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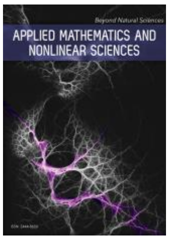


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# Study on the application of BOPPPS teaching model based on multi-objective planning in the educational management of second class students

Huanhuan Chen[1,†]

1. College of Electrical & Information, Hubei University of Automotive Technology, Shiyan, Hubei, 442002, China.

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## Abstract

This paper first analyzes the definition and characteristics of education management for second-class students. Secondly, we construct the BOPPPS teaching model of multi-objective planning based on the algorithm theory of traditional static multi-objective planning algorithm, dynamic multi-objective planning algorithm and performance index of DMOP algorithm. Finally, an empirical analysis of the BOPPPS instructional model in the educational management of second-classroom students was conducted using some students and teachers of Eleventh Middle School. The results showed that most teachers felt that the BOPPPS teaching model was very good, 95.35% were satisfied with the teaching effect, and 98.21% of the secondary teachers were willing to use the BOPPPS teaching model in their future teaching process. Based on this study, it has been concluded that the BOPPPS teaching mode can encourage students' interest in learning.

**Keywords:** Multi-objective planning; Student education management; DMOP algorithm; Performance metrics; BOPPPS teaching model.
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†Corresponding author.
Email address: liebechh@163.com

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## 1 Introduction

The new era of informatization has had a profound impact on the entire international community. First, the current competition between countries is increasingly intense [1]. The new century is the era of information supremacy, and countries' political economy, science, and culture are developing rapidly. In essence, the competition among countries is the competition of human resources [2]. As China enters a new era, it must actively respond to international competition and continuously promote the overall progress of society and the renewal of educational concepts [3]. This also puts forward new requirements for the cultivation of talent in China, how school education can adapt to the needs of the times, and how to provide the country with new talents of high quality and comprehensive ability to meet the new challenges at home and abroad has become an important issue in the current education field [4]. The development of student education management is a key asset to cope with international competition, achieving the great rejuvenation of the Chinese nation and cultivating new talents of the times [5-6].

As an important part of the talent training system, a supplement and extension of the first classroom, a carrier of practical education, and a position of quality cultivation, the second classroom has received more and more attention [7]. With the advancement of the second classroom, our learning style has changed accordingly [8]. The informationization of social life and the globalization of the economy has made the importance of student education management increasingly prominent [9]. Facing the requirements of the new era, how to implement the fundamental task of moral education management of students in the second course, from the actual needs of local universities and students' growth, accurately grasp the characteristics and growth dynamics of students, and innovate the working mechanism based on student education management is a systematic project that needs comprehensive reform from the concept, a working mechanism to the way of realization [10]. An in-depth study of the connotation of the new model of education and management of students in the second course and practice of the new system model of education is of practical significance to achieve the goal of cultivating builders and successors of all-around development [11-12].

To improve students' academic performance, literature [13] conducted a study and analysis of management education and found that traditional educational techniques, augmented by social media applications, can attract students' attention and improve academic performance and student satisfaction. The literature [14] elaborated an entrepreneurial competency evaluation system based on the second classroom, through which the effectiveness of entrepreneurship education was studied, and concluded that the innovative entrepreneurship education system could make students pay more attention to their professional courses and cultivate their innovative thinking. The literature [15] proposed the concept of a digital museum to address the constraints of attending museums as a second classroom activity, and through a comparative analysis of traditional museum education and digital museum education, it was concluded that digital museum education activities are not restricted by transportation and can improve the efficiency of visits.

Secondly, Yang H et al. studied the application of a university student education management system and concluded that data mining techniques applied to the system could improve the speed of data processing and ensure the user's experience of the system [16]. Liu X Y et al. conducted an evaluation experiment on the hybrid BOPPPS teaching model by comparing the final grades of classes taught in different models and concluded that the teaching model of HBOPPPS is more beneficial than the offline BOPPPS teaching model is more conducive to student learning and increases students' learning initiative [17]. Chen L et al. used statistical analysis to study the effect of the BOPPPS model combined with CBL and traditional lecture-based learning on pediatric undergraduate ophthalmology teaching and concluded that the BOPPPS model combined with CBL is more effective than traditional teaching methods by comparing the final exam scores [18].

This paper analyzes the definition of a second classroom, student education management, and the characteristics of combining these two. Then, the multi-objective algorithm is conditionally constrained, and goal planning based on indirect methods such as the weighted summation method, $\varepsilon$ -constraint method, max-min method, efficacy coefficient method and hierarchical sequence method, and the BOPPPS teaching model of multi-objective planning is constructed through the main performance indexes of DMOP algorithm. Finally, the empirical analysis is conducted for the BOPPPS teaching model constructed in this paper, including the descriptive statistical analysis of the BOPPPS teaching effect situation and the result analysis of the BOPPPS teaching effect. Under this teaching model, students' learning becomes more goal-oriented, according to the analysis. More interaction between students and teachers stimulates their interests and makes learning more effective and efficient.

