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# An Empirical Study on the Cultivation of Students' Innovation Ability by Flipped Classroom

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**Abstract:** Innovation ability training is the main goal of talent cultivation in China. Firstly, in view of the deficiency in the traditional teaching mode, based on literature analysis and existing research, this article explored the key factors that can affect the innovation ability, which includes the self-exploration consciousness, self-exploration strategy, cooperation ability, time management ability and volition. Secondly, through the practice of flipped classroom in the public computer course of the university, this research used two scales—the LASSI scale and CUCEI scale to carry out pre-test and post-test; through the measurement data contrast, analyzed the influence of the flip classroom teaching mode of learners. Empirical research method was used to analyze the important role of flipped classroom in cultivating students' innovation ability. Then, the study found that the students in the experimental class had a great improvement in their independent exploration consciousness, independent exploration strategies and volition. Moreover, flipped classroom has different effects on learners of high levels and low levels, and the proportion of high score students and low score students in the experimental class was significantly higher than that in the control class. Finally, aiming at the problems in flipped classroom teaching practice, the teaching process, teaching activities, effective control strategies and the suggestions to teachers of flipped classroom were summarized to provide references for high-quality flipped classroom teaching design.

**Keywords:** Flipped Classroom, Innovation Ability, Self-Learning Ability, Instructional Design

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## 1. Introduction

According to the Outline of the National Medium-Long Term Talent Development Plan (2010-2020), the country is in urgent need of cultivating comprehensive talents with strong independent innovation ability and cooperation ability in schools, and the traditional education at present obviously cannot meet this demand. In April 2018, the Chinese Education Department issued the Education Informatization 2.0 Action Guide, which clearly proposed the cultivation of innovation ability and the development of knowledge reengineering ability as the central task of talent cultivation in the current era.

In order to grasp the development level of contemporary college students' self-learning ability, and provide the first-hand data to support for the college teaching reform,

Beijing Normal University computer basic course teaching team used to measure and track the autonomous learning ability of some students from 2011 to 2014 for four consecutive years by using LASSI scale and autonomous learning task in 2012 and 2013. According to the survey, most freshmen were more accustomed to asking their teacher for help when they encountered problems, and hope that teachers can tell the final answer directly. They are not good at finding answers through searching materials or courseware, and their self-exploration ability is poorly. Thus when they get troubled in school or life, instead of exploring the solution to problems, freshmen tend to wait for the assistance of teacher, nevertheless drawing inferences about other cases from one instance [1].

This kind of lazy thinking way makes them unwilling to carry out exploratory and innovative practice, which is obviously manifested as the deficiency of independent inquiry

consciousness and the absence of independent inquiry strategy. On the other hand, with the increase ratio of the only-child generation in the college students, the students' self-regulated ability, time management ability and active learning ability downward year by year [2], which directly lead to the lack of innovation consciousness and innovation ability among students.

The Chinese government strongly promotes innovation, especially among college students, and the student-centered flipped classroom has obvious advantages in cultivating students' innovation ability and self-exploration ability. Based on the above ideas, this paper will focus on the following aspects:

(a). Based on literature analysis and induction, the factors and evaluation mode of innovation ability cultivation will be discussed.

(b). Based on empirical research, the advantages and limitations of flipped classroom in the cultivation of innovation ability are demonstrated.

(c). On the basis of teaching practice, this paper will focus on exploring the process and organization strategy of effective flipped classroom, and analyze how to use flipped classroom to improve the innovation ability of Chinese students.

## 2. Literature Review

### 2.1. The Famous "Asking of Xuesen Qian"

In 2005, the famous scientist Xuesen Qian raised one of the biggest questions in education: "no student who has been trained for so many years has achieved as much academic achievement as the master who was trained in the Republic of China." "Why can't our schools produce elitist?" This is the famous "Asking of Xuesen Qian" [3].

The "Asking of Xuesen Qian" expresses the predicament of China's education, which is an abstruse proposition about the development of Chinese education. And the subsequent questions arise. One is that the development of the country requires a large number of talents with innovative ability and capable of independent exploration and research, which Chinese education fails to achieve. And another question is that compared with developed countries, Chinese students' innovation ability, self-learning and self-exploration ability is obviously insufficient. Therefore, a new education mode is needed to make breakthroughs in cultivating students' innovation ability and self-learning ability.

### 2.2. Factors Influencing Students' Innovative Ability

#### 2.2.1. The Traditional Teaching Mode Is Not Conducive to the Development of Students' Innovative Ability

The current K-12 education are mainly teacher-centered, and students are tending to be the audience or listener of the class. The efficiency of knowledge transfer cannot negate the positive effect of this model. However, because students in this mode are in the state of passive learning in the process of acquiring knowledge, the growth of students' knowledge is "fed up". Although students' individual knowledge

accumulation and knowledge level are not low at this teaching mode, many students have obvious deficiencies in active retrieval and acquisition of knowledge, autonomous inquiry and induction [4].

The current exam-oriented education mode has serious defects, and its evaluation system is a static exam-oriented indicator. The evaluation and assessment of teaching effect and students' ability mainly adopts the normative summative evaluation method. Teachers and students with initiative and creativity are evaluated through standardized and normative examination papers, thus eliminating the creativity of teachers and students.

The traditional teaching mode and evaluation mode of "teacher teaching and student listening" is a kind of "spoon-feeding" learning mode, which does not provide students with the opportunity of independent inquiry, and deprives students of pursuing the opposite sex and divergent thinking. In the long run, it will inevitably affect the development of students' innovation ability.

