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Curriculum Design and Learning Path in Grassland Ecological Study Tour Based on Support Vector Machine and Decision Tree Optimization

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ABSTRACT

With the in-depth promotion of ecological civilization education, the grassland natural ecology study course has become an important way to realize the comprehensive development of students. The article takes the design idea of grassland study course as the entry point, analyzes the design links of grassland ecology study course development, and proposes the design process of grassland ecology study course development based on this. Taking the second grade students of the first middle school in X city as the research object, the decision tree algorithm is used to optimize the relevant variables in the development of the grassland ecological study course, and the optimization model of the study path of the grassland ecological study course is established starting from the shortest distance and the least time. Based on the variables optimized by the decision tree algorithm, a DT-SVM model is built by combining the support vector mechanism to solve the learning path of the grassland ecological study course. Through the simulation and example data, it can be seen that the convergence accuracy of the DT-SVM algorithm shows the optimal accuracy under all experiments, and its mean value can be up to 3.652, and the average time consumed for obtaining the optimal learning path of the grassland ecology research course is only about 3.17min. And more than 65% of the students agreed with the teaching effect of the grassland ecology study course. The grassland ecology study course can significantly improve students' core literacy in geography, enhance their independent living skills, and better realize the school's teaching goal of promoting moral education.

Keywords: decision tree algorithm, support vector machine, DT-SVM model, grassland ecological study

1. Introduction

With the rapid development of science and technology and industrialization, the globalized economy is growing by leaps and bounds all over the world. While pursuing wealth to satisfy their own needs, human beings continue to seize resources from nature, resulting in the dynamic balance between

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human society and natural resources has been broken, the ecological environment in nature has been damaged, and human society is facing a serious ecological crisis [1-4].

The construction of ecological civilization has become one of the mainstreams of social development, and achieving a win-win situation between economic growth and environmental protection is the value expectation of human production and life, so it is particularly important and urgent to improve people's ecological literacy level [5-7]. Specifically in secondary schools, schools should allow students to learn and deepen their understanding of ecological civilization from the theoretical and practical levels, cultivate the concept of ecological civilization, and make students understand the importance of maintaining a balance between the ecological environment and human development and be able to put forward the corresponding measures to cultivate students' ecological literacy [8-10]. The relevant state departments proposed that “ecological education should be incorporated into the national education system to enhance the awareness of resource conservation, natural environmental protection, and ecological behavior of all people [11-12].” The focus of ecological education is to guide students to consciously cultivate their awareness of the protection of the natural environment with the starting point of mankind's need for sustainable access to the natural ecological environment [13-14]. Rooted in real ecological situations, the ecological study program advocates the cultivation of students' ecological literacy through field practice, field investigation and other methods, practicing ecological protection regulations, and ultimately guiding students to rationally deal with the relationship between human society and the environment, and to establish a correct awareness of the ecological environment [15-16].

Ecological education is an important part of the study trip is an important part of the comprehensive practical activities in primary and secondary schools, but also an important way to implement the fundamental task of moral education and cultivate the core literacy of students in the discipline [17-18]. Study tours make up for the weak links of previous geography classroom teaching, reflect the nature and concept of geography curriculum, and are very useful for enriching students' learning styles, broadening their horizons, and improving their geography practice [19].

Ecological research is an educational approach to enhance the understanding of the natural environment through field trips and interactive learning, which combines grassland ecological conservation with ecological education to improve young people's understanding of grassland ecological conservation. In order to further enhance the school's teaching goal of moral education, this paper proposes a learning path optimization design method for grassland ecological study course that combines support vector machine and decision tree optimization. The decision tree algorithm is used to optimize the key variables of students' activities in the grassland ecology study course, the study course learning path planning model is established with the objectives of shortest distance and least time-consuming, and the DT-SVM model is constructed to solve the optimal learning path of the grassland ecology study course. The second grade students of the first middle school in X city were selected as the research subjects, and the effectiveness of the DT-SVM model and the teaching effect of the grassland ecology study course were verified through the study path planning and teaching practice.

2. Design and development of grassland ecology study programs

Digging deep into the educational value of grassland ecological resources, combining them in depth with study courses, and designing diversified teaching contents and activities for grassland ecological study courses. In this way, the ecological concepts of students and the quality of teaching can be improved, and the interesting and educational nature of the grassland ecology study program can be enhanced by carrying out a variety of teaching forms, such as field trips, ecological experiments, interactive games and so on.

2.1. Grassland Ecology Study Program

2.1.1. Grassland ecology study program. Study travel is a kind of educational tourism activity that takes primary and secondary school students as the main object, takes collective travel life as the carrier, takes the improvement of students' quality as the teaching purpose, relies on social resources such as tourist attractions, and carries out experiential education and research study. Elementary and middle school students study trip is organized by the education sector and the school systematic arrangements, through collective travel, centralized accommodation to carry out research studies and travel experience combined with out-of-school educational activities.

Study travel is a kind of innovative educational services, this kind of service can satisfy both educational demand and tourism demand at the same time, both educational significance and economic value, is a kind of social service products. The school strategically plans the duration and schedule of study trips based on its specific circumstances and academic calendar, with the primary participants being students from grades 4-6 in elementary school, grades 7-8 in junior high school, and grades 10-11 in senior high school. Schools organizing study tours should gradually establish a multi-type curriculum system by segments according to the developmental stages of the students, taking into account the characteristics of the location of the school.

Grassland ecological study course is the main carrier and landing point of grassland ecological study, which not only refers to a subject written in the teaching plan, but also includes the design of the course program, pre-travel preparation, implementation process, evaluation system, vehicles, medical care, food and accommodation, and other links and multiple content [20]. Grassland ecological research course should have the core literacy and comprehensive development of the curriculum objectives, experiential curriculum content, rich organizational methods, outdoor activities as the main form of completion of an interdisciplinary and dynamic integrated practice course.

2.1.2. Ideas for the design of study programs. Study tours are an important component of the comprehensive practical activities in primary and secondary schools, and also serve as a vital means to fulfill the fundamental task of fostering moral development and cultivating the students' core disciplinary competencies. The concept of ecological civilization serves as the foundational principle for its construction. The grassland ecology study course is designed to guide students in exploring the development of grassland ecosystems, helping them recognize that protecting the grassland ecological environment equates to safeguarding productive forces, while improving it fosters the advancement of productive forces. Through a variety of activities including field excursions, experimental measurements, and exploratory visits, the course immerses students in the accomplishments of contemporary ecological civilization development. It enriches their practical geographical knowledge, encourages active participation in the advancement of ecological civilization, and cultivates the growth of future citizens who are imbued with a sense of environmental stewardship and a commitment to sustainable development.

Figure 1 shows the design idea of the grassland ecology study course, which follows the modern student-centered curriculum concept and highly emphasizes the comprehensive character of the course. By encouraging students to explore and construct new knowledge in interaction with teachers and peers, and by combining classroom knowledge with real-world situations, the grassland ecology study program becomes an experiential program. In addition, the grassland ecology study program should rigorously adhere to the cultivation standards of geographical core competencies, aiming to holistically enhance students' geographical literacy through diverse and engaging learning experiences. This approach ensures the fulfillment of the fundamental mission of fostering moral integrity and well-rounded development.

