

An Empirical Study of Scaffolding Strategy to Cultivate College Students' Self-Directed Learning Ability: Taking the Basic Computer Course of North Normal University as an Example

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Abstract

With the updating of knowledge and the development of talent strategy, diversified talents with innovation and self-directed learning ability are valued. Higher education requires more autonomy from students, but some university freshmen have the phenomenon of maladaptation, which affects the formation of growth and innovation ability, and requires teachers to cultivate their sense of independent inquiry, time management ability and so on. The paper divides the cultivation of autonomous learning ability into 4 first-level dimensions and 15 specific dimensions, and adopts a scaffolding teaching strategy, which is divided into two kinds of scaffolding oriented to knowledge points and process and method. The teaching practice was carried out with the freshmen of 2023 Inspirational Class and Pedagogy Class as the target and the university information technology class as the carrier: firstly, the scaffolding strategy was used as the basis for analyzing the teaching content and target, designing the curriculum and forming the cultivation model; then, the practical activities were carried out to determine the starting point of the teaching through questionnaires and interviews, and the teaching practice was carried out in multiple rounds to validate the feasibility and validity based on the data, and to improve the teaching design in an iterative manner. The results show that the experimental class has higher final grades than the control class, significantly higher collaboration, motivation and other abilities than the control class, and the dimensions of independent learning ability are greatly improved, and the model is feasible and effective, which can be used as a reference for the cultivation of students' independent learning ability.

Keywords

Scaffolding, Self-Directed Learning Ability, Information Technology, Instructional Design

1. Objectives and Background

1.1. Background

1) Innovative talents are an important driving force for national development

The country urgently needs schools of all levels and types to cultivate comprehensive talents, and the Outline of the National Medium- and Long-Term Talent Development Plan (2010-2020) points out that it is clear that it is necessary to improve the ability of independent innovation and build an innovative country. In April 2018, the Ministry of Education issued the Education Informization 2.0 Action Outline, which takes the cultivation of innovation and other abilities as the central task of talent cultivation. And independent learning ability is extremely important and key to the cultivation of innovative talents. For this reason, schools and teachers should make use of the informational teaching environment to promote the development of students' innovative ability through the cultivation of their independent learning ability to meet the national talent demand.

2) Some of the new students are not capable of independent learning and need in-depth guidance from teachers

From the current practice of university teaching, some students still use the learning method of "listening to lectures and taking notes according to the textbook" after entering the university, with poor learning efficiency and effectiveness, poor time management, lack of active thinking, not being able to reflect on what they have learnt, weak independent inquiry ability, which can't satisfy the requirements of national talent cultivation. Therefore, in university education, teachers should explore effective strategies to guide students to carry out in-depth, create an environment for independent inquiry, standardize the process, and help students to form an awareness of independent inquiry, cultivate their independent inquiry strategies, so as to enhance their independent learning ability.

3) The lack of self-directed learning ability is mainly reflected in the lack of independent inquiry thinking and strategy

In the flipped classroom teaching activities of information technology courses, penman found that some students have insufficient independent learning ability, lack of independent inquiry awareness and strategies, inflexible use of professional knowledge, and are still accustomed to the passive listening method in high school. This requires teachers to establish relevant scaffolding in teaching, guide students to deep processing of knowledge, standardize the inquiry process, provide a variety of knowledge application contexts, and help students internalize and apply knowledge.

4) Information technology courses have advantages in developing students' self-directed learning ability

The information technology and general technology courses are interesting and practical, and have become the forefront of cultivating students' self-directed learning and collaboration skills, and play a key role in achieving the training goals of STEM (Ma, Wu, & Liu, 2015). The Information Technology curriculum facilitates self-directed inquiry, and the work is designed to enable research-based learning and collaborative inquiry. In this course, teachers can provide a variety of scaffolds, build a platform for independent inquiry, deeply process professional knowledge, guide students to form a sense of independent inquiry, standardize their inquiry process and learning strategies, and gradually develop their independent learning ability.

1.2. Research Objectives

With the help of information technology courses, this study explores the effective scaffolds and application strategies for the development of self-directed learning ability, and explores its impact on college students' self-directed learning ability. According to the course content and teaching situation, the scaffolds are divided into two categories: "knowledge-oriented" (using "blank space correction") and "process-oriented and method-oriented" (using "work design report"). After one semester of teaching practice, the impact of the questionnaire on self-directed learning ability and teaching effect of college students was analyzed, so as to form an effective scaffold and feasible teaching model.

2. Literature Review

There are many research results on the development of self-directed learning ability and the cultivation of this ability with the help of information technology courses both at home and abroad, and they show different development trends and research tendencies.

On the domestic front, a search on China Knowledge Network (CNN) using the keyword "self-directed learning" shows that there are many relevant papers and the number of papers issued has been on the rise in recent years, reflecting the deepening of scholars' research and the growth of social demand. Theoretical researches have been gradually carried out since the 1980s, from the innovation of teaching methods in the early stage to the multi-dimensional in-depth analysis, but a universal cultivation model has not yet been formed, and most of them are focused on specific disciplines and contexts. In the combination of disciplinary teaching practice, foreign language teaching is a hot spot, such as Wang, Zhou and Wu (2015) exploring the change of college students' English self-directed learning ability in the transition from high school to university, Li (2016) studying the relationship between college students' English self-directed learning ability and self-efficacy, Yun and Du (2013) exploring college students' English self-directed learning mode in the network environment, Hu (2007), Lu and Li (2007) discussing

the ways of cultivation, respectively, Xu (2020) defines the connotation of self-directed learning ability of foreign language majors and explores the cultivation path and related roles and synergistic development. There are also researchers focusing on independent learning implementation, purpose, mode construction and effectiveness (Huang & Zhang, 2018). Ma et al. (2016) from Beijing Normal University, on the other hand, used the flipped classroom to cultivate college students' self-directed learning ability in the information technology course with remarkable effect. Comprehensively, subject teaching mostly explores the cultivation path from the three-dimensional perspective of teachers, students and environment, and foreign language research is more concentrated. Ma et al. (2022) adopted a qualitative and quantitative method to investigate freshmen's autonomous learning ability, deeply analyzed the influencing factors and specific attribution of freshmen's autonomous learning ability, and put forward corresponding strategies for cultivating their autonomous learning ability, and then verified it through teaching practice.