#### 2.2.2. The Doctrine of the Mean in Traditional Chinese Culture Restricts Students' Innovative Thinking

Chinese traditional Confucian culture advocates the principle of "moderation" and pays attention to the "unity of humanity". There is an adage says "wood show in the forest, the wind will destroy it", and folk proverbs says "the outstanding usually bear the brunt of attack" said. Thousands of years of history have shaped the nation's tendency to seek stability and convergence rather than to take risks.

Chinese children have been told to listen to parents at home, teachers at school and leaders at work since childhood. Therefore, obedience has become the basic rules of life for them. They lack an inner impulse to create and a critical thinking to question boldly.

### 2.3. Rise and Achievements of Flipped Classroom

Compared with the traditional teaching mode, the biggest characteristic of the teaching mode of flipped classroom is "learning first and teaching later". Different from traditional class in which teacher teaching first and learning by oneself later, flipped classroom makes students learn new knowledge and concept in advance, and classroom is turned into a place for teachers and students interact, mainly used for the instruction, and presentations, so as to achieve the purpose of deep learning [5]. Marco Ronchetti, an Italian scholar, based on the idea that "technology can change traditional teaching mode and provide better strategies and modes for teaching", focused on exploring the methods, strategies and the effects that should be adopted by "Video On-Line as Replacement of Old Teaching Practice" [6].

Flipped classroom completely hands over the initiative of learning to students, and pays more attention to students. It provides every student involved in flipped classroom learning with sufficient opportunities of self-exploration and self-management, and it can improve students' innovation ability in such dimensions as self-exploration awareness and self-exploration strategy. Jeremy F. Strayer, an expert of educational technology in the United States, conducted

practical research on collaboration, innovation and task orientation in flipped classroom. It proves that flipped classroom has a significant impact on the cultivation of collaboration ability and innovation ability, and it is an effective means to help cultivate learners' collaboration ability, innovation ability and cohesion [7].

**2.4. Research Status at Home and Abroad**

Flipped classroom has been fully practiced at home and abroad. In China, Peking University launched the construction of "Peking University open online course" in 2013, and set the goal of opening 100 courses within five years, and realized the cooperation with Edx and Coursera in the same year [8]. In October 2013, Shanghai Jiao Tong University became a global partner of hundreds of Coursera platforms, with six courses on the MOOC platform [9]. Such as Tsinghua University, Beijing Normal University, and other universities also made flipped classroom. In the United States, the Lake Elmo elementary school used flipped classroom from September 2011 to January 2012. The Moodle platform had been well applied into teaching practice, encouraging students to discuss with each other and promoting collaborative learning, which had achieved good teaching results, and many students had expressed their reluctance to use traditional teaching [10]. The Riverside Unified School district of California, also used flipped classroom, featured an iPad-based digital interactive textbook. This kind of flipped classroom had better user experience, can attract students to immerse themselves in it, and had achieved good teaching results [11].

**3. Research Scheme Design**

**3.1. Definition and Interpretation**

**3.1.1. Definition and Elements of Innovation Ability**

The ability of innovation is a necessary comprehensive quality for innovative talents, and it is not a single ability. Innovation ability is composed of a variety of abilities, including learning ability, analytical ability, comprehensive

ability, imagination ability, critical ability, creativity ability, problem solving ability, practice ability, organizational coordination ability and integration ability [12]. Some scholars believe that there are three basic elements in many factors of innovation ability: systematic thinking ability, creative thinking ability and practical ability [13].

**3.1.2. Cultivation of Innovation Ability**

The definition and elements of innovation ability clearly explain the various abilities of innovative talents. However, the learning ability, analytical ability, comprehensive ability and other elements contained in the elements are still a combination of multiple abilities, and each ability will be affected by many factors. Therefore, it is impossible to outline effective strategies for cultivating innovation ability from the definition and elements of innovation ability.

From the perspective of the potential of innovative talents, "solid and comprehensive professional knowledge, strong independent inquiry awareness, rigorous and efficient independent inquiry strategy, strong willpower, excellent cooperation ability and strong time management ability" are all available for every innovative talent. Therefore, apart from the influence of the dimension of professional knowledge, this study regards the others as five key dimensions of the cultivation of undergraduates' innovation ability. Among them, collaboration ability and time management ability are often used as elements in the self-exploration strategy [14].

For undergraduates who are still at the student stage, the level of independent inquiry strategy can be supported by the related research of self-learning strategy, while the factors of volition can be supported by the data indexes of the attitude, motivation, anxiety control, confidence and efficacy.

Based on the above decomposition, the factors to cultivate students' innovation ability are divided into four dimensions: professional knowledge, autonomous inquiry consciousness, autonomous inquiry strategy and willpower. The sub-index items and logical structure under each dimension are shown in figure 1.

