

Research on the Application of Question Chains Based on Deep Learning in Senior English Reading

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Abstract: Thinking quality, as one of the important goals of reading teaching, is an indispensable way to implement the cultivation of core competencies. However, in the current reading teaching, there are problems such as shallow thinking and separation of learning and thinking, which hinder the development of students' higher-order thinking. Question chains, as an effective teaching method, can promote students' output of language knowledge and enhance their thinking ability to achieve deep learning. Therefore, this paper aims to explore how to apply question chains based on deep learning of senior English reading teaching, so as to activate students' higher-order thinking ability, optimize high school teachers' question design ability, and improve the effectiveness of senior English reading teaching.

Keywords: Deep learning, Senior English, Reading teaching, Question chains.

1. Introduction

National English Curriculum Standards for General High School (2017 version revised in 2020) (hereinafter referred to as the *New Curriculum Standard*) points out that the English curriculum aims to develop students' four core competencies: language ability, cultural awareness, thinking quality, and learning ability, and to implement the fundamental task of moral education. Among them, the thinking quality aims to cultivate students' ability to analyze and solve problems from three dimensions: logic, criticality and innovation. How to help students train logic ability through learning and thinking in teaching, change the habit of shallow thinking, and enhance creativity is the focus of the new curriculum reform. Deep learning means a type of learning in which learners aim to develop higher-order thinking and solve practical problems, and are able to transfer existing knowledge into new contexts (An, 2014). The concept of deep learning is the product of the development of modern education, which can maximize students' problem-solving ability, broaden the depth of students' thinking, and implement the cultivation of core competencies to achieve the goal of education. Therefore, it is essential to explore how to promote students' deep learning in English teaching.

Additionally, viewing is supplemented in *New Curriculum Standard* besides listening, speaking, reading and writing, among which reading is listed as a comprehension skill (Ministry of Education, 2020). Reading, as an important part of English teaching, is a vital way for students to obtain information, develop their ability and improve their thinking. An efficient reading class is inseparable from intelligent tasks and activities, and the essence of activities comes from the design of questions. Currently, there are some problems in teachers' question design in senior English reading teaching. The design type of teachers' questions, for instance, is monotonous, resulting in shallow learning, which is difficult to meet the requirements of higher order thinking training. Secondly, teachers do not highlight the sequence of questions when asking questions, causing a lack of gradient in question design, which undermines students' enthusiasm for answering questions and hinders ZPD (Zone of Proximal Development).

Question chains are the transformation of textbook knowledge into a distinct, systematic series of teaching questions, a set of centered, sequential, relatively independent and interrelated questions (Yang, 2017). Reading teaching based on question chains aims to involve learners in thinking learning activities by using questions, construct new knowledge in the process of problem solving, and establish a rich network structure between concepts, which is conducive to the formation of learners' deep understanding (Tang, 2020). Therefore, it is necessary to introduce question chains in English teaching, which not only meets the requirements of core competencies, but also provides a platform for improving students' problem-solving ability and promoting deep learning.

Based on it, this study aims to construct the question-chain teaching mode based on deep learning, and apply it to senior English reading teaching, so as to improve the effectiveness of reading teaching and optimize the English reading teaching mode. In terms of theoretical significance, this study aims to provide some experience for front-line teachers in the field of question-chain teaching and deep learning teaching, and provide some inspiration for the reform of English reading teaching. In terms of practical significance, this study designs question chains from the perspective of deep learning, aiming to propose concrete and feasible improvement schemes, which can help activate students' higher-order thinking ability, promote senior English teachers' question design ability, and enhance the interest and flexibility of senior English teaching.

2. Literature Review

2.1. Related Researches on Deep Learning Abroad and at Home

According to existing research, since the concept of deep learning was put forward, its connotation has been constantly explored and improved. At present, the research on deep learning at home and abroad has a certain depth and breadth, which can be roughly divided into theoretical research and application research.