## 2 Second classroom student education management

### 2.1 Second Classroom

The second class is an indispensable part of the talent cultivation process in colleges and universities, and it is what students have to learn outside of attending the first classroom, which is not limited by time and space. The second classroom is an important way of providing quality education and represents a milestone first step in higher education reform. The second classroom is the expansion and extension of the first classroom in terms of naming. At present, scholars have a common definition of the concept of a “second classroom”. The “second classroom” is a teaching method relative to classroom teaching. In the end, the second classroom is a method of teaching which can be referred to as second classroom teaching. Classroom teaching is the practice of full-time teachers conducting classroom teaching activities strictly following the syllabus and teaching contents within the prescribed teaching time. Second-class teaching, on the other hand, refers to teaching and learning activities outside the traditional classroom.

### 2.2 Student Education Management

In the twenty-first century, most students are after “90”, and the management of student education includes ideological and political education, mental health education, student apartment management, evaluation and issuance of scholarships, application and examination of national student loans, financial support for poor students and student medical insurance. Medical insurance and other tasks.

Student education management should use the core content of the people-oriented concept, respect the law of education, the law of talent growth, the law of physical and mental development of the education object, the personality and humanity of students, and so on. In the actual work to establish the “student is the focus and center of all work” concept of education. That is, on the one hand, we should pay attention to the role of students, pay attention to the development and use of students’ potential resources, on the other hand, to improve the quality of students, which is the starting point of work, but also the purpose and destination of work. The success or failure of student education and management is determined by its contribution to the overall development of students and the improvement of comprehensive quality.

### 2.3 Characteristics of the second classroom student education management

By analyzing various scholars' research on the connotation of second-classroom teaching, we have identified the following layers of connotation characteristics concerning the educational management of second-classroom students:

1) Emphasis on flexibility.

Compared with the fixed schedule and fixed classrooms of classroom teaching, the second classroom teaching is relatively free and independent in terms of time and space, and teachers have more room to make flexible arrangements for teaching activities that are conducive to students' development according to their learning conditions and contents.

2) Emphasis on planning.

As one of the teaching methods, the second classroom teaching activity courses must be offered by the school according to the development needs of the students and the school's training goals. The school puts forward clear training objectives, formulates training programs, implementation rules and curriculum plans around the objectives, and then arranges for teachers to carry out, organize and implement them effectively according to the actual situation of students. When implementing second-classroom teaching, teachers must adhere to the relevant regulations and have a thorough teaching plan and curriculum objectives as they do in classroom teaching.

3) Emphasis on activity.

As a unique teaching method, the second classroom teaching should closely focus on the openness and flexibility of the "second classroom" and carry out colorful and educationally meaningful teaching activities. The second classroom teaching should not only consolidate the theoretical knowledge of the first classroom teaching but also improve students' practical ability on this basis, thus promoting the development of students' comprehensive quality.

## 3 BOPPPS teaching model based on multi-objective planning algorithm

### 3.1 Multi-objective planning and related theories

#### 3.1.1 Static multi-objective planning

Taking the minimization problem as an example, Assumption $x \in R^n$, $f : R^n \to R^m$, the static multi-objective planning problem is denoted as:

$$\min_x f(x) = \left( f_1(x), f_2(x), \cdots, f_m(x) \right)^T$$
$$s.t. \begin{cases} g_k(x) \geq 0, k = 1, 2, \cdots, K \\ H_l(x) = 0, l = 1, 2, \cdots, L \\ x_i^{(L)} \leq x_i \leq x_i^{(U)}, i = 1, 2, \cdots, n \end{cases} \tag{1}$$

Where $x = \left[ x_1, x_2, \cdots, x_n \right]^T$ is the decision variable and $f(x)$ is the objective function. $g(x)$ is an inequality constraint, and $K$ inequality constraints are defined. $h(x)$ is the equation constraint, and $L$ equation constraints are defined. $S = \left\{ x \in R^n \mid g_k(x) \geq 0, h_l(x) = 0, x_i^{(L)} \leq x_i \leq x_i^{(U)} \right\}$ denotes the feasible domain of problem (1).

In the 1890s, the French scholar V. Pareto first introduced the plain idea of Pareto optimal solution. The relevant definitions are as follows:

Definition 1: For any two feasible solutions $x$ and $y$, if for $\forall i \in \{1,2,\cdots,m\}$ satisfies $f_i(x) \le f_i(y)$ and $\exists i = \{1,2,\cdots,m\}$ such that $f_i(x) < f_i(y)$, then $x$ is said to dominate $y$, denoted as $x \prec y$, and $x$ is called an undominated solution.

