The Effect of Problem-chain Teaching Model on College Students' Autonomous Learning Ability

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Abstract

Background and Aim: The arrival and rapid development of the Internet era have greatly changed all aspects of society. In the face of this profound change, it is particularly important to find an effective learning path suitable for Chinese college students. This study aimed 1) to compare autonomous learning ability before and after using the problem chain teaching model. And 2) to study autonomous learning ability after using the problem chain teaching model with an expectation of passing with the criteria of 60 percent.

Materials and Methods: The sample in this research was 30 students to take part in the course "Basic Accounting" in the autumn semester of the 2022-2023 academic year at Zhujiang College, South China Agricultural University. The research instruments used were 1) lesson plan 2) autonomous learning ability evaluation form and 3) classroom observation form of autonomous learning ability. The data were analyzed using mean, standard deviation, t-test for a dependent sample, and one sample t-test.

Results: The research finding was as follows: 1) The score of students' autonomous learning ability after using the problem-chain teaching model was higher than before using the problem-chain teaching model at a .05 level of statistical significance. 2) The score of students' autonomous learning ability after using the problem chain teaching model was higher than the criterion of 60% of full marks at the 05 levels of statistical significance.

Conclusion: In this study the results show that after using the problem chain teaching model the college students' autonomous learning ability was higher than before and higher than the criterion of 60 percent. It meant that the problem-chain teaching model influence the college students' autonomous learning ability.

Keywords: Problem Chain; College Students; Autonomous Learning Ability

Introduction

For a long time, the discussion of future talent quality has been enduring. The World Economic Forum released the 2020 Future Employment Report, which mentioned that the most needed skills of future talent in 2025 include: self-management abilities such as active learning, resilience, pressure resistance, and flexibility. Modern education requires the educated not only to learn what, but also to learn how to learn. After each kind of "learning" goes out of the campus, without the help, management and supervision of the school and teachers, to achieve personal continuous development, we need to

have the ability of independent learning to truly achieve lifelong learning. Therefore, autonomous learning is one of the important abilities related to the sustainable development of students in the training of comprehensive abilities of talents in colleges and universities.

In 2012, the Opinions of the Ministry of Education on Improving the Quality of Higher Education in an All-round Way required colleges and universities to follow the "connotative development path with quality improvement as the core", and the "connotative development" required that colleges and universities must establish the status of the undergraduate teaching center so that students can survive and develop well in the society. The study of learning theory and education theory shows that individual learning ability is the basic ability of students' survival and development, and the core part of learning ability is individual independent learning ability, so independent learning ability is the basis of individual lifelong learning and lifelong development. In 2021, the Fourteenth Five-Year Plan for National Economic and Social Development and the Outline of Vision and Objectives for 2035 proposed to give full play to the advantages of online education, improve the lifelong learning system, and build a learning society.

The concept of autonomous learning was first proposed by the American psychologist Bandura in the 1970s. This concept originated from the field of psychology and has gradually become the research focus of pedagogy, information technology-assisted education, language teaching, and other disciplines. Experts and scholars at home and abroad have studied autonomous learning abilities from different perspectives, so their concepts are also different. Holec (1981) first introduced the concept of autonomous learning into the field of teaching research. He defined autonomous learning as "the ability to be responsible for one's own learning". Later, he described these abilities as "determining learning objectives, determining learning content and progress, selecting learning methods and technologies, monitoring learning process and evaluating learning results". Wenden (1991) proposed that they have the attitude of using knowledge and skills confidently, flexibly, appropriately, and independently of teachers. They are called autonomous. " Zimmerman (1994) comprehensively summarized autonomous learning as "learners' active participation in metacognitive strategies, learning ability, and learning behavior" after integrating the views of Holke and several other schools and combining their own views. Dickinson (1992) further pointed out that autonomous learning mainly includes "the attitude of learning and the ability of independent learning". "Attitude is the responsibility of making decisions about one's own learning; ability is the decision and reflection on the learning process" Little (1999) further developed the above view, pointing out that autonomous learning is "an independent ability to think critically and make decisions, and to implement independent behavior".