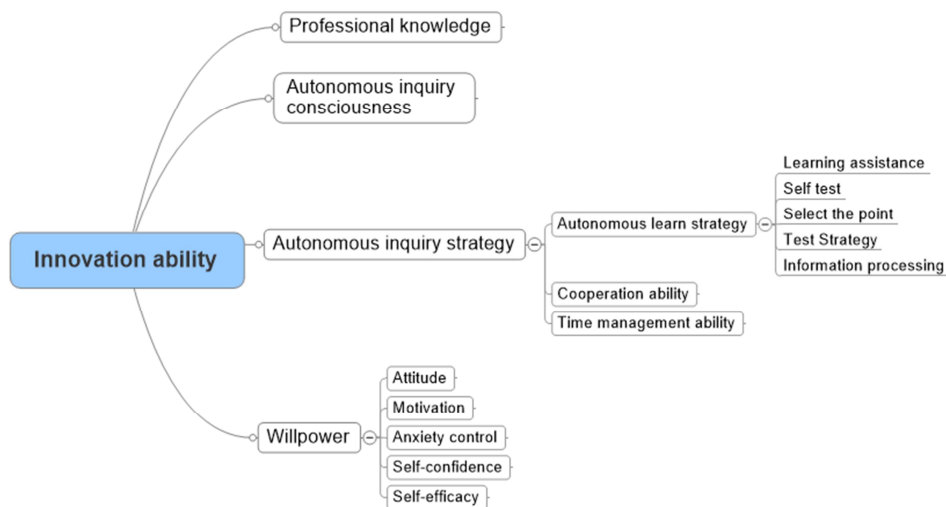


Figure 1. Innovation ability cultivation and factors' decomposition.

**3.1.3. Measurement Method for Undergraduates' Innovation Ability Evaluation**

Based on the logic structure shown in figure 1 of the innovation ability cultivation, in order to response the status of students' innovation ability and its changes, the researchers decided to organized organically learning strategy scale (LASSI scale), the university classroom environment questionnaire (CUCEI questionnaire) and self-efficacy scale (GSES) to comprehensively and accurately measure each student in each dimension of performance, innovation ability and comprehensive.

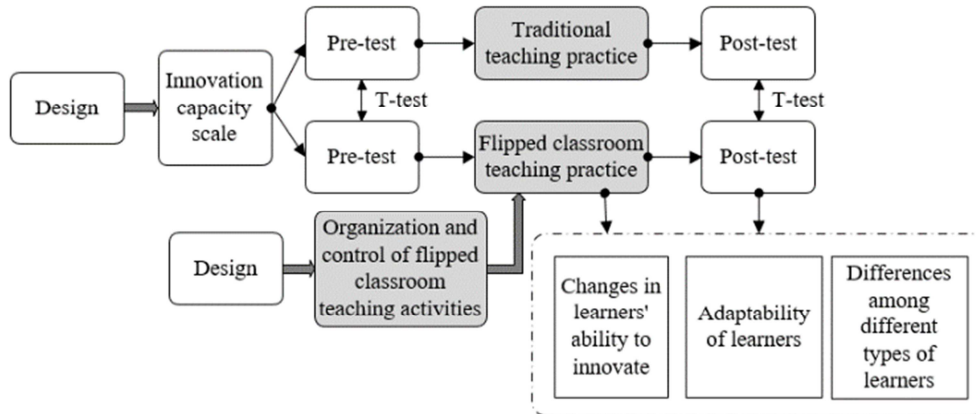


Figure 2. The main process and objectives.

Firstly, the teaching process should strictly follow the general process and rules of flipped classroom to design and organize teaching activities, and ensure the effectiveness of flipped classroom teaching activities.

Secondly, based on the LASSI scale, CUCEI questionnaire and general self-efficacy scale, the researchers designed an effective scale in line with Chinese education. Then measured students' performance respectively in self-learning strategies, self-exploration and collaboration at the beginning of freshman year and after a school year. Analyze whether there is a significant difference between students using flipped classroom and those not using flipped classroom teaching, so as to analyze and demonstrate the education value of flipped classroom [16].

Thirdly, through the collection of students' performance data and comparative analysis, the researchers carried out the correlation and difference test, and explored the influence of flipped classroom on different types of learners in computer course teaching in university by demonstrating the learning effect of students' academic performance and the quality of their works.

Finally, in view of the problems in the teaching practice of several rounds (4-5 semesters), the paper gave solutions with the help of relevant theories of educational technology.

**3.3. Research Process Design**

Since 2010, the researchers have been conducting research related to flipped classroom, and the biggest feeling is: the research of teaching mode and teaching strategy is closely

**3.2. Research Process Design**

With the help of computer basic course teaching, this study tries to test the teaching effect of flipped classroom. The participants were comprised of undergraduates under different levels and grades. The significance, advantages and limitations of talent cultivation are also discussed. The main process and objectives of the study are shown in figure 2 [15].

related to teaching system design and teaching activities of the organization and process control, the research conclusion is determined by teaching process control strategies and its precision. Once control method "miss a little", it will lead to the conclusion "big difference", this is the basic characteristics of teaching and research.

**3.3.1. Design of Flipped Classroom Teaching Process**

Flipped classroom is characterized by reversing the traditional learning process and allowing students to complete independent learning of knowledge points and concepts in extracurricular time. The classroom becomes an interactive place between teachers and students, which is mainly used to answer questions and report for discussion, so as to achieve better teaching results. Therefore, the teaching processes of flipped classroom teaching mode can be divided into four stages: guided learning stage, autonomous learning stage, class sharing stage and teacher comment and promotion stage. In these four stages, guided learning stage and independent learning stage are the process of learning new knowledge independently. Students can be required to learn and explore independently as an individual, or they can be carried out through group collaboration. Class sharing is a process in which students discuss in groups and construct their social knowledge through free discussion and brainstorming. The teacher's comment is the stage of the conclusion and improvement of students' knowledge system. The teacher's comment should analyze and summarize the discussion contents of students from a high level, and point out the problems of students in the process of learning new

knowledge, so as to have a "eureka effect" on students [17]. The working process of flipped classroom is shown in figure 3. It can be seen from the process sections in figure 3 that flipped classroom teaching can be divided into four stages.

