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Information Literacy Development Path for Teachers of Finance and Economics in Higher Vocational Colleges and Universities in the Era of Big Data Based on Dynamic Planning

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ABSTRACT

Teachers' information literacy is related to the quality and efficiency of education and teaching in higher vocational colleges and universities. In this paper, a dynamic planning-based scheduling method is constructed to improve teachers' time allocation efficiency and information literacy. First of all, according to the factors and constraints involved in the scheduling problem to determine the goal of solving the scheduling problem, mathematical model, and then the constraints involved in the scheduling of classes, converted into a dynamic planning of the mutually independent and related stages, with 1, 0 indicates whether to meet the constraints. By solving each stage and analyzing the solution of each stage, the optimal value function is summarized, and ACAA is used to traverse all the optimal solutions for each set of constraints. Examples are selected for scheduling test to verify the effectiveness of the algorithm, and the teacher information literacy assessment scale is designed. Applying the class scheduling algorithm to a higher vocational college, the mean value of the overall information literacy scores of the surveyed teachers is 0.15 points higher than the standard reference value, and the effectiveness of the class scheduling algorithm in this paper is verified. Practical experience (58.27%), teaching philosophy (50.19%), and subject requirements (33.36%) are the top three factors affecting teachers' information literacy.

Keywords: Class scheduling algorithm, dynamic programming, ACAA, information literacy

1. Introduction

With the rapid development of modern information technology, promoting the development of education informatization has become an important task in the reform of education and teaching. The goal of education informatization is to comprehensively and deeply use modern information

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technology to promote the reform and development of education, change the form of education and learning mode, improve the quality of education and cultivate innovative talents [1-4].

Nowadays, new technologies such as big data, artificial intelligence and cloud computing are used in education, and the development of teachers' information literacy has become a realistic demand in the information age, and an important measure for the construction of high-quality, specialized and innovative teacher teams [5-6]. However, at present, the development of Chinese teachers' information literacy still exists in a series of problems such as the lack of information knowledge, poor information application ability, insufficient depth of the integration of information technology and education and teaching, and the uneven development of teachers' information literacy, etc. It is obvious that comprehensively improving teachers' information literacy has become a real problem that needs to be solved urgently at present [7-9].

Teachers in colleges and universities shoulder important responsibilities in teaching and research. In teaching, they are the nurturers and shapers of national talents, responsible for creating innovative talents facing the society, the world, and the future, and guiding students to find problems, think about problems, and solve problems [10-12]. Emerging technologies promote the development of society while putting forward new demands on talent cultivation, and also put forward new requirements on the role of teachers. As a teacher, not only do we need to adapt to the social changes brought about by the development of technology, but we also need to apply emerging technologies to education and teaching to add new vitality to education and teaching [13-15]. Specifically to the college teachers themselves, in terms of teaching, college teachers need to use emerging technologies to improve the quality of teaching, and to find out how to combine emerging technologies and disciplines, to promote professional development with disciplinary innovation, and then enhance the quality of training of professionals, in terms of academic research, college teachers are the main force of academic research, shouldering the major tasks of scientific and technological innovation, civilizational progress, and social development, college teachers need to Utilize the emerging information technology to improve their scientific research level, and actively use the emerging technology for problem discovery, problem research in their own professional fields, and form their own research results [16-19]. Emerging information technology is characterized by high efficiency and convenience, and a variety of advanced scientific research software greatly saves the workload of research, greatly improves the efficiency of scientific research, and improves the accuracy of empirical research [20-21]. In conclusion, college teachers, whether in the field of teaching or in the field of scientific research, emerging information technology is gradually becoming an important role, and mastering the relevant technology is of great importance to the professional development of teachers themselves [22].

Teachers are in the school system, and the level of their information literacy development is affected by various factors such as school hardware and software facilities, digital resources, and informatization guarantee mechanism. Therefore, it is necessary to explore the path to improve teachers' information literacy [23-24].

Research in the field of education related to teachers' digital information literacy is mainly divided into several key directions, the status quo of teachers' digital information competence practice, the factors influencing teachers' digital information competence, and the path of teachers' digital information competence enhancement, etc., in which the main use of literature review and questionnaire survey methods to examine the status quo of teachers' digital information competence practice, and the factors influencing teachers' digital information competence and attitudes. Literature [25] combined questionnaire methodology and regression analysis strategy to examine the digital competence practices of Swiss vocational education teachers and the factors influencing teachers' attitudes and application of digital competence, and the results of the study showed that personal factors such as attitudes towards digital information technology and the use of digital tools significantly influenced teachers' digital competence, and curricular factors other than personal factors also significantly influenced teachers' digital competence. Literature [26] examined the attitudes of Indian college teachers towards digital information literacy and digital information technology used in teaching and learning, as well as listing the digital information skills that teachers need to have, and uncovering the factors that impede teachers' digital information literacy, the study provides an effective reference for the discovery of paths to improve digital information literacy among college teachers. Literature [27] systematically reviewed the research on the topic of teachers' digital competence, in which the more important research direction is the self-assessment of teachers' digital competence, and many studies have revealed the inadequacy of teachers' digital competence, and also pointed out that the direction of future research is to further optimize the assessment method of teachers' digital competence and the training of teachers' digital competence improvement. Literature [28] reviewed the dissertation journals on digital competence and teachers' professional development and provided an in-depth analysis by combining PRISMA systematic evaluation and meta-analysis methods, which emphasized the significance of digital competence for teachers as well as for the future of the education field, and also revealed a serious lack of training related to teachers' digital competence and information technology literacy. Based on a quantitative and cross-sectional work design, [29] revealed the shortcomings of digital competence of teachers in the Andalusian (Spanish) community, especially in the creation of digital content, and pointed out that training programs on digital competence do not go far enough to effectively develop teachers' digital pedagogical competence, and that they need to be further optimized and improved. Literature [30] empirically analyzed the factors hindering teachers' digital teaching based on the cases of teachers' IT practices in five countries (the Netherlands, Denmark, Australia, Poland, and Germany), which made a positive contribution to the promotion of teachers' use of digital technology and the digitalization of classroom information. At the end of the above studies also put forward some opinions on the training and paths to improve teachers' digital competence, but they are not detailed enough, and some scholars focus on analyzing the specific contents and methods of the training programs that affect teachers' digital information competence. Literature [31] used a focus interview strategy to examine teachers' attitudes towards digital competence in the field of teaching and learning before and after digital information competence training and how digital competence affects their careers, and based on deductive and inductive analysis techniques, it was clarified that teachers' digital competence training programs should include the categories of, Digital Content Creation, Digital Information Literacy Enhancement, Communication and Collaboration, and that the training should cover the modalities of. Professional Engagement, Digital Resources, Training, etc. Based on theoretical analysis, literature [32] revealed that pre-service teachers' information literacy is directly related to the self-efficacy of information skills practice in teaching, and the indirect impact of perceptual information evaluation literacy on teachers' ICT self-efficacy is stronger, and the direct impact of perceived information search literacy on teachers' ICT teaching self-efficacy is stronger, which is helpful for the optimization of teachers' information literacy training program.

In this paper, we design a class scheduling method based on dynamic planning and use the scheduling algorithm to improve teachers' time allocation efficiency and information literacy. The scheduling factors and soft constraints are analyzed and modeled, and based on the dynamic planning algorithm, the ACAA scheduling algorithm is proposed to transform the multiple constraints in scheduling into mutually independent phases in dynamic planning, analyze the states in each phase, determine the state transfer equations, and analyze and generalize the optimal value function of the dynamic planning to seek for the optimal set of solutions under the compliance of multiple constraints. After checking its performance on examples, the algorithm is applied to a higher vocational college to analyze the information literacy of finance and economics teachers, so as to put forward the proposal of information literacy development path.

2. Dynamic planning based teaching scheduling methods

Dynamic programming is a mathematical method for solving the optimization of the decision-making process and is a basic tool for solving multistage decision-making problems. Dynamic programming is based on the actual nature of various problems, divided into stages to deal with the problem, solve the subproblems, and determine the conditions for the optimal solution. The stages are solved step by step, and the optimal solution of the original problem is finally obtained.

Teaching scheduling based on dynamic programming can greatly optimize the allocation of teachers' time and energy resources and improve teaching efficiency. On this basis, teachers can better plan the allocation of teaching and research time and improve information literacy.

