

III. B. 2) Deviation-share analysis of development

The basic idea of the "deviation-share" analysis commonly used in modern times is to divide the changes in a region's economic aggregate in a certain period into share component (N), structural deviation component (P) and competitiveness deviation component (D), use these three variables to explain the causes of regional economic development and recession, evaluate the advantages and disadvantages of regional economic structure and the strength of its own competitiveness, find out the industrial sectors with relative competitive advantages in the region, and determine the rational direction of regional economic development in the future and the principle of industrial structure adjustment.

It is assumed that the study area i is within the time period $[0,t]$, 0 is the initial period and t is the reporting period. The economic aggregate of region i in the initial period is denoted as b_{i0} and the sectoral variables in the reporting period are denoted as b_{it}. Dividing region i into m economic sectors, with industries in each economic sector denoted by j, the sectoral variables for each sector of region i in the initial and reporting periods are denoted as $b_{ij,0}$, $b_{ij,t}\left(i=1,2,\cdots,n; j=1,2,\cdots,m\right)$. Sectoral variables for the initial and reporting periods of the larger region in which region i is located, i.e., the reference region, are denoted by B_0 and B_t, and sectoral variables for the j th industry sector in the initial and reporting periods of the reference region are denoted by $B_{j,0}$ and $B_{j,t}$, respectively. The growth rate of region i is denoted as r and the growth rate of the reference region is denoted as R.

The growth rate of the j th industrial sector of the region in the time period $[0,t]$ can be expressed as:

$$r_{ij} = \frac{b_{ij,t} - b_{ij,0}}{b_{ij,0}} \quad (i=1,2,\cdots,n; j=1,2,\cdots,m) \tag{4}$$

The growth rate of industry sector j in the reference region:

$$R_{ij} = \frac{B_{j,t} - B_{j,0}}{B_{j,0}} \quad (i=1,2,\cdots,n; j=1,2,\cdots,m) \tag{5}$$

Standardization of economic sectors in each industry: Standardization of industrial sectors in the region using the weights assigned to industrial sector No. j in the reference region, expressed by the formula:

$$b'_{ij} = \frac{b_{ij,0} \cdot B_{j,0}}{B_0} (i=1,2,\ldots\ldots,n; j=1,2,\ldots\ldots,m) \tag{6}$$

Share Weight:

$$N_{ij} = \sum_{j=1}^{m} b'_{ij} \cdot R_j (i=1,2,\ldots\ldots,n; j=1,2,\ldots\ldots,m) \tag{7}$$

Structural deviation component:

$$P_{ij} = \sum_{j=1}^{m} \left(b_{ij,0} - b'_{ij}\right) R_j (i=1,2,\ldots\ldots,n; j=1,2,\ldots\ldots,m) \tag{8}$$

Competitiveness deviation component:

$$D_{ij} = \sum_{j=1}^{m} b_{ij,0} (r_{ij} - R_j) \quad (i=1,2,\cdots,n; j=1,2,\cdots,m) \tag{9}$$

Finally, the model for the “deviation-share” analysis is expressed as follows:

$$\sum_{i=1}^{n} G_i = \sum_{i=1}^{n} N_i + \sum_{i=1}^{n} P_i + \sum_{i=1}^{n} D_i \tag{10}$$

On this basis, the regional relative growth rate index L, the regional structural effect index W, and the regional competitiveness index U are introduced as reference coefficients, and the value of K is used to measure the regional weights first, and the proportion of the study area j industries in the base period to the reference area j industries is $K_{j,0}$, and the study area j in the report period The share of industry in the reference region j industry is $K_{j,1}$.

The equations for L, W, and U are respectively expressed as:

Regional relative growth rate index:

$$L = \frac{b_{j,t}}{b_{j,0}} : \frac{B_t}{B_0} \tag{11}$$

Regional structural effects index:

$$W = \frac{\sum_{j=1}^{n} k_{j,0} \times B_{j,t}}{\sum_{j=1}^{n} k_{j,t} \times B_{j,0}} \div \frac{\sum_{j=1}^{n} B_{j,t}}{\sum_{j=1}^{n} B_{j,0}} \tag{12}$$

Competitiveness Effectiveness Index:

$$U = \frac{\sum_{j=1}^{n} k_{j,t} \times B_{j,t}}{\sum_{j=1}^{n} k_{j,0} \times B_{j,t}} \tag{13}$$

When $L > 1$, the larger G is, the higher the growth rate of the study region is than that of the reference region.

When $W > 1$, the larger P is, the larger the proportion of sunrise and fast-growing industrial sectors in the study region is, the overall structural advantages are obvious, and the contribution to economic growth is relatively large. On the contrary, it indicates that the proportion of sunset industries is significant and the economic structure is facing adjustment.