Definition 2: For a feasible solution $x^*$, if there is no $x \in S$ such that $x \in x^*$, then $x^*$ is a Pareto-optimal solution to the problem (1).

Definition 3: All Pareto optimal solutions of problem (1) form an optimal set, which is called the set of Pareto optimal solutions and is denoted as:

$$P^* = \left\{ x^* \in S \mid \exists x \in S, x^* \prec x \right\} \tag{2}$$

Definition 4: The target vector in the target space corresponding to the Pareto optimal solution set in equation (2) forms the Pareto front of the problem (1), denoted as:

$$PF^* = \left\{ f(x) = \left( f_1(x), f_2(x), \cdots, f_m(x) \right) \mid x \in P \right\} \tag{3}$$

Definition $x \in R^n$ corresponds to an objective vector of $Z^i = f(x), Z^i \in R^M, i = 1,2,\cdots,M$. As an example of 2 objective functions, Figure 1 shows a schematic diagram of $PF$.

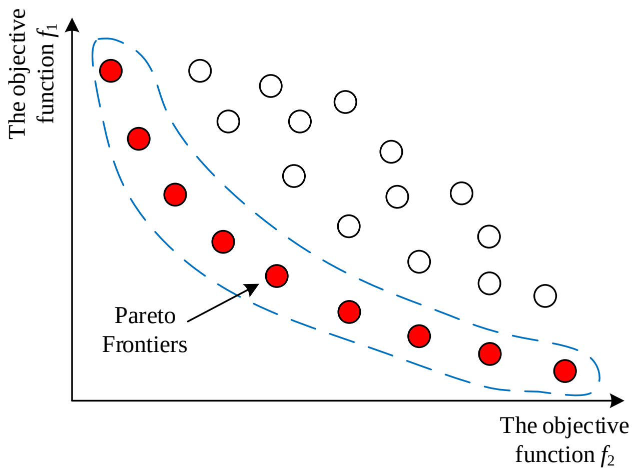


**Figure 1.** Schematic diagram of Pareto Front

In the target space shown above, the set of vectors consisting of the red solid points in the blue dashed box is the Pareto front. There is no dominant relationship between any two points in this set of vectors.

### 3.1.2 Traditional static multi-objective algorithm

In general, the conventional ideas of static multi-objective planning algorithms generally consist of two types of methods: direct and indirect. The direct method is simply defined as solving a multi-objective problem directly or transforming the problem to solve it directly. The indirect method is to transform the multi-objective planning problem into a single objective and then solve it for the single-objective planning problem. The weighted summation method, -constraint method, max-min method, efficacy factor method, hierarchical sequence method, and other traditional algorithms are all indirect methods.

1) Weighted summation method

This method is also known as the linear weighting method, and the main process is to assign weights to each objective in the multi-objective planning problem, that is, to multiply each objective by a weight value customized by the decision maker, and finally to weight and sum. The transformation is denoted as:

$$\min y = F(x) = w_1 f_1(x) + w_2 f_2(x) + \cdots + w_r f_r(x) \tag{4}$$

Where, $x \in \Omega$ is the decision variable, $F(x)$ is the objective function, $w_i (i = 1, 2, \cdots, r)$ is the weight, and $w_i \geq 0$, usually $\sum_{i=1}^{r} w_i = 1$. If we choose weights under different combinations, we are able to obtain different weighted objective functions and solve for the optimal solution that meets the needs of the decision maker.

2) $\varepsilon$ - Constraint method

The core idea of this method is to select only one of the objectives as the optimization objective of the whole problem and use the other objectives as the constraints of $\varepsilon$. The method model is noted as follows:

$$\begin{aligned} &\min y = F(x) = f_k(x) \\ &s.t. g_i(x) = f_i(x) \leq \varepsilon_i, l \leq i \leq r, i \geq\neq k \end{aligned} \tag{5}$$

where the decision variable $x \in X_f$ and $X_f$ is the entire set of feasible solutions and $\varepsilon_i$ is the upper bound of the variable objective function. After the above transformation, the conventional single-objective algorithm is then used to solve the problem. The disadvantage of this method is also obvious, if you need to obtain multiple optimal solutions, you need to take multiple values of $\varepsilon$ and perform multiple calculations, and the computational complexity is large.