In this paper, we will construct a dynamic planning-based faculty information scheduling system and design a method to evaluate teachers' informationized teaching ability.

2.1. Modeling of Academic Scheduling Issues

2.1.1. Factors and constraints related to the scheduling problem. Scheduling is the rationalization of teachers, students and courses in time and space according to different constraints. The schedules currently used in colleges and universities are generally two-dimensional, with five days of classes per week, four classes per day, and two classes in the morning and two in the afternoon.

The main factors involved in the course scheduling process are teachers, classes, courses, time and classrooms, which are interconnected, and any problems in any step will lead to failure in scheduling and affect the smooth running of teaching activities in schools. Therefore, it is necessary to analyze the factors involved in class scheduling in detail, and the factors to be considered are as follows:

1) Teacher factors. Each teacher has a unique number and the number is related to the college or department to which he or she belongs.

2) Class factors. Classes have a unique number and a corresponding name, which is formulated according to the program to which they belong, the college in which they are located, and the year in which they were enrolled.

3) Course Factor. Different colleges offer different study courses according to their majors. Each course has a corresponding name and number, and depending on the type of course, there are requirements for classrooms, for example, computer classes can only be arranged in the computer room, and so on.

4) Time factor. School classes are held on a weekly basis, five days a week, four classes a day, and the weekly schedule can be different if there is an odd or even weekly situation.

5) Classroom factor. Each faculty has its own classroom, and each classroom has a unique number that distinguishes the type of function of the classroom, as well as a fixed number of seats in the classroom.

Problems such as one person for many classes and one class for many people are frequent conflict phenomena in the process of class scheduling, so constraints need to be introduced to avoid the above conflicts. Constraints consist of two parts: hard constraints and soft constraints. Hard constraints are the conditions that must be observed in the course of scheduling, which can also be called rules; soft constraints are the conditions that are chosen to be satisfied according to the reality.

Hard constraints are the guidelines to measure whether the scheduling program is feasible or not, as long as any one of these conditions is not satisfied, the scheduling work can not be successfully completed. The general hard constraints are as follows:

1) Only one teacher can be assigned to a classroom during the same time period;

2) Only one classroom can be assigned to a class during the same time period;

3) Only one course can be assigned to a classroom during the same time period;

4) The seating capacity of a classroom cannot be less than the class size;

5) The type of classroom must match the type of course.

Soft constraints are used in measuring the degree of merit of the class schedule. The number of soft constraints is related to the reality of the scheduling, if the soft constraints to meet the reality of the situation, which may lead to schedule conflict phenomenon, resulting in the scheduling work can not be carried out smoothly. Usually the soft constraints include the following points:

1) a course in the case of more than one week, the interval between classes should be reasonably

arranged;

2) When teachers or classes have consecutive courses, the distance between classrooms should not be too far;

3) Specialized or difficult courses should preferably be scheduled at times when students' minds are active;

4) Physical education classes should be scheduled in the afternoon or in the second major period of the morning because the human body is tired after physical education classes and it is not appropriate to schedule the classes.

Under the premise of following the hard constraints, the choice of soft constraints is made according to the reality of the school, so that the schedule is not only scientific and reasonable, but also meets the needs of most teachers and students.

2.1.2. Objectives for solving the scheduling problem. The class scheduling problem is an NP-complete problem, and the more combinatorial schemes there are, the higher the complexity of the planning problem. Due to the special characteristics of the NP-complete problem, it is necessary not only to study the factors and constraints associated with the scheduling process, but also to analyze the key problem that is prone to occur: the phenomenon of combinatorial explosion of the class schedule.

An example of the combinatorial explosion phenomenon of the scheduling process: classes are held five days a week, two classes are scheduled in the morning and two classes in the afternoon each day, and the schedule is not divided into odd and even weeks. The existing three courses, the weekly hours were 1, 2, 3, with F, S, T, respectively, the three courses, n that the number of spaces in the schedule [33]. Scheduling for the three courses, as the number of spaces in the schedule n changes, the number of scheduling options for these three types of courses also changes, the course algorithm formula is as follows:

$$F(n)=C_n^1(n=1,2,3,\ldots,20) \tag{1}$$

$$S(n)=C_n^2(n=1,2,3,\ldots,20) \tag{2}$$

$$T(n)=C_n^3(n=1,2,3,\ldots,20) \tag{3}$$

2.1.3. Mathematical modeling of the scheduling problem. The scheduling problem is a multi-objective decision-making problem with multiple constraints, if we set the objective function as k, the constraints as m, and the decision variables as n, the mathematical model of the scheduling problem is as follows:

$$\max y=f\left(f_1(x),f_2(x),\ldots,f_k(x)\right) \tag{4}$$

$$s.t.e(x)=\left(e_1(x),e_2(x),\ldots e_m(x)\right)\leq 0 \tag{5}$$

where: $x=\{x_1,x_2,\ldots,x_n\}\in X$, $y=\{y_1,y_2,\ldots,y_k\}\in Y$.

Eq. (4) is the objective function of the scheduling problem and Eq. (5) is the constraints of the scheduling problem. Where x is the decision vector, y is the objective vector, X is the decision space formed by x and Y is the objective space formed by y. The multi-objective optimization of the scheduling problem is to find the maximum value of y.

In class scheduling, each teacher teaches a fixed course, and each class also has a fixed course, so the decision vector of the class scheduling problem is mainly composed of two factors: time and classroom. The time aspect is reflected in the day of the week, the number of classes per week, etc., and the classroom aspect is reflected in the type of classroom, number of seats, etc., in which the course is scheduled.

The essence of the scheduling problem is to rationalize classrooms and time to teachers and classes, and to avoid conflicts between these five factors at the same time. Five sets can be used to represent these factors: class set $C=\{C_1,C_2,C_3,\ldots C_M\}$, teacher set $S=\{S_l,S_2,S_3,\ldots,S_K\}$, time set $T=\{T_1,T_2,T_3,\ldots,T_D\}$, classroom set $R=\{R_1,R_2,R_3,\ldots,R_N\}$, course set $L=\{L_1,L_2,L_3,\ldots,L_P\}$.

According to the definition of the above sets, the following conditions must be followed in the scheduling process to ensure the feasibility of the class schedule.

1) A teacher cannot be in two classrooms at the same time:

$$R1:\sum_{p=1}^{P}\sum_{n=1}^{N}\sum_{m=1}^{M} xl_p c_m r_n s_k t_d \le 1 \tag{6}$$

Where: $k=1,2,\ldots,K$; $d=1,2,\ldots,D$; $xl_p c_m r_n s_k t_d = \begin{cases} 1, \text{ fulfillment of conditions} \\ 0, \text{ condition not met} \end{cases}$.

2) A class cannot be taught in two classrooms at the same time:

$$R2:\sum_{p=1}^{P}\sum_{n=1}^{N}\sum_{k=1}^{K} xl_p c_m r_n s_k t_d \le 1 \tag{7}$$

Where: $m=1,2,\ldots,M$; $d=1,2,\ldots,D$; $xl_p c_m r_n s_k t_d = \begin{cases} 1, \text{ fulfillment of conditions} \\ 0, \text{ condition not met} \end{cases}$.

3) A classroom cannot have two courses scheduled at the same time:

$$R3:\sum_{p=1}^{P}\sum_{m=1}^{M}\sum_{k=1}^{K} xl_p c_m r_n s_k t_d \le 1 \tag{8}$$

In the formula: $n=1,2,\ldots,N$; $d=1,2,\ldots,D$; $xl_p c_m r_n s_k t_d = \begin{cases} 1, \text{ fulfillment of conditions} \\ 0, \text{ condition not met} \end{cases}$.

Eqs. (6) to (8) are hard constraints that must be observed in the scheduling problem, and only by observing the hard constraints can we avoid the conflict phenomenon in the class schedule and ensure that the scheduling work is carried out smoothly.

2.2. Dynamic Planning Algorithm

2.2.1. Algorithmic thinking. Dynamic programming algorithms are generally used to solve problems with some optimal properties, the basic idea of the algorithm will be solved by decomposing the problem into a number of interrelated phases, the phases are arranged in a certain order, one by one to solve the phases, the solution of the next phase depends on the solution of the previous phase, and ultimately get the solution of the original problem. For the recurring sub-problems, the table record method is used, so that when the sub-problems are calculated again, only the solution of the sub-problems that have been calculated can be found in the table, which avoids a large number of repetitive calculations, saves time, and improves the speed of solving the problem.