The larger $U > 1$ and D, the greater the momentum of the total growth of each industrial sector, and the more competitive the industry is. On the contrary, the competitiveness is weak and the status tends to decline.

III. C. Spatial autocorrelation analysis methods

Spatial autocorrelation test [15] is used to analyze whether the variables are spatially correlated or not, as well as the degree of closeness of correlation, which is based on the spatial measurement model and provides the basis for subsequent spatial data analysis. Spatial autocorrelation analysis includes global spatial autocorrelation and local spatial autocorrelation analysis.

III. C. 1) Global spatial autocorrelation

Global spatial autocorrelation is a comprehensive and systematic evaluation of the degree of spatial autocorrelation in a given spatial system to determine whether there is a tendency for the data to be clustered, dispersed, or random in this spatial system. The global Moran'I index is a broad measure of global spatial autocorrelation, and the global Moran'I index determines the clustering and dispersion of spatial autocorrelation with respect to the degree of similarity of the objects of study in neighboring areas.

The value of global Moran'I index ranges from -1 to 1. The value of Moran'I index is less than 0, which indicates that there is a negative spatial correlation between the data, and the high value areas are adjacent to the low value areas, and the smaller the value is, the greater the spatial variability is; the value of Moran'I index is greater than 0, which indicates that there exists a positive spatial correlation between the areas, i.e., the high value areas are adjacent to the high value areas, the low value areas are adjacent to the low value areas, and the low value areas are adjacent to the low value areas. adjacent to each other, and low value areas are adjacent to low value areas, showing the phenomenon of spatial agglomeration; Moran's index is equal to 0, indicating that there is no spatial autocorrelation between spatial areas, which are independent of each other, and the change of one area does not have any effect on its neighboring areas. The global Moran'I index is calculated by the formula:

$$I=\frac{n\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}\sum_{i=1}^{n}(x_i-\bar{x})^2}=\frac{\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{S^2\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}} \tag{14}$$

where $\bar{x}=\frac{1}{n}\sum_{i=1}^{n}x_i$, $S^2=\frac{1}{n}\sum_{i=1}^{n}(x_i-\bar{x})^2$, n is the number of study objects in the space, x_i , x_j are the observed values of the i th object and the j th object, respectively, and w_{ij} is the number of rows and columns of the spatial weighting matrix in i th row and column in j th column, with the value of 1 for the two regions to be neighboring, and 0 for not neighboring.

The statistical test for the significance of z-value for the results of global spatial autocorrelation is calculated as follows:

$$Z(I)=\frac{I-E(I)}{\sqrt{Var(I)}}-N \tag{15}$$

where $Var(I)$ is the theoretical variance of the global Moran index, and $E(I)=-\frac{1}{n-1}$ is the theoretical expectation. The Z value reflects the degree of dispersion of the research object, $Z>0$ and the statistical test is significant, the research object is significantly positively correlated in spatial distribution.

III. C. 2) Local spatial autocorrelation

The global Moran index can describe the autocorrelation of the spatial distribution of all research objects, but it represents the average difference in the spatial range, and cannot reflect the local spatial autocorrelation among research objects. Local spatial autocorrelation test considers the regional differences of different research objects, analyzes the interrelationship between a research object and its neighboring objects, determines whether the numerical change is spatially clustered, discrete or random tendency to the neighboring objects, and also reflects whether there exists spatial heterogeneity among research objects in the spatial range. Local spatial autocorrelation analysis is generally performed with Moran scatterplot and LISA. Decomposition of the global Moran index into the provincial and district units leads to local spatial autocorrelation, which is expressed by the local Moran index. For the provincial and district spatial units i there are:

$$I_i=\frac{(x_i-\bar{x})}{\sum_i(x_i-\bar{x})^2}*\sum_j W_{ij}(x_j-\bar{x})=Z_i\sum_j W_{ij}Z_{ij} \tag{16}$$

where W_{ij} is the spatial weight matrix, Z_i and Z_j are normalized observations, and $Z_i=\frac{x_i-\bar{x}}{\sigma}$ is the weight matrix with a sum of 1 in each row and asymmetry after the normalization transformation.

III. C. 3) Moran Scatter Plot

The Moran scatterplot is drawn from the global Moran index to analyze the local spatial autocorrelation between a geographic unit and its neighboring units over the entire spatial extent. The quadrant where each point is located in the scatterplot represents the correlation between each geographic unit and its neighboring geographic units. With the observations in the spatial geographic units defined as the horizontal coordinates, and the spatial lag vectors represented by the average observations in the neighboring regions as the vertical coordinates, a planar coordinate system is established and the scatterplot is drawn, i.e., it is the Moran scatterplot.