In foreign research, the concept of independent learning has been proposed early, since the 1980s, the teaching and learning model, constructivism in the 1990s gave birth to a variety of pedagogical methods, the United States, Professor Zimmerman proposed a six-dimensional framework for the study of independent learning (Zimmerman & Risemberg, 1997). In the influencing factors research mostly based on the Zimmerman framework to select factors research, learning models are rich and diverse, such as Grow (1991) put forward the stages of independent learning model, Boyatzis (2005) put forward the independent learning theory model, explored the relationship between motivation, self-management, self-monitoring, independent learning, Pilling-Cormick (1997) put forward the independent learning process model. The ways of cultivation have been explored from various aspects, such as Betts, Kapushion and Carey (2016) proposed the 21st century self-directed learning competence student model, and others studied the impact of virtual reality and other technologies on self-directed learning in higher education (Martín-Gutiérrez et al., 2015), and others paid attention to the development of collaborative self-directed learning competence in language learning (Kessler & Bikowski, 2010), and self-directed learning activities in the networked learning environment, etc. (Lee, 2016), and in recent years, attention has been paid to the effect of its impact on the development of other competencies, such as Literature, Culture and Communication. In recent years, attention has been paid to its impact on other competencies, such as Serçu (2010) focus on the impact of self-directed learning on intercultural communication competence.

In terms of fostering self-directed learning with the help of information technology courses, the number of related literature searched on the Domestic Knowledge Network has stabilized since the increase in 2013. The research focuses on two aspects: one is to regard the information technology course as an important way and pay attention to the connotation characteristics and so on, as described by Hou (2011), Zhang (2017), and Zhang (2009); the second is to combine information technology

with the subject curriculum, and to cultivate students' self-directed learning ability in the subject curriculum. There are strategy studies at home and abroad but more discursive, lack of empirical evidence, implementation and evaluation to be improved.

In summary, although some results have been achieved at home and abroad, it is still necessary to strengthen empirical research and explore effective teaching models that are oriented to the dimension of competence, optimize the training mode and evaluation of information technology courses, and aim at enhancing students' self-directed learning ability.

3. Design of the Research Scheme

3.1. Research Process Design

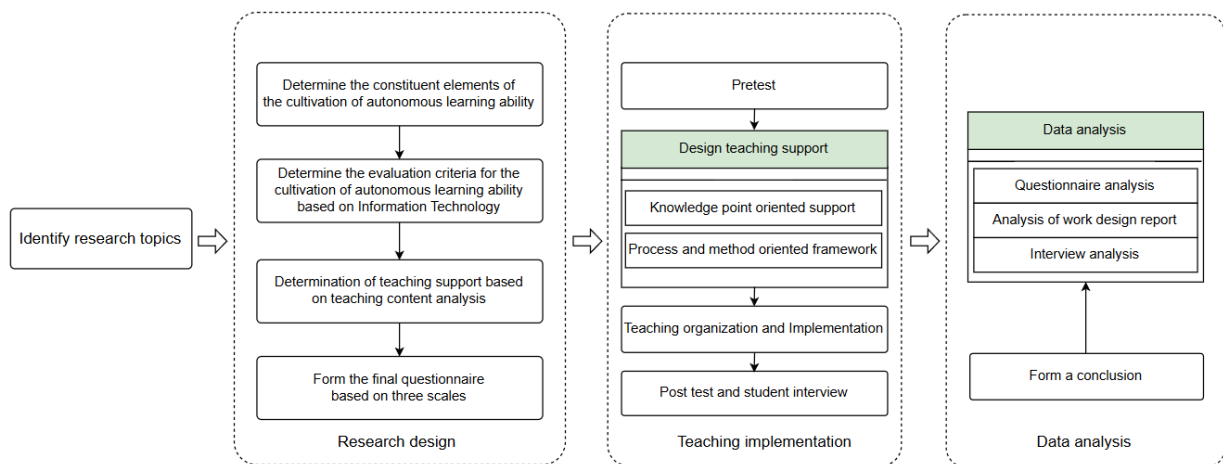


Figure 1. Flow chart of the research process.

This study focuses on university information technology courses, aiming to explore the role and teaching effect of scaffolder teaching strategies on the cultivation of college students' self-directed learning ability, as shown in **Figure 1**. The theme was first identified through literature study, the elements of the cultivation of college students' independent learning ability were analyzed and clarified, the teaching design was carried out to determine two scaffolding designs and cultivation models. The knowledge-based scaffolding adopts the "semi-finished product" strategy, while the process- and method-based scaffolding is presented in the form of a work design report. The questionnaire was then combined with the relevant scale and the actual course to determine the questionnaire, and the questionnaire and interview were conducted at the beginning and end of the semester. Afterwards, multidimensional data analyses were carried out, covering the questionnaire, the work, the work design report, the interviews and the final grade. Finally, based on the results, the scaffolding role is explored, changes in the dimensions of independent learning ability of students in the experimental class and the impact of teaching strategies are analyzed, and the cultivation path is summarized and verified through multiple rounds of iterations in order to improve the

application of strategies and enhance the independent learning ability of college students.

3.2. Instructional Design for the Development of Self-Directed Learning Ability

1) Research framework design

This study argues that in the process of self-directed learning ability cultivation, the accumulation of basic knowledge related to curriculum content and self-directed learning strategies are the basis for the cultivation of self-directed learning ability, the collaboration ability and time management ability in self-directed learning strategies are not only the elements of self-directed learning ability, but also an important condition to promote the development of self-directed learning ability, and the self-directed learning consciousness gradually grows up with the formation of self-directed learning strategies. Willpower is an important quality in the development of self-directed learning ability, and good willpower is conducive to the cultivation of self-directed learning ability, while the process of self-directed learning ability development will positively promote the development of willpower. In addition, with the deepening of the cultivation of self-directed learning ability, students' self-learning ability is gradually developing, and the teaching scaffolds will gradually decrease, and finally reach a state without scaffolds. The structural framework for the development of self-directed learning ability is shown in **Figure 2**.

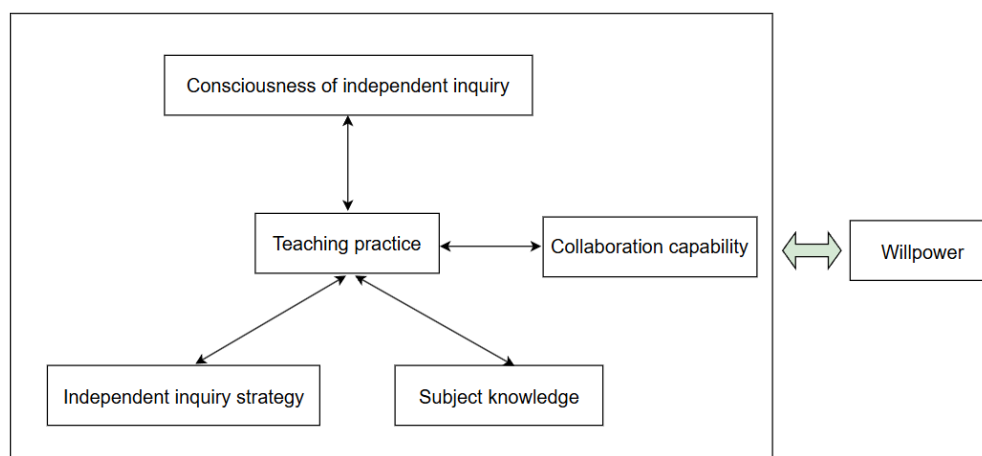


Figure 2. Structural framework for self-directed learning ability training.