3) Maximum-minimum method

For the minimization problem, the main idea of the maximum-minimum method is to minimize the maximum deviation between the function value of each target and the ideal target value. The biggest drawback of this method is that the ideal target value needs to be known in advance. The mathematical model is noted as follows:

$$\min \sum_{i=1}^{k} \left| f_i(x) - T_i \right| \tag{6}$$

4) Efficacy coefficient method

Assuming that the total number of targets is $m$, the main idea of the efficacy coefficient method is to assume that the first $r$ target functions are minimized and the last $(m-r)$ target functions are maximized. In this method, an efficacy factor of $d_k \left(0 \leq d_k \leq 1, k = 1, 2, \cdots, m\right)$ is used to indicate the "good or bad" value of the objective function. If $f(x)$ is the most "good", then $d_k = 1$, and if $f(x)$ is the most "bad", then $d_k = 0$. Finally, the problem is solved by constructing an evaluation function.

Among them, there are various specific forms of the efficacy function $d_k\left(0 \le d_k \le 1, k=1,2,\cdots,m\right)$, such as linear and exponential.

5) Hierarchical sequence method

Based on the importance of each objective, these objectives are ranked, and the corresponding sequence is obtained as $f_1(x), f_2(x),\cdots, f_m(x)$. For a given initial point $x_0$, the corresponding optimization objective is denoted as

$$\begin{aligned} f_1\left(x_0\right) &= \max_{x\subset R_0 \subset R} f_1(x) \\ f_2\left(x_0\right) &= \max_{x\subset R_1 \subset R_0} f_2(x) \\ &\vdots \\ f_m\left(x_0\right) &= \max_{x\subset R_{m-1} \subset R_{m-2}} f_m(x) \end{aligned} \tag{7}$$

6) Other traditional algorithms include the virtual objective method, trade-off ratio substitution method, ideal point method, interaction planning method, etc.

### 3.1.3 Dynamic multi-objective planning

In brief, based on static multi-objective planning with a time parameter $t$, it becomes a DMOP problem. Different combinations of the problem's objective, objective function, parameters, and decision variables with time $t$ can be generally classified into four types of variations, and the multi variability of the types makes the solution of the problem more complicated. The DMOP problem contains two or more objective functions, and the objective function, decision variables, or parameters may all change with time $t$, which makes the DMOP algorithm more difficult than the static multi-objective planning algorithm, which makes the DMOP algorithm more difficult to close than static multi-objective planning algorithms. In general, the minimization DMOP problem containing $M$ objectives can be written as follows:

$$\begin{aligned} &\min F(x,t) = \left(f_1(x,t), f_2(x,t),\cdots, f_M(x,t)\right)^T \\ &s.t.\begin{cases} g_i(x,t) \ge 0, i=1,\cdots,p \\ h_j(x,t)=0, j=1,\cdots,q \\ x\in\Omega_2, t\in\Omega_2 \end{cases} \end{aligned} \tag{8}$$

Where $x$ is a $n$-dimensional decision vector in the decision space $\Omega_x \subseteq R^n$ and $t$ is a discrete-time instance belonging to the time threshold $\Omega \subseteq R$. $f(x,t)$ is the set of minimization objectives relative to time $t$ and $F(x,t):\Omega_x \times \Omega_\uparrow \to R^M$ is the objective vector corresponding to the $x$ vector at the time of evaluation $t$. In addition, $g_i(x,t)$ and $h_j(x,t)$ define the problem constraints over time, where $p$ and $q$ are the number of non-equation constraints and equation constraints, respectively.

When solving dynamic multi-objective planning problems, the intensity or frequency of problem or parameter changes over time should be taken into account. In general, the value of $t$ can be found by the total number of population iterations $\tau$ and the calculation formula is noted as:

$$t = \frac{1}{n_T}\left\lfloor \frac{\tau}{\tau_T} \right\rfloor \tag{9}$$

Where $\tau_T$ is the frequency of environmental change, i.e., the number of dynamic time windows set at a fixed length of a single time window, and $n_T$ represents the degree of drastic environmental change, i.e., the number of population iteration steps set in a single dynamic window.

Several basic definitions of the DMOP problem are presented below:

Definition 5: For a definite time $t$, say that vector $u_t = \left(u_1^t, u_2^t, \cdots, u_n^t\right)^T$ Pareto dominates vector $v_t = \left(v_1^t, v_2^t, \cdots, v_n^t\right)^T$ when and only when $\forall i \in \{1, 2, \cdots, n\}$ makes $u_i^t \le v_i^t$, and $\exists i \in \{1, 2, \cdots, n\}$ makes $u_i^t < v_i^t$.

Definition 6: For a deterministic time $t$, the decision variable $x_u \in D$ is called a Pareto-optimal solution to the DMOP problem when and only when there is no $x_v \in D$ such that $v_t = f\left(x_v, t\right)$ Pareto dominates $u_t = f\left(x_u, t\right)$.

Definition 7: For a deterministic time $t$, all Pareto optimal solutions in the decision space constitute an optimal set, which is called the Pareto optimal solution set.