In China, the examination has long been regarded as an important standard to measure students' achievements and abilities, which limits and hinders the cultivation of students' autonomous learning ability and the formation of independent thinking consciousness. The autonomous learning ability of college students is generally low. At present, China's research on autonomous learning is mainly concentrated in the lower grades of primary and secondary schools. Li (2015) believes that most new college students have not realized the change in learning concepts, and most of them are not willing to give up the traditional passive way of accepting knowledge. They are highly dependent on teachers in determining goals, accepting and completing learning tasks, lack learning interest and motivation, and have no reasonable learning plan. But at the same time, the characteristics of autonomous learning of college students are higher than before, and

the development level of cognitive learning strategies is higher, but it needs to be further improved and improved. Sun (2014) investigated the current situation of autonomous learning ability of a university in Hebei Province in the form of a questionnaire. The survey results showed that: college students still showed their overall autonomous learning ability and learning strategies are still low in the learning process, and colleges and universities have the awareness of cultivating students' autonomous learning ability, but the actual lack of active and effective guidance for students' autonomous learning is reflected in the following aspects: unclear learning objectives The enthusiasm for learning is not high, the will to learn is weak, colleges and universities lack effective guidance for students' autonomous learning, and family education hinders the formation of students' autonomous learning. Zuo (2003)'s "Investigation and Analysis of the Status Quo of College Students' Autonomous Learning" believes that when college students combine learning autonomy in theory with reality, they are not very good, their application is not easy, and their understanding of the concept of autonomous learning is not perfect, most of them stay in a half-understanding, and they really do not have specific awareness to implement, and students should pay more attention to their learning attitude. Peng (2001), according to Cartel's intelligence theory, at the age of 22, the individual's ability in all aspects of intelligence will reach its peak. Therefore, the undergraduate stage of higher education is a very critical period for cultivating the students' autonomous learning ability. The primary task of the individual in the undergraduate stage is to cultivate the autonomous learning ability, which is not only the basis of the entire undergraduate stage of learning but also the ability that must be able based on the society in the future.

All countries in the world regard the cultivation of learners' autonomous learning abilities as an important educational goal. The cultivation of learner autonomy is restricted by some factors. Zimmerman (1990) pointed out that autonomous learning includes internal autonomy, behavioral autonomy, and environmental autonomy. Among them, the factors affecting "internal autonomy" mainly include self-efficacy, existing knowledge, metacognitive process, emotional factors, etc. "Behavior autonomy" is mainly affected by three factors: self-observation, self-judgment, and self-response. "Environmental autonomy" mainly refers to the influence of the material environment and social environment. Candy (1991) believed that learners' individual learning personalities, teachers' comments, and learning methods would affect students' autonomous learning ability. Brockett (1991) believed that autonomous learning ability is restricted by personal characteristics, self-set goals, social background, and other factors. Garrison (1997) believed that autonomous learning ability was mainly affected by emotion and self-monitoring ability. Hussein (2012) pointed out that autonomous learning ability and learning motivation are complementary and interactive, so learning motivation is one of the key factors affecting autonomous learning ability. Ben-Eliyahu & Linnenbrink-Garcia (2013) and others believed that the management of self-emotion is closely related to autonomous learning, and teachers play an important role in the development of learners' autonomous learning ability. Cheng (2002), Feng, C.,(2003), Wu (2010), Zhang, et al. (2019), and Yu & Yang (2020) believe that the factors that affect the ability of autonomous learning include information ability, research ability, cooperation ability, self-awareness, learning motivation, metacognitive ability, etc. Schunk, D. H. (2000) and other researchers found that learners' self-efficacy is related to the use of autonomous learning strategies, and the use of autonomous learning strategies will improve students' autonomous learning ability. Wang (2007) believes that goal setting is not only a process of autonomous learning but also an important internal factor that affects students' autonomous learning. Learning goals are of great significance to

autonomous learning. Ren & Sang (2006), and Gaith (2000) pointed out that learning support, including campus resource support, social resource support, teacher teaching support, and peer support, can help promote learners' active learning, active internalization, and active development, and make them truly become the subject of education and the master of learning. This means that the support of teachers and classmates is an indispensable external condition for the development of autonomous learning ability. (Benson, 2007; Little, 1995; Oxford, 2003; Xu, 2014) pointed out that in the process of autonomous learning, the internal cognitive psychological mechanism of college students and the external environment composed of teachers, peers, and their collective factors interact with each other, affecting the track and process of the dynamic development of autonomous learning ability.