2) The guiding ideology for the cultivation of self-directed learning ability

Awareness of self-directed learning is based on self-directed learning strategies and subject knowledge, without which it is not feasible to talk about self-directed learning awareness, and it will increase students' anxiety. The development of awareness should start with the development of strategies, and subject knowledge should be of appropriate level of difficulty. Willpower is crucial for the implementation of self-directed learning strategies and ability development, and especially

attention should be paid to motivation, attitude, and anxiety control. When cultivating self-directed learning ability, it is necessary to provide all-round support, pay attention to anxiety to protect motivation and prevent learning boredom. The cultivation of self-directed learning ability is inseparable from the learning of specific disciplines, and should be “cultivated and developed in learning”, combined with the inherent characteristics of learning content, and the ability training objectives and learning content should be organically integrated. Focus on certain aspects of cultivation in stages, and continue to cultivate them through the characteristic teaching stage, so as to promote the all-round development of students’ independent learning ability.

3) Learner analysis

The teaching object of this study is the freshmen of the class of 2023 in North Normal University, who are mostly adapted to the passive learning mode in high school, and have poor independent learning and inquiry ability. The survey found that: some students used to listen and memories, low efficiency in class; when on the computer, they mostly mention the problems that have been taught, and when they encounter difficulties, they are eager to seek answers; in the instruction, there are two extremes in students’ questioning, either they are shy to ask questions leading to low efficiency, or they rely too much on asking for help. For example, when doing Excel module exercises, some students gave up trying because of interface problems. These phenomena show that students have low self-confidence and poor foundation, and it is difficult for them to adapt to the university independent learning mode. The flexibility of the university classroom, some students are at a loss, stemming from the lack of independent learning ability cultivation in primary and secondary schools, which is manifested in the lack of independent learning awareness and strategies, and it is difficult to cope with the university’s high information content and the increase in the number of open-ended questions in the learning life. In addition, the university has a lot of free time, but students do not know how to arrange it reasonably, and often feel confused, empty and anxious.

4) Selection of teaching strategies oriented to the development of self-directed learning ability

In teaching the course Fundamentals of Information Processing, teachers use a variety of teaching strategies in order to achieve teaching goals and develop students’ self-directed learning ability. The four main areas are as follows:

a) Stimulate students’ interest in learning with new and interesting teaching cases

Teaching case is the first step of students into the classroom, teachers should choose interesting and can arouse the curiosity of the case. For example, in teaching Photoshop’s “layers” concept, show “puppy face” case, interesting cases can quickly let students into the classroom situation and follow the teacher’s pace.

b) Cultivating students’ sense of self-directed inquiry and strategies with a task-driven approach

The development of self-directed learning ability focuses on students' self-directed inquiry activities, and the task-driven approach allows students to focus on a common task, driven by a strong motivation to actively apply learning resources for self-directed inquiry or collaborative learning to complete the task. Teachers follow the concept of "student-oriented" in teaching, guiding students to use the scaffolding independent inquiry to solve problems. For example, when students design posters independently, teachers give design rules, requirements and examples, and standardize the process of inquiry with the work design report, so that students can use the existing resources to complete the design with autonomy and creativity, and then gradually cultivate the awareness and strategies of independent inquiry.

c) Reflecting changes in students' self-directed learning abilities with work design reports

Students' self-directed learning ability is cultivated throughout the teaching practice. Teachers not only pay attention to the final work, but also to the production process. Students or groups are required to record the design process of the work, and the report can clearly show the design process, so that teachers can reflect on and optimize the teaching design accordingly. At the same time, students fill in the report is a knowledge output process, which can sort out, evaluate and reflect on the design process and optimize it in time, and also strengthen the understanding of knowledge.

d) Exercise collaborative skills with collaborative group learning

Group cooperation is an effective way to exercise students' collaborative ability, which is conducive to the mutual complementarity of group members, and is more conducive to the cultivation of students' time management ability and sense of responsibility. Teachers should consciously cultivate and exercise students' collaborative ability in the process of education and teaching by means of group learning, so as to lay the foundation for the development of students' self-directed learning ability and even comprehensive ability. In this teaching practice, there are rules to guarantee the quality of learning in group cooperation to produce PPT, limiting the number of groups to 4 - 6 people, requiring the completion of the work design report, mutual evaluation of members and the use of inter-group mutual evaluation and teacher evaluation, and the teacher randomly designates the reporter, prompting the members to prepare carefully.

5) Selection and design of learning content

This study takes the course "Fundamentals of Information Processing" as a carrier, designs the system of cultivating self-directed learning ability according to the sequence of "self-directed inquiry strategy-collaborative ability-awareness of self-directed inquiry-comprehensive evaluation", and pays attention to the use of scaffolding to cultivate students' awareness of self-directed inquiry and self-directed learning ability.

a) Selection and design of learning content for the cultivation of self-directed learning strategies

The content selection follows the principles of rich knowledge and clear logical

relationship, rich online resources, easy to set exercises, clear knowledge logical system and difficulty level. The module “Excel-based statistics and data analysis” was chosen because Excel is closely related to students’ lives, has a strong knowledge system and is rich in resources, which is conducive to the development of students’ multiple learning abilities. The teaching design adopts a semi-finished white space design for knowledge points, leaving key knowledge points white and providing corresponding scaffolding and resources for students to choose scaffolding to solve problems in order to achieve the purpose of internalizing knowledge.

b) Selection and design of learning content for collaborative capacity development

The selected content should be suitable for project teaching, the knowledge content is simple, interesting and practical, the comprehensive tasks are moderate and can be disassembled, the acquisition of raw materials is easy and flexible, and there is enough time to complete the tasks. Selected “PPT slide presentation” module, the content is suitable for the layout of the presentation development design tasks, the organization of materials and task management is suitable for group work, and suitable for students’ daily learning and reporting. Teaching activities are organized in a group cooperation way, and students make PPTs around topics closely related to campus life or university study at BNU. To ensure the quality of group learning, we set requirements for the number of students in the group, work reports, mutual evaluation and randomly formulated reporters, etc., and design relevant forms in advance with reference to the theory of CSCL to strictly manage the process of the activities.