Definition 8: For a deterministic time $t$, the set of objective vectors corresponding to the PS in the objective space is the Pareto optimal frontier, referred to as PF.

The goal of the DMOP problem is to track the continuously varying PS and PF in a continuous time window, combining the different cases of PS and $PF$ dynamics with time. Table 1 shows the classification of the DMOP problem.

**Table1.** The classification of DMOP problems

| Type of change | PS invariant | PS variation |
|---|---|---|
| PF invariant | Type IV | Type I |
| PF variation | Type III | Type II |

### 3.1.4 Dynamic multi-objective planning algorithm

In dynamic multi-objective planning algorithms, it is a great challenge to quickly detect changes in the environment at every moment, respond promptly, and accurately track the PF within the time window. The algorithm design process must consider the following factors and the abovementioned requirements.

1) The frequency or intensity of changes in the objective function, decision variables, or parameters in the problem must be considered over time.

2) The type of change in the problem and the conditions under which the change occurs need to be considered.

3) It is necessary to consider both the distributivity and convergence of the population.

Compared with the static multi-objective planning algorithm, the detection of environmental changes in a dynamic environment and the response process of the algorithm after the environmental changes are the hotspots of the algorithm design for dynamic multi-objective planning problems, which are also the key points and difficulties. The design flow chart of the DMOP algorithm can be seen in Figure 2.

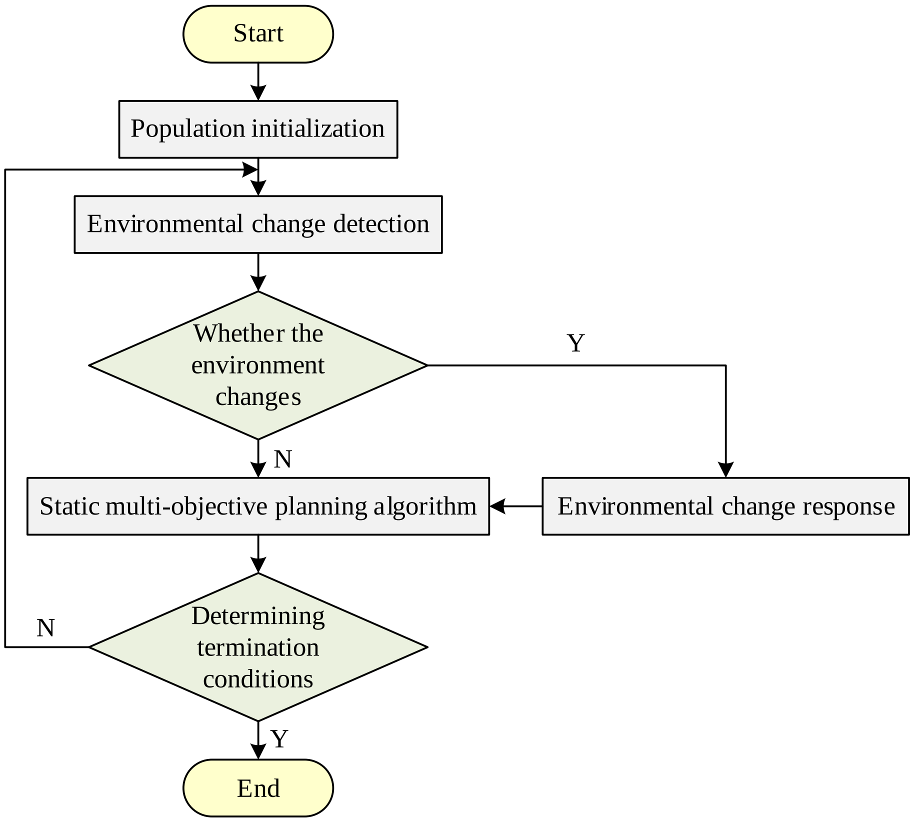


**Figure 2.** Flow chart for the design of dynamic multi-objective programming algorithm

Initial progress in the study of dynamic multi-objective planning problems has been made due to the incessant efforts of scholars, especially since many DMOP evolutionary algorithms have been proposed.

### 3.1.5 Key performance indicators of DMOP algorithm

Scholars have proposed various metric systems to assess the good or bad performance of various dynamic multi-objective planning algorithms. The following considerations are commonly used to measure the performance of DMOP algorithms. The first step is to assess the algorithm's convergence, which reflects the degree of approximation between the optimal solution tracked by the algorithm and the true Pareto optimal frontier. Then, it is to assess the diversity of the optimal set of solutions tracked by the algorithm, where the uniformity in diversity is mainly used to assess the uniformity of the distribution of individuals on the Pareto optimal frontier. Then, it is a measure of the algorithm's detection success in detecting changes in the environment.