2.2.2. Basic Model. When using dynamic programming to study the optimal value of a problem, the real problem needs to be transformed into the mathematical terminology of dynamic programming, and the following terminology is agreed upon as follows:

1) Phase. The actual problem to be dealt with is divided into independent and interrelated processing stages in time or space, and each stage is solved one by one to finally find the optimal solution of the problem. Stage variables are variables that describe each stage. It is represented by $U(k)(k\in N)$. For example, $U(5)$ represents the 5th stage.

2) State. Indicates the natural state or objective conditions within each stage, described by a set of variables. The state variable is denoted by $U_i(k)(k,i\in N)$. For example, $U_2(5)$ denotes the 2nd state

variable of stage 5;

3) Decision-making. Solving for the decision to be made in the next stage, based on the state of each stage, through the state of this stage, is called decision making. $D\left[U_i(k)\right]$ denotes the set of decisions allowed in stage k from state variable U_i to the next stage, and $D_j\left[U_i(k)\right](i, j \in N)$ denotes the decision from state variable i in stage k to state variable j in stage $k+1$;

4) State transfer. When moving from the previous stage to the next stage, its state is shifted and the solution of the previous stage has an effect on the next stage, denoted by $X_j\left[U_i(k)\right](i, j \in N)$ the state transfer from the k stage $U_i(k)$ state variable to the $k+1$ stage $U_j(k+1)$ [34]. State transfer equation:

$$U_j(k+1) = X_j\left[U_i(k)\right] \tag{9}$$

5) Optimal value function. Denote by $r_i\left\{U_i(k), X_j\left[U_i(k)\right]\right\}$ the value function of the decision on $U_i(k)$, $X_j\left[U_i(k)\right]$ state variables under the set of permissible decisions, analyze the state of each stage with the solution of each stage, and generalize the optimal value function according to the state transfer equation:

$$f\left\{X_j\left[U_i(k)\right]\right\} = opt\left\{f\left[U_i(k)\right] + r_{ij}\left\{U_i(k), X_j\left[U_i(k)\right]\right\}\right\} \tag{10}$$

2.2.3. Solution ideas. Dynamic programming is a mathematical method for solving the optimization of the decision-making process, and its solution steps are specifically divided into the following parts:

1) Analyze whether the original problem can be solved by a dynamic programming algorithm;
2) Determine the decision object of the problem;
3) Divide the decision-making process into stages;
4) Determine the state variables for each stage;
5) Establish the transfer process of state variables in each stage;
6) Determine the optimal value function;
7) Derive a solution to the original problem.

2.3. ACAA Algorithm

2.3.1. Solution ideas. Each factor to be considered in scheduling is transformed into associated phases of a dynamic plan, with each phase containing multiple state variables. A solid line connecting the state variables between two phases indicates a state that meets the constraints of the preceding and following phases. The state variables between two phases connected by a dashed line represent states that do not meet the constraints of the before and after state variables. Where a solution meets all constraints, its per-phase connections are solid lines. By solving for the solution that meets the constraints at each stage, the total solution for all stages is obtained. Thus, the complex scheduling problem is transformed into a problem of solving for the maximum value of the path.

2.3.2. Modeling. According to the general model of class scheduling, in order to facilitate the analysis and demonstration of the ACAA algorithm and simplify the actual class scheduling environment, according to the actual situation of class scheduling, the algorithm analysis temporarily considers only seven factors: classroom, operating system, software, semester, teaching week, teaching day, class time; each factor contains only a small number of variables, based on the definition of the constraints model, and in accordance with the general process of considering the factors in the scheduling of the class, the various factors into the following stages, assuming that the simplified scheduling model diagram is shown in Figure 1:

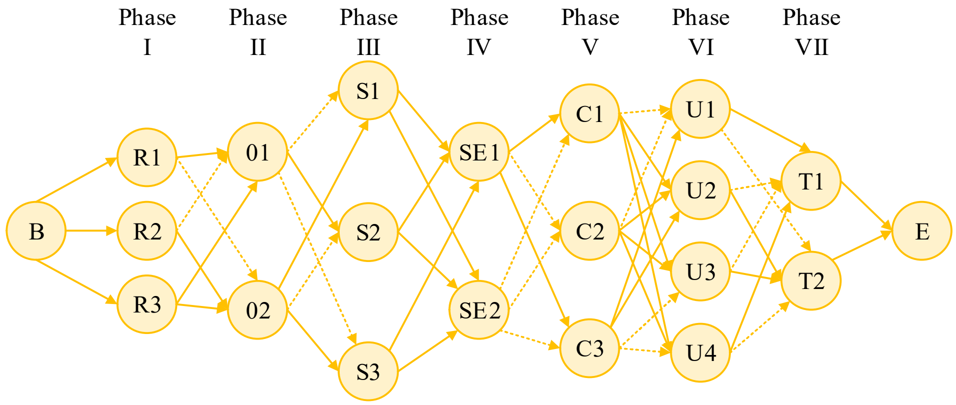

Fig. 1. the class model diagram

As can be seen from the figure, the scheduling system is divided into seven phases, from the start condition to the end of scheduling, excluding the start and end phases, and the state variables are both the end of the previous phase and the beginning of the next phase. A real line is found dynamically through each phase based on the constraints of the machine room scheduling. The existence of a real line that meets the constraints is said to have a solution to the dynamic programming optimal value function for this set of constraints. Where the real line runs through the state variables of the second stage, i.e., the machine rooms that meet the constraints, an optimal solution under this set of scheduling constraints [35].

$U_i(k)$ denotes the i rd state variable of stage k, then:
$U(0)=\{B\}$, the start phase;
$U(1)=\{R_1,R_2,R_3\}$, Phase 1, which includes three machine rooms;
$U(2)=\{O_1,O_2\}$, Phase 2, which has two optional operating systems;
$U(3)=\{S_1,S_2,S_3\}$, Phase 3, which contains 3 applications;
$U(4)=\{SE_1,SE_2\}$, Phase 4, which consists of 2 semesters;
$U(5)=\{C_1,C_2,C_3\}$, Phase 5, which contains 3 teaching weeks;
$U(6)=\{U_1,U_2,U_3,U_4\}$, Phase 6, which contains 4 optional instructional days;
$U(7)=\{T_1,T_2\}$, Phase 7, which consists of 2 class periods;
$D[U_i(k)]$ denotes the set of allowed decisions in stage K, e.g., $D[U_1(5)]=\{U_2,U_3,U_4\}$, denotes the set of paths between C_1 and U_2,U_3,U_4 that can be selected from stage 5; $X_j[U_i(k)]$ denotes the state transfer from the k-stage $U_i(k)$ state variable to the $k+1$-stage $U_j(k+1)$, then:

$$U_j(k+1)=X_j[U_i(k)] \tag{11}$$

Fetch function:

$$r_{ij}\left[U_i(k),X_j(k)\right]\in\{0,1\} \tag{12}$$

0 means that the line connecting the two state variables is dashed, and 1 means that the line connecting the two state variables is solid.