c) Selection and design of learning content for the cultivation of self-directed inquiry

The content selection should meet the principles of learners’ familiarity with the knowledge and experience in using it, a large number of online resources, and having knowledge-oriented and comprehensive tasks. The module “Word-based Text Information Processing” was chosen because its knowledge points are simple and most students have experience, so the teacher reduces the scaffolding for students to explore independently. Teaching activities are organized in such a way that the knowledge points are oriented to exercise students’ basic operation ability with semi-finished products, and the process and methodology are oriented to let students complete comprehensive tasks and standardize the design process with the help of the framework with the help of the work design report, and the students, after completing the basic tasks, will complete the design of the work and fill in the work design report by finding materials independently with the use of online resources.

d) Selection and design of learning contents for comprehensive competency development

The selected content should be suitable for comprehensive tasks, creative space, rich in knowledge with a certain degree of difficulty and many resources, etc. The

module “Multimedia Material Processing” is in line with this principle and is suitable for comprehensive tasks in the category of short video production, with simple knowledge, teachers withdrawing most of the scaffolding without affecting the learning effect, and rich in content with many resources. The organization of teaching activities adopts the method of half-finished products and white space, and the comprehensive work design refers to the short video design, which is designed as the last round of teaching without scaffolding, and is explored and played by the students independently, and the design of their works can be used as a reference for the change of students’ self-directed learning ability in a semester.

3.3. A Preliminary Model of Self-Directed Learning Ability Development Based on Scaffolding Strategy

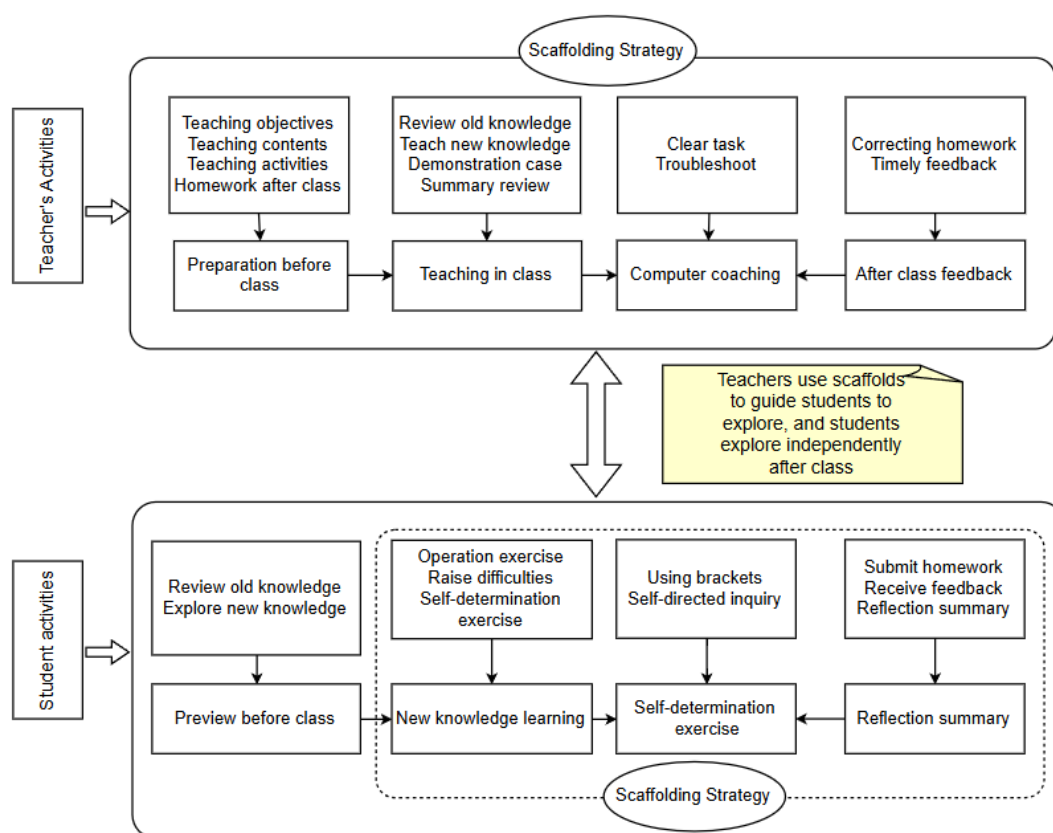


Figure 3. Model of developing self-directed learning ability based on scaffolding strategy.

According to the actual teaching situation, the teacher’s activities are mainly divided into three parts: pre-course preparation, in-class instruction and post-course feedback, of which the in-class instruction is divided into theoretical instruction and computer tutoring. Teachers mainly create a good environment for students to explore, and provide students with problem-solving scaffolding to guide students to solve problems independently. Student activities are mainly divided into four parts, namely, pre-course preparation, new knowledge learning,

independent investigation and reflection and summary, students mainly in the environment created by the teacher, using the scaffolding given by the teacher, independent investigation or mutual collaboration to solve the problem. According to the construction principle of the model, the author designed a model of self-directed learning ability cultivation based on scaffolding strategy, as shown in **Figure 3**. Finally, the teacher summarizes the effects and shortcomings of this round of teaching practice in time after each round of teaching practice, and improves the teaching design of the next round based on the students' learning effect, work design and work design report.

As can be seen in **Figure 3**, the model is characterized by the scaffolding strategy throughout the entire process of teacher and student activities, turning the previous emphasis on students' operational skills into the cultivation of students' self-directed learning ability on the basis of the emphasis on the mastery of basic operational skills. At the same time, this study also focuses on the instructional design in terms of both knowledge points and comprehensive large tasks to optimize and improve teaching practices through an iterative approach.

4. Teaching Practice of Autonomous Learning Ability Training Based on Scaffolding Strategy

In this study, the teaching practice is carried out in the course of "Information Processing Foundation" and the research activities are organized in the mode of "experimental class-control class" (one class in the experimental class and two classes in the control class), aiming to explore the effective support for cultivating students' autonomous learning ability. There were four rounds of activities, and the scaffolding strategies used in each round were different.

4.1. Scaffolding and Design for the Development of Autonomous Learning Strategies

1) Objective

To enable students to master the knowledge and skills related to Excel, form independent inquiry strategies, and improve their independent learning ability in many aspects.