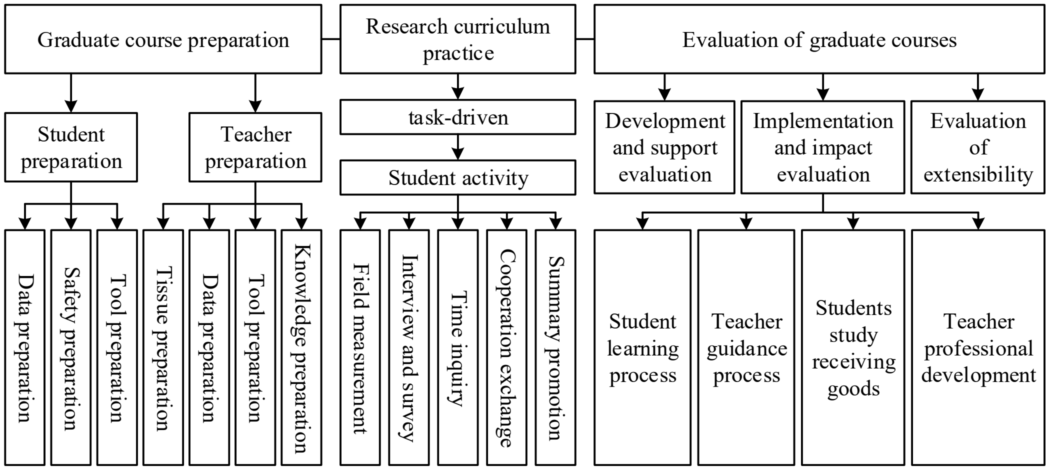


Fig. 1. The design idea of grassland ecology research course

2.2. Grassland Ecology Study Program Development

2.2.1. Research Course Design Sessions:

1) Theme design. The theme design of the grassland ecology study course is not without rules to follow, but can start from the regional characteristics, subject content, students' interests and development needs, to further determine the main content of the course, select the course to carry out the region, and then carry out the general theme design of the course. At the same time, we should consider the student body's learning situation and the actual situation of the region in which the course is carried out, to determine the course learning theme in line with the cognitive level of students.

2) Objective design. The goal design of the grassland ecology study course should be reasonable and operable, and the expression of the goal should be clear and specific. The objectives of the geography study tour course are characterized by clear disciplinary integration. During the design process, guided by the inherent nature of the course and established design principles, the course objectives are systematically categorized into three modules: the overarching course objectives, specific sub-objectives, and the objectives aligned with the geography discipline.

3) Route design. Grassland ecological research course route is a complete route of the course connected by a determined classroom location, and its design usually takes into account the nature of safety, economy, time, accessibility, etc., and adheres to the principles of adapting to the local conditions, teaching for fun and practicing. Under this premise, discipline integration of geography study travel course route design, in line with the concept of "geography +", not only to make in the limited time and space as much as possible involved in the geography teaching content, highlighting the idea of geography, but also to be able to integrate with the content of other disciplines.

4) Content design. In the process of designing the geography subject as a link, linking up the chaotic and fragmented knowledge of other subjects, applying multidisciplinary knowledge to practical situations, and promoting the diversified development of students. Attention should also be paid to combining with the contents of other disciplines, the standard and the cultivation of literacy, otherwise it is difficult to reflect the characteristics and role of integration.

2.2.2. Course design and development process. Based on the main links in the design and development of grassland ecology research courses, the general process of grassland ecology research course design plan mainly includes five processes: selecting and determining the theme of research trips, inspecting and screening and determining research destinations and research routes, selecting discipline research content and setting research objectives, selecting activity organization methods and designing research course plans, and evaluating research results. Figure 2 shows the design process of the grassland ecology research course, in which the design plan of the research course generally includes the research theme, research route, applicable section, research objectives, course content, research achievement evaluation, etc., covering three stages: preparation, implementation and summary.

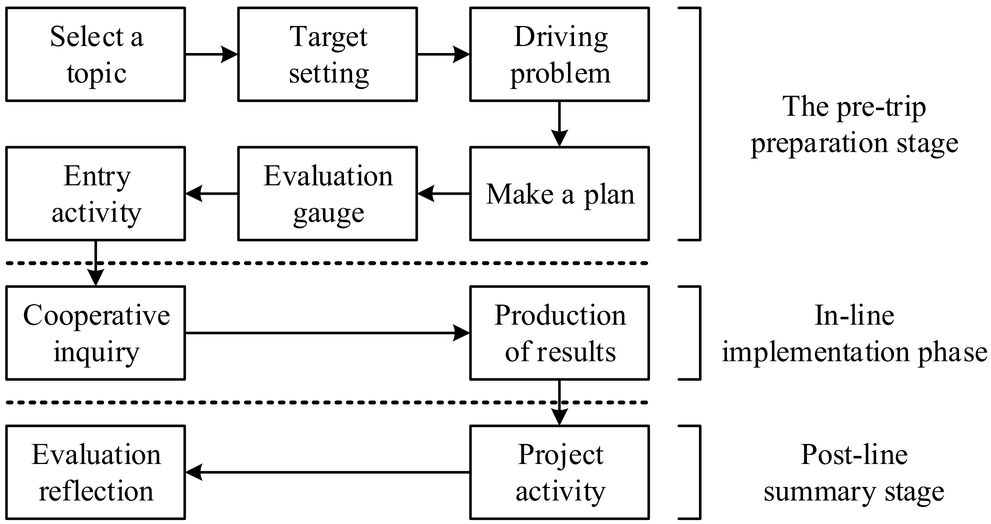


Fig. 2. The design process of grassland ecology research course

The preparation stage mainly includes six aspects, namely, the selection of the research theme, the booking of the research objectives, the formulation of driving questions, the development of the research activity plan, the design of the evaluation scale, and the entry activities. The first five aspects are formulated by the teacher, and the entry activities are organized by the teacher, and through a series of activities, the students are grouped together and get to know the preliminaries for the conduct of the research activities, so as to prepare for the research project to be carried out in the field. In the implementation stage, students work together in groups to explore and carry out activities through the research program developed in the preparation stage, and gradually produce project results. Finally, in the concluding stage, the exit activity is held, in which students present their results, express their understanding and gains from the study, and finally evaluate and reflect on the evaluation scale of the first stage.

3. Grassland Ecology Study Program and Learning Path Planning

Carrying out grassland ecological research is an innovative measure to give full play to ecological advantages, effectively promote the high-quality development of environmental education bases, strengthen ecological environment education, and comprehensively promote the construction of ecological civilization, which is conducive to the implementation of the fundamental task of establishing morality and cultivating people in primary and secondary schools, cultivating builders and successors of "Beautiful China" with ecological civilization literacy and ecological morality, and creating an atmosphere and laying a solid foundation for in-depth pollution prevention and control. To enhance the alignment of grassland ecology research courses with students' academic requirements, this study employs a decision tree algorithm for course optimization. Furthermore, by integrating Decision Tree-Support Vector Machine (DT-SVM) methodology, we construct an optimized learning pathway for grassland ecology research. This dual approach ensures that the course outcomes effectively meet the established teaching objectives while simultaneously improving the overall efficacy of grassland ecology research education.