2.3.3. Algorithm analysis. In the following, the scheduling problem which has been divided into stages is solved step by step from the final stage to the forward stage by using the dynamic programming method reverse recursive method. Let $f_k[U_i(k)]$ denote the value of arriving at the end scheduling stage from each state $U_i(k)$ in stage k, when $k=7$, since the line between the points T_1 and E is real, and the line between the points T_2 and E is real, then:

$$f_7(T_1)=1, f_7(T_2)=1 \tag{13}$$

When $k=6$: The values of state variables U_1, U_2, U_3, U_4 in stage 6 to state variables T_1, T_2 in stage 7 as a function of the imaginary reality of the line segment between two points:

$$f_6(U_1)=\max\begin{bmatrix} r_6(U_1,T_1)+f_7(T_1) \\ r_6(U_1,T_2)+f_7(T_2) \end{bmatrix}=\max\begin{bmatrix} 1+1 \\ 0+1 \end{bmatrix}=2 \tag{14}$$

$$f_6(U_2)=\max\begin{bmatrix} r_6(U_2,T_1)+f_7(T_1) \\ r_6(U_2,T_2)+f_7(T_2) \end{bmatrix}=\max\begin{bmatrix} 0+1 \\ 1+1 \end{bmatrix}=2 \tag{15}$$

$$f_6(U_3)=\max\begin{bmatrix} r_6(U_3,T_1)+f_7(T_1) \\ r_6(U_3,T_2)+f_7(T_2) \end{bmatrix}=\max\begin{bmatrix} 0+1 \\ 0+1 \end{bmatrix}=1 \tag{16}$$

$$f_6(U_4)=\max\begin{bmatrix} r_6(U_4,T_1)+f_7(T_1) \\ r_6(U_4,T_2)+f_7(T_2) \end{bmatrix}=\max\begin{bmatrix} 1+1 \\ 0+1 \end{bmatrix}=2 \tag{17}$$

Due to $Z=8$, this set of multiple constraints in order to have a solution to the objective function, when $f_6(U_3)=1$, even if the function value of the previous phases are 1, the final objective function value can only be 7, that is, $7<8$. Obviously, U_3 does not meet the conditions, and the U_3 state can be excluded in the next projection. Based on the function value of 1 for each variable in the phase 6 stage to each variable in the phase 7 stage, the result of removing the non-compliant conditions yields all the paths that meet the current constraints as follows:

Path 1: $U_1->T_1$;
Path 2: $U_2->T_2$;
Path 3: $U_{4\_}>T_1$;

When $k=5$: The value of each state variable C_1, C_2, and C_3 in stage 5 as a function of the state variables U_1, U_2, and U_4 in stage 6, based on the imaginary reality of the line segment between the two points:

$$f_5(C_1)=\max\begin{bmatrix} r_5(C_1,U_1)+f_6(U_1) \\ r_5(C_1,U_2)+f_6(U_2) \\ r_5(C_1,U_4)+f_6(U_4) \end{bmatrix}=\max\begin{bmatrix} 0+2 \\ 1+2 \\ 1+2 \end{bmatrix}=3 \tag{18}$$

$$f_5(C_2)=\max\begin{bmatrix} r_5(C_2,U_1)+f_6(U_1) \\ r_5(C_2,U_2)+f_6(U_2) \\ r_5(C_2,U_4)+f_6(U_4) \end{bmatrix}=\max\begin{bmatrix} 0+2 \\ 1+2 \\ 1+2 \end{bmatrix}=3 \tag{19}$$

$$f_5(C_3)=\max\begin{bmatrix} r_5(C_3,U_1)+f_6(U_1) \\ r_5(C_3,U_2)+f_6(U_2) \\ r_5(C_3,U_4)+f_6(U_4) \end{bmatrix}=\max\begin{bmatrix} 1+2 \\ 1+2 \\ 0+2 \end{bmatrix}=3 \tag{20}$$

Based on the function value of 1 for each variable in stage 5 to each variable in stage 6, the result of removing the non-compliant conditions yields all paths that meet the current constraints as follows:

Path 1: $C_1->U_2->T_2$;
Path 2: $C_1->U_4->T_1$;
Path 3: $C_2->U_2->T_2$;
Path 4: $C_2->U_4->T_1$;
Path 5: $C_3->U_1->T_1$;
Path 6: $C_3->U_2->T_2$;

When $k=4$: the value of each state variable Se_1, Se_2 in stage 4 as a function of the state variables C_1, C_2, C_3 in stage 5, based on the imaginary reality of the line segment between the two points:

$$f_4\left(Se_1\right)=\max\begin{bmatrix} r_4\left(Se_1,C_1\right)+f_5\left(C_1\right) \\ r_4\left(Se_1,C_2\right)+f_5\left(C_2\right) \\ r_4\left(Se_1,U_3\right)+f_5\left(C_3\right) \end{bmatrix}=\max\begin{bmatrix} 0+3 \\ 1+0 \\ 1+3 \end{bmatrix}=4 \tag{21}$$

$$f_4\left(Se_2\right)=\max\begin{bmatrix} r_4\left(Se_2,C_1\right)+f_5\left(C_1\right) \\ r_4\left(Se_2,C_2\right)+f_5\left(C_2\right) \\ r_4\left(Se_2,U_3\right)+f_5\left(C_3\right) \end{bmatrix}=\max\begin{bmatrix} 0+3 \\ 0+3 \\ 0+3 \end{bmatrix}=3 \tag{22}$$

Since $Z=8$ is the only way to meet the multi-constraints under the objective function has a solution, when $f_4\left(Se_2\right)=3$, even if the function value of the previous phases are 1, the objective function value can only be 7 in the end, it is clear that Se_2 does not meet the conditions, and the Se_2 state is excluded from the next projection. Based on the function value of 1 for each variable in stage 4 to each variable in stage 5, the result of removing the conditions that are not met yields all paths that meet the current constraints as follows:

Path 1: $Se_1>C_1->U_2->T_2$;
Path 2: $Se_1->C_1->U_4->T_1$;
Path 3: $Se_1>C_3->U_1->T_1$;
Path 4: $Se_1>C_3->U_2->T_2$;

When $k=3$: the value of state variable S_1,S_2,S_3 in stage 3 as a function of state variable Se_1 in stage 4, based on the imaginary reality of the line segment between the two points:

$$f_3\left(S_1\right)=\max\left[r_3\left(S_1,Se_1\right)+f_4\left(Se_1\right)\right]=\max[1+4]=5 \tag{23}$$

$$f_3\left(S_2\right)=\max\left[r_3\left(S_2,Se_1\right)+f_4\left(Se_1\right)\right]=\max[1+4]=5 \tag{24}$$

$$f_3\left(S_3\right)=\max\left[r_3\left(S_3,Se_1\right)+f_4\left(Se_1\right)\right]=\max[1+4]=5 \tag{25}$$

Based on the function value of 1 for each variable in stage 3 to each variable in stage 4, the result of removing the conditions that are not met yields all paths that meet the current constraints as follows:

Path 1: $S_1->Se_1->C_1->U_2->T_2$;
Path 2: $S_1->Se_1->C_1>U_4>T_1$;
Path 3: $S_1->Se_1->C_3>U_1->T_1$;
Path 4: $S_1->Se_1->C_3->U_2->T_2$;
Path 5: $S_2->Se_1->C_1->U_2->T_2$;
Path 6: $S_2->Se_1->C_1>U_4->T_1$;
Path 7: $S_2->Se_1->C_3>U_1>T_1$;
Path 8: $S_2->Se_1->C_3>U_2->T_2$;
Path 9: $S_3->Se_1->C_1->U_2->T_2$;
Path 10: $S_3->Se_1>C_1->U_4->T_1$;
Path 11: $S_3->Se_1>C_3>U_1->T_1$;
Path 12: $S_3->Se_1>C_3->U_2->T_2$;

When $k=2$: the value of each state variable O_1,O_2 in stage 2 as a function of state variable S_1,S_2,S_3 in stage 3, based on the imaginary reality of the line segment between the two points:

$$f_2\left(O_1\right)=\max\begin{bmatrix} r_2\left(O_1,S_1\right)+f_3\left(S_1\right) \\ r_2\left(O_1,S_2\right)+f_3\left(S_2\right) \\ r_2\left(O_1,S_2\right)+f_3\left(S_3\right) \end{bmatrix}=\max\begin{bmatrix} 0+5 \\ 1+5 \\ 0+5 \end{bmatrix}=6 \tag{26}$$

$$f_2\left(O_2\right)=\max\begin{bmatrix} r_2\left(O_2,S_1\right)+f_3\left(S_1\right) \\ r_2\left(O_2,S_2\right)+f_3\left(S_2\right) \\ r_2\left(O_2,S_2\right)+f_3\left(S_3\right) \end{bmatrix}=\max\begin{bmatrix} 1+5 \\ 0+5 \\ 1+5 \end{bmatrix}=6 \tag{27}$$

Based on the function value of 1 for each variable in stage 2 to each variable in stage 3, the result of removing the non-compliant conditions yields all paths that meet the current constraints as follows:

Path 1: $O_1 -> S_2 -> Se_1 -> C_1 -> U_2 \rightarrow T_2$;

Path 2: $O_1 -> S_2 -> Se_1 -> C_1 -> U_4 -> T_1$;

Path 3: $O_1 -> S_2 -> Se_1 -> C_3 -> U_1 > T_1$;

Path 4: $O_1 -> S_2 -> Se_1 -> C_3 -> U_2 -> T_2$;