2) Stent design and application

a) Multi-type resource scaffold

Providing micro-video, text materials, PPT and discussion posts. The micro video introduces the concept and operation steps of knowledge points, the text material lists the detailed operation steps, PPT helps recall knowledge, and the discussion post contains difficult problems and thinking process. With the help of this scaffold, students can improve their ability of resource selection and learning auxiliary application.

b) Self-diagnosis and information processing support

Through the practice questions and operation materials in the micro-course resource package, and the process recording information of the learning platform,

students are encouraged to self-diagnose, check for deficiencies, and improve their information processing ability.

c) Interactive communication scaffold

The micro-video playback interface has a posting function, which encourages teachers and students to exchange views and question each other, and promotes students' deep thinking, summarizing points and information processing.

d) Homework Assistance Scaffolding

The job requirements interface provides scaffolding, such as links to learning resources such as functions and text materials (Figure 4). Students can click to get help and maintain learning motivation when they are confused.

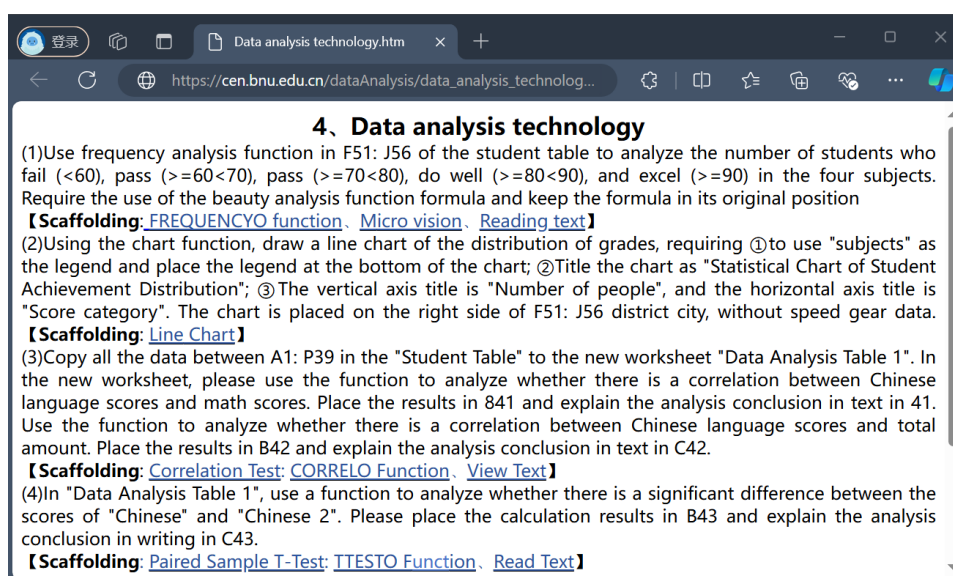


Figure 4. Excel knowledge point task (part).

e) Scaffolding of teaching activities

Teachers encourage students to describe their views on problems and guide them to explore independently; support students to use resources to try and communicate, improve self-confidence and self-efficacy.

3) Implementation process

Pre-class teachers emphasize the importance of autonomous learning, guide the use of scaffolding to explore; in the lesson, the theoretical teaching is combined with the case demonstration, and the task is arranged and the use of the bracket is explained. After class, students basically master the basic knowledge of Excel, and the self-exploration strategy has developed, but there are problems such as function use.

4.2. Scaffolding and Design for Collaborative Ability Training

1) Objective

Let students master PPT operation, and exercise the ability of collaboration and time management in teamwork.

2) Stent design and application

a) Collaborative guidance and reflection scaffold

Create a “work creativity and design report” focusing on creativity and division of labor, guide students to divide and cooperate, record the contribution, collaboration and harvest of each student at each stage, and encourage students to reflect on the creativity and design process.

b) Supervision and mutual evaluation support

Create a “mutual evaluation form within the group” to encourage members to supervise each other and evaluate contributions and help.

c) With the help of the “inter-group evaluation form”

Encourage group mutual evaluation, require to find the strengths and weaknesses of other groups, give full play to students subjectivity in the process of mutual evaluation, and learn from each other (Figure 5).

Evaluation Form for Student Creativity and Gains in Project-based Learning					
Rated group number: first group	Name of reporter:		Group member names:		
	Title of work:				
	Main advantages of the work:				
	Main shortcomings of the work:				
	What have you learned from this work?				
	Report performance score:	Work quality score:	Technical level score:	Composition color score:	Smooth playback score:
	Final score:				

Figure 5. Evaluation table between the groups.

d) Task decomposition and time management support

“Creative Works and Design Report”, which divides PPT design into stages, sets time intervals, and helps students decompose tasks and manage time.

e) Teaching content support

Provide excellent works appreciation, templates and key operation steps, and teach key and difficult points through classroom questions.

3) Implementation process

Clear learning methods and group requirements before class; in the course of theoretical teaching, questions are asked instead of lectures, difficult operation demonstrations, tasks are arranged and brackets are explained in the computer class; after class, students’ PPT design ability is improved, collaboration and time management ability is enhanced, and the effect of intra-group mutual evaluation and inter-group evaluation is good.

4.3. Scaffolding and Design for the Cultivation of Self-Inquiry Consciousness

1) Objective

To enable students to master the Word operation, complete the mixed operation of pictures and texts, and form a sense of independent inquiry.

2) Stent design and application

a) Knowledge and comprehensive task scaffolding

knowledge point tasks adopt the “semi-finished” strategy, such as setting title style exercises to leave blank key content to help students master knowledge and skills; comprehensive tasks provide blank design reports, standardize design processes, and externalize knowledge and thinking (Figure 6).

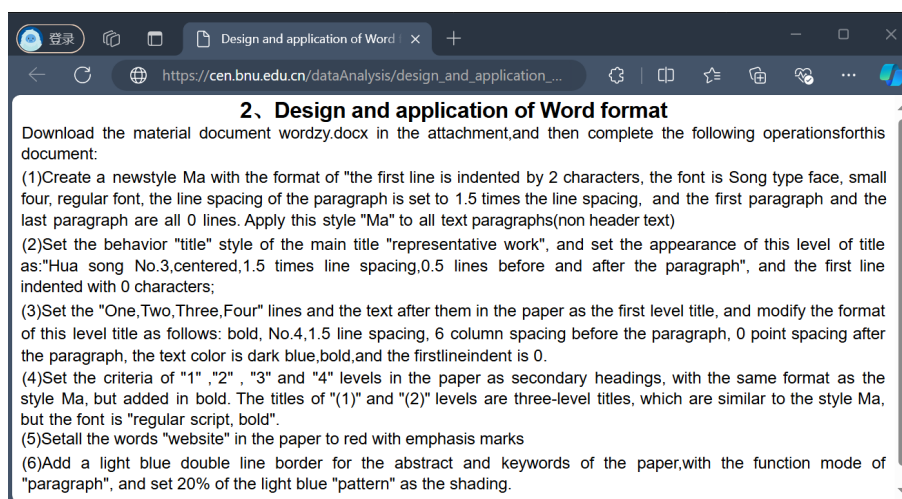


Figure 6. Word knowledge point task (part).

b) Self-inquiry consciousness training bracket

Inform students to solve problems independently in advance, change dependence habits, and cultivate self-inquiry consciousness.