3.1. *Machine learning related algorithms*

3.1.1. Support vector machines. The fundamental principle of Support Vector Machine (SVM) involves identifying an optimal separating hyperplane within the training sample space that effectively discriminates between distinct sample classes. This hyperplane is strategically positioned to maximize the margin - the distance between the hyperplane and the nearest data points from each class (support vectors). Through this geometric separation, the feature space is partitioned into distinct classification regions, where data points on either side of the hyperplane are assigned to different categories. During the classification phase, new data points are categorized based on their relative position to this established decision boundary [21].

In the training sample space, any hyperplane can be described by the following linear equation:

$$\omega^T x + b = 0 \tag{1}$$

where $\omega = (\omega_1, \omega_2, \cdots, \omega_d)$ is the normal vector, which determines the direction of the hyperplane, and b is the displacement term, which determines the distance between the hyperplane and the origin. Clearly the dividing hyperplane can be determined by the normal vector ω and the displacement b, denoted as (ω, b).

The distance from any point x in the sample space to the hyperplane (ω, b) can be written as:

$$r = \frac{|\omega^T x + b|}{\|\omega\|} \tag{2}$$

Assume that hyperplane (ω, b) classifies the training samples correctly, i.e., for $(x_i, y_i) \in D$, if $y_i = +1$, then there is $\omega^T x + b > 0$ if $y_i = -1$, then there is $\omega^T x + b < 0$. Then:

$$\begin{cases} \omega^T x_i + b \geq +1, & y_i = +1 \\ \omega^T x_i + b \leq -1, & y_i = -1 \end{cases} \tag{3}$$

In the hyperplane space of a support vector machine, the sample points through which the two dashed lines pass are called support vectors, and the sum of the distances from the two types of support vectors to the hyperplane is:

$$\gamma = \frac{2}{\|\omega\|} \tag{4}$$

where γ is called the interval.

If we want to find a dividing hyperplane with "maximum interval", we have to find the parameters ω and b that satisfy the constraints in Eq. (3), such that γ is the maximum, i.e:

$$\begin{aligned} &\min_{\omega,b} \frac{1}{2}\|\omega\|^2 \\ &\text{s.t.} \quad y_i(\omega^T x_i + b) \geq 1 \end{aligned} \tag{5}$$

The SVM obtains the optimal hyperplane parameter (ω, b) by solving its dual problem, and the Lagrange multiplication method is used to obtain its "dual problem", which can be written as the Lagrange function of the problem:

$$L(\omega, b, \alpha) = \frac{1}{2}\|\omega\|^2 + \sum_{i=1}^{m} \alpha_i (1 - y_i(\omega^T x_i + b)) \tag{6}$$

where $\alpha = (\alpha_1; \alpha_2; \cdots; \alpha_m)$ is obtained by making the partial derivatives of $L(\omega, b, \alpha)$ with respect to ω and b zero:

$$\omega = \sum_{i=1}^{m} \alpha_i y_i x_i \tag{7}$$

$$0 = \sum_{i=1}^{m} \alpha_i y_i \tag{8}$$

Then:

$$\begin{aligned}
&\max_{\alpha} \sum_{i=1}^{m} \alpha_i - \frac{1}{2} \sum_{i=1}^{m} \sum_{j=1}^{m} \alpha_i \alpha_j y_i y_j x_i^T x_j \\
&s.t. \quad \sum_{i=1}^{m} \alpha_j y_i = 0 \\
&\alpha_i \geq 0, \quad i = 1, 2, \ldots, m
\end{aligned} \tag{9}$$

After solving for α, the model is obtained by solving for ω and b:

$$f(x) = \omega^T x + b = \sum_{i=1}^{m} \alpha_i y_i x_i^T x + b \tag{10}$$

3.1.2. Decision tree algorithm. Decision tree (DT) algorithm is a tree-based classification model, the classification idea is to decompose the data space hierarchically, which mainly consists of a root node, a number of internal nodes, and a number of leaf nodes [22]. The root node contains all the samples of the training set, the internal nodes represent the feature test, and the set of samples contained in each node is divided into different sub-nodes according to the feature test results, and finally divided into leaf nodes to form the decision results. The algorithm flow of decision tree is as follows:

1) Input initial training set. That is:

$$TD = \{(d^{(1)}, y^{(1)}), (d^{(2)}, y^{(2)}), \cdots, (d^{(m)}, y^{(m)})\} \tag{11}$$

where $d^{(i)} \in R^n, i = 1, 2, \cdots, m, y^{(i)} \in \{1, 2, \cdots, C\}$ is the category label of $d^{(i)}$.

2) Input initial feature set. Namely:

$$F = \{f_1, f_2, \cdots, f_n\} \tag{12}$$

3) Input algorithm termination conditions. Condition 1: If all the training samples contained in the current node belong to the same category, the node is labeled as a leaf node. Condition 2: If the current feature set F is empty or all the samples take the same value on all the features, the current node is labeled as a leaf node, and the category to which the leaf node belongs is set as the category with the most samples contained in the node. Condition 3: The sample set TD contained in the current node is empty, mark the current node as a leaf node and set its category to the category whose parent node contains the most samples.

4) Generate node. The samples contained on the node are all the samples in TD, and the feature set is F.

5) Judge whether the training set and feature set on the current node satisfy the algorithm termination condition in step 3, if not, go to the next step.

6) Find the optimal segmentation features. Select the optimal division feature f_* from F. The decision criterion for the optimal division feature is:

$$f_* = \arg\max_{f_i \in F} Gain(TD, f_i) \tag{13}$$

Where $Gain(TD, f_i)$ denotes the “information gain” of feature f_i to dataset TD:

$$\text{Gain}(TD, f_i) = \text{Ent}(TD) - \sum_{v=1}^{V} \frac{|TD^v|}{|TD|} \text{Ent}(TD^v) \tag{14}$$

Where $Ent(TD)$ represents the "information entropy" of training set TD, i.e., the "clutter level" of data set TD. Assuming that the set of all possible values of discrete feature f_i is $\{f_i^1, f_i^2, \cdots, f_i^V\}$, if we use feature f_i to divide the training set TD, there will be V branch nodes, the v th branch node contains all the samples in the training set that take the value of f_i^v on the feature f_i, the subset will be recorded as TD^v. The information entropy of the training set TD is:

$$Ent(TD) = -\sum_{c=1}^{c} p_c \log_2 p_c \tag{15}$$

Where p_c is the proportion of the number of samples in the c nd category, and the information entropy of sample subset TD^v is calculated as above.

7) Divide the sample set according to the optimal segmentation feature. For the current optimal segmentation feature f_*, the sample set is divided according to each possible value $f_*^1, f_*^2, \cdots, f_*^V$ of f_*, and the corresponding sample set is divided into $TD^1, TD^2, \cdots, TD^V$.

8) Recursively generate a decision tree. For each sample subset $TD^v, v = 1, 2, \cdots, V$, update the corresponding training set $TD \leftarrow TD^v, FarrowF \setminus \{f_*\}$ respectively, and repeat steps (4) to (8).