In 2001, the Ministry of Education of the People's Republic of China issued the Outline of Basic Education Curriculum Reform (for Trial Implementation). This curriculum reform is the eighth curriculum reform after the founding of the People's Republic of China. It clearly proposes that the transformation from knowledge teaching to students' active learning should be made. Under this value orientation, fundamental changes have taken place in the curriculum structure, curriculum content, curriculum implementation, curriculum evaluation, and teaching mode of education. Among them, the biggest change and the most far-reaching impact is the reform of teaching modes and students' learning styles. The research theory of problem chain appeared in the 1980s, when American scholar Beau Fly Jones first proposed the concept of "driving problem chain", which is also the earliest research data. Through the literature review, it is found that there are few foreign literature on problem chain teaching, and most of them focus on the research of problem chain teaching. In 1992, American educator Meike put forward the theory of problem continuum based on the view of acquiring knowledge and ability through problem-solving. This study aims to test the impact of problem chain teaching mode on individual autonomous learning ability, with a view to promoting the change of college students' learning mode, reaching the educational concept of training students' thinking, tapping students' potential, stimulating students' learning motivation, and cultivating teachers' development, So as to achieve the goal of imparting scientific learning methods to students and provide the impetus for the development of higher education.

Research Questions

How is the effective of problem-chain teaching mode to improve college students' autonomous learning ability?

Research Objectives

1. To compare autonomous learning ability before and after using the problem chain teaching model.

2. To study autonomous learning ability after using the problem chain teaching model with an expectation of passing with the criteria of 60 percent.

Research conceptual Framework

In this study, the independent variable was the problem chain teaching model and the dependent variable was autonomous learning ability. Figure 1 illustrates the conceptual framework of this study.

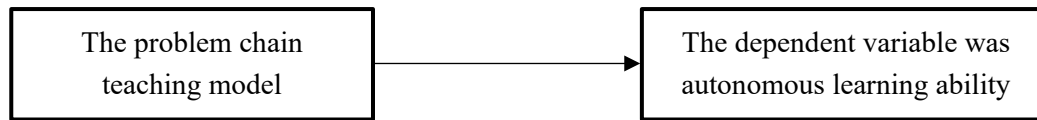**Independent Variable**   **Dependent Variables**

Figure 1 Independent Variable and Dependent Variables

Research Method

1. Population and samples: Population: 200 students (6 classes) who majored in accounting at Zhujiang College of South China Agricultural University. Sample: Randomly select 30 students (1 class) majoring in accounting from Zhujiang College of South China Agricultural University

2. Research design: The one-group pretest and posttest design (Campbell and Stanley, 1963) was used as a procedure to investigate the effectiveness of implementing the revised instructional model.

3. Research instruments: The research instruments which were used in this study were as follows:

3.1 lesson plan: The researcher provided an evaluation form to a group of experts to check or evaluate the teaching plan. After collecting data, analyze the collected data to determine the appropriateness and consistency of the teaching plan. If the average score of appropriateness and consistency assessed by a group of experts is higher than 3.51, it means that the components of the teaching plan have good appropriateness quality and internal consistency. After obtaining the expert evaluation results, the developed teaching model was revised and improved according to the expert's suggestions.

3.2 Autonomous Learning ability evaluation form: The evaluation form is provided to 5 experts for content validity check and suggestions. The quality of the evaluation form is considered according to the project objective consistency index (IOC) obtained in the performance test evaluation form. If the project objective consistency index (IOC) of each project in the evaluation table is greater than 0.5, it can be used in the evaluation table. The analysis of the IOC index shows that all the items in the evaluation table are appropriate and can be used for testing. Then, modify the evaluation table according to the opinions and suggestions of experts. Finally, analyze each item tested and find out the item identifiability (r) including reliability. The item identifiability (r) should be greater than 0.20. The reliability of the test shall be calculated using Kurd and Richardson formula 20 and shall be greater than 0.7 (Kurd and Richardson 1939: 681-687).