In terms of theoretical research, it can be divided into research on the concept of deep learning, research on the

characteristics of deep learning, and research on the influencing factors of deep learning. In terms of the research on the concept of deep learning, Ference Marton and Roger Saljo (1976) took the lead in pointing out the definition of deep learning through the comparison between deep learning and shallow learning. They pointed out that deep learning was a proactive learning process for learners, in which students needed to apply the knowledge they had learned to practical situations to solve new problems. In China, Li (2005) first proposed the concept of deep learning. He believed that deep learning referred to the ability of learners to critically learn new ideas and facts based on understanding learning, integrate them into their existing cognitive structure, and transfer existing knowledge into new contexts.

In terms of the research on characteristics of deep learning, An (2014) pointed out that deep learning included the following four characteristics: deep learning focused on the critical understanding of knowledge learning, deep learning emphasized the integration of learning content, deep learning placed emphasis on the constructive reflection of the learning process, and deep learning attached importance to the transferring and applying of learning and problem solving. Guo (2016) proposed five main characteristics of deep learning: association and structure, activity and experience, essence and variation, transferring and application, value and evaluation. In terms of the research on the influencing factors of deep learning, Buckland (2001) pointed out that effective textbooks were helpful to promote deep learning. In China, Wu (2017) pointed out that students' individual factors can affect deep learning, such as motivation and self-efficacy. In addition, she also pointed out the behavioral factors and the environmental factors that affected the occurrence of students' deep learning. Undoubtedly, the above studies have accelerated the construction of the theoretical research system of deep learning, and played a macro guiding role for the application of deep learning in English teaching research.

In terms of application research, it can be divided into research on deep learning strategy, research on deep learning evaluation and research on English teaching based on deep learning. In terms of the research on deep learning strategies, Du et al. (2013) pointed out the strategies to promote the informative instructional design of deep learning through the comparison between shallow learning and deep learning, including the dominant strategy, scaffolding strategy, modeling strategy, reflection strategy and meta cognition strategy. Based on the interactive hierarchical model of deep learning, Duan (2012) deeply analyzed the learning strategies to promote deep learning in e-Learning environment.

In terms of research on deep learning evaluation, Liu and Hao (2017) built a "3+2" evaluation model of deep learning effect based on the transfer theory and the SOLO level classification method. Zheng (2019) pointed out that classroom evaluation should adhere to three principles: ethical evaluation, multiple evaluation subjects, and integration of evaluation into teaching and learning. In terms of research on English teaching based on deep learning, Yang Zheng (2018) introduced the design ideas of a junior English writing lesson from three aspects: goal setting, activity design and continuous evaluation, with the aim of guiding students to deep understanding, positive experience and deep reflection. Based on teaching cases and project research results, Sun et al. (2019) discussed how teachers promoted deep learning in junior English reading teaching by carrying

out learning and understanding activities, applying and practicing activities, transferring and creating activities. Tang (2022) proposed a practical approach to primary school English reading teaching based on deep learning: stimulating students' inquiring thinking, designing higher order thinking problems, promoting deep communication, strengthening the application of transferring.

To sum up, the theoretical research on deep learning started earlier abroad and achieved leading results. Although the domestic research on deep learning started relatively later, it has received a lot of attention from educational researchers after the concept of deep learning was put forward as an advanced teaching theory and teaching method. However, research on deep learning at home still exists certain limitations. Firstly, the research on the integration of deep learning with English reading teaching mainly focuses on strategy research and lacks practical research. Secondly, research on deep learning is mostly focused on the junior high school level, with less attention paid to the senior high school level. Thirdly, there is a lack of research on deep learning in the field of foreign language education. Fourthly, there is a lack of research on the correlation between deep learning and question-chain teaching. Therefore, the study aims to apply the problem chain teaching based on deep learning to Senior English teaching, aiming to find out more effective and feasible practical strategies.

2.2. Related Researches on question chains Abroad and at Home

From the existing literature, it is shown that fewer localized researches concerning question chains have been done abroad, and foreign scholars mainly focus on the research on proposing and solving problems. Therefore, there is no comprehensive research system abroad yet. In terms of research on problem-based teaching, Dewey (1916) pointed out that teachers can create situations in teaching and ask continuous and in-depth questions concerning the context. Howard Barrows (1980) proposed the problem-based learning (PBL), which had been applied in the fields of education, law, and media, etc. In addition to research on problem-based teaching, many scholars focused on studies of the questions themselves, which showed some similarities to research on question chains. For example, Maker (1991) proposed the problem continuum theory. In this theory, questions were divided into five categories: closed, sub-closed, semi-open, open and fully open, with each of the five categories corresponding to different cognitive abilities. Christine Chin (2007) explored the characteristics of different questioning methods, the conditions for their use, and their impact on teaching practice. The results showed that the continuity of questioning can improve students' thinking ability.