Path 5: $O_2 -> S_1 -> Se_1 -> C_1 > U_2 > T_2$;

Path 6: $O_2 -> S_1 -> Se_1 -> C_1 -> U_4 > T_1$;

Path 7: $O_2 -> S_1 -> Se_1 -> C_3 -> U_1 > T_1$;

Path 8: $O_2 \rightarrow S_1 -> Se_1 -> C_3 \rightarrow U_2 \rightarrow T_2$;

Path 9: $O_2 -> S_3 -> Se_1 -> C_1 -> U_2 -> T_2$;

Path 10: $O_2 -> S_3 \rightarrow Se_1 > C_1 -> U_{4-} - T_1$;

Path 11: $O_2 -> S_3 -> Se_1 -> C_3 -> U_1 > T_1$;

Path 12: $O_2 -> S_3 -> Se_1 > C_3 -> U_2 -> T_2$;

When $k=1$: the value of each state variable R_1,R_2,R_3 in stage 1 as a function of state variable O_1,O_2 in stage 2, based on the imaginary reality of the line segment between the two points:

$$f_1\left(R_1\right)=\max\begin{bmatrix} r_1\left(R_1,O_1\right)+f_2\left(O_1\right) \\ r_1\left(R_1,O_2\right)+f_2\left(O_2\right) \end{bmatrix}=\max\begin{bmatrix} 1+6 \\ 0+6 \end{bmatrix}=7 \tag{28}$$

$$f_1\left(R_2\right)=\max\begin{bmatrix} r_1\left(R_2,O_1\right)+f_2\left(O_1\right) \\ r_1\left(R_2,O_2\right)+f_2\left(O_2\right) \end{bmatrix}=\max\begin{bmatrix} 0+6 \\ 1+6 \end{bmatrix}=7 \tag{29}$$

$$f_1\left(R_3\right)=\max\begin{bmatrix} r_1\left(R_3,O_1\right)+f_2\left(O_1\right) \\ r_1\left(R_3,O_2\right)+f_2\left(O_2\right) \end{bmatrix}=\max\begin{bmatrix} 1+6 \\ 1+6 \end{bmatrix}=7 \tag{30}$$

Based on the function value of 1 for each variable in stage 1 to each variable in stage 2, the result of removing the non-compliant conditions, the optimal value function for kth and $k-1$nd order can be derived from the above reasoning as follows:

$$f_k\left[U_i(k)\right]=\max\left\{r\left[U_i(k),X_j(k)\right]+f_{k-1}\left[U_i(k-1)\right]\right\}(k,i,j\in N) \tag{31}$$

A state variable that meets the constraints can make a recursive decision to the next stage if and only if $f_k[U(k)]=K+1-k$ (K denotes the number of stages).

According to the solved path, there are at most 24 sets of constraints that can satisfy the scheduling requirement in the current case. When the given scheduling multi-constraints group is $\left\{O_2,S_3,Se_1,C_3,U_2,T_2\right\}$, recursively solving U_2 to O_2 from T_2, according to the ACAA scheduling algorithm, the optimal set of solutions that satisfy this multi-constraints group can be quickly queried $\left\{R_2,R_3\right\}$; according to the analysis of the algorithm, the ACAA scheduling algorithm is able to find out all optimal solutions that satisfy the constraints.

3. Experiment on the testing of teaching scheduling algorithms

3.1. Test examples

3.1.1. Introduction to examples. A scheduling experiment was conducted for a general finance and economics foundation course at a higher education institution. The teaching schedule of the application example was organized on a weekly basis, with six working days per week, and each working day was divided into eight teaching time slots (four in the morning and four in the afternoon). This includes a Saturday afternoon break, self-study in the eighth time slot on Mondays and Fridays, and career planning education in the eighth session on Wednesdays. The actual number of available instructional time slots is 41, with each 1 time slot being 1 class period.

All classes are 13 courses, of which A Microeconomics, B Macroeconomics, C Statistics, D Finance, E Insurance, and F Investments do not differentiate between credit or elective courses and do not require walk-in classes. F Investment and G Financial Management require attendance at the appropriate classroom. H International Finance, I Econometrics, J Corporate Law, K Banking Management, L Securities Investment, and M Accounting do not distinguish between examination or elective courses.

3.1.2. Experimental environment. The running environment and development tools for this paper are as follows:

Operating system: Win7 Professional SP1, 64-bit.
Processor: Inter® Core(TM) i5-5300U CPU@2.30Ghz
Memory: 4GB
Development tools: Microsoft Visual Studio 2010

3.2. Experimental results

3.2.1. Results of the class combination of elective courses determined based on the dynamic programming strategy. Based on the results of the student course selection statistics, the class elective course portfolio is set up in such a way that it can maximize the students' course selection needs. At this stage, the main goal is to try to match the curriculum of the class elective course portfolio with the overall student elective results. At the same time the students are divided into classes with an initial solution to facilitate the next stage of class optimization for each class and student. The detailed initial class placement results and class characteristics settings are shown in Table 1.

Table 1. Class selection

Class	H	I	J	K	L	M	G
1	0	21	37	38	32	0	29
2	0	38	0	0	0	0	0
3	0	0	0	30	0	26	22
4	43	51	29	25	33	26	0
5	0	0	40	0	0	0	45
6	0	31	0	26	23	0	0
7	0	0	51	38	32	0	21
8	43	45	0	0	0	51	0
9	39	50	41	25	29	52	52

10	46	0	0	23	42	0	0
11	0	35	45	0	0	0	0
12	0	0	0	38	36	34	0
13	0	0	47	0	0	0	0
14	37	21	36	48	44	32	34
15	48	0	0	0	38	0	0
16	31	0	0	34	0	52	0
17	30	30	20	23	0	0	0

3.2.2. Curriculum alignment program. As can be seen from the previous class placement results, some students in some classes choose elective courses that are not in the class elective course portfolio of the class, which means that the relevant courses offered in this class are academic exam courses, and it will be necessary for these students to walk to other classes that offer corresponding elective courses. The detailed course walk program is shown in Table 2.

Table 2. Class plan

Class	Student number							Learn the number of students in the exam						
	H	I	J	K	L	M	G	H	I	J	K	L	M	G
1	0	21	37	38	32	0	29	25	21	24	0	37	0	30
2	0	38	0	0	0	0	0	52	36	0	34	38	51	0
3	0	0	0	30	0	26	22	0	0	52	0	0	23	24
4	43	51	29	25	33	26	0	0	0	0	50	52	31	41
5	0	0	40	0	0	0	45	25	51	0	44	0	0	0
6	0	31	0	26	23	0	0	0	48	33	27	36	24	42
7	0	0	51	38	32	0	21	24	0	0	0	26	42	47
8	43	45	0	0	0	51	0	42	43	43	31	0	46	0
9	39	50	41	25	29	52	52	0	25	26	29	20	29	43
10	46	0	0	23	42	0	0	49	0	0	0	46	0	53
11	0	35	45	0	0	0	0	0	0	22	36	35	21	0
12	0	0	0	38	36	34	0	24	21	44	41	44	50	30
13	0	0	47	0	0	0	0	48	28	27	0	0	0	33
14	37	21	36	48	44	32	34	0	30	0	24	37	22	29
15	48	0	0	0	38	0	0	0	33	41	23	41	49	0
16	31	0	0	34	0	52	0	39	0	29	0	26	46	50
17	30	30	20	23	0	0	0	20	27	0	27	0	0	0

3.2.3. Dynamic Planning Approach to Resolving Teacher Conflicts. Before scheduling classes, it is first necessary to assign teachers to each course, for each course in accordance with certain teacher constraints, for each teacher to arrange classes, in the courses that distinguish between elective and academic courses, try to arrange for the same teacher to teach only elective or academic courses. The specific teacher allocation scheme is shown in Table 3.

In the scheduling process, it is required that the same teacher cannot be arranged in two different classrooms in the same period of time. In the first stage of scheduling, the hill-climbing method is firstly utilized to generate an initial solution without teacher conflict (hard conflict), and due to the relative abundance of the number of teachers, it is easy to obtain an initial solution without hard conflict.