3.2. Course Preferences and Learning Path Planning

3.2.1. Preferred process for research courses. In this paper, the second grade students of the first middle school in X city were selected as the research object, which had conducted a grassland ecology study course in April 2024, and in order to improve the teaching effect of the subsequent grassland ecology study course, the relevant contents of the grassland ecology study course need to be further optimized. The data from the last grassland ecology study program was used as the basis for the study program optimization. The grassland ecology research curriculum framework employed in this study encompassed multiple dimensions, including ecological typology, temporal allocation, content structure, pedagogical approaches, instructional pathways, student demographics (enrollment size and academic level), learning objectives, faculty qualifications, resource availability, and educational goals. In order to determine the optimal combination of grassland ecology research course parameters from the 12 commonly used grassland ecology research course parameters, this study adopted the decision tree algorithm, which is a supervised learning technique that can be used to solve classification problems. Its workflow is as follows:

1) Build a classification tree model with training and test datasets (i.e., data related to the grassland ecology study course). Use the information gain to find out the most informative feature parameter, and set this feature parameter as the root node, then split the root node into more sub-nodes, and establish the branches of the tree according to the numerical distribution of the feature parameter. Repeat the above steps until the node can no longer be split (i.e., information entropy = 0), at which time the whole tree is completely constructed.

2) After constructing the tree model, the hyperparameters of the tree model were adjusted and several tree models were built. We use the SCORE function to evaluate the score of each tree model and select the tree model with the highest score as the final tree model.

3) In the final decision tree model, we employed the feature importance analysis to quantitatively evaluate the relative contribution of each feature parameter to the predictive accuracy of the grassland ecology research program, thereby identifying the primary optimal feature parameter.

4) The optimal feature parameter was removed from the dataset and steps 1-4 were repeated until all remaining 11 feature parameters were assessed. Then, the 2nd, 3rd, ... and 12th optimal feature parameters were identified, following which the optimal combination of grassland ecological study programs was established.

3.2.2. Research and study path planning. Learning path planning refers to the process of designing an educational trajectory that effectively conveys the essence of grassland ecology, based on the known information about the starting and ending points of knowledge acquisition. The designed learning pathway for the grassland ecology curriculum should be strategically aligned with the course objectives, optimizing one or more key parameters including distance minimization, time efficiency, and risk reduction. The learning path planning algorithm developed in this study conceptualizes the educational trajectory design as a mathematical optimization problem, utilizing contextual information about both the target learning outcomes in grassland ecology and the surrounding environmental parameters. The optimization process incorporates two primary objectives: temporal efficiency minimization and spatial distance reduction, ensuring the designed learning pathway achieves both time-optimal and distance-optimal solutions. From this metric, the following optimization problem can be constructed:

$$\begin{aligned} \min_{R,D} \quad & R + D \\ s.t. \quad & \text{Grassland ecological environment} \\ & \text{Learning goal} \end{aligned} \tag{16}$$

Where R represents the least time consuming learning path and D represents the distance of the planned path.

Through systematic analysis and comparative evaluation of the proposed modeling approach, the mathematical formulation exhibits substantial structural parallels with support vector machine (SVM) architecture. This theoretical correspondence enables the conceptualization of the learning path planning challenge as a classification problem within the machine learning framework. That is, by defining the grassland ecological study destinations into different categories and classifying the grassland ecological study destinations through the model, the generated classification hyperplane can be used as the learning path to be planned.

However, in order to ensure the optimization objectives of minimum time and shortest distance as proposed above, as well as to take into account the location information of the grassland ecology study course, it is not possible to use the standard support vector machine for direct path planning, so the standard support vector machine must be extended. Since the algorithm only considers the case of straight-through paths, which belongs to the category of linearly differentiable problems in classification problems, the DT-SVM model constructed in the previous section is introduced for the planning of learning paths of grassland ecology study courses. The mathematical model of learning path planning constructed based on the linear support vector machine extension is given first. Namely:

$$\begin{aligned} \min_w \quad & \frac{1}{2}\|w\|^2 + \|w - w_0\|^2 \\ s.t. \quad & y_i(w \cdot x_i + b) \geq 1 \\ & w \cdot x_0 + b = 0 \end{aligned} \tag{17}$$

Where $\frac{1}{2}\|w\|^2$ corresponds to the distance between two fields, w is the normal vector of the classification hyperplane, and w_0 refers to the normal vector of the line connecting the start and end coordinates. According to the mathematical principle of the shortest line segment between two points, $\|w - w_0\|^2$ means that the smaller the difference between the normal vector of the classification hyperplane and w_0, the shorter the length of the resulting classification hyperplane, i.e., the optimization of the length of the planned path. x_0 refers to the starting point coordinates.

3.2.3. DT-SVM model construction. The construction of the DT-SVM model is based on Python programming language processing, and the libraries used mainly include Scikitlearn, Pandas and NumPy, etc., and the compiler is selected as Jupiter Notebook.

The total sample data consisting of positive and negative samples are randomly divided into 80% training set and 20% test set, which are used for model training and validation respectively. Based on the Bagging algorithm and combined with the random subspace method, the decision tree is used as the underlying algorithm, and the model construction is completed through the decision tree integration, and the SVM model is constructed with a radial basis kernel. Subsequently, model evaluation indexes are selected for model comparison, and the model with better performance is selected to participate in the study of learning path optimization, and the construction process of DT-SVM model and the learning path planning process are shown in Figure 3.

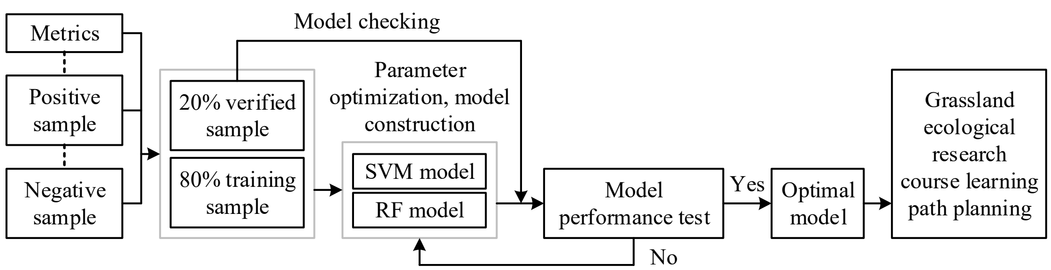


Fig. 3. Model build and learning path planning process

the optimal performance. Additionally, problems such as underfitting and overfitting are likely to emerge. Parameter optimization is an effective way to improve the performance of the model, and this paper adopts the grid search algorithm to achieve model parameter optimization. The method is more general, its essence is to partition the parameter space into a number of grids of the same length in each dimension, and each intersection is a set of parameters, and the optimal parameter combinations are determined by traversing all the intersections of the grids, and calculating the highest accuracy or the lowest root-mean-square error in comparison with the corresponding models. The scikit-learn built-in class GridSearchCV grid search is used to fix the other parameter values and combined with ten-fold cross validation to obtain the optimal combination of important hyper-parameter values.