The top row in figure 3 shows the responsibilities and values of teachers in flipped classroom, and the bottom row shows the responsibilities of students in flipped classroom and the learning strategies they can adopt.

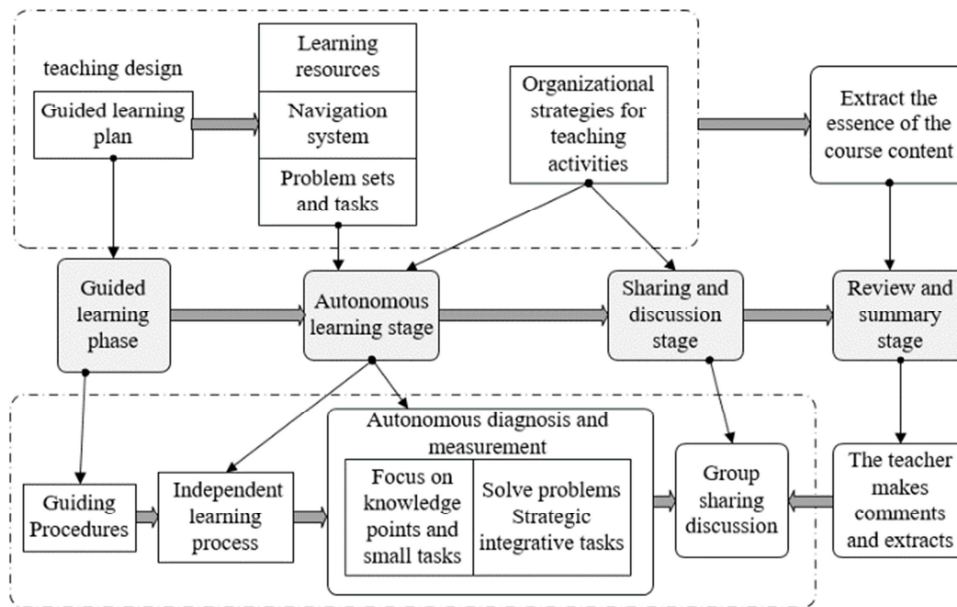


Figure 3. Workflow of flipped classroom mode.

### 3.3.2. Support Flipped Classroom Teaching Activities with a Complete Learning Support System

Since flipped classroom arranges the learning of new knowledge outside the classroom, teachers must provide complete learning support and teaching control for students' self-learning after class, which puts forward high requirements on teachers' teaching design and control. In order to organize an effective flipped classroom teaching activity, teachers should first complete the construction of the learning support system under the guidance of the instructional design theory, so they should do a good job in the following three aspects.

Firstly, organize effective introductory content in front of each knowledge module. As the main goal of introduction is to stimulate students' intrinsic learning motivation and guide students to independently organize learning activities, the content of introduction should conform to the age characteristics and psychological characteristics of students; and at the same time, the depth and breadth of knowledge points should be paid attention to, as well as the hierarchical and progressive nature of the problem [18].

Secondly, provide efficient learning support for the independent learning process of each knowledge module, and provides different types of learning resources and navigation. In the teaching activities carried out with the flipped classroom, whether teachers can provide abundant learning resources to support students' autonomous learning process is the decisive factor of flipped classroom's success or failure. In this respect, teachers need to think carefully and implement carefully, which usually includes two requirements: one is to provide a variety of learning

resources to meet the needs of students of different types and levels [19]; the other is to present the logical relationship between knowledge nodes and the distribution of resources with a clear knowledge map [20].

Thirdly, design two levels of learning tasks to support the learning of knowledge points and the cultivation of comprehensive problem-solving ability, providing support for students' solidified learning effect and self-diagnosis. The task oriented to knowledge points is helpful for students to check their learning progress and make self-diagnosis. The comprehensive task belongs to the expansion task, which is helpful for students to expand and improve.

### 3.3.3. Strict Organization and Control Strategies Are Adopted to Ensure the Effectiveness of Flipped Classroom

In flipped classroom, the learning of new knowledge takes place outside the classroom, and the sharing and social construction of knowledge takes place in the class group discussion stage. As the knowledge construction in these stages is completed by students independently, it is difficult for teachers to monitor the learning process of each student on site one by one. Therefore, in this mode, students with poor knowledge foundation can easily become "bystanders" in the discussion process and "hitchhikers" in group collaboration. In order to guarantee the teaching quality of flipped classroom, teachers must come up with a set of effective strategies to monitor the effect of students' autonomous learning and make every learner achieve maximum development. After five years of teaching practice, the researchers summarized the following teaching strategies: (a). Based on the types of learning contents, guide students to

adopt effective independent learning methods; (b). To autonomous learning in the form of group collaboration, establish necessary monitoring mechanism to avoid the "free rider" phenomenon of group members; (c). Control classroom discussion and comment, making the discussion and sharing process complete and effective; (d). Improve the quality of teacher comments and the value.