1) Convergence evaluation metric mIGD

In static MOEAs, IGD is widely used to measure the diversity and convergence of non-dominated optimal solutions, measuring the degree of offset between the theoretical frontier of the problem and the PF tracked by the algorithm. Furthermore, to consider the optimal frontier PF tracked by all time windows in the dynamic problem, mIGD is proposed, which represents the average IGD throughout the entire running time step.

If $P_f^{t*}$ represents the theoretical PF of the problem at moment $t$ and $P_f^t$ represents the PF tracked by the algorithm at moment $t$, i.e., $P_f^t$ is an approximation of $P_f^{t*}$. At this point, mIGD is denoted as:

$$mIGD\left(P_f^{t*}, P_f^t\right) = \frac{1}{|T|}\sum_{t\in T}\frac{\sum_{v\in P_f^{t*}} d\left(v, P_f^t\right)}{\left|P_f^{t*}\right|} \tag{10}$$

Here, $d\left(v, P_f^t\right)$ represents the minimum Euclidean distance between points $v$ and $P_f^t$ in $P_f^{t*}$ and $\left|P_f^{t*}\right|$ is the modal length of $P_f^{t*}$. $T$ is a set of discrete time variables in the experimental run, and $|T|$ is the modal length of $T$. The smaller the $mIGD$, the better the algorithm performance. The advantage of the reverse generation distance metric is that it is simpler to calculate, and the disadvantage is that it needs to know and set the reference solution set, i.e., the theoretical PF frontier, in advance and cannot evaluate the DMOP problem where the theoretical PF frontier is not known.

2) Uniformity evaluation index Schott spacing

In order to observe the average degree of distribution of individuals in the Pareto optimal frontier, Schott proposed a measure, Schott spacing, denoted as:

$$S_t = \sqrt{\frac{1}{|PF_t|-1}\sum_{i=1}^{|PF_t|}\left(D_i - \bar{D}\right)^2} \tag{11}$$

$$D_i = \min_{k=1,\cdots,|PF_t|,k\neq i}\left(\sum_{j=1}^{m}\left|PF_t(i,j) - PF_t(k,j)\right|\right) \tag{12}$$

Where $PF_t$ is the Pareto optimal frontier tracked by the algorithm at time $t$, $D_i$ is the Euclidean distance between the $i$ th population individual in $PF_t$ and its nearest individual, and $D$ is the average of all $D_i\left(i = 1, 2, \cdots, PF_t\right)$. In the above equation, the smaller the value of $S_t$, the more evenly distributed the individuals of the population $PF_t$ tracked by the algorithm. The advantage of $S$ indicator is that it can visually reflect the distribution of points on PF, and it is also suitable for high-dimensional multi-objective planning problems, but the disadvantage is the high computational complexity.

3) Detection success rate indicator TP

In this paper, we apply this step to the determination of the accuracy of change detection in dynamic multi-objective planning problems. That is, if the distribution uniformity of PF exceeds a certain threshold range, it is determined that the environment of the dynamic multi-objective problem has changed. If the algorithm detects a change in the environment, the situation is noted as the detection success rate TP. Therefore, the TP calculation formula is noted as:

$$TP \approx \frac{L_1}{L_2} \tag{13}$$

Where L1 is the number of changes in the environment detected by the algorithm for the dynamic multi-objective problem during the specified time, and L2 is the total number of actual changes in the environment during the same specified time in that problem.

## 3.2 BOPPPS model definition

The BOPPPS model was originally developed by ISW in Canada, and its specific theoretical model was formally established by Douglas Kerr's team in 1976, which was certified by ISW in North America. They are introduction, learning objectives, pre-test, participatory learning, post-test, and summary. These six elements are represented by six acronyms, which is why the academic community calls this model the BOPPPS model. The whole model highlights student-centered characteristics, emphasis on student subjectivity, participatory learning, and modularity of the teaching process. New teachers can master a set of special teaching model training through training and use this model to ensure the achievement of teaching objectives. Specifically, the BOPPPS teaching model divides the entire classroom teaching into six main teaching links, cutting the teaching content into small units, each expressing their respective connotations in six alphabetic abbreviations. These six links are interlinked, not isolated from each other but interrelated and unified to serve the teaching objectives. Figure 3 shows the teaching process of the BOPPPS teaching model.