4. Examples of the application of the grassland ecology study program explored

Study tours in primary and secondary schools constitute a pivotal component within the realm of education and teaching, representing an efficacious approach to implementing comprehensive practical education. This form of educational activity not only enriches students' learning experiences but also plays a crucial role in cultivating their practical abilities, innovative thinking, and social awareness, thereby serving as an indispensable complement to traditional classroom - based instruction. The dissemination of study tours exerts a positive influence on the thorough implementation of quality - oriented education. It serves as a guiding force for students to proactively acclimatize to society, and simultaneously promotes the profound integration of book - based knowledge and life - based experiences. This integration, in turn, enriches students' cognitive structures and equips them with more practical skills and a broader perspective, fostering their all - around development in the context of a changing social environment. The development and application of the Grassland Ecology Study Program aim to deepen students' knowledge of grassland ecosystems, broaden their understanding of the complex mechanisms within these ecosystems, and enhance the teaching effectiveness of grassland ecosystem - related courses in schools. Moreover, this program serves to achieve the educational objective of cultivating students' moral character while imparting knowledge, in line with the fundamental mission of education to foster well - rounded individuals.

4.1. Learning Path Planning for Grassland Ecology Studies

4.1.1. Learning path optimization process. In the existing research literature, Support Vector Machine (SVM), Back Propagation Neural Network (BPNN), and [fully expand "CERT" here if possible] are employed as comparison algorithms for learning path planning. In light of this, this paper selects SVM, BPNN, and CERT to conduct algorithmic comparisons with the DT - SVM proposed herein. Taking the learning path model of grassland ecology study course given in the previous paper as the core, particle swarm optimization algorithm (PSO) is used to optimize the learning path of grassland ecology study course respectively. In order to verify the effect of learning path optimization of grassland ecology research courses under different models, six different sizes of learning path optimization problems of grassland ecology research courses were set up, and the mean (Avg) and variance (Var) were used to evaluate the model performance. Table 1 shows the comparative results of the accuracy of the optimization search, and the optimal values are bolded.

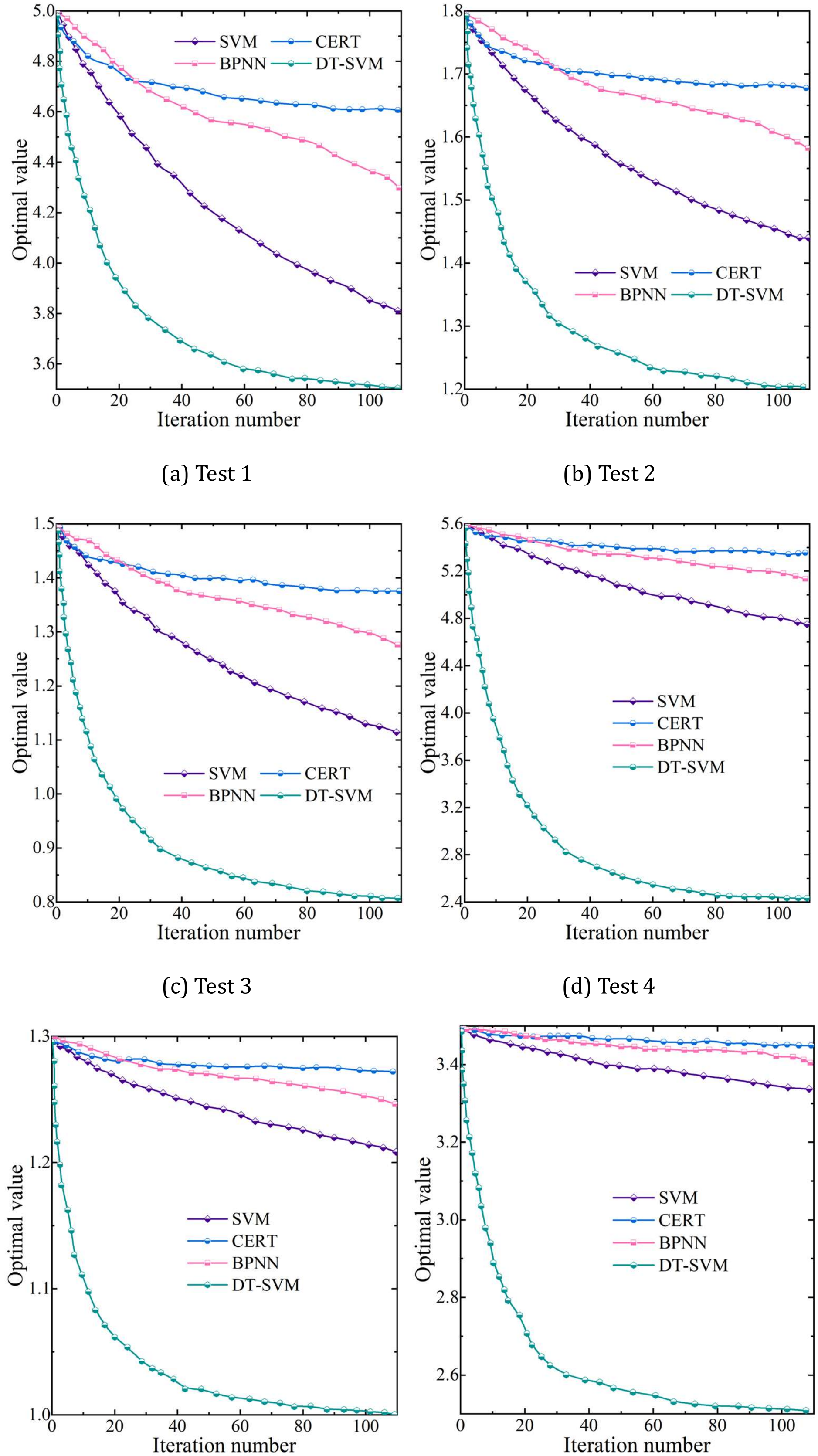
In the context of the grassland ecology research course, an optimal learning path is characterized by the minimum time consumption and the shortest distance traversed. A smaller value of these metrics indicates that this particular learning path is more congruent with the actual teaching requirements of the grassland ecology research course. It is highly conducive to students' engagement and progress in the study of this course. Conversely, a larger value implies a deviation from the teaching needs of the research - oriented course, and thus may pose challenges to students' effective learning and research in the field of grassland ecology. The experimental data in experiment 1, experiment 2 and experiment 3 are only different in the number of grassland ecology learning knowledge, by comparing these three groups of experimental data in the table, it is found that with the increase of the number of grassland ecology learning knowledge, the DT-SVM algorithm has the best convergence accuracy, and its mean value is 3.652, 1.328 and 0.957, respectively, and its variance is only in experiment 1 is the best, but it is not very much different from other algorithms, indicating that the DT-SVM algorithm has the best convergence accuracy. It shows that the stability of DT-SVM algorithm is acceptable. The data of Experiment 4, Experiment 5 and Experiment 6 are different only in the number of students participating in the grassland ecology study course. By observing the data of these three experiments in the table, it is found that, with the increase of the number of learners, the DT-SVM algorithm has the best convergence accuracy, and the mean values of the accuracy are 2.435, 1.112, and 2.537, respectively, and the same variance is not the best but not very much different from that of other algorithms, which indicates that the stability of the DT-SVM algorithm is acceptable. SVM algorithm's stability is acceptable. Among the six experiments, the convergence accuracy of the DT-SVM algorithm proposed in this paper is the best, indicating that the learning path recommended by this algorithm for grassland ecology study course is more accurate and more in line with the needs of learners, which can meet the teaching needs of grassland ecology study course.