The four quadrants in the Moran scatterplot represent four different local spatial distribution patterns: the observation point in the first quadrant indicates that the observation value of the geographic unit is high, and the observation value of the geographic unit adjacent to it is also high, which belongs to the High-High (H-H) type. The observation point in the second quadrant indicates that the observation value of its own geographic unit is relatively low, but the observation value of the neighboring geographic units around it is high, showing a negative correlation with it, which belongs to the Low-High (L-H) type. Observations in the third quadrant indicate that the geographic unit itself has low values and its neighboring geographic units also have low values, which belongs to the Low-Low (L-L) type. An observation in the fourth quadrant indicates that the geographic unit has a high observation but its neighboring geographic unit has a low observation and is of the High-Low (H-L) type.

III. C. 4) LISA space-time jump measurements

LISA, i.e., local correlation index [16], according to the index and the significance level p worth to the size and direction of the correlation between each region and the neighboring regions, quantitatively expresses whether it has a spatial correlation or not, and presents the results in the form of images, so that the test results can be more intuitive.

LISA reveals the spatial dependence between research objects from a localized perspective. According to the transfer of local spatial correlation types of research objects in Moran scatter plot in a specific time period, spatio-temporal leap is proposed to portray the evolution direction of the spatial transfer form of research objects over time. Among them, spatio-temporal leaps include four types:

Type I: Only the studied geographic units undergo a leap, including $HH_t \to LH_{t+1}$, $HL_t \to LL_{t+1}$, $LH_t \to HH_{t+1}$, and $LL_t \to HL_{t+1}$.

Type II: Only neighboring geographic units undergo jumps, including $HH_t \to HL_{t+1}$, $HL_t \to HH_{t+1}$, $LH_t \to LL_{t+1}$, and $LL_t \to LH_{t+1}$.

Type III: The studied geographic unit and neighboring geographic units both jump, including $HH_t \to LL_{t+1}$, $HL_t \to LH_{t+1}$, $LH_t \to HL_{t+1}$, $LL_t \to HH_{t+1}$, $HH_t \to LL_{t+1}$, and $LL_t \to HH_{t+1}$ jump in the same direction, and the other two cases jump in different directions.

Type IV: The studied geographic units are unchanged from the neighboring geographic units and no leaping occurs, i.e., $HH_t \to HH_{t+1}$, $HL_t \to HL_{t+1}$, $LH_t \to LH_{t+1}$, and $LL_t \to LL_{t+1}$.

The spatio-temporal leap method is utilized to measure the transfer direction of local spatial correlations between provinces at different times. The spatio-temporal leaps are classified into the following four types to reveal the transfer state of study travel competitiveness between the studied inter-provinces and neighboring inter-provinces: the first type is that the study inter-provinces themselves undergo a transfer, and the neighboring inter-provinces do not undergo a leap in study travel competitiveness, i.e., their own leaps in neighboring provinces are stable. The second type is that there is no transfer between the studied provinces, but there is a transfer between neighboring provinces, i.e., the neighboring provinces are stable in their own leaps. The third type is that both the studied inter-province and the neighboring inter-province are shifted, and they are divided into shifting in the same direction and shifting in the opposite direction, i.e., own leap-neighboring province leap. The fourth type is that both the studied interprovince and the neighboring interprovince do not undergo transfer and show the same stabilization phenomenon, i.e., self-stabilized-neighboring province stabilized. The degree of spatial stability can be expressed by S_t, and the formula for S_t is as follows:

$$S_t = \frac{F_{0,t}}{n} \tag{17}$$

where $F_{0,t}$ denotes the number of inter-province study travel competitiveness in the study time t that shows the type of "self-stable-neighboring province stable" jump. n is the number of all interprovinces in which a leapfrog is possible. $S_t \in [0,1]$, the larger the value of S_t, the stronger the degree of spatial stability of the competitiveness of research and study travel, the less likely to occur spatio-temporal leaps, and the greater the resistance.

IV. Deviation-Share Analysis of Study Tour Industry Structure

This chapter takes Guangxi, China, as a specific research object, and conducts a deviation-share analysis of its study travel industry structure as well as study travel competitiveness.

IV. A. Data sources and collection

In this paper, we mainly intercepted the latest data released in the past ten years from 2015-2024, such as the official bulletin of national economic and social development of Guangxi cities and Guangxi Statistical Yearbook, and collected the data of total tourism income, gross product, and gross domestic product of Guangxi province, and total tourism income of Guangxi province from 14 municipalities in Guangxi province, so as to make a comparative analysis of the state of tourism development of the municipalities in Guangxi province.