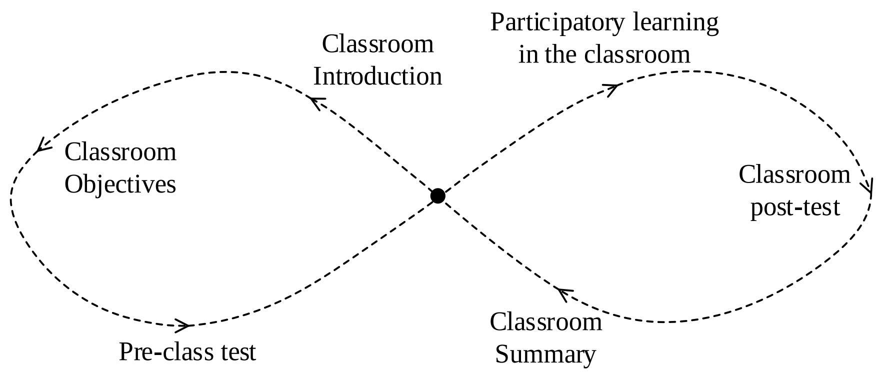


**Figure 3.** Teaching process of the BOPPPS teaching model

## 3.3 BOPPPS teaching model based on multi-objective planning algorithm

This section is about the overall design of the BOPPPS-based teaching model and the content of managing student education in the second classroom.

The second classroom student education management is to cultivate and regulate students' code of conduct by the requirements of the Ministry of Education so that the moral and student management is institutionalized. The school manages to communicate the relationship between the school and students and between students in terms of ideology, teaching administration, teaching work, and general affairs work to achieve the goals and prospects of the school, teachers, and students. The management of student relations should be given attention by schools as it directly affects the school teaching indicators. Strict management of students, standardized management, and humane management, with guidance, motivation, and restraint, so that students learn, grow healthily, and live happily.

1) Introduction

The introduction link should be displayed before the start of the class to attract the attention of students who are brought into the class.

2) Learning Objectives

The learning objectives and expected results of the entire class provide students with a clear direction for learning.

3) Pre-test

The mapping or pre-testing of students after the learning objectives have been set to understand the student's current status and adjust the course's pace.

4) Participatory learning

The teacher and students collaborate to accomplish the classroom objectives and enhance interactivity through participatory learning.

5) Post-test

Before the end of the class, students are tested or evaluated to understand the effectiveness of their learning and to determine whether the teaching objectives can be achieved.

6) Summary

A classroom summary at the end of the course is used to integrate the learning and emphasize the required objectives.

## 4 Empirical analysis of the BOPPPS teaching model in the educational management of second-class students

### 4.1 Data sources

To study and explore the application of the BOPPPS teaching model in the educational management of students in the second classroom, this paper surveyed Eleventh Middle School. Questionnaires and interviews were conducted with some students and teachers as research subjects. Firstly, three classes, each named Senior A, Senior B, and Senior C, with 210 students, were selected as samples. Then, they were surveyed and analyzed using questionnaires. The recovery rate of questionnaires was 94.29%, with 198 valid questionnaires, with 116 male students accounting for 55.23% and 94 female students accounting for 44.76%. After selecting five teachers from each office for interviews, they were combined to summarize the current teaching situation in eleventh-grade classrooms. Figure 4 shows the feedback graph for the questionnaires of the nine classes.

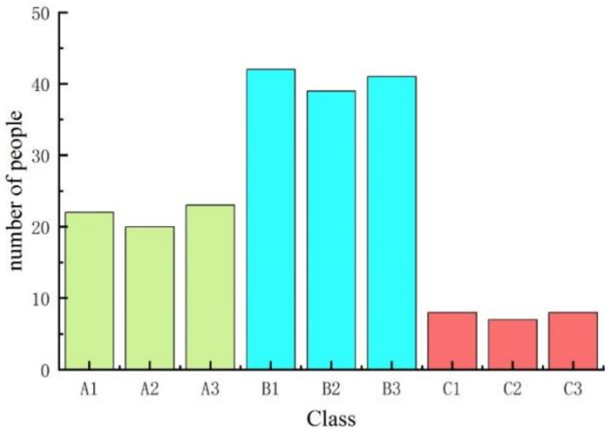


**Figure 4.** Questionnaire situation

From Figure 4, it can be seen that sophomores are the most involved, and juniors are the least involved. Since the senior students just entered the school and the seniors had to prepare for exams, considering all aspects, the author finally chose two classes, B2 and B3, in the sophomore year as the subjects of the educational experiment.

## 4.2 Descriptive statistical analysis of the teaching effectiveness of BOPPPS

In this survey, the questionnaire was divided into five scales: “completely disagree”, “disagree”, “average”, “partially agree”, and “completely agree”. The questionnaire was divided into 5 scales: “totally disagree”, “disagree”, “average”, “partially agree,” and “totally agree”, and the level of agreement of each evaluation dimension can indicate the strength of the respondents’ attitude. The questionnaire consists of 10 questions on a 5-point scale, with 12 questions in the main part, corresponding to 12 factors and 2 dimensions, of which 10 questions belong to the learner dimension. Table 2 shows the descriptive statistical analysis table of the questionnaire.