Table 1. The comparison of the optimal precision

Method		SVM	CERT	BPNN	DT-SVM
Test 1	Avg	3.882	4.262	4.559	3.652
	Var	6.351	1.213	1.854	0.141
Test 2	Avg	1.513	1.655	1.721	1.328
	Var	3.165	4.973	1.265	3.436
Test 3	Avg	1.144	1.251	1.333	0.957
	Var	2.067	4.324	1.142	1.423
Test 4	Avg	4.732	5.286	5.596	2.435
	Var	6.851	8.357	2.231	4.089

Test 5	Avg	1.226	1.265	1.257	1.112
	Var	1.283	1.243	2.734	1.641
Test 6	Avg	3.218	3.351	3.335	2.537
	Var	1.051	1.426	0.354	3.852

Figure 4 shows the convergence results of the match between learners and grassland ecological research course resources under different experiments. Among them, Fig. 4(a)~(f) shows the convergence results of experiments 1~6, respectively. Figure 4(a)~(c) the number of grassland ecology research course knowledge in the three groups of experiments is different, it can be seen that the DT-SVM algorithm has the best convergence speed and convergence stability, indicating that with the increase of the number of knowledge of the grassland ecology research course, the learning paths obtained by using the DT-SVM algorithm are more in line with the needs of the grassland ecology research course and the learner, revealing a better optimization speed and matching degree. Figure 4(b)~(f) represents the different number of students in the experiment. It can be seen that the DT-SVM core algorithm also has the best convergence speed and convergence stability, indicating that with the increase of the number of learners, the learning path optimized by using the DT-SVM algorithm is also able to better meet the needs of the grassland ecological research course and the learners, showing better optimization speed and optimization matching degree.



(a) Test 1 (b) Test 2

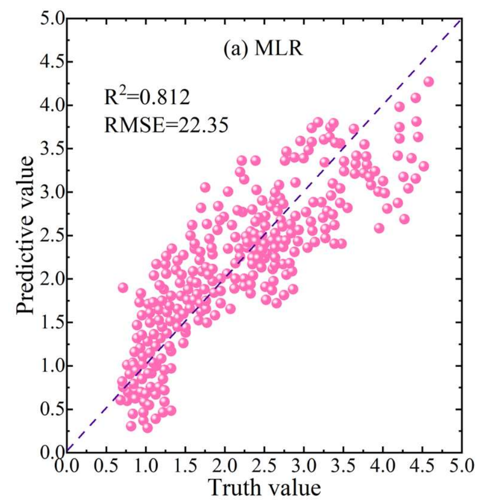
(c) Test 3 (d) Test 4

(e) Test 5 (f) Test 6

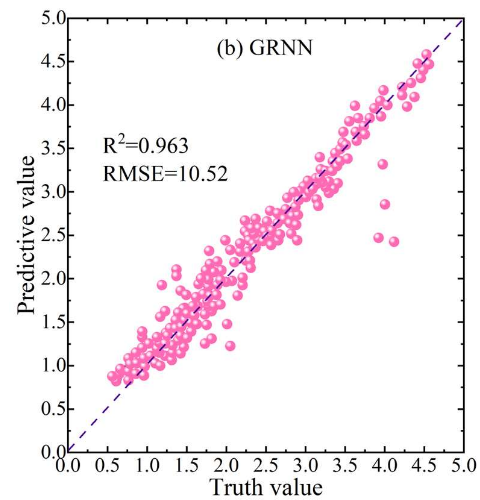
Fig.4. Convergence curve of repulsion function

4.1.2. Learning Path Optimization Comparison. The objective of this section is to accurately predict the learning paths of grassland ecology study courses using the DT-SVM method, and to quantify the uncertainty in the prediction to establish a high-quality predicted demand interval for grassland ecology study courses. In order to verify the effectiveness and superiority of the DT-SVM method proposed in this paper, the prediction results of the learning paths of grassland ecology study courses of a single traditional machine learning algorithm, such as BPNN, SVM, multivariate linear regression (MLR), Extreme Learning Machine (ELM), and generalized regression neural network (GRNN), are compared and analyzed with those of the DT-SVM model. The ratio of the training set to the test set is 7:3, and after the above models are trained on the training set, the learning path prediction results of different machine learning models on the test set are obtained as shown in Fig. 5, in which Fig. 5(a)~(f) shows the learning path prediction results of MLR, GRNN, ELM, BPNN, SVM and DT-SVM, respectively.

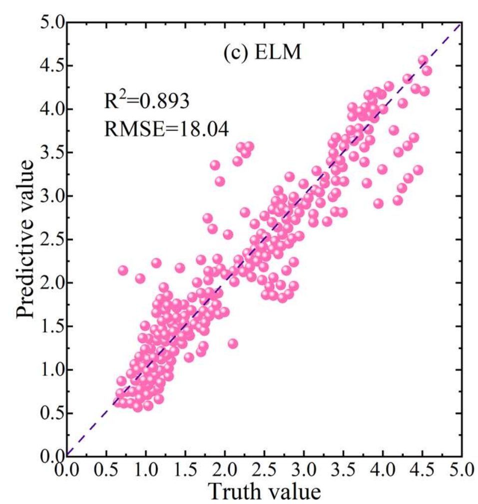
Significant variations were observed in the predictive performance across different models when applied to learning path analysis in grassland ecological studies. The variation of R^2 of each machine learning model on the test set ranged from 0.812 to 0.985, and the variation of RMSE ranged from [7.39,22.35], among which the DT-SVM model had the best performance with the largest R^2 and the smallest RMSE, while the MLR had the worst prediction. The DT-SVM model has the best performance in the prediction of learning paths in grassland ecological research courses on the test set, indicating that the DT-SVM proposed in this paper is more suitable for the prediction and evaluation of learning paths in grassland ecological research courses.