3) Implementation process

Emphasizing the layout of academic papers before class, and guiding independent inquiry; the combination of theoretical teaching and case demonstration in the class, the arrangement of tasks in the computer class and the provision of support; after class, most students can design beautiful posters, and their independent inquiry consciousness develops well, but there are problems in time management.

4.4. Scaffolding for the Cultivation of Comprehensive Ability of Autonomous Learning

1) Objective

Let students master the knowledge of image processing, audio processing and video production, and improve the comprehensive ability of autonomous learning.

2) Stent design and application

Retain some knowledge points, adopt the “semi-finished” strategy, such as leaving white filter operation in the knowledge structure, and exercise students’ autonomous learning ability; the comprehensive task removes the bracket and encourages students to explore independently (Figure 7).

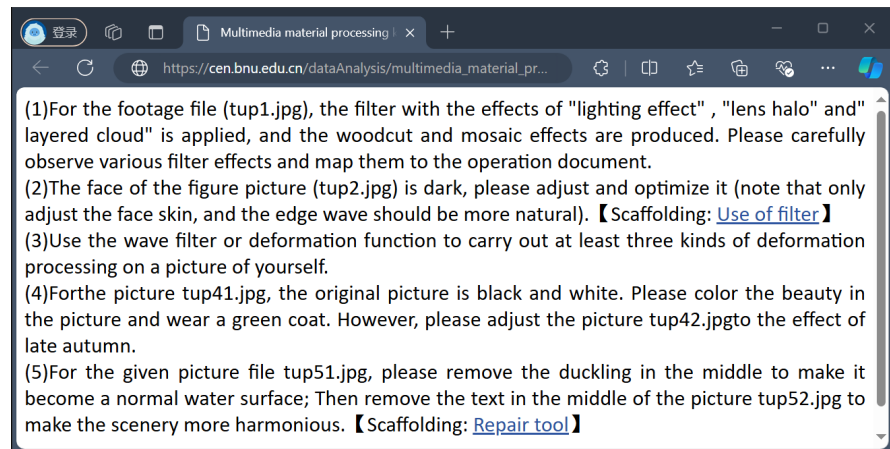


Figure 7. Multimedia material processing knowledge point tasks.

3) Implementation process

Teachers guide students to explore independently before class; in the lesson, the theoretical teaching explains the knowledge and operation demonstration, and the computer class explains the task bracket and guides the autonomous learning; after class, students' tasks are completed well, their autonomous learning ability is improved, their works are innovative, and the quality of questions is improved.

5. Analysis of the Practical Effect of Scaffolding Strategy for Autonomous Learning Ability Training

Based on the university information technology curriculum, this study starts from the teaching objectives of the two dimensions of curriculum teaching and self-learning ability training, and analyzes the practical effects of the scaffolding strategy through three aspects: self-learning ability post-test questionnaire, experimental class students' works and reports, and final examination results.

5.1. Analysis of the Effect of Autonomous Learning Ability Training

162 questionnaires were distributed to three classes, and the changes of students' autonomous learning ability were investigated from multiple dimensions such as scaffolding, professional knowledge and self-inquiry consciousness.

1) Difference test of autonomous learning ability among the three classes

Because most of the data do not satisfy the normal distribution and the variance is not homogeneous, the author uses the K-independent sample non-parametric test (Kruskal-Wallis test). The results show that there are significant differences between classes in self-efficacy, collaboration ability, motivation, learning assistance, self-test and understanding of the role of scaffolding.

a) Kruskal Wallis test

b) Grouping variable: Class

It can be seen from **Table 1** that at the level of each dimension of autonomous learning ability, except that self-confidence and learning assistance in the experimental class are slightly lower than those in the control class 2, the average values

of other dimensions are higher than those in the control class, especially the advantages of collaboration ability and motivation dimension are obvious.

Table 1. Post-test data K-Non-parametric test results of independent samples.

	Detection statistics ^{a,b}		
	Chi-square	df	Asymptotic Significance
Professional knowledge	2.010	2	.366
Collaboration capability	11.477	2	.003
Consciousness of independent inquiry	4.704	2	.095
Self-confidence	4.185	2	.123
Attitude	3.125	2	.210
Motivation	8.951	2	.011
Practical management ability	1.522	2	.467
Anxiety control	.046	2	.977
Concentration	1.793	2	.408
Information processing	5.045	2	.080
Select key points	4.805	2	.091
Learning aids	9.346	2	.009
Self test	9.047	2	.011
Pre exam strategies	1.691	2	.429
Function of support	28.361	2	.000

2) Specific reasons for the differences in each dimension

a) Collaboration ability, motivation, learning assistance, self-test dimension

Through the non-parametric test, it is found that the experimental class is significantly higher than the control class in the dimension of collaboration ability and motivation. In the dimensions of learning assistance and self-test, the experimental class is higher than the control class 1 and there is a significant difference, but there is no significant difference with the control class 2; the recognition of the scaffold effect in the experimental class was significantly higher than that in the control class.

b) Self-efficacy dimension

Using independent sample T test, there was a significant difference in self-efficacy between the experimental class and the control class 1, and the score was higher than that of the control class 1 ($t = 2.128$, $\text{Sig} = 0.038$); compared with the control class 2, although the mean value was higher than that of the control class 2, there was no significant difference ($t = 1.302$, $\text{Sig} = 0.192$).

3) Changes of students' autonomous learning ability in the experimental class

Table 2. Differences in students independent learning ability in the experimental class before and after the semester.