Research on question chains at home started at the beginning of the 21st century. According to the existing research, domestic scholars' research on question chains mainly focused on the design aspect of problem chain, and most of them were from science and technology disciplines. With the deepening of the new curriculum reform, many scholars began to apply the question chains to English teaching. At present, the research on question chains at home can be divided into theoretical research and application research. In terms of theoretical research, it can be divided into research on concept of question chains and research on

classification of question chains. As for research on concept of question chains, Huang (2003), by linking problem chain with mathematical thinking, pointed out that question chain was a mathematical thinking method that took question as the main line and took problem discovery - problem solving - problem rediscovery as the whole process. Wang (2010) defined a problem chain as a set of relatively independent and interrelated problems with a center and sequence.

As for research on classification of question chains, Wang (2010) divided the question chains into introducing question chains, differential question chains, diagnostic question chains, exploratory question chains, transferring question chains, flexible question chains, summary question chains and progressive question chains. In terms of application research on question chains, many scholars were committed to combining the problem chaining mode with English language teaching. For example, Xu (2020) applied question chains to senior English reading practice to guide students to explore the main idea of the passage and analyze the structure of the discourse. Lu (2021) aimed to promote the cultivation of students' language ability through the angle design, breadth design and depth design of the "main question" chain. Wang (2023) applied the question chains to primary school English reading and writing teaching to provide scaffolding for students to promote the in-depth development of students' thinking.

Through the research status at home and abroad, domestic research on question-chain teaching is more advanced than foreign countries, and there is a lack of systematic research on question chains abroad. However, the research on question chains in China is still insufficient. In terms of research disciplines, the research on question chains at home mostly focused on scientific and technical disciplines such as physics, chemistry, mathematics, etc., and the research on question chains in English disciplines is still immature. In terms of the type of research, the research on question chains in English teaching in China focuses on the design of question chains and lacks teaching practice. In terms of research level, question chain is mostly applied in junior high school, and there is a lack of research in senior high school. Finally, there is a lack of research on the correlation between problem chaining and deep learning, so it is of necessity to further research on it.

3. Problems of Senior English Reading Teaching in Questioning

3.1. Failure to Consider the Realistic Level of Students

Students are the main subjects of the classroom, all the questions in reading teaching should be designed from the students' perspective (Yang, 2017). Liang (2011) divides questions into display questions, reference questions and assessment questions. In practical classroom teaching, teachers should ensure the design of all kind of questions should be in line with students' cognition. If the questions are too difficult, it will weaken the students' desire to express themselves and even make them resist answering the questions. If the questions are too simple, they will not stimulate students' interest and attract their attention, leading to inefficiency in the classroom. Therefore, when teachers design the question chains, they should take into account zone of proximal development of students and make the difficulty

of the questions slightly higher than the students' current level. It not only increases the challenge of the question, but also makes students willing to answer.

3.2. Monotonous Question Design

At present, the most common type of questions used by teachers in teaching is display questions, and there is a lack of reference questions and assessment questions. Most of the students prefer the display questions since they do not require much thinking to come up with an answer. On the other hand, there are no direct answers for reference questions and assessment questions, which require to be answered after thinking, thus most students are reluctant to answer these two types of questions. Therefore, in the process of designing questions, teachers should balance the difficulty of the three types of questions and combine them skillfully, so as to provide scaffolding for students to reduce the difficulty.

3.3. Lack of Logic in Question Design

Many teachers have realized independent questions can lead to a loss of coherence in teaching, and have begun to gradually make simple combinations of questions. In this process, teachers do not realize that the sequence of questions and the logic between questions can also affect the efficiency of the classroom. Generally speaking, the question chain has a certain hierarchy. The former question in question chains is the basis and foreshadowing of the latter. The answer to the latter question is an improvement of the former question (Chen, 2021).