IV. B. Analysis of results

IV. B. 1) General analysis

This paper takes the tourism industry status of Guangxi province as a big background reference system, respectively takes 2015 as the base period when 2018 is the end, takes 2018 as the base period when 2021 is the end, and takes 2021 as the base period when 2024 is the end, and utilizes the calculation method and process of

SSA to get the results of SSA analysis of the structure of the tourism industry of 14 cities in Guangxi province as shown in Table 2. At the same time, taking 2015 as the base period and 2024 as the end period, the average annual growth rate of tourism revenue and GDP from 2015 to 2024 is calculated as shown in Table 3.

As can be seen from Table 2, the share components calculated in the continuous time series and different periods during 2015-2024 are all positive, and the top five in the period of 2021-2024 are Guilin, Liuzhou, Nanning, Wuzhou and Qinzhou, indicating that the tourism industry of Guangxi cities has been showing a growth trend, and as can be seen from Table 3, the average annual growth rate of tourism revenue of each city from 2015-2024 is larger than the The average annual growth rate of each city's GDP, in which the average annual growth rate of tourism is higher than the average annual growth rate of tourism in the whole of Guangxi, there are 9 cities, namely Nanning, Beihai, Wuzhou, Hezhou, Chongzuo, Baise, Qinzhou, Fangchenggang and Hechi, and the average annual growth rate of tourism revenue of these cities is obviously higher than the average annual growth rate of the local GDP, which indicates that the tourism industry of these cities has been growing strongly in recent years.

Table 2: SSA analysis of the tourism industry structure of 14 cities in Guangxi Province

City	2015-2018				2018-2021				2021-2024			
	Ni	Pi	Di	Gi	Ni	Pi	Di	Gi	Ni	Pi	Di	Gi
Guilin	233.2	42.5	24.5	300.2	311.6	37.0	-43.6	305	609.5	5.3	-229.0	385.8
Nanning	54.3	20.7	-2.9	72.1	67.8	22.8	-24.5	66.1	134.3	17.0	208.2	359.5
Liuzhou	148.2	32.4	-38.2	142.4	169.8	30.2	176.5	376.5	292.0	184.9	-110.1	366.8
Beihai	80.4	-48.0	41.1	73.5	85.2	-27.6	-9.2	48.4	111.8	-5.6	-14.4	91.8
Wuzhou	78.4	-45.5	84.6	117.5	88.6	-5.9	0.5	83.2	139.0	13.9	98.0	250.9
Hezhou	27.3	-13.3	2.8	16.8	30.4	-11.7	11.3	30.0	60.3	-17.8	4.9	47.4
Chongzuo	73.7	-34.5	28.1	67.3	90.7	-27.7	14.3	77.3	165.3	-39.4	-21.6	104.3
Yulin	79.1	9.5	-16.3	72.3	89.0	11.5	2.1	102.6	163.6	23.9	-52.4	135.1
Baise	49.4	-45.5	-1.5	2.4	54.7	-51.6	0.2	3.3	110.3	-104.3	16.1	22.1
Qinzhou	84.7	-68.6	5.0	21.1	98.9	-75.4	-6.1	17.4	179.6	-144.4	101.5	136.7
Guigang	42.3	-34	-0.8	7.5	46.0	-34.5	0.4	11.9	82.3	-63.2	-5.8	13.3
Fangchenggang	49.9	-13.3	55.9	92.5	65.0	9.4	2.2	76.6	105.0	32.8	9.5	147.3
Hechi	126.0	-79.1	33.0	79.9	132.7	-55.6	-12.7	64.4	212.5	-79.8	20.3	153.0
Laibin	73.2	-64.6	-1.9	6.7	77.7	-68.0	-9.0	0.7	149.8	-137.4	1.1	13.5

Table 3: The average annual growth rates of tourism revenue and GDP in 2015-2024

	Annual growth rate of tourism income /%	Annual growth rate of GDP /%
Guilin	0.18	0.17
Nanning	0.22	0.15
Liuzhou	0.20	0.13
Beihai	0.29	0.12
Wuzhou	0.25	0.14
Hezhou	0.23	0.14
Chongzuo	0.28	0.14
Yulin	0.18	0.13
Baise	0.23	0.13
Qinzhou	0.31	0.14
Guigang	0.19	0.12
Fangchenggang	0.40	0.15
Hechi	0.25	0.11
Laibin	0.16	0.15
Guangxi	0.21	0.15

IV. B. 2) Analysis of changes in industry structure share

From the comparative analysis of the dynamics of the 2015-2018, 2018-2021, and 2021-2024 stages in Table 2, it can be seen that the structural deviation component P_i of Beihai City obviously shows a gradual weakening trend, indicating that the competitiveness of the city's tourism is gradually declining, which needs to be paid attention to.