Table 3. Teacher assignment scheme

Class	H	I	J	K	L	M	G	A	B	C	D	E	F
1	T0003	T0104	T0203	T0308	T0403	T0504	T0603	T0707	T0802	T0901	T1007	T1104	T1205
2	T0005	T0105	T0204	T0308	T0406	T0505	T0607	T0708	T0805	T0907	T1005	T1102	T1202
3	T0003	T0101	T0202	T0302	T0408	T0503	T0603	T0705	T0806	T0906	T1001	T1103	T1203
4	T0006	T0106	T0207	T0306	T0401	T0507	T0601	T0706	T0801	T0909	T1002	T1107	T1204
5	T0003	T0109	T0204	T0308	T0405	T0501	T0605	T0704	T0802	T0901	T1004	T1102	T1208
6	T0004	T0107	T0202	T0307	T0409	T0504	T0608	T0707	T0808	T0905	T1003	T1101	T1209
7	T0001	T0115	T0205	T0301	T0404	T0504	T0607	T0702	T0804	T0904	T1005	T1108	T1201
8	T0007	T0108	T0209	T0305	T0402	T0505	T0606	T0701	T0803	T0903	T1006	T1109	T1207
9	T0005	T0104	T0204	T0309	T0406	T0507	T0604	T0703	T0801	T0907	T1007	T1105	T1205
10	T0006	T0103	T0202	T0303	T0409	T0509	T0608	T0705	T0805	T0902	T1008	T1104	T1206
11	T0003	T0109	T0203	T0304	T0407	T0502	T0603	T0704	T0805	T0908	T1009	T1102	T1206
12	T0004	T0105	T0207	T0305	T0405	T0501	T0604	T0706	T0806	T0906	T1005	T1108	T1202
13	T0009	T0102	T0201	T0307	T0406	T0503	T0607	T0707	T0801	T0904	T1004	T1107	T1201
14	T0006	T0101	T0208	T0305	T0401	T0505	T0605	T0701	T0804	T0906	T1006	T1101	T1209
15	T0004	T0109	T0202	T0303	T0408	T0502	T0603	T0703	T0809	T0901	T1008	T1105	T1202
16	T0006	T0102	T0205	T0304	T0407	T0508	T0609	T0704	T0805	T0909	T1002	T1106	T1203
17	T0003	T0103	T0201	T0306	T0405	T0506	T0601	T0706	T0806	T0905	T1008	T1107	T1201

The current class placement results for the school are shown in Table 4. Since the class placement results are different, the corresponding scheduling results are also different. In the current scheduling results, the minimum working day penalty value is 0 points, the recommended time period penalty value is 126 points, and the course uniformity penalty value is 16 points, totaling 147 points. In contrast, the scheduling algorithm based on dynamic programming successfully solves all the soft and hard conflicts.

Table 4. The school's current division results

Class	H	I	J	K	L	M	G	N
1	48	51	44	45	33	25	42	51
2	52	27	41	52	38	33	23	52
3	32	36	25	25	39	40	24	40
4	42	46	50	41	27	34	32	50
5	43	46	30	48	46	42	52	52
6	48	45	52	28	51	45	30	52
7	35	37	26	51	36	24	27	51
8	25	38	44	43	47	47	27	47
9	38	39	45	24	23	29	31	45
10	53	29	45	48	29	24	20	53
11	42	28	30	31	51	20	50	51
12	20	51	39	42	35	41	50	51
13	47	44	27	23	31	23	26	47
14	21	29	21	53	43	38	23	53
15	39	26	46	34	48	45	20	48
16	43	48	33	37	51	52	50	52
17	41	23	46	37	45	31	34	46

4. Teacher information literacy scale design

4.1. Selection of scale dimensions

The teacher informational teaching competency scale designed for this study consists of six first-level dimensions:(1) Subject matter pedagogy knowledge. Subject matter pedagogy knowledge is a common focus of IBSTPI, APST and TAPCK, so this scale designed the first dimension to measure teachers' subject matter pedagogy knowledge competence. (2) Informational Instructional Design Competencies. Instructional design ability is the most basic and important skill advocated by IBSTPI, and this scale is designed to measure the dimension of informationized instructional design ability, taking into account the developmental needs of the informationization era. (3) Informatization teaching implementation ability. Teaching implementation ability is also another basic ability that IBSTPI focuses on, so this scale takes informationized teaching ability as the third dimension. (4) Informatized Teaching Management Competency: IBSTPI takes management as a special dimension. (5) Informatized Teaching Evaluation Competence. It is used to assess teachers' informatized teaching evaluation ability. (6) Informatized Teaching Reflection Competence. Teaching reflection is an important way to promote teachers' professional growth.

4.2. Scale Validity Tests

In this study, questionnaires were distributed through an online questionnaire platform to the teachers of seven higher education institutions in a certain area, and a total of 705 questionnaires were collected, of which 660 were valid, with a validity rate of 93.62%.The demographic information of the 660 teachers is shown in Table 5.

Table 5. The demographic information of teachers

Primary dimension	Secondary dimension	number	proportion	Primary dimension	Secondary dimension	number	proportion
Gender	Male	178	26.97%	Teaching discipline	Liberal arts	307	46.52%
	Female	482	73.03%		Science class	283	42.88%
Age	18~ 30	338	51.21%		Art class	41	6.21%
	31~ 40	143	21.67%		Sports class	29	4.39%
	41~ 50	128	19.39%	Degree distribution	High school	16	2.42%
	51~60	51	7.73%		Junior college	75	11.36%
					undergraduate	518	78.48%
					Graduate student	51	7.73%

The study used IBM SPSS 24.0 and IBM SPSS AMOS 24.0 statistics and conducted scale validity tests in the following process:(1) Statistics and description of the questionnaire data; (2) Assessment of internal consistency of the dimensions using Cronbach's alpha reliability coefficients; (3) Test of the model for suitability of the normalized factor analysis using Kaiser-Meyer-Olkin (KMO) and determine the validity of the scale; (4) investigate the structural validity of each dimension using structural equation modeling.

4.2.1. Reliability test. Through IBM SPSS AMOS 24.0 statistics, this study obtained the structural validity of the model as shown in Table 6, the internal consistency reliabilities (Cronbach's alpha) of the six dimensions ranged from 0.829 to 0.937, and the range of the 20 indicator loadings ranged from 0.53 to 0.97, with a total Cronbach's alpha value = 0.947, indicating that the internal consistency of the scale's question items is good and has good reliability. According to IBM SPSS 2 AMOS 4.0 statistics, the Kaiser-Meyer-Olkin (KMO) composite value of this scale is 0.938, indicating that the scale has good validity and is suitable for factor analysis.

Table 6. Model structure validity

Dimension	N	Estimated value	P	Reliability coefficient value	Square variation
Knowledge of discipline teaching	1	0.63	***	0.835	0.472
	2	0.752	***		
	3	0.531	***		
	4	0.638	***		
	5	0.744	***		
	6	0.805	***		
Information teaching design ability	7	0.84	***	0.918	0.775
	8	0.896	***		
	9	0.921	***		
Information teaching implementation ability	10	0.929	***	0.937	0.869
	11	0.965	***		
Information teaching management ability	12	0.899	***	0.829	0.671
	13	0.932	***		
	14	0.637	***		
Information teaching evaluation ability	15	0.912	***	0.841	0.662
	16	0.882	***		
	17	0.633	***		
The ability to reflect on information	18	0.814	***	0.892	0.718
	19	0.876	***		
	20	0.876	***		

4.2.2. Factor analysis. RMSEA (including confidence intervals with interrupted criterion less than 0.08 and comparative fit index (CFI, TLI) with interrupted criterion greater than 0.90) was used to indicate acceptable model fit. The SEM results show that the CFI, TLI and RMSEA values of this scale meet the criteria for fit acceptance, which indicates that the scale is rigorous and reasonable. The path coefficients between different dimensions are shown in Table 7.