### **3.4. The Formation of Measurement Indicators for the Cultivation of Innovation Ability and the Assurance of Reliability and Validity**

#### **3.4.1. Formation of Measurement Indicators of Innovation Ability**

Based on elements as shown in figure 1 of the innovation ability and its decomposition, innovation ability measurement scale is given priority to with LASSI scales, and according to the requirement of measurement, some new measurement items were added; supplementary item is mainly used to test the learner's independent inquiry consciousness, cooperation ability, time management skills, self-efficacy and confidence. The design of complementary option mainly refers to the CUCEI scale [21] and general self-efficacy scale (GSES scale).

As the main part of the survey index system is constituted by the internationally mature LASSI scale, it has good reliability and validity guarantee. In the parts of self-confidence, self-efficacy and collaboration, the international self-efficacy scale and CUCEI scale were mainly used for reference and adjusted appropriately according to the course content. Especially in efficacy dimensions, considering that learners' self-evaluation values of self-efficacy vary greatly in different courses and academic knowledge, this study added to the information technology course of attributive to the GSES measure items, such as "If I try my best to do, I always can solve any problem" measurement items into "If I try my best to do, I always able to solve any problems in computer courses", to form a "information technology application self-efficacy" indicator, so raising the efficacy evaluation of targeted.

#### **3.4.2. Ensure the Reliability and Validity of the Survey Indicator System**

As the main part of the survey index system is constituted by the internationally mature LASSI scale, it has good reliability and validity guarantee. In the areas of confidence, self-efficacy and collaboration ability, mature CUCEI scale and GSES scale are also taken as references to ensure the scientific nature of the measurement index system.

In order to guarantee the reliability and validity of the adjustment part, the author firstly conducted a small scale measurement with the new questionnaire. SPSS 18.0 was used to conduct the data reliability analysis with the sample size of 51 people, and the Cronbach Alpha was 0.792, which proved that the questionnaire had a good reliability. In addition, two experts of educational technology were invited to fully solicit their suggestions on the new survey indicators,

which ensured the structural validity of the survey indicators.

#### **3.4.3. Dependability Assurance of the Source of Survey Data**

The author has been exploring the impact of flipped classroom mode on students' autonomous learning ability since 2012, and has accumulated a certain amount of raw data (mainly based on the LASSI scale measurement), online survey data for many years in the ten LASSI scales dimensions is showing a high consistency, illustrates the reliability level in measuring ability of autonomic learning. In addition, after years of research, the research group has accumulated a series of achievements and published a series of influential research papers in Chinese core journals, with the total citations reaching thousands of times.

This study is an extensive study on the basis of the cultivation of independent learning ability. Its teaching strategies, measurement methods and data collection all inherit the foregoing research paradigm. All data collection took place in the classroom and was completed online and in concentrated form. Therefore, the dependability of data sources and the proportion of effective questionnaires can be guaranteed.

## **4. Summary and Discussion**

In the fall of 2017, the author selected two parallel classes of the liberal arts department of Beijing Normal University as subjects, including one class with 90 students (control class) and another class with 104 students (experimental class).

The improved scale (including 10 dimensions of LASSI scale and additional measurement items) was used to carry out pre-test and post-test for the subjects in the two classes at the beginning and end of school respectively, so as to obtain the data of students in various dimensions of innovation ability cultivation. In addition, students' entrance grade test scores, final assessment scores and works in the learning process were extracted as auxiliary data to support the research.

### **4.1. Overall Effect of Flipped Classroom on Cultivating Students' Innovation Ability**

#### **4.1.1. Data Analysis**

For the collected data, the mean value and standard deviation were calculated first, and then the t-test of independent samples was carried out to analyze the relationship between the pre-test data and the post-test data, and the comparison between the experimental class and the control class was conducted.

According to the pre-test data collected at the beginning of enrollment, there is no significant difference between the two classes in each dimension. According to the post-test data collected at the end of the term, there was a significant difference in some dimensions between students who used flipped classroom and those who did not. The analysis results of the two batches of data are shown in table 1.

**Table 1.** Personal qualities of the experimental group and the control group.

| Category                | Traditional mode (2017)(final) |        | Flipped classroom (2017) (final) |        | Diff. (t -test) (sig) | Instructions |
|-------------------------|--------------------------------|--------|----------------------------------|--------|-----------------------|--------------|
|                         | Mean                           | Stdev. | Mean                             | Stdev. |                       |              |
| Attitude                | 2.68                           | 0.85   | 3.15                             | 1.30   | 0.003* * *            | Rising       |
| Motivation              | 2.79                           | 1.12   | 3.62                             | 1.16   | 0.000* * *            | Rising       |
| Anxiety control         | 2.31                           | 1.78   | 3.92                             | 1.81   | 0.02*                 | Rising       |
| Self-confidence         | 2.94                           | 0.92   | 4.18                             | 0.80   | 0.000* * *            | Rising       |
| ICT Self-efficacy       | 2.96                           | 1.34   | 4.02                             | 0.94   | 0.000* * *            | Rising       |
| Learning assistance     | 3.13                           | 0.97   | 3.84                             | 1.08   | 0.000* * *            | Rising       |
| Self test               | 3.27                           | 0.90   | 3.87                             | 1.01   | 0.000* * *            | Rising       |
| Select the point        | 3.31                           | 1.05   | 3.90                             | 0.89   | 0.000* * *            | Rising       |
| Infor-mation processing | 3.21                           | 0.97   | 2.38                             | 1.12   | 0.05*                 | Decline      |
| Test strategy           | 3.47                           | 1.18   | 3.44                             | 1.13   | 0.884                 | No diff.     |
| Time management         | 2.48                           | 1.27   | 4.31                             | 1.19   | 0.01*                 | Rising       |
| Cooperation ability     | 3.57                           | 1.06   | 3.91                             | 1.22   | 0.038*                | Rising       |
| Inquiry awareness       | 2.93                           | 1.13   | 4.09                             | 0.86   | 0.000* * *            | Rising       |

+\* p < 0.05; \* \* p < 0.01; \* \* \* p < 0.001; The same below.