3.4. Lack of the Main Line in Question Design

In the process of teaching, many teachers focus their questioning on words, phrases, grammar and fixed sentence patterns, and lacking attention to the main line of questions. Discourse is a whole, there is a main line that runs through all the time, and the question chains designed around the main line is more capable of aiding students understand the framework structure and connotation of the text as a whole, and training students' thinking ability (Yang, 2017). Therefore, teachers should consciously explore and design the main line questions according to the teaching objectives and teaching content, and integrate them with sub-questions to promote students' discourse analysis ability. In addition, the main question and sub-question form a hierarchical thinking chain, which can promote students to move from lower-order thinking to higher-order thinking, and assist students to examine, analyze and adjust the new knowledge that has been constructed (Chen, 2017).

3.5. Lack of Analysis and Evaluation in Question Feedback

Evaluation feedback, as an indispensable part of classroom teaching, is a vital way to improve teaching efficiency and promote the coordination of teaching and learning. However, currently, there is a problem with teacher feedback. After students' answers, teachers generally adopt encouraging strategies, which contribute to the development of students' confidence. Nevertheless, teachers did not point out the strengths and weaknesses of students' responses. Monotonous evaluation method would hinder the access to effective feedback from students. Therefore, teachers should employ analysis and evaluation to promote students' problem-solving ability.

4. The application Strategy of Question chains Based on Deep Learning in Senior English Reading

At present, students ignore the significance of reading, resulting in their learning level still remaining at a shallow learning. In order to change this situation, this study applies question chains to senior English reading teaching by combining Foreign Language Teaching and Research Press (FLRC) high school English textbooks, aiming at realizing deep learning.

4.1. Arousing Interest

Deep learning results from students' interest in what they are learning. Lead-in is a key part of classroom teaching which helps to promote students' deep learning. Therefore, before the text explanation, the teacher should carefully design a question chain and relate it to students' authentic life contexts, so as to create a relaxing learning atmosphere for students, stimulate their curiosity, and activate their schema. Taking *My First Ride on the Train* as an example, the teacher tries to stimulate students' interest through the question chains. The text is a travel article which introduces what Alice Thompson saw, heard and felt during her trip from her hometown Sydney to Alice Springs. Travel articles are familiar to students, since they are closely related to daily life. Therefore, in order to arouse the students' interest, the teacher tells the students the story of his self-drive trip to Jiuzhaigou for the purpose of enjoying the scenery during the summer vacation. After the teacher's overall introduction to the trip, the following question chains was proposed to the students:

- Q1. Where did I go during the summer vacation?
- Q2. What was the purpose of my trip?
- Q3. How did I get there?
- Q4. How did I feel?

Based on the four questions, the teacher introduces his own travel experience as the context, which can not only attract students' attention, but also promote students' perception of the theme of this article, laying the foundation for subsequent reading activities and enabling students to form reading expectations.

4.2. Facilitating Prediction

Reasonable predictions in deep learning facilitate the development of logical thinking in students. Predicting the topic through the title contributes to the decomposition of the difficult points and drives students to actively perceive the text. Taking *My First Ride on the Train* as an example, in order to mobilize students' multiple senses, the teacher shows students a video of a train trip, after that, the teacher asks students to observe the title and the teacher constructs the following question chains:

- Q1. What is the title of the text?
- Q2. What can you see in the video?
- Q3. Can you predict what does the text mainly talk about?
- Q4. If you were the author, what would you write about?

Q1 and Q2 attract students' attention to title and video information, while Q3 involves students predicting texts by integrating text and video information. Q4 can activate students' background knowledge related to the topic and expand their thinking. The four questions are in line with the

requirements of the "Zone of Proximal Development", and there is a hierarchy among the questions, with the former question paving the way for the latter question, which can cultivate the students' ability to predict the content of the discourse through the questions.