3.3 Classroom Observation form of Autonomous Learning Ability: Submit the classroom observation form and evaluation form to five experts for evaluation. The evaluation form was provided to five experts for content validity checks and suggestions. The quality of the evaluation form is considered according to the project objective consistency index (IOC) obtained in the performance test evaluation form. If the project objective consistency index (IOC) of each project in the evaluation table is greater than 0.5, it can be used in the evaluation table. The analysis of the IOC index shows that all the items in the evaluation table are appropriate and can be used for testing.

4. Data collection: Within the scope of this study, teaching plans, autonomous learning ability evaluation forms, and autonomous learning ability classroom observation forms are used as data collection tools.

5. Data analysis: In this study, quantitative data were analyzed using statistical procedures that met the research objectives. Through t-test and analysis of variance on dependent samples, the problem chain teaching model is adopted to determine the significance of the difference in the scores of autonomous learning ability before and after learning at the level of 0.05.

Results

1. Comparison of autonomous learning ability before and after using the problem chain teaching model.

The results were shown the overall autonomous learning ability and the fore components of autonomous learning ability which were 1) learning motivation 2) learning strategies 3) learning resources support and 4) learning goal. The results are shown as follow.

Table 1 Comparison of the difference between pretest and posttest scores of overall autonomous learning ability

Overall ability	Group	N	Pretest scores		Posttest scores		t	p
			$\overline{\text{X}}$	S.D.	$\overline{\text{X}}$	S.D.		
Autonomous learning ability	Experimental group	30	99.23	10.87	103.53	6.57	3.285	.003

As shown in Table 1, the posttest score of overall autonomous learning ability was 99.23 points, and the posttest score was 103.53 points. The score of students' autonomous learning ability after using the problem-chain teaching model was higher than before using the problem-chain teaching model at a .05 level of statistical significance (t = 3.285, p = .003＜0.05). This shows that through the teaching practice of the problem-chain teaching model, college students' autonomous learning ability is significantly improved, and the problem-chain teaching model can improve college students' autonomous learning ability.

Table 2 Comparison of differences between pre-test and post-test scores of learning motivation, learning strategies, learning resources support, and learning goal

Component of autonomous learning ability	Group	N	Pretest scores		Posttest scores		t	p
			$\overline{\text{X}}$	S.D.	$\overline{\text{X}}$	S.D.		
Learning motivation	Experimental group	30	24.70	4.45	26.03	2.71	3.010	.005
Learning strategies	Experimental group	30	25.90	4.34	27.07	2.19	2.482	.019
Learning resource support	Experimental group	30	23.07	3.16	23.97	1.49	2.287	.030
Learning objective	Experimental group	30	25.43	4.38	26.47	2.29	2.417	.022

As shown in Table 2, the score of students' learning motivation, learning strategies, learning resource support, and learning objectives after using the problem-chain teaching model was higher than before using the problem-chain teaching model at a .05 level of statistical significance. (t = -3.010, p = . 005 $<$ 0.05, t = 2.482, p = . 019 $<$ 0.05, t = 2.287, p = . 030 $<$ 0.05, t = 2.4176, p = . 022 $<$ 0.05) respectively. The above shows that the problem chain teaching model can promote the cultivation of students' learning motivation, significantly improve students' awareness of initiative and participation, and then enhance students' learning motivation. The problem chain teaching has a significant positive effect on students' learning strategies as a whole. In the problem-chain teaching class, the teacher uses various methods such as situational setting, problem-driven, group cooperation, summary, and reflection to guide students to sort out their knowledge together, so as to help students understand the problem in depth. Students then gradually develop their ability to use learning strategies through independent learning activities such as exercises and tests. The problem-chain teaching can significantly improve students' ability to use learning resources. In problem-chain teaching, learning resources support expands students' learning space, which is conducive to students' active exploration of knowledge, thus cultivating the development of independent learning ability. And problem chain teaching can strengthen students' ability to set learning goals. In the problem chain teaching class, teachers use the problem chain to guide students to analyze and solve problems, and students learn professional knowledge, professional skills, and comprehensive quality cultivation through the problem chain.