#### 4.1.2. Discussion

From the data analysis results presented in table 1, three aspects can be seen. The dimension of consciousness is the first one. Under the flipped classroom, learners can continuously learn and explore independently in the learning process, which directly promotes the development of learners' consciousness of autonomous inquiry. It can be seen from table 1 that compared with the control class, the independent inquiry consciousness of the experimental class has been greatly improved (from 2.93 to 4.09 on average). The strategy dimension is the second one. The flipped classroom improves significantly students' learning assistance, self-testing, selection points, collaboration ability and time management ability. In flipped classroom teaching, students are given back the learning opportunities which belong to learners' autonomous control and management, providing a platform for learners to explore independently and giving full play to students' subjectivity and initiative. In conclusion, flipped classroom plays a significant role in promoting the development of learners' independent inquiry strategies. Willpower is the third dimension. It can be seen from the first five items in table 1 that there are significant differences in the dimensions related to willpower in two teaching mode (attitude, motivation, anxiety control, self-confidence and efficacy). Compared with the traditional mode, students who adopt the flipped classroom generally improve their willpower. After adopting the flipped classroom, students have improved their attitude, motivation, anxiety control, confidence and efficacy, and there are significant differences. This shows that flipped classroom mode can improve students' concentration, devotion and motivation to information technology courses, and thus exercise students' willpower.

To sum up, flipped classroom is of great significance in promoting the development of learners' innovation ability. Therefore, flipped classroom is of great value to the cultivation of students' cooperative ability and innovation ability. This is the same as the study by Jeremy F. Strayer

[22].

#### 4.2. Classified Tracking to Explore the Influence of Flipped Classroom on Different Types of Learners

##### 4.2.1. Different Types of Students Show Differences in the Development of Innovation Ability

In order to analyze the influence of flipped classroom on the development of innovation ability of learners of different types, the researchers divided the students in the experimental class into three categories: excellent, general and poor according to the entrance grade test scores and the final test scores. It can be found by the group results that: two rounds of the group have larger overlap, namely students with high scores on the entrance and placement tests tend to have higher final scores, and students with low scores on the placement tests tend to have lower final scores, only some of the students have made major changes; it mainly refers to students with low grade scores and good final scores, and no students with high grade scores and low final exam scores were found.

By comparing the above three types of students, it is found that after adopting the flipped classroom teaching mode, the double-higher students, with high initial test scores and high final scores, have little change in the dimensions of learning attitude, motivation and efficiency of information technology application; but they have great progress in collaboration ability, time management ability and anxiety control. After adopting the flipped classroom teaching mode, the double-low students, with low initial test scores and low final scores, have no significant changes in the learning attitude, motivation and efficiency of information technology application, collaboration, time management and anxiety control, and some students even fell. Biggest change in the dimension of cultivating the ability of innovation is these students who have low or medium initial test scores, but higher the final result. After using flipped classroom teaching mode, learning attitudes, motivation and self-efficacy of information technology application, collaboration ability, time management skills, anxiety control have changed dramatically, most of the students in the information technology application

self-efficacy has soared from 1.0 to 5.0, its average has risen from 1.8 to 4.72. These students are the key factors leading to significant differences in the analysis results in table 1.

Based on the above classification and comparison, the following conclusions can be drawn: Firstly, regardless of academic achievements, students' collaboration ability, time management ability and information technology application efficiency have been improved to a certain extent after adopting the flipped classroom teaching mode. Secondly, some students have made great progress in their academic performance in flipped classroom mode. This part of students in the cultivation of innovation ability in each dimension has also undergone tremendous changes, the two performance show a high degree of consistency. Thirdly, in the teaching practice of flipped classroom, it's found that a small number of students with low scores did not change into a good direction, no matter their academic performance or innovation ability. As for them, teachers need to give special guidance in learning methods and knowledge accumulation.

**4.2.2. The Adaptability of Different Types of Learners to Flipped Classroom from the Perspective of Learning Effect**

The study on flipped classroom adaptability of learners is mainly carried out from the following two aspects. First of all, the two parallel classes participating in the teaching and research practice, the class without flipped classroom is called the control class and the class with flipped classroom is called the experimental class, are compared in the final evaluation of the university computer basic course, and the impact of different types of teaching mode on the overall teaching effect is analyzed. Then, 10 students from the experimental class with the lowest entrance grade test were selected as the study objects, and their growth in computer application ability was analyzed based on the difference between the final score and the entrance grade test score.

The following conclusions were obtained based on the students' final overall evaluation scores and the works submitted by the students.

(a). There was no significant difference between the two classes in general, which indicated that the adoption of flipped classroom teaching mode did not lead to a decline in academic performance.

(b). The final score of flipped classroom is more polarized, that is, the proportion of students with high scores and those with low scores is much higher than that of the control class. After tracking the academic performance of low-scoring students, it was found that the majority of low-scoring students in flipped classroom class grew slowly. Of the 10 students with lower scores, less than 30 percent got higher marks at the end of the semester, slightly lower than the traditional teaching mode of the control class.