Table 7. The path coefficient between different dimensions

Path		Estimated value	P
Pedagogy	Design	0.831	***
Pedagogy	Iimplement	0.882	***
Pedagogy	Management	0.731	***
Pedagogy	Evaluation	0.689	***
Pedagogy	Reflection	0.668	***
Design	Implement	0.798	***
Design	Mnagement	0.809	***
Design	Evaluation	0.839	***
Design	Reflection	0.741	***
Iimplement	Management	0.914	***
Implement	Evaluation	0.873	***
Implement	Reflection	0.813	***
Management	Evaluation	0.983	***
Management	Reflection	0.835	***
Evaluation	Reflection	0.911	***

4.2.3. Correlation analysis. This study used Pearson's correlation analysis to examine the relationships between the six exogenous variables of this scale. According to the criteria provided by Cohen, correlations between 0.10 and 0.29 are considered weak correlations, correlations between 0.30 and 0.49 are moderate correlations, correlations between 0.50 and 0.69 are strong correlations, and correlations greater than 0.70 are very strong correlations. The results of the analysis are shown in Table 8, where the six exogenous variables interact with each other. The dimensions that are very strongly correlated are pedagogy and design (0.739) and pedagogy and implementation (0.752); and the dimensions that are strongly correlated are pedagogy and management (0.638), pedagogy and evaluation (0.564), and pedagogy and reflection (0.566).

Table 8. The correlation between the six dimensions of the scale

	Pedagogy	Design	Implement	Management	Evaluation	Reflection
Pedagogy						
Design	0.739**					
Implement	0.752**	0.765**				
Management	0.638**	0.721**	0.817**			
Evaluation	0.564**	0.719**	0.703**	0.816**		
Reflection	0.566**	0.662**	0.705**	0.752**	0.803**	

5. Teacher information literacy after the scheduling application

After applying the dynamic planning scheduling method designed in this paper in a higher vocational institution, the information literacy level of its finance and economics teachers is analyzed. The overall situation was first analyzed based on the results of the questionnaire and interview survey, then the group differences existing among teachers of different disciplines, titles, qualifications, and specialties were analyzed, and finally the influencing factors were briefly analyzed based on the data results of the open-ended multiple-choice questions of the questionnaire. Two hundred valid questionnaires were collected with a validity rate of 91.6%.

5.1. Overall status of teachers' information literacy

The average score can present the basic situation of the survey respondents in an intuitive and concise manner, and a higher average score can indicate to a certain extent that the survey respondents' performance in this area is better, while a lower average score indicates a deficiency.

Higher mean scores can indicate to some extent that the survey respondents' performance in this area is better, while lower mean scores indicate that there are deficiencies. In this chapter, we will analyze teachers' information literacy based on the overall questionnaire and the mean scores of each structure. The coefficient of variation (CV), as a relative amount of variation, can be used to compare the degree of dispersion of different observations of the same group. In this study, the coefficient of variation was used to analyze the degree of dispersion of teachers' information literacy in each dimension. The one-sample t-test can be used to test the relationship between the mean of an observation and some reference value. In order to analyze the mean score and dispersion of teachers' information literacy and its dimensions, SPSS 26.0 software is used here to conduct a one-sample t-test (test level a=0.05, the same below), and the specific data are shown in Table 9.

After the application of the dynamic planning scheduling method designed in this paper, the overall information literacy scores of the surveyed teachers are high (mean value of 4.15), which is slightly ahead of the standard reference value of 4. In terms of the mean scores of each structure, the scores, from high to low, are information awareness (4.32), information knowledge (4.28), information competence (4.09), and information ethics and security (4.03), and the differences between the other three components, except information competence, and the reference value are significant.

It can be concluded that after applying the dynamic planning-based faculty scheduling method of this paper, the time and energy resource allocation of finance and economics teachers is optimized, and the teaching efficiency and their own information literacy are improved.

Table 9. The results of the analysis of the teachers' information literacy

Structure	N	M	CV	Reference value	T	P
A Information consciousness	200	4.32	18.08%	4	7.905	0
B Information	200	4.28	18.96%	4	4.708	0
C Information ability	200	4.09	24.61%	4	1.026	0.008
D Information morality and security	200	4.03	25.48%	4	-0.029	0.002
Information literacy	200	4.15	22.37%	4	2.893	0.003

5.2. Information Literacy Group Differences

5.2.1. Differences across disciplines. All teachers were divided into four groups by subject, labeled by subject taught: 1 Economics, 2 Finance, 3 Finance, and 4 Other Subjects. At this point, the grouping variable is 4. A grouping variable greater than three is no longer suitable for an independent samples t-test, and the dependent variable is continuous, implying that the data in this group can be analyzed using one-way ANOVA. One-way ANOVA was used with teachers' information literacy and each of its structures as the test variable and the subject taught by the surveyed teachers as the grouping variable. The results of the analysis are shown in Table 10.

There are differences but not significant in information literacy between groups of teachers of different subjects.

The main reasons for this include: (1) from the point of view of the links and time points of information technology application in teaching, regardless of the discipline, classroom introduction, problem presentation and classroom summarization are the most frequent use of multimedia, and the time points and specific links of using multimedia and other equipment in each class are preset by the teachers before the class, which is mainly based on the teachers' own judgments about the teaching content and teaching methods; (2) from the point of view of the frequency of the application of information technology in teaching, the same discipline is the same as that of the surveyed subject, which is the same as that of the surveyed subject. (2) From the point of view of the frequency of the application of information technology in teaching, the frequency of the use of information technology is different when teachers of the same subject teach different class contents, and the frequency of the application of information technology is also different when teachers of the same contents adopt different teaching methods.

Table 10. Variance analysis of "different discipline teacher information literacy"

Structure	Disciplines	M	F	P
A Information consciousness	1	4.398	0.875	0.459
	2	4.649		
	3	4.422		
	4	4.401		
B Information	1	4.531	1.189	0.312
	2	4.413		
	3	4.398		
	4	4.239		
C Information ability	1	4.023	0.542	0.653
	2	4.129		
	3	4.186		
	4	4.161		
D Information morality and security	1	4.127	2.261	0.084
	2	4.322		
	3	4.266		
	4	3.973		
Information literacy	1	4.278	0.843	0.477
	2	4.374		
	3	4.371		
	4	4.2		

5.2.2. Differences by job title. In order to facilitate data analysis, teacher titles were grouped and numerically labeled, and all teachers were divided into five groups according to their titles, labeled as 1 No title yet, 2 Level 3 title, 3 Level 2 title, 4 Level 1 title, and 5 Senior and above title. At this point, the grouping variable is 5, and the dependent variable is continuous, which is suitable for one-way ANOVA. Therefore, in comparing the information literacy of teachers with different titles, this study used one-way ANOVA with teachers' information literacy and each of its structures as the test variable and the title of the investigated teachers as the grouping variable. The results of the analysis are shown in Table 11.

The differences in the scores of the groups of teachers with different titles on information literacy and its various structures are not significant, and their mean scores are, in descending order, title III, title II, no title, senior and above, and title I. The groups of teachers with different titles are not in the same order of high and low standard deviation on information literacy and its structures. This means that the correlation between the level of teachers' titles and the performance of teachers' information literacy and its structure is low, i.e., it is not the case that the higher the title, the higher the level of teachers' information literacy. As can be seen from the mean and standard deviation, the mean score of the surveyed teachers' information literacy with the first level of title and the senior and above title scored the lowest and had the highest variance, followed by the teachers without title.

Table 11. Variance analysis of "different job title teacher information literacy"

Structure	Disciplines	M	SD	F	P
A Information consciousness	1	4.265	0.502	0.936	0.443
	2	5.146			
	3	4.625	0.499		
	4	4.406	0.652		
	5	4.477	0.642		
B Information	1	4.692	0.186	1.195	0.312
	2	5.08			
	3	4.565	0.444		
	4	4.345	0.733		
	5	4.344	0.659		
C Information ability	1	3.988	0.959	0.419	0.795
	2	4.326			
	3	4.357	0.817		
	4	4.095	0.669		
	5	4.159	0.806		
D Information morality and security	1	4.247	0.81	0.623	0.637
	2	4.707			
	3	4.305	0.562		
	4	4.087	0.823		
	5	4.026	0.767		
Information literacy	1	4.232	0.508	0.975	0.428
	2	4.792			
	3	4.496	0.445		
	4	4.195	0.567		
	5	4.231	0.563		

5.2.3. Differences by educational level. To facilitate data analysis, teachers' qualifications were grouped and numerically labeled, and all teachers were divided into three groups according to their qualifications, which were labeled as 1 specialist and below, 2 undergraduate, and 3 postgraduate and above. In this study, when comparing the information literacy of teachers with different academic qualifications, a one-way ANOVA was used, with teachers' information literacy and its various structures as the test variables, and the academic qualifications of the investigated teachers as the grouping variables. The results of the analysis are shown in Table 12. The differences in the scores on information literacy and its various structures among the groups of teachers with different academic qualifications are not significant, and their standard deviations are, in descending order, bachelor's degree, specialist and below, and graduate student and above.