2. Study autonomous learning ability after using the problem chain teaching model with an expectation of passing with the criteria 60 percent through the classroom observation table, as shown in Table 3

Table 3 Analysis of classroom observation results

Group	N	Full score	Criteria score	$\overline{X}$	S.D.	t	p
Experimental group	30	12	7.2	9.67	1.15	11.700	.000

As shown in Table 3, after practice, the average score of students' autonomous learning ability is 9.6667, which is higher than the standard of 60%, and has reached a statistically significant difference (t = 11.700, p = .000 $<$ 0.05). This shows that through the teaching practice of the problem-chain teaching model, college students' autonomous learning ability has been significantly improved.

Discussion

This study the results showed that after using the problem chain teaching model the college students' autonomous learning ability was higher than before and higher than the criterion of 60 percent. It meant that the problem-chain teaching model influenced on the college students' autonomous learning ability. The objective of this teaching model was to enhance autonomous learning ability. This teaching

model is based on the theories of constructivism, humanism, and autonomous learning and designed five steps of teaching which enhance autonomous learning ability.

Step1: create the situation and problem chain, which prepares before class. Constructivist learning view that knowledge was required by meaning construction in a certain situation. The teachers created specific situations and problem chains relevant to the course to stimulate learning motivation. Hussein(2012) and Kormos (2010) point out that learning motivation was one of the key factors affecting autonomous learning ability.

Step 2:provide situation and core problem chain, which transform the content or knowledge into a systematic problem group. This step aims to enhance independence and interrelatedness in the learning process of students. Zheng (2015) found in practice that neo-constructivism theory guided learners to construct knowledge independently, which was conducive to learners' personalized learning.

Step 3:analyze the core problem with the subproblem chain, this step aims to practice and cultivate students to solve the problem, based on students' existing experience. Li (2004) emphasized that the problem can be directly raised by the teacher, but also pay attention to classroom teaching, hierarchy, flexibility, and grasping the core problems. This step enhances learning strategies in which the students learn behaviors in a specific way to continue tasks through difficulty or obstacles. This step also enhances the student to find and use learning resources support.

Step 4:presentation of the solution, this step focuses on the solution of the core problem, group process, and individual responsibility, to ensure that the goals were attached to value. A group of students cooperates, exchanges, and interacts among members to achieve goals. It meant they scaffold the learning process to reach the goals. Rosenshine (1992) views scaffolding as helping learners to solve independently, so the group process can help to achieve learning goals.

Step 5:forming overall knowledge, this step focuses on knowledge, solution, and autonomous learning. The students construct their own knowledge and the teachers also prepare and provide overall knowledge. The role of teachers was evaluating learning outcomes, which related to learning goals. In this step, the students can evaluate themselves. Peng (2015) believed that from the perspective of autonomy, students as the main body of evaluation.

Conclusion

This study the results showed that after using the problem chain teaching model the college students' autonomous learning ability was higher than before and higher than the criterion of 60 percent. It meant that the problem-chain teaching model influenced the college students' autonomous learning ability. The objective of this teaching model was to enhance autonomous learning ability. The problem chain teaching model of this study introduces the collection of problem situations and problem-related points, linking existing knowledge, new knowledge, and problem-solving. Through teaching experiments, observation of learning performance in class, and objective analysis of self-evaluation survey data before and after the test, it is found that students' learning motivation, learning strategies, use of learning resources, and learning objectives have changed, which has greatly improved students' autonomous learning ability and enhanced their interest in learning.

Through the raising and solving of teaching problems, students' traditional learning methods will change accordingly, their personal thinking level will be improved, the good relationship between

teachers and students will be further maintained, and the interaction and communication between both sides will be promoted. Through the observation of students' expressions, actions, behaviors, and task completion in classroom activities, students' interest in and cognition of the course have improved. By asking questions, students can better understand the purpose of learning. Through team discussion and thinking, they gained the ability to solve problems. In addition, they also acquired some learning skills, such as independent data search, data analysis, data display, and information technology application capabilities. They can be aware of the driving role of learning motivation, know that setting learning goals can promote active learning, and they know that learning methods and learning resources are very helpful to the improvement of autonomous learning ability. They were impressed by the problem chain teaching model, which improved their learning motivation, helped them learn how to set learning goals, and improved their autonomous learning ability. The students gradually get rid of their own learning concepts, their learning motivation is more obvious, their ability to use learning strategies is improved, and they are willing to cooperate in learning. The practical application of the problem-chain teaching mode has proved the effectiveness and feasibility of the teaching mode and has a good effect on the improvement of learners' autonomous learning ability.