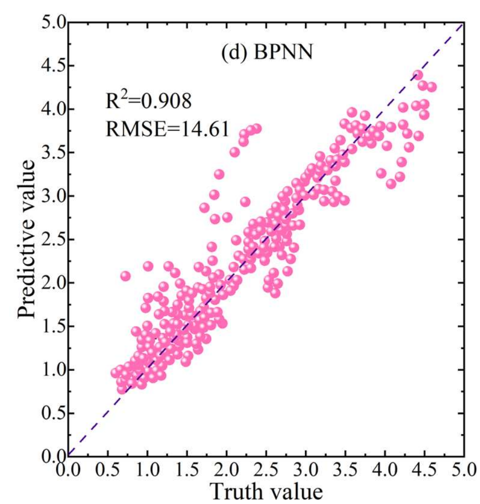


(a) MLR

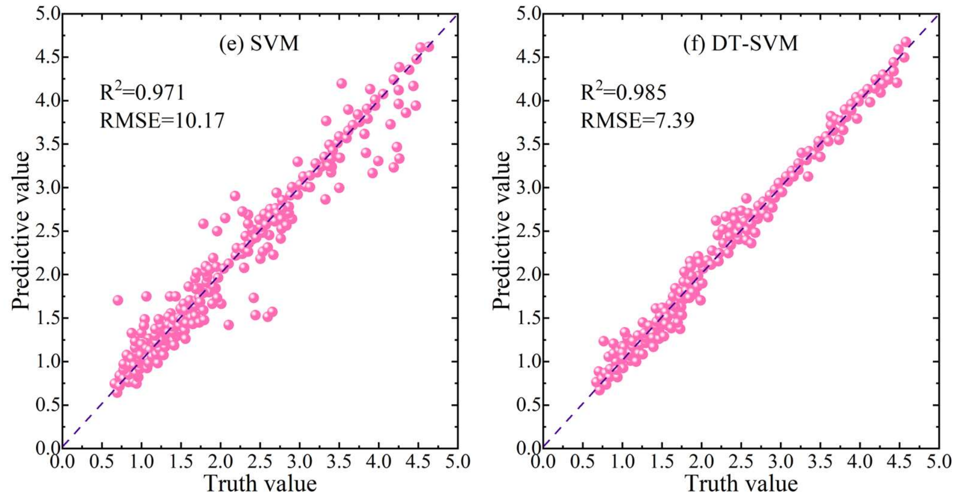


(b) GRNN





(c) ELM (d) BPNN



(e) SVM (f) DT-SVM

Fig. 5. The learning path of different models is predicted

4.1.3. Learning path optimization time consuming. For the optimization model pertaining to the learning path of the grassland ecology study course, it is imperative not only to achieve the shortest distance but also to ensure that the recommended learning trajectory minimizes the duration. In order to verify whether the learning path optimization model based on DT-SVM for grassland ecology study course is effective in terms of time minimization, the actual time consumed by the recommended learning paths of the DT-SVM model and other learning paths are compared. For the recommended learning path given by the DT-SVM-based learning path optimization model for grassland ecology study course, the total time consumed for the whole journey from the starting point to the end point is recorded as the recommended learning path time consumed. For the other reachable learning paths obtained by SVM, BPNN and MLR algorithms, the three learning paths with the smallest total elapsed time from the starting point to the end point are taken for comparison with the model recommended learning paths. Figure 6 shows the results of time-consuming comparison of learning paths of grassland ecology study courses with different algorithms.

It can be seen from the simulation results that the learning path optimization model recommended by the DT-SVM-based learning path optimization model for the grassland ecology study course is indeed the least time-consuming of all the reachable routes, with an average time of about 3.17 min. Therefore, it can be proved that the model is effective in terms of time minimization. In addition, in order to compare the model with traditional algorithms, this paper chooses 20 pairs of starting and ending points as simulation objects, and compares the recommended learning paths of this paper's model with the time consumption of the shortest paths calculated using different algorithms as the optimal paths, and it can also be seen that this paper's algorithm recommends the learning paths of the grass ecological study course which consumes less time. In conclusion, using the decision tree algorithm to obtain the learning characteristics data of the grassland ecology study course, combined with the support vector machine to optimize the learning path of the grassland ecology study course, can improve the teaching effect of the grassland ecology study course through the shortest distance and the least time-consuming, and lay a solid foundation for enhancing the effect of the grassland ecology study course in the moral and humanistic aspects of the grassland ecology study course.

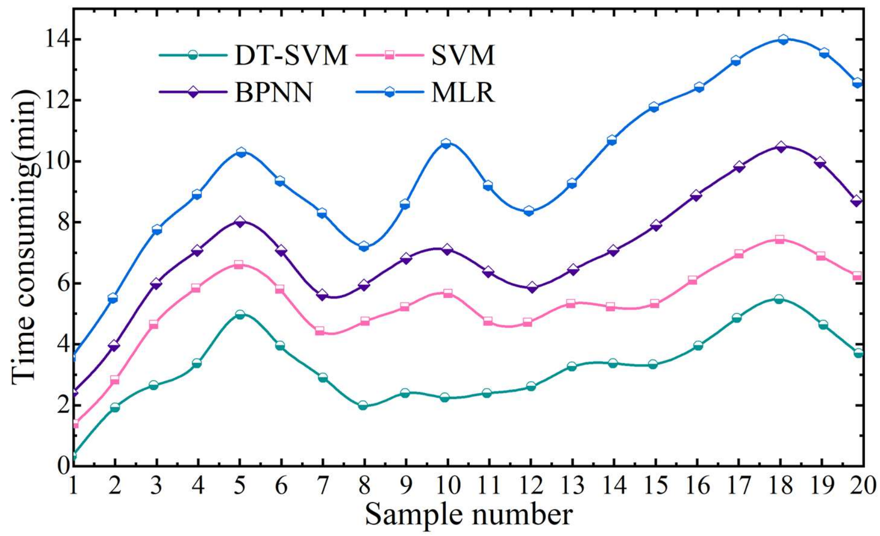


Fig. 6. The learning path of different algorithms is time compared

4.2. Teaching Practices of Grassland Ecology Research Course

4.2.1. Grassland Ecology Research Design. To ascertain the practical application efficacy of the grassland ecology study course within the framework of teaching practice, this paper undertakes a study utilizing the learning path derived from the Decision Tree-Support Vector Machine (DT-SVM) model. The research focuses on second-year middle school students from the First Middle School in X City, with due consent obtained from both the students and their parents subsequent to confirming the study's theme and location. Prior to the commencement of the study, a field trip to the designated site was conducted, accompanied by the formulation of a comprehensive study plan. Additionally, all transportation and accommodation arrangements were confirmed to guarantee safety throughout the study period. The study was conducted with the consent of the students and their parents. Teachers familiarized themselves with the study sites in advance and conducted field trips, and then carried out the grassland ecology study program in the form of teacher-guided + student-led.

Teachers need to relocate the process of formulating classroom learning objectives and operational requirements based on students' actuality, characteristics of the study resources, requirements of the curriculum standards and content of the teaching materials, etc. Teachers need to formulate clear learning objectives and make sure that the objectives are sufficiently specific and operable, and that the objectives of the study trip are sufficiently detailed in order to play a good guiding role in the selection of the subsequent study routes, and in the choice and organization of the contents of the study trip. The objectives of this grassland ecology study program are to enhance students' view of human-land coordination, improve their knowledge of grassland ecology, improve their comprehensive thinking, and expand their geography practice.

In addition, for the teaching effect of this grassland ecology study course, students were evaluated on their knowledge, awareness, behavior and literacy of grassland ecological civilization in three aspects, namely, process, summative and motivational evaluation, and the specific contents are shown in Table 2. Based on the evaluation content, a questionnaire was designed and quantified by Likert scale, 40 questionnaires were distributed and 40 were effectively recovered, and the collected data were organized to provide a data basis for the teaching effect of the grassland ecological study course later on.