However, the competitiveness deviation of Wuzhou City obviously shows a gradually increasing trend, indicating that the competitiveness of the city's tourism industry gradually increases and develops better. In addition, Guilin's tourism industry competitiveness deviation component D_i has been smaller than the structure deviation component P_i, indicating that Guilin's structural advantages of the industry sector contribute more to the local economy. The competitiveness deviation scores of Wuzhou, Hezhou, Chongzuo, Baise, Qinzhou and Hechi are positive at most stages and higher than the structural deviation scores, indicating that the competitiveness of the tourism industry in these cities contributes more to the local economic growth.

From the perspective of recent years' development, analyzing the 2021-2024 stage data in the table, it can be seen that Nanning, Wuzhou, Qinzhou and Hechi have higher values of the competitiveness deviation component, indicating that the competitiveness of the tourism industry in these areas is relatively good. Analyzing the structural deviation component of the 14 cities in Guangxi province at this stage, it can be seen that there are six cities with positive values of P_i, namely Guilin, Nanning, Liuzhou, Wuzhou, Yulin and Fangchenggang, and the larger the value of P_i indicates that the industrial structure of these cities contributes more to the local economic growth. The structural deviation scores of other cities are all negative, especially Baise, Qinzhou, Guigang, Hechi, and Laibin have lower values of structural deviation scores, indicating that the development of the tourism industry in these cities in recent years has had a greater negative impact on the development of the local economy.

Then, according to the structural deviation component Pi calculated with 2021 as the base period and 2024 as the reporting period for the 14 city-regions in Guangxi province as the vertical axis and the competitive deviation component D_i as the horizontal axis, the regions representing each scatter are labeled in the axes, and the analysis chart of the deviation components in each region is plotted as shown in Figure 1.

It can be seen that there are only three cities located in the first quadrant among the 14 prefectural and municipal regions in Guangxi, which are Nanning, Wuzhou and Fangchenggang, and the regions distributed in the first quadrant indicate that the region has a good industrial foundation in the development of tourism industry in the recent four years, and the growth rate of tourism industry in these regions is greater than the average growth level of the province's tourism industry, and their structural and competitive advantages of tourism industry are obvious, and the structural advantages The structural and competitive advantages of their tourism industries are obvious, and the structural advantages and competitive advantages contribute more to the total growth of the industry, among which the competitive advantages of Nanning and Wuzhou's tourism industry are more prominent relative to their structural advantages in contributing to the local tourism industry. There are three cities located in the second quadrant, namely Guilin, Liuzhou and Yulin, indicating that the foundation of the tourism industry in these regions has structural advantages, while their competitive advantages are weak, and their status in the tourism industry of the whole Guangxi Province is in a declining trend, among which Liuzhou's structural advantages of the tourism industry are obvious, and its structural advantages have a greater contribution to the development of the local tourism industry, but due to the lack of competitive advantages, which restricts the overall rapid development of the tourism industry in the region. The overall rapid development of the tourism industry in the region is constrained by the lack of competitive advantages. However, from the perspective of the whole Guangxi Province, most of the cities are located in the third or fourth quadrant, which indicates that there are certain problems in the development of tourism industry in most of the cities in Guangxi Province, and some of the cities with D_i less than 0 are constrained from the further development of the tourism industry in all regions of Guangxi Province due to the lack of competitive advantages.

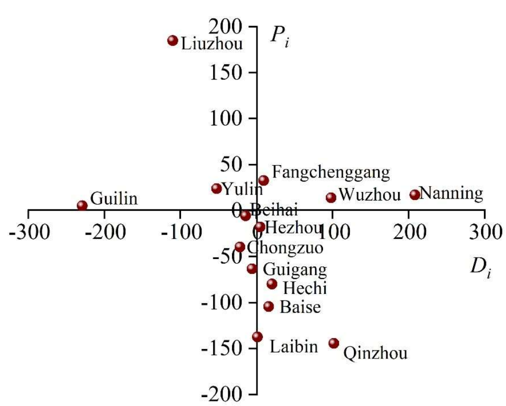

Figure 1: Deviation components of each region

Similarly, with the data calculated with 2021 as the base period and 2024 as the reporting period, the coordinate system is established with the deviation component PD_i of the 14 cities and regions in Guangxi Province as the horizontal axis and the share component N_i as the vertical axis, and the regions representing the scatters are labeled in the coordinate system, and the advantageous analysis of each region is plotted as shown in Figure 2.