Recommendations
    1. Recommendation for implication
        1.1 Suggestions on the cultivation of learning motivation
        We should use multimedia and other teaching methods to set up a reasonable teaching situation for students. The accounting discipline is characterized by its strong practicality and operability. When we can show an intuitive and vivid relevant situation in teaching, it can greatly stimulate students' interest in relevant learning, so that students can enhance their initiative and creativity while deepening their understanding of the professional knowledge. Teachers can also guide students into roles through role-playing, or let students actively create situations. This is conducive to stimulating students' learning motivation of autonomous learning.

        In the classroom practice of cultivating autonomous learning, teachers should not only mobilize students' perceptual cognition but also mobilize students' rational cognition by setting reasonable topics. Teachers should not only consider the relevance of students' interests and learning content but also take full account of future employment scenarios. However, in the actual classroom teaching, the school is particularly deficient in the training of students' practical ability, which should be strengthened as soon as possible. In general, we should adopt appropriate teaching strategies to stimulate students' learning motivation and lay a good foundation for their future work and learning.
        1.2 Suggestions on training learning objectives
        In the classroom of autonomous learning, the best way to arouse students' autonomous learning is to implement the principle of autonomous choice. Teachers can put forward some goals for students to choose so that students' initiative can be fully played, and students can determine their own learning goals independently. When guiding students to set learning goals independently, teachers should create a classroom atmosphere that is both democratic and full of equality. Here, we can take the way of discussion, and students can put forward their own learning objectives, which can effectively improve students' learning autonomy. The classroom teaching of autonomous learning emphasizes that

students should set learning objectives independently, but sometimes the learning objectives set by students may not be perfect. Therefore, when setting learning objectives, students should first set the objectives independently, and then teachers should guide them to make the final learning results close to the teaching objectives.

1.3 Suggestions on training learning strategies

Learning methods are an important part of autonomous learning ability. Therefore, when setting teaching objectives in the teaching process, learning methods should also be an important part of teaching objectives. In the classroom teaching of autonomous learning, students are the main body of solving problems, and teachers are the guide and inspiration of students. In the process of students solving problems independently, teachers must participate in it and find problems in time. When guiding students to solve practical problems, teachers should first guide students to develop their cooperation ability. Moreover, we should guide students to pay attention to the process of solving problems, and let them form a good habit of autonomous learning in the process. Learning methods will have an important impact on the effect of students' autonomous learning. However, in the current teaching class, teachers rarely teach learning methods, and students can only rely on their own groping to obtain these methods. This leads to the low learning efficiency of many students, and even some students have been using inappropriate learning methods.

1.4 Suggestions on training learning resources

The rational use of learning resources is conducive to the cultivation of independent learning awareness. For learners, the stronger the support resources a person has in the learning process, the better they can cope with the challenges in the learning process. For college students' learning, there are not only common campus learning resources and slightly different social learning resources, but also teachers' teaching support of different grades, majors, and courses and friendly classmates' mutual assistance due to personal relationships. With the development of modern technology, information technology has provided more convenient conditions for students' autonomous learning.

2. Recommendation for further research

Learners' autonomous learning ability belongs to the concept of psychological category, and its cultivation and promotion are interfered with by many factors. The problem chain teaching model based on the design and implementation of problem teaching also involves various theories, methods, and technologies. Therefore, it is very difficult to carry out the reform and practice of the problem chain teaching model to improve the ability of autonomous learning. There are still many deficiencies in this study, which need to be further revised and improved in practical application.

2.1 In terms of research objects, the survey samples have a certain regional concentration. There are relatively few classes that carry out problem-chain teaching practice. The developed teaching cases are mainly designed according to the opinions of the instructors, combined with their own teaching experience and understanding of the subject, and need further optimization and improvement.

2.2 The research method needs further improvement. Cultivating students' autonomous learning ability based on the problem-chain teaching model involves many factors, complex variables, and high requirements for research methods. In this study, the data collection and data analysis methods are mainly observation and evaluation methods, which are relatively simple. In the future, case data should be collected

from multiple perspectives, and data should be analyzed by multiple methods, so as to make a more accurate and objective evaluation of the change in students' autonomous learning ability.

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