Autonomous learning ability of each dimension	At the beginning of the semester	The end of a semester	D-value
1. Professional knowledge	2.63	3.77	1.14
2. Autonomous inquiry consciousness	3.83	4.08	0.25
3. Autonomous exploration strategy	3.40	3.59	0.18
3.1. Autonomous learning strategy	3.38	3.62	0.24
3.1.1. Learning assistance	4.16	4.05	-0.11
3.1.2. Self test	3.03	3.68	0.65
3.1.3. Choose the key points	3.22	3.73	0.51
3.1.4. Examination strategy	3.14	3.08	-0.06
3.1.5. Information processing	3.35	3.57	0.22
3.2. Collaboration ability	3.49	4.00	0.51
3.3. Time management ability	3.43	3.00	-0.43
4. Psychokinesis	3.31	3.66	0.35
4.1. Manner	3.97	3.92	-0.05
4.2. Motive	3.54	4.05	0.51
4.3. Whole-hearted	3.08	3.11	0.03
4.4. Self-confidence	3.70	3.86	0.16
4.5. Efficacy	3.08	3.57	0.49
4.6. Anxious controls	2.51	3.46	0.95

In order to explore the changes of autonomous learning ability of students in the experimental class after one semester of teaching practice, the average level and difference of each dimension before and at the end of the semester were counted (Table 2). The results show that the students' professional knowledge scores change the most, reflecting the good learning effect. The degree of anxiety control changed from 2.51 to 3.46, which was significantly improved after scaffolding teaching, and the improvement of self-confidence and self-efficacy was also reflected. The level of self-test, selection points, collaborative ability, motivation and other dimensions has been significantly improved, and the scores of learning assistance, examination strategy and information processing have not changed much. The scores of learning assistance, examination strategy, time management ability and attitude at the end of the semester were lower than those at the beginning of the semester, and the scores of time management decreased more, which may be due to the overestimation of their own ability at the beginning of enrollment and the dissatisfaction with the individual's time allocation after entering college life.

5.2. Evaluation and Analysis Based on the Quality of Works

After four rounds of teaching practice, the students' autonomous learning ability in the experimental class has changed significantly, and the works and reports can also reflect this conclusion. Through the cultivation of self-exploration strategies, group collaboration ability, time management ability, self-exploration awareness and habits, students' comprehensive ability of self-learning has been significantly developed.

The analysis found that students changed from the initial "ask teachers without thinking when they encounter problems" to "solve common problems by themselves, and only ask teachers if they are too difficult or unable to find answers", indicating that students' awareness of independent inquiry has gradually increased. They are able to complete and innovate on time when they finally submit their works, which shows that they overcome inertia and generally enhance their self-learning ability.

5.3. Analysis Based on the Final Test Scores

Table 3. Statistical analysis of the final test results of the experimental class and the control class.

Classes and grades in school	M ± SD
Liyun Liberal Arts Class (experimental class)	85.85 ± 10.95
Educational class (control Class 2)	83.25 ± 14.32
Liyun Science Class (compare with class 1)	84.05 ± 13.85

The three classes were taught by the same teacher. The experimental class used the scaffolding strategy, and the control class used the conventional teaching. After the final paperless examination, the average score of the experimental class was higher than that of the control class and the standard deviation was smaller (**Table 3**), indicating that the experimental class had higher scores and the student gap was small, which also verified the feasibility of scaffolding strategy to cultivate autonomous learning ability.

6. Discussion and Reflection

6.1. Thoughts on the Cultivation of Autonomous Learning Ability Based on Scaffolding Strategy

After literature analysis, this study summarizes the relevant content of independent learning ability and scaffold strategy, determines the training dimension of college students independent learning ability, takes the information technology course as the carrier to construct the training model, carries out four rounds of teaching practice, and verifies the effect. Many conclusions are drawn: ① Through literature analysis, the cultivation dimension of college students independent learning ability is formed, including professional knowledge, independent inquiry consciousness, strategies and willpower. ② The autonomous learning ability training

model based on stent strategy has been formed, which has been proved feasible and effective by teaching practice. ③ Teaching practice has proved that the cultivation of independent learning ability is integrated in the teaching of university information technology courses, and the scaffold teaching strategy is feasible and effective. ④ According to different teaching contents, it is feasible to divide the support into “semi-finished products” teaching strategies for knowledge points and process-oriented and method-oriented work design reports. ⑤ University information technology courses based on independent learning ability can effectively cultivate students independent learning ability, such as collaboration ability, anxiety control, motivation, independent inquiry consciousness and strategies, and can improve the teaching effect of information technology courses. ⑥ The “semi-finished product” teaching strategy can effectively help the students to master the knowledge points, and the work design report can realize the teachers control of the students design process, and can effectively standardize the learning. ⑦ Homework design report and group cooperation activity form play a significant role in cultivating students independent learning ability, but teachers need to carefully design and clear requirements, otherwise the report will lead to a mere formality and lack of connotation. ⑧ The formation of college students independent learning ability requires teachers to achieve the iterative improvement of the training effect in multiple rounds of teaching practice.

6.2. Self-Learning Ability Training Model Based on Scaffolding Strategy

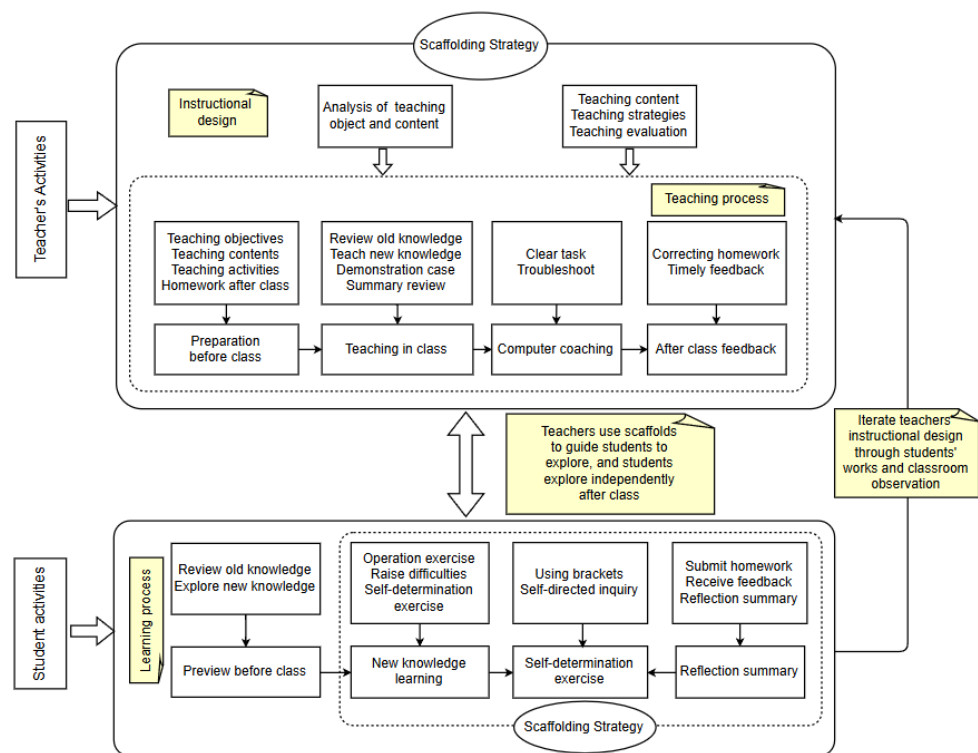


Figure 8. Self-directed learning training model based on stent strategy-optimization.