Table 2. The evaluation of grassland ecology research course

Type	Index	Code

Process evaluation	Ecographic mapping	PE1
	Social survey information collection	PE2
	Field experiment	PE3
	Process analysis of grassland formation	PE4
	Ecological protection behavior experience	PE5
	Ecological community structure analysis	PE6
	The analysis of the contradiction of man	PE7
	The grassland aesthetic examination	PE8
Summative evaluation	Complete quality of the graduate school handbook	SE1
	Study course activities	SE2
	Summary report of research course	SE3
	Emotional experience and harvest	SE4
Motivational evaluation	Ecological protection behavior	ME1
	Ecological experience inspiration	ME2

4.2.2. Teaching Effectiveness of Research Programs. The acquired questionnaire data were organized to obtain the teaching effect scores of the grassland ecology research course as shown in Table 3. As can be seen from the table, under the condition of 5 points, the average scores of process, summary and motivational evaluation scores are 4.175, 4.261 and 4.097 respectively, and the average value of the overall evaluation scores of the teaching effect of the grassland ecology study course by the students participating in the course is 4.178 points. Overall the teachers and students evaluated the feasibility of the study activities and the richness of ecological civilization literacy training highly, which all exceeded the median score of 3. At the same time, they also thought that the program had a certain degree of difficulty but the difficulty was within the acceptable range.

In addition, it can be seen from the various subindicators of the process, summative and motivational evaluation that their score values ranged from 3.794 points to 4.252 points. Specifically, teachers and students thought that this grassland ecological study course activity was basically feasible, and they thought that this study activity could roughly achieve most of the study objectives. The cultivation of ecological civilization literacy is relatively rich, and basically involves the cultivation of ecological civilization knowledge, awareness, and behavioral literacy. Both educators and students alike perceive the relevance of this study activity to ecological civilization education as being moderately to highly significant, acknowledging its incorporation of essential elements pertaining to ecological civilization education. In terms of the enjoyment derived from the study activity, students, in particular, have bestowed a high appraisal upon its fun elements, exhibiting considerable willingness and interest in participating. In terms of relevant integration, teachers and students thought that this study tour integrated the education of ecological civilization with the educational knowledge of disciplines to a certain extent, which was in the middle evaluation. In terms of the complexity of emotional and behavioral experiences encountered during the study tour, both teachers and students concur that the level of challenge is not insignificant yet remains within an acceptable range. Therefore, according to the existing feedback, the case of the grassland ecological study program designed in this paper has certain feasibility and implementation significance in the opinion of teachers and students.

Table 3. The teaching effect of grassland ecology study course

Type	Index	Score
Process evaluation (4.175)	Ecographic mapping	3.808
	Social survey information collection	3.794
	Field experiment	4.182

	Process analysis of grassland formation	4.217
	Ecological protection behavior experience	3.969
	Ecological community structure analysis	4.096
	The analysis of the contradiction of man	4.252
	The grassland aesthetic examination	4.101
Summative evaluation (4.261)	Complete quality of the graduate school handbook	4.014
	Study course activities	3.994
	Summary report of research course	3.938
	Emotional experience and harvest	3.925
Motivational evaluation (4.097)	Ecological protection behavior	3.972
	Ecological experience inspiration	4.119

4.2.3. Survey and analysis of research courses. The purpose of the grassland ecology study program is to enhance students' view of human-land harmony (T1), improve their knowledge of grassland ecology (T2), improve their comprehensive thinking (T3), and expand their practical geography skills (T4). In addition, the grassland ecology study program was used to enhance students' hands-on practice (T5), life skills (T6), and analytical problem-solving ability (T7) were developed. Based on the above objectives, a questionnaire was used for data collection, and a four-point Likert scale (poor, fair, good, excellent) was utilized to continue to understand the specifics of the students' experiences during the grassland ecology study. The collected data were organized to obtain the results of the survey on the grassland ecological research course as shown in Table 4.

As can be seen from the table, after carrying out the grassland ecology study course, the students' view of human-land coordination, grassland ecology cognitive level, comprehensive thinking and geography practical power all appeared to be improved to a large extent, and the percentage of students who recognized that the above mentioned abilities could be developed reached 69.67%, 73.07%, 70.94%, and 71.83%, respectively. From the new information in these data, it is clear that students have all made great improvements in their core literacy through this grassland ecology study program activity. It also equally reflects that students are more satisfied with the effect achieved by this grassland ecology research course activity. After the school systematically and purposefully carries out research and learning activities and experiences life, students' view of human-land coordination, grassland ecological cognitive level, comprehensive thinking and geography practicality are all better developed, and we should pay more attention to the cultivation of this aspect of the ability and the effect of the ecological research course session in the future. In the future ecological study program, more attention should be paid to the cultivation of this ability and the achievement of the effect.

In addition, the number of students who recognized the practical operation, life skills and analytical problem solving ability reached 75.02%, 80.16% and 76.85% respectively, and their enhancement effect was higher than that of the core literacy. This shows that the grassland ecological study program can enhance students' hands-on ability in the teaching process, enhance students' life skills in the learning process, and better cultivate their independent skills. In the actual social and natural ashes, students can better analyze the problems they face in depth, reasonably use the appropriate knowledge to explain and solve the relevant problems they face, and fully combine the knowledge learned from the textbook to promote a more thorough and clear understanding of the grassland ecosystem, which will enhance the students' awareness of the core qualities related to the ecology of the grassland from the side.

Table 4. The results of the study of grassland ecology

	Level 1	Level 2	Level 3	Level 4

T1	2.06%	28.27%	52.43%	17.24%
T2	3.79%	23.14%	48.16%	24.91%
T3	4.68%	24.38%	42.39%	28.55%
T4	3.14%	25.03%	30.75%	41.08%
T5	2.57%	22.41%	35.28%	39.74%
T6	1.25%	18.59%	40.04%	40.12%
T7	2.43%	20.72%	42.57%	34.28%

5. Conclusion

This article proposes an innovative learning path planning model for grassland ecology courses, which integrates Support Vector Machine (SVM) algorithms with Decision Tree optimization techniques. Through comprehensive analysis of teaching practice data from grassland ecology courses, the research systematically evaluates the effectiveness of the study paths generated by this optimized model.

1) With the increase in the amount of grassland ecology learning knowledge, the convergence accuracy of the DT-SVM algorithm shows optimal accuracy under all experiments, with a mean value of up to 3.652, and although the variance is not the lowest in every experiment, the overall difference is small. The average time consumed to obtain the optimal grassland ecology study course learning path using the DT-SVM model is only about 3.17min.

2) Conducting the grassland ecology research course with the generated optimal grassland ecology research course learning path, the mean value of the overall evaluation score of the students on the teaching effectiveness of the grassland ecology research course was 4.178 points. More than 80% of the students indicated that the grassland ecology study course could enhance their life skills, and more than 70% of the students indicated that it could significantly improve their core literacy related to the discipline of grassland ecology and geography.

The optimized grassland ecology learning pathway, developed through the integration of Support Vector Machine (SVM) algorithms with Decision Tree optimization techniques, significantly enhances the pedagogical framework of grassland ecology studies. This advanced approach enables the design of more diversified and effective curriculum structures, facilitating innovative teaching methodologies that foster students' autonomous learning capabilities and geographical core competencies. Furthermore, this optimization effectively supports the institution's educational objectives in cultivating moral development through ecological education.

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