The survey can show to some extent that there is a positive correlation between the level of teachers' information literacy and their education level, and that graduate education has an upgrading effect on teachers' information awareness, information knowledge and ability. On the other hand, the five teachers with postgraduate education collected in this study are all young teachers, affected by the age factor, the research situation does not singularly represent that the higher the education level the higher the level of information literacy.

Table 12. Variance analysis of "different degree teachers information literacy"

Structure	Disciplines	M	F	P
A Information consciousness	1	4.382	0.274	0.752
	2	4.506		
	3	4.638		
B Information	1	4.319	0.925	0.396
	2	4.363		
	3	4.782		
C Information ability	1	4.223	0.408	0.554
	2	4.262		
	3	4.432		
D Information morality and security	1	4.048	0.556	0.571
	2	4.124		
	3	4.471		
Information literacy	1	4.254	0.717	0.493
	2	4.303		
	3	4.58		

5.2.4. Differences by specialty. To facilitate data analysis, teachers' specialties were grouped and numerically labeled, and all teachers were divided into three groups according to their specialties, which were labeled as: 1 Education (referring to non-teacher training specialties in education), 2 Teacher training, and 3 Other. In comparing the information literacy of teachers with different titles, this study used one-way ANOVA with teachers' information literacy and each of its structures as the test variable and the specialty of the investigated teachers as the grouping variable. The results of the analysis are shown in Table 13.

Table 13. Variance analysis of "different professional teacher information literacy"

Structure	Disciplines	M	F	P
A Information consciousness	1	4.467	0.946	0.397
	2	4.649		
	3	4.515		
B Information	1	4.322	0.588	0.562
	2	4.377		
	3	4.454		
C Information ability	1	4.085	4.785	0.02
	2	4.514		
	3	4.071		
D Information morality and security	1	3.989	1.974	0.15
	2	4.282		
	3	4.207		
Information literacy	1	4.214	2.086	0.11
	2	4.447		
	3	4.311		

5.3. Variety of Factors Influencing Teachers' Information Literacy

Taking the literature analysis and the results of teachers' interviews as reference, this study lists 16 factors in the questionnaire that may affect the information literacy of higher vocational teachers, and counts the three factors that the surveyed teachers think have the greatest influence on teachers' information literacy, as shown in Figure 2. Among the factors 1~16 are practical experience, teaching philosophy, subject requirements, professional learning experience, hardware facilities, in-service training experience, school support, student situation, peer communication, personal character, social influence, school requirements, pre-service training experience, student-age experience, parental influence, and others.

The statistics showed that practical experience, teaching philosophy, and subject requirements were considered the three most important factors affecting teachers' information literacy. More than half of the teachers chose practical experience (58.27%) and teaching philosophy (50.19%), and more than one-third (33.36%) chose subject requirements.

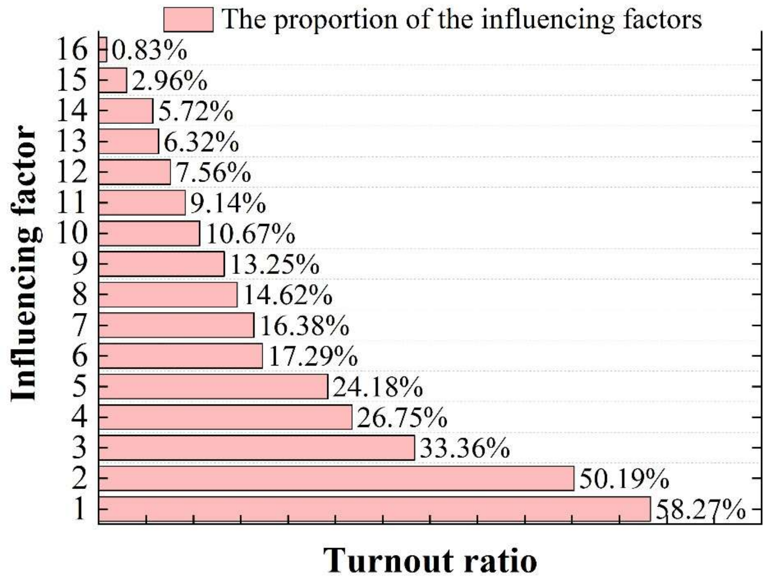

Fig. 2. The teacher information literacy factor statistics chart

6. Suggested paths for the development of information literacy among finance teachers

6.1. Strengthening integrated leadership and policy interpretation

Provide a guarantee mechanism for the development of informatization. The local government needs to build a regional overall guarantee mechanism to carry out overall planning and macro-control of the region's informatization construction, establish communication channels with schools, understand the attitudes and views of school leaders on the development of education informatization in their own schools, and ensure that the management department can adopt the relevant feedback from the schools in a timely manner; at the same time, it needs to strengthen the interpretation of informatization-related policies, notify and convey the relevant documents on education informatization in a timely manner and provide relevant suggestions according to the informatization development needs of the schools in the region. At the same time, we strengthen the interpretation of informatization-related policies, notify and communicate education informatization-related documents in a timely manner, and provide relevant suggestions according to the needs of the development of informatization in schools in the region.

6.2. Strengthening the coordination of all types of educational informatization activities

Take the activity with the application. Further strengthen the development of activities related to education informatization, encourage teachers to actively participate, and provide corresponding incentives, and give certain recognition or rewards to teachers with outstanding performance. By using the activities as a tool, the management can understand the level of teachers' information literacy and promote the optimization and innovation of their teaching mode; at the same time, it can strengthen the communication between teachers in each school, promote the development of teachers' ability to apply information technology in their daily teaching work, and establish a sound institutional mechanism for the sustainable development of teachers' information literacy.

6.3. Precise policy making based on assessment results

Focus on the development of specific groups of teachers. The management needs to carry out relevant assessments on a regular basis, such as information security knowledge sampling and information technology teaching ability assessment, to grasp the weaknesses of teachers' information knowledge and to understand their common problems and deficiencies in information security, to provide targeted training resources for school principals, teaching and researchers, and tenured teachers respectively, and to carry out thematic training activities such as the basic operation of information technology teaching equipment and the basic operation of office software, resource-processing software, and subject-specific software. Thematic training activities such as basic operation of IT teaching equipment, as well as office software, resource processing software, subject-specific software, and so on. In addition, the management needs to pay special attention to the level of development of informatization in education in remote areas, to understand their needs and provide assistance to narrow the gap between the level of development of informatization of teachers in urban and rural areas.

6.4. Strengthening the selection and excavation of typical cases

Gradually expand its influence. Vigorously build up overall regional resources. On the one hand, we can collect excellent cases of informatization construction of schools in the region, and make learning materials for schools to learn by collating and summarizing them; on the other hand, we can organize experience exchanges, inviting excellent principals to share the successful experience of informatization construction of their own schools, as well as the experience of teachers in the process of their own informatization teaching practice. Through the learning of excellent typical cases, we can promote the communication between schools, teaching and researchers, and teachers, continuously build a regional development community, promote the sharing and opening of high-quality educational resources, promote the overall enhancement of the information literacy of principals, teaching and researching staff, and drive the sustainable development of regional education informatization level.

7. Conclusion

In this paper, a dynamic planning-based faculty scheduling method is designed to improve the information literacy of finance and economics teachers in higher vocational colleges and universities. After selecting examples for scheduling test to verify the effectiveness of the algorithm, it is applied to a higher vocational college and analyzed the information literacy of finance and economics teachers. Compared with the current scheduling course uniformity penalty value of 16 points, a total of 147 points, this paper based on dynamic planning scheduling algorithm is successful in solving all the soft and hard conflicts, reflecting the superiority. After the application of the dynamic planning scheduling method designed in this paper, the average information literacy score of finance and economics teachers in the selected higher education institutions is 4.15. The scores of information awareness, information knowledge, information ability, and information ethics and security are 4.32, 4.28, 4.09, and 4.03 respectively. It can be assumed that after applying the teaching scheduling method based on dynamic planning in this paper, finance and economics teachers optimize the allocation of their time and energy resources, and improve the efficiency of teaching and their own information literacy. Accordingly, the development path of information literacy for finance and economics teachers is proposed from the aspects of policy interpretation, activity coordination and case selection.

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