(c). The quality of the group works in the class with flipped classroom is generally higher than that in the class with traditional teaching mode; but in some groups of the class with flipped classroom, the personal growth of the members with low scores is very little. In some collaboration groups, some members give full play to their strengths for the success of their works, but pay less attention to the deficiencies in their knowledge system, leading to the undesirable phenomenon of "stronger strengths and weaker weaknesses".

**4.3. The Applicability of Flipped Classroom to Different Types of Learners**

In order to understand whether different types of learners like flipped classroom, the researchers at Beijing Normal University computer teaching process, chose respectively three classes, the first one was arts regular class, a total of 102 people, the second one was science regular class a total of 64 people, the third one was the talented person training a total of 82, surveyed the students' view of flipped classroom, in order to understand to promote the feasibility of flipped classroom mode in computer basic course for students.

The adaptability survey mainly involves three questions: (a). What do you think about the adoption of flipped classroom in computer courses? (b). Students' opinion on whether flipped classroom will increase the burden of schoolwork; (c). What do you think of the extensive discussion sessions in flipped classroom?

**4.3.1. Survey Data and Distribution**

The survey was conducted online and required every student to fill in every question carefully. The survey results are shown in table 2, table 3 and table 4.

*Table 2. Learners' views on flipped classroom model.*

| The class              | Like it very much | like  | It doesn't matter | Don't like | Dislike |
|------------------------|-------------------|-------|-------------------|------------|---------|
| The liberal arts class | 15.7%             | 31.4% | 27.5%             | 20.6%      | 4.9%    |
| In science class       | 3.1%              | 9.4%  | 17.2%             | 37.5%      | 32.8%   |
| Top class              | 12.2%             | 39.0% | 25.6%             | 19.5%      | 3.7%    |

*Table 3. Students' views on the burden of schoolwork in flipped classroom mode2.*

| The class              | Very heavy | The heavier | Appropriate | Easily | Very easily |
|------------------------|------------|-------------|-------------|--------|-------------|
| The liberal arts class | 24.5%      | 40.2%       | 20.6%       | 14.7%  | 0           |
| In science class       | 28.1%      | 46.9%       | 23.4%       | 1.6%   | 0           |
| Top class              | 23.2%      | 25.6%       | 23.2%       | 18.3%  | 9.8%        |



**Table 4.** Students' views on classroom discussion in flipped classroom mode.

| The class              | Great help | Help  | There is no help | Can't adapt to | It is difficult to adapt to |
|------------------------|------------|-------|------------------|----------------|-----------------------------|
| The liberal arts class | 30.4%      | 39.2% | 21.6%            | 8.8%           | 0                           |
| in science class       | 10.9%      | 37.5% | 15.6%            | 9.4%           | 26.6%                       |
| Top class              | 37.8%      | 39.0% | 13.4%            | 9.8%           | 0                           |

### 4.3.2. Conclusion

There are more learners in the general class who do not adapt to the flipped classroom mode, and the opposition of science students is stronger, but most of them admit that "classroom discussion is helpful for the internalization of knowledge". In comparison, the students in the experimental class of top-notch talents are more adapted to flipped classroom and less resistant to the flipped classroom teaching mode. In conclusion, compared with flipped classroom, more learners prefer traditional teaching mode.

From the perspective of learners' analysis, students with good knowledge foundation can adapt to the flipped classroom teaching mode quickly, and they can get good scores by virtue of this mode. However, students with poor knowledge foundation are more likely to free-ride. During the class discussion, they may be reluctant to talk and discuss because of their lack of confidence. In the production stage based on group collaboration, most learners with poor knowledge foundation become "observers" and "bystanders". Based on these phenomena, it eventually leads to the polarization of "the strong is stronger and the weak is weaker". This situation is also easy to occur in the extracurricular cooperative learning process of "heterogeneous grouping".

The phenomenon of "free rider" and "bystander" is not conducive to the cultivation of learners' consciousness of active inquiry and independent learning ability, which directly affects the development of learners' innovation ability cultivation, and is a key factor influencing the value of flipped classroom education. Teachers should pay great attention to this phenomenon in the process of teaching organization.

## 5. Summary and Discussion

### 5.1. The Value and Function of Flipped Classroom Mode in the Cultivation of Innovation Ability

After years of teaching practice, the researchers believe that the value of flipped classroom in the cultivation of innovative talents is mainly reflected in the following aspects:

#### 5.1.1. Flipped Classroom Provides Students with the Opportunity to Control Their Learning Process and Realize Deep Learning

Compared with teachers' teaching as the center of the traditional classroom, the flipped classroom teaching mode has changed the way students thinking and learning, helping students to control the learning process according to their existing knowledge and ability, select the appropriate individual cognitive styles of learning resource, organization learning process, promote the students'

personalized thinking, and realize the deep learning for students [23].

#### 5.1.2. The Flipped Classroom Teaching Mode Conforms to the Constructivist Learning Theory and Is Beneficial to the Active and Meaningful Construction of Students

From the original idea of flipped classroom, the reversal of teaching structure and mode comes from the basic thinking of "student-centered". Flipped classroom advocates to leave a lot of learning time to students' independent inquiry and learning. Students control their learning process according to their cognitive style, learning habits and learning progress, which fully reflects the "students' subjective status" in the learning process and conforms to the theory of "dominant-subject", which is conducive to the active construction of students [24].