Located in the first quadrant of the region for the better development of the tourism industry, it can be seen that four of the 14 municipalities in Guangxi Province are located in the first quadrant, respectively, Nanning, Wuzhou, Liuzhou and Fangchenggang, which is far from the zero coordinates of the point such as Nanning, Wuzhou and other cities of the tourism industry structural advantages, although not as good as the structural advantages of the tourism industry in Liuzhou, Fangchenggang and other areas, but its competitiveness advantage greatly compensates for structural advantages of the insufficiency, thus making the whole tourism industry development level of these cities still in the forefront of Guangxi Province. The other cities in the second quadrant show that the structural advantages or competitive advantages of the tourism industry in these cities have greater constraints on the development of the local tourism industry, which affects the development of the local tourism industry to a greater extent.

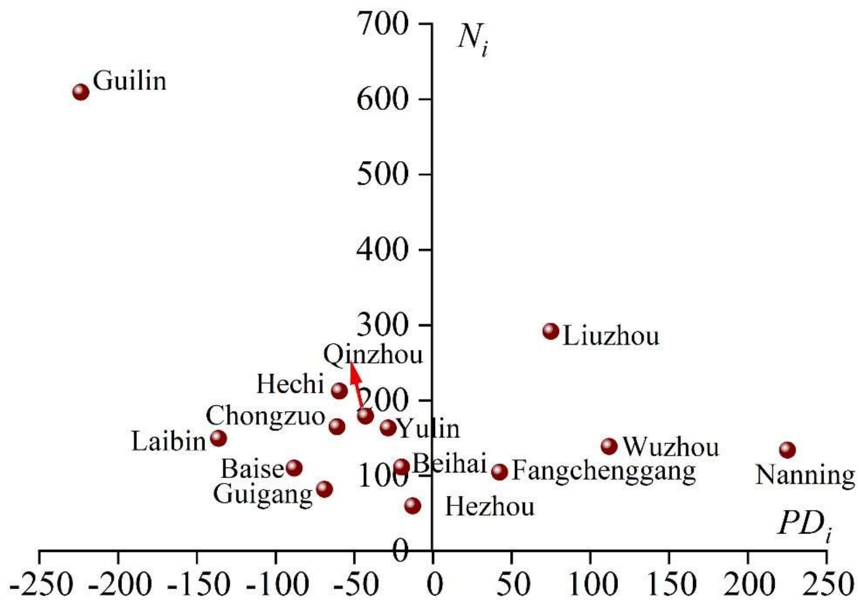

Figure 2: Analysis of advantages in each region

V. Analysis of the evolution of the spatial pattern of competitiveness of study tours

This chapter continues to analyze the evolution of the spatial pattern of study tour competitiveness in 14 municipalities in Guangxi, China, with Guangxi as the research object.

V. A. Global spatial autocorrelation analysis

In order to characterize the spatial aggregation of Guangxi's competitiveness in research and study travel, the global Moran index and its related indexes of Guangxi's competitiveness in research and study travel from 2020 to 2024 were calculated by Open Geoda software as shown in Table 4. Through observation, it can be seen that the global Moran index of five years are positive and show an overall upward trend, and the Z value is greater than the confidence level at the 5% significance test level, which indicates that the cities with the same characteristics of Guangxi's competitiveness of study and research travel show the phenomenon of spatial agglomeration, and the agglomeration is increasing year by year, i.e., there are positive spatial autocorrelation characteristics of Guangxi's competitiveness of study and research travel. At the same time, it also shows that in terms of the competitiveness of study and learning travel, Guangxi as a whole is characterized by unbalanced development, and there exists the Matthew effect of “the stronger the stronger, the weaker the weaker”. The main reason is that the competitiveness level of study and learning travel in Guangxi has a strength fault phenomenon, that is, the indicators of Nanning, the capital of Guangxi, are far more than those of other cities, and the average value of study and learning travel competitiveness of Nanning is 2.3 times that of Guilin, 2.7 times that of Liuzhou, and 11.3 times that of Laibin at the end of the ranking.