After a semester of teaching practice, there are some problems in the preliminary design of the “self-learning ability training model based on scaffolding strategy” in the early stage. Therefore, this study optimizes the training model, as shown in **Figure 8**. In the optimized training model, the teacher’s pre-class teaching design is added, and the model is improved by iterative optimization of multiple teaching practices.

6.3. Reflection

This study innovatively integrates the cultivation of autonomous learning ability into the university information technology curriculum, and carries out four rounds of teaching practice, covering Excel, PPT, Word and multimedia material processing teaching. Although each has its own emphasis, it is interrelated and promotes each other. It has three innovations to improve students’ multi-faceted ability. First, according to the literature, it is clear that the training elements of autonomous learning ability are applied to the curriculum to promote relevant research. The second is to build scaffoldings in two types of teaching activities, set different levels according to content and time, and reflect on optimization to promote the development of scaffolding strategies; the third is to reveal the influence and reasons of scaffolding strategy on the dimension of autonomous learning ability, and provide reference for teaching.

Although the final results of the study show that the university information technology course integrated into the cultivation of autonomous learning ability has achieved good teaching results, some problems have also been found in the teaching practice, which need to be improved in the follow-up research: ① The course selected in this study is the course of “Information Processing Foundation”, and the teaching design is limited to this course. The application of scaffolding teaching strategy and the cultivation effect of autonomous learning ability in other information technology courses needs to be verified and promoted. ② After a semester of teaching practice, the level of each dimension of autonomous learning ability changes differently, the reasons for the different levels of change in the dimensions and the impact of the instructional design on the type of learner need to be further investigated.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- Betts, G., Kapushion, B., & Carey, R. J. (2016). The Autonomous Learner Model. In D. Ambrose, & R. J. Sternberg (Eds.), *Giftedness and Talent in the 21st Century* (pp. 201-220). SensePublishers. https://doi.org/10.1007/978-94-6300-503-6_12
- Boyatzis, R. E. (2005). Developing Leadership through Emotional Intelligence. In D. Ambrose, & R. J. Sternberg (Eds.), *Research Companion to Organizational Health Psychology: Advances in Creativity and Giftedness* (pp. 189-210). Edward Elgar Publishing. <https://doi.org/10.4337/9781845423308.00052>

- Grow, G. O. (1991). Teaching Learners to Be Self-Directed. *Adult Education Quarterly*, 41, 125-149. <https://doi.org/10.1177/0001848191041003001>
- Hou, Y. J. (2011). Research on Cultivating Students' Independent Learning Ability by Using Information Technology. *Software Guide*, 3, 177-178.
- Hu, C. H. (2007). On the Cultivation of Open Education Students' Independent Learning Ability. *Educational Exploration*, 5, 62-63.
- Huang, Z. Z., & Zhang, X. L. (2018). An Exploration of the Influence Mechanism of Independent Learning Ability on Online Learning Effectiveness: Also on the Mediating Role of Online Learning Interactive Experience. *Modern Educational Technology*, 3, 66-72.
- Kessler, G., & Bikowski, D. (2010). Developing Collaborative Autonomous Learning Abilities in Computer Mediated Language Learning: Attention to Meaning among Students in Wiki Space. *Computer Assisted Language Learning*, 23, 41-58. <https://doi.org/10.1080/09588220903467335>
- Lee, L. (2016). Autonomous Learning through Task-Based Instruction in Fully Online Language Courses. *Language Learning & Technology*, 20, 81-97.
- Li, H. (2016). An Empirical Study on College Students' English Independent Learning Ability and Self-Efficacy. *Modern Foreign Languages*, 2, 235-245, 292-293.
- Lu, Y., & Li, Q. (2007). On the Cultivation of Students' Independent Learning Ability under the Background of Educational Innovation. *Heilongjiang Researches on Higher Education*, 10, 191-192.
- Ma, X. L., Wu, T., & Liu, L. C. (2015). Computational Thinking: The Integration of Thinking Ability Cultivation and the Teaching of Information Technology Basic Courses. *China Education Informatization*, 2, 22-25.
- Ma, X. L., Zhao, G. Q., & Wu, T. (2016). An Empirical Study on How the Flipped Classroom Promotes the Development of College Students' Independent Learning Ability: Based on the Practice of College Public Computer Courses. *China Educational Technology*, 7, 99-106, 136.
- Ma, X., Jiang, X., Tian, S., & Jia, Y. (2022). Research on the Investigation and Cultivation Strategy of Freshmen's Autonomous Learning Ability. *Open Journal of Social Sciences*, 10, 170-194. <https://doi.org/10.4236/jss.2022.1012012>
- Martín-Gutiérrez, J., Fabiani, P., Benesova, W., Meneses, M. D., & Mora, C. E. (2015). Augmented Reality to Promote Collaborative and Autonomous Learning in Higher Education. *Computers in Human Behavior*, 51, 752-761. <https://doi.org/10.1016/j.chb.2014.11.093>
- Pilling-Cormick, J. (1997). Transformative and Self-Directed Learning in Practice. *New Directions for Adult and Continuing Education*, 1997, 69-77. <https://doi.org/10.1002/ace.7408>
- Sercu, L. (2010). Autonomous Learning and the Acquisition of Intercultural Communicative Competence: Some Implications for Course Development. *Language, Culture and Curriculum*, 15, 61-74. <https://doi.org/10.1080/07908310208666633>
- Wang, Z. R., Zhou, Y. Y., & Wu, H. (2015). A Dynamic Study on College Students' English Independent Learning Ability during the Academic Transition Period. *Foreign Language World*, 2, 25-33.
- Xu, J. F. (2020). The Composition and Cultivation of Foreign Language Majors' Independent Learning Ability. *Foreign Language World*, 6, 26-32, 62.
- Yun, T. Y., & Du, Z. Q. (2013). A Study on the Autonomous English Learning Model of College Students in the Network Environment. *China Educational Technology*, 11, 129-131.

- Zhang, G. P. (2017). Research on Cultivating Students' Independent Learning Ability in Information Technology Teaching. *Way of Success*, 3, 39.
- Zhang, Y. (2009). Cultivating Students' Independent Learning Ability in Information Technology Classroom Teaching. *China Educational Technology & Equipment*, 17, 68-70.
- Zimmerman, B. J., & Risemberg, R. (1997). Self-Regulatory Dimensions of Academic Learning and Motivation. In G. D. Phye (Ed.), *Handbook of Academic Learning* (pp. 105-125). Elsevier. <https://doi.org/10.1016/b978-012554255-5/50005-3>