#### 5.1.3. Flipped Classroom Promotes the Development of the Self-Management Ability and Time Management Ability

Students in flipped classroom need to arrange their learning schedule by themselves, and should be able to choose appropriate learning resources according to their existing knowledge base, learning habits and cognitive styles. This requires a certain degree of self-management, preliminary schedule planning and task management. Flipped classroom provides students with such an opportunity, during which their self-management and time management skills are well developed.

#### 5.1.4. Flipped Classroom Is Conducive to the Cultivation of Independent Exploration and Innovative Talents

As a new teaching mode, flipped classroom handed back the "initiative" originally belonging to students' active learning to students. It respects students' right to independently organize the learning process, and encourages students to "forage" rather than "feed" during the learning process, which can well solve the problem of "teaching students according to their aptitude". Flipped classroom is conducive to help students to organize learning resources and arrange learning progress according to their cognitive style and learning habit, and is conducive to cultivating students' independent learning ability, and has a good promoting effect on the cultivation of students' cooperative ability and innovation ability.

### 5.2. The Challenges of Teaching in Flipped Classroom Mode

Although flipped classroom mode plays an important role in cultivating learners' independent exploration and innovation ability, it is confronted with many specific problems that need to be solved in the specific teaching practice.

### ***5.2.1. Flipped Classroom Is Conducive to the Cultivation of Independent Exploration and Innovative Talents***

Today, education has formed a very stable teaching operation mode -- a teacher-centered teaching mode, which is deeply rooted in the minds of many students and parents and is hard to shake. As pointed out above, when some teachers try to organize teaching in the mode of flipped classroom, some parents and students immediately question "the teacher did not prepare for lessons and was not responsible", "the teacher taught the students to be self-taught" and "sheep teaching". To change this concept, it is absolutely not a short-term solution for teachers and a small number of scholars. It needs the joint action of education administrative department of a region and a country, and the joint promotion and support of education administrative department and school leaders.

### ***5.2.2. The Development of Flipped Classroom Teaching Activities Requires Highly Skilled Teachers and Students***

It can be seen from the successful experience of foreign flipped classroom teaching activities that the development of flipped classroom teaching activities requires highly skilled teachers and students. Studies have pointed out that without highly skilled teachers and students, it is impossible to have significant changes in the "flipped" teaching structure, teaching methods and teaching modes [25]. Because flipped classroom teaching mode put preliminary study of the new knowledge in the classroom, and given priority to with students' autonomous learning, which requires the school and teachers provide students with adequate but type abundant learning resources, and with the help of the information-based learning environment for students' autonomous learning process to provide support, in some cases, even with the help of information-based social tools (for example, QQ group, WeChat group) and provide support for learners' communication and knowledge sharing, and thus for the learners' autonomous learning provide a good scenario creation platform, knowledge sharing communication environment, To ensure learners' independent knowledge construction can be completed efficiently and effectively.

### ***5.2.3. The Front-Line Teachers in the Flipped Classroom Environment Must have Higher Teaching Design Ability, Teaching Management and Control Ability***

To carry out teaching activities in the flipped classroom mode is by no means to free students, let alone to let students go at their own pace. The flipped classroom mode not only requires teachers to be fully prepared in terms of learning resource support and learning activity organization, but also requires monitoring strictly of students' learning process, and avoiding the phenomenon of "free rider", so as to support, manage and control students' independent learning process in many aspects. Therefore, only when the teachers have a higher level of teaching design ability can they be competent to meet the requirements of the construction of learning support system in flipped classroom mode, and only then can they

design an independent learning support environment in line with the advanced education concept, providing better support for students' independent learning. That is to say, with flipped classroom mode to carry out teaching activities, has a high capacity requirements for teachers, including the use of information technology ability to design and management of multimedia courseware resources, including systematic teaching design ability, also includes the use of existing resources and the environment, and based on the characteristics of students, all students to participate in the active learning activities, fully play to develop ability of every student learning potential.

## **6. Conclusion**

As a new teaching mode, flipped classroom not only innovates the teaching mode, but also reverses the traditional teaching structure and teaching mode, and establishes a more thorough "student-centered" teaching mode. In this mode, students are the real subject of learning, while teachers are the organizers, helpers and guiders of students' learning. Flipped classroom is a typical "student-centered" learning mode, which is helpful for learners to arrange their learning progress according to their cognitive style and learning habit, providing good support for the implementation of "individualized teaching" and reducing the problem of "one-size-fits-all" and "one-size-fits-all" in traditional class. Flipped classroom shakes the foundation of "teacher-centered" traditional teaching mode, gives full play to learners' subjective initiative. And it is conducive to learners' independent exploration and development of inquiry learning, plays an important role in exercising and cultivating learners' independent learning ability; and is conducive to the cultivation of inquiry ability and innovation ability. Compared with the traditional classroom, flipped classroom replaces the traditional "spoon-feeding" teaching mode with communication and sharing, which is undoubtedly beneficial to learners' communication, communication and collaboration abilities. Therefore, flipped classroom teaching has certain practical value for cultivating students' cooperative ability, innovation ability and class cohesion. Although flipped classroom has many advantages, there are still many problems in the course content applicability, learner adaptability and other aspects in the implementation process of flipped classroom. There are many requirements for teachers and teaching environment design, requiring teachers to conduct more systematic teaching design and exert more effective management and control on teaching activities.

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