Table 4: The global Moran index for the competitiveness of study tours in 2020-2024

Year	Global Moran index	Probability (P)	Z value	Standard deviation
2020	0.4378	0.0100	3.2970	0.1554
2021	0.4488	0.0100	3.2799	0.1594
2022	0.4732	0.0120	3.2682	0.1676
2023	0.4591	0.0180	3.2390	0.1649
2024	0.4991	0.0100	3.4610	0.1662

V. B. Local spatial autocorrelation analysis

Compared with global spatial autocorrelation, local spatial autocorrelation analysis is usually used to test the phenomenon of variable clustering in local areas, and the Moran scatterplot is used to study local spatial instability. The Moran scatterplot is divided into four quadrants by the variable Z represented by the horizontal axis and the spatial lag represented by the vertical axis, which are the diffusion effect zone (HH), the transition zone (LH), the low growth zone (LL), and the polarized growth zone (HL). Open Geoda software was applied to obtain the Moran scatterplot of the competitiveness level of study tours in 14 municipalities in Guangxi from 2020 to 2024, and the significance information in the aggregated plot from 2020 to 2024 was summarized in Table 5.

It can be seen that most of the cities that pass the significance test are clustered in the low growth area (LL) and polarized growth area (HL), which confirms the polarization phenomenon of “the stronger the stronger, the weaker the weaker” in the competitiveness level of study and research travel in Guangxi. In addition, most of the cities in the quadrant did not change from 2020 to 2024, which indicates that the spatial autocorrelation and agglomeration characteristics of the competitiveness of study and learning travel in Guangxi cities have strong stability. Liuzhou becomes the first city in the first tier to reach the diffusion effect zone (HH) in 2024, indicating that Liuzhou's development is no longer purely siphoning, but will gradually spread to the surrounding.

Table 5: Statistical analysis of the agglomeration map of 14 prefecture-level cities

Quadrant	2020	2021	2022	2023	2024
HH					Liuzhou City
LH	Beihai, Wuzhou	Yulin, Beihai, Wuzhou	Yulin, Wuzhou, Beihai	Beihai, Wuzhou	Beihai, Yulin, Wuzhou
LL	Fangchenggang, Qinzhou, Guigang, Chongzuo, Baise, Hezhou, Hechi, Laibin	Fangchenggang, Qinzhou, Guigang, Chongzuo, Baise, Hezhou, Hechi, Laibin	Fangchenggang, Qinzhou, Guigang, Chongzuo, Baise, Hezhou, Hechi, Laibin	Fangchenggang, Qinzhou, Guigang, Chongzuo, Baise, Hezhou, Hechi, Laibin	Fangchenggang, Qinzhou, Guigang, Chongzuo, Baise, Hezhou, Hechi, Laibin
HL	Nanning, Guilin, Liuzhou, Yulin	Nanning, Guilin, Liuzhou	Nanning, Guilin, Liuzhou	Nanning, Guilin, Liuzhou, Yulin	Nanning, Guilin

V. C. LISA space-time jump analysis

In order to further explore the evolution pattern of local spatial association and identify the spatio-temporal evolution characteristics of the competitiveness of Guangxi's study tours, the LISA spatio-temporal leap analysis method is introduced. The LISA temporal paths can reflect the temporal trajectory of spatial units on the Moran scatter plot, and the spatio-temporal leaps further reveal the temporal changes in the spatial relationship between the units and their neighborhoods.

V. C. 1) Characterization of LISA time-path geometry

According to the relevant formula and the changes of the coordinates of each district and city on the Moran scatter plot, the relative length and curvature of the LISA time path of Guangxi's competitiveness in study and learning travel are calculated and graded by the natural discontinuity point method, and the higher the value, the greater the dynamics and volatility of the local spatial structure is reflected. The geometric characteristics of the LISA time path of study and learning travel in 14 district cities in Guangxi are shown in Table 6.

Among the 14 district cities in Guangxi, the relative lengths of the LISA time paths are larger in Guilin and Wuzhou, and the spatial structural stability of the competitiveness of study and research travel in Nanning, Chongzuo, Hechi, Laibin, Fangchenggang and Beihai is higher than that of cities such as Guilin, Wuzhou, Baise and Qinzhou, and in general, most of them are in the stable state of lower relative lengths. In addition, the mean value of its relative length is 0.069, with 58.6% of the cities below the mean value, and the extreme difference of the path length is small, and the overall spatial structure is more stable.