**Table 2.** Descriptive statistical analysis of the survey questionnaire

| Name | Sample | Minimum value | Maximum value | Mean value | Standard deviation | Median |
|---|---|---|---|---|---|---|
| 5. The educational knowledge and basic skills I learned in the classroom can be fully applied in real life | 198 | 1.000 | 5.000 | 3.663 | 0.923 | 4.000 |
| 6. I can consult a variety of materials before class to study in advance | 198 | 1.000 | 5.000 | 3.326 | 0.956 | 3.000 |
| 7. I can get into the classroom quickly | 198 | 1.000 | 5.000 | 3.326 | 0.953 | 4.000 |
| 8. The teacher has a good classroom teaching session | 198 | 1.000 | 5.000 | 3.663 | 1.140 | 3.000 |
| 9 The teaching process my teacher regularly conducts classroom summaries and teaching reflections | 198 | 1.000 | 5.000 | 3.635 | 1.224 | 4.000 |
| 10.My basic knowledge level is good | 198 | 1.000 | 5.000 | 3.115 | 1.235 | 4.000 |
| 11 My teacher teaches very well | 198 | 1.000 | 5.000 | 3.635 | 1.102 | 3.000 |
| 12.The teacher of the class is able to use the teaching methods he/she has mastered flexibly | 198 | 1.000 | 5.000 | 3.526 | 1.025 | 4.000 |
| 13.The teacher has - a perfect teaching design | 198 | 1.000 | 5.000 | 3.601 | 1.064 | 4.000 |
| 14. The teacher interacts with me very much in class | 198 | 1.000 | 5.000 | 3.115 | 0.922 | 3.000 |
| 15. I can gain a lot of new knowledge from the classroom | 198 | 1.000 | 5.000 | 3.842 | 0.8336 | 4.000 |
| 16. I can complete each task assigned by the teacher carefully | 198 | 1.000 | 5.000 | 3.845 | 0.972 | 4.000 |

As can be seen from Table 2, there are no outliers in the current data so the analysis can be performed directly on the mean values. The average score of the above analysis items ranged from 3.1 to 3.9, with an overall average of about 3.45. The mean value of questions 15 and 16 is 3.84, which means that some students have good self-control, can acquire new knowledge in class, and can consciously complete the tasks assigned by the teacher. However, questions 10 and 14 are lower, only 3.11, which indicates that many students do not have good basic knowledge, and there is less interactive learning between the teacher and students in the classroom.

### 4.3 Result analysis of the teaching effectiveness of BOPPPS

Table 3 displays the result analysis table for the teaching effect of BOPPPS. Table 3 shows that most teachers highly regarded the BOPPPS teaching mode. 49.12% of the teachers were satisfied with the teaching effect, 46.23% were very satisfied with the teaching effect, only 3.05% were uncertain about the teaching effect, and 1.60% were dissatisfied with the teaching effect. Most teachers felt that the BOPPPS teaching mode could be used in the teaching process. The percentage of teachers willing to use BOPPPS teaching mode was 55.86%, 46.25% used BOPPPS teaching mode depending on the situation, and only 1.79% were not willing to use BOPPPS teaching mode.

**Table 3.** The result analysis of BOPPPS teaching effect

| | | | | | |
|---|---|---|---|---|---|
| Content | Teaching evaluation | Satisfied | Very satisfied | Uncertain | Dissatisfied |
| | Percentage | 49.12% | 46.23% | 3.05% | 1.60 |
| | Likelihood of application | Fully applied | Depends on application | Do not apply | |
| | Percentage | 55.86% | 42.35% | 1.79% | |

## 5 Conclusion

The article developed a BOPPPS teaching model for multi-objective planning based on multi-objective planning analysis. Questionnaires and interviews were conducted with some students and teachers of Eleventh Middle School as research subjects, and the following results were obtained:

1) From the descriptive statistical analysis of the teaching effectiveness of BOPPPS, there were no outliers in the data, and the descriptive analysis could be conducted directly for the mean value to obtain an average score value between 3.1-3.9 overall, with an overall mean value of about 3.45. The average value of question 15 and question 16 is 3.84, which means that some students have good self-control, can acquire new knowledge in class, and can consciously and seriously complete the tasks the teacher assigns.

2) From the analysis of the results of the BOPPPS teaching effect, most teachers feel that this mode is very good given the teaching effect of BOPPPS teaching mode, 95.35% of them are satisfied with the teaching effect, and 98.21% of the secondary teachers said they are willing to use BOPPPS teaching mode in the future teaching process.

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## About the Author

Huanhuan Chen, female, Han nationality, 1987-10, born in Hubei Province, Hubei University of Automotive Technology, with the title of Lecturer, director of Office of Student Affairs, graduate’s degree, master’s degree, research direction: mainly engaged in ideological and political education.