Table 6: Geometric characteristics of the LISA time path for study tours

Relative length	
Grade 3 (0.041-0.062)	Hezhou, Laibin, Hechi, Nanning, Chongzuo, Fangchenggang, Beihai
Grade 2 (0.063-0.091)	Liuzhou, Guigang, Yulin, Qinzhou, Baise
Level One (0.092-0.125)	Guilin, Wuzhou
Curvature	
Grade 3 (1.146-1.821)	Hezhou, Liuzhou, Guigang, Hechi, Qinzhou, Chongzuo
Grade 2 (1.822-3.645)	Wuzhou, Laibin, Nanning, Fangchenggang, Beihai, Baise
Level One (3.646-12.869)	Guilin, Yulin

The spatial distribution pattern of the curvature of Guangxi's study tour competitiveness is roughly comparable to the spatial characteristic change of relative length, with higher values in Guilin and Baise, and lower values in Hechi, Chongzuo and Hezhou. The larger the value of curvature, the stronger the spatio-temporal dependence effect, the more drastic the volatility of the growth process, the more susceptible to external disturbances, and the lack of development continuity. It can be seen that cities such as Guilin and Yulin are more dynamic and volatile, with strong spatial dependence effects susceptible to external disturbances, while Hechi, Chongzuo and Hezhou have stronger spatial structure stability. In addition, the mean value of its curvature is 3.41, which is smaller than the mean value of 79.4% of the cities, indicating that on the whole the spatial structure of the competitiveness of study tours in Guangxi has a high degree of stability, and the fluctuation characteristics are not significant.

V. C. 2) LISA Time Path Movement Direction Analysis

The geometric characterization of the LISA time path reveals the moving trend of each district city in the Moran scatterplot, and then further borrows the space-time jump to describe the process of local Moran scatterplot evolution among different local types. By comparing the positional coordinate changes of 14 cities in Guangxi in 2020 and 2024 in the Moran scatter map, and analyzing the moving direction of the coordinates of each city in 5 years with the help of Geoda software, we get the characteristics of the Moran scatter movement of 14 cities in Guangxi in the period of 2020-2024, as shown in Figure 3. The arrow direction is the moving direction of the coordinates of each district and city, and the length of the arrow is the moving distance of each district and city during 5 years.

Overall, the local spatial correlation pattern is relatively stable from 2020 to 2024, with most cities changing only within the quadrant, and only Liuzhou City jumping from HL to HH. Specifically, the spatial stability of the Moran index of Guangxi's study tour competitiveness is 0.937, i.e., the probability that the Moran scatter remains in the same quadrant is 93.7%, indicating that the probability that the local spatial correlation does not undergo a spatial and temporal leap during the study period is 93.7%, reflecting that the spatial and temporal leap of the study unit in the period of 2020-2024 is not significant, and that there exists a certain degree of path locking.

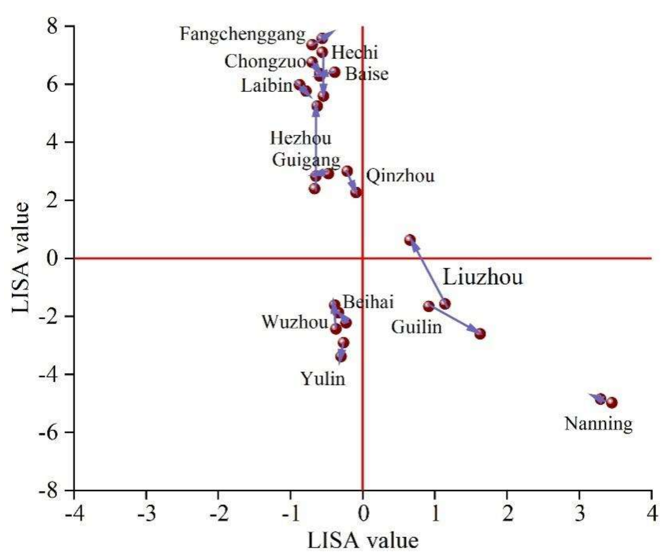

Figure 3: The movement characteristics of the Moran scattered points

VI. Conclusion

This study shows that the competitiveness of study tours in cities and towns within Guangxi province exhibits more significant regional differences. From 2015 to 2024, the average annual growth rate of tourism revenue and GDP in Guangxi region shows a more stable growth trend, in which the growth rate of tourism revenue in Nanning City is 0.22%, higher than the average level of the province, showing a strong competitiveness of the tourism industry. Through the "deviation-share" analysis of 14 cities in Guangxi, the results show that Nanning, Wuzhou, Qinzhou and other cities have higher deviation scores of competitiveness from 2021 to 2024, indicating that the competitiveness of the tourism industry in these areas is relatively strong. In addition, the results of spatial autocorrelation analysis show that the competitiveness of study and research travel in Guangxi presents a more obvious spatial clustering characteristic, especially Nanning and Guilin are significantly more competitive than other regions. Through local spatial autocorrelation and spatio-temporal leap analysis, this paper further reveals the evolutionary trend of research and study travel competitiveness in Guangxi, suggesting that the competitiveness of cities such as Nanning and Guilin may continue to maintain a leading position in the next few years, whereas other cities need to further narrow the regional gap by improving the structure of the tourism industry and enhancing competitiveness.

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