4.3. Analyzing Structure

Argumentative essays, expository essays and narrative essays are the most common genres of English reading discourse in high school, whose structures are different from each other. Therefore, the teacher is required to design logical and targeted question chains according to the types and characteristics of the discourse to support students in analyzing the structure of the discourse and to promote deep learning. Taking *Sandstorms in Asia* as an example, this text is an explanatory text which introduces the situation, causes and effects of sandstorms in Asia, as well as the advice and measures towards sandstorms. Therefore, the teacher sets up the following question chains in order to assist students to clarify the structure of the text:

- Q1. What do sandstorms look like?
- Q2. What causes sandstorms?
- Q3. What effects do sandstorms have?
- Q4. What does the text suggest in the face of sandstorms?
- Q5. What measures are mentioned in the face sandstorms?

As an expository text, this text is logical and clearly structured, and the interlocking chain of questions assists students in grasping the elements of an expository text. At the same time, students' discourse analysis ability is developed under the drive of the questions.

4.4. Exploring Theme

New Curriculum Standard points out that the English curriculum should consider the exploration of the meaning of themes as the core task of teaching and learning (Ministry of Education, 2020). Therefore, as the reading process proceeds, teachers should guide students to interpret the text on the basis of their understanding of the main idea, which is conducive to promoting deep learning. Taking *The Student Who Asked Questions* as an example, the teacher will adopt inquiry question chains to aid students in analyzing the text. The text tells the story of a famous scientist in China who studied hard when he was young, and when he grew up, he concentrated on the research of hybrid rice and finally achieved great success. The teacher sets up the following question chains for the theme exploration:

- Q1. What did Yuan Longping discover?
- Q2. What is the impact of Yuan Longping's discovery?
- Q3. What kind of person do you think Yuan Longping is?
- Q4. What do you think the title *The Student Who Asked Questions* means?

Q1 and Q2 are display questions, which mainly aim at training students to extract information effectively. Q3 is based on the first two questions, students need to analyze and synthesize the text to obtain answers. Q4 mainly aims at helping students to explore the author's intention to write and to think about the main idea of the text. There is no direct answer to these types of questions, students' answers are required to incorporate experiences and perceptions. With deeper understanding of the text, the depth and breadth of students' thinking is enhanced.

4.5. Developing Critical Thinking

Deep learning focuses on active learning and critical thinking, which aims to promote the development of students' advanced thinking quality. In order to solve the "separation of learning and thinking" in English reading teaching, the teacher should cultivate students' critical thinking and create a space for students to give full play to their thinking ability and apply language knowledge (Liu, 2020). Taking *The Human Traffic Signal* as an example, the text tells the story of Timoteo Apaza, who serves as a traffic director in order to reduce traffic accidents. Critical thinking is a challenge for students, the teacher should design question chains with a certain depth of thought.

Q1. Who is Timoteo Apaza? What happened to him?

Q2. Why does he want to be the human traffic signal?

Q3. If you were him, would you like to be the human traffic signal?

Q4. What kind of person do you think he is?

Q1 and Q2 are display questions in which students are able to find the answers quickly through reading. Q3 and Q4 are assessment questions that require students to think deeply after understanding the content information, which are designed to guide students to evaluate through cognitive knowledge with the aim of developing students' ability of independent inquiry and critical thinking.

4.6. Promoting Transferring

The essence of deep learning is to apply the new knowledge acquired to other similar situations, or to solve new problems (Liu, 2022). Therefore, the teacher should relate the known and new contexts to promote students' knowledge transfer. Taking *The Magic of the Mask* as an example, the text is a narrative text, which introduces the origin and development of carnival. After analyzing the content and structure of the article, the teacher sets up a situation for the students: If your foreign friends invite you to participate in their students' foreign culture forum, and the topic of the forum is festivals in your country, what will you share on the forum? Based on the context, the teacher provide scaffolding for students through the question chains, which is set as follows:

Q1. What is your favorite festival?

Q2. What are the activities in this festival?

Q3. What is the significance of this festival?

Q4. What is your overall impression of this festival?

Q5. Do you like this festival?

The five questions are arranged hierarchically and logically, in order to complete this contextual task, students need to mobilize their own cognition and experience to process the information. It facilitates students' interpretation of the meaning of the theme, which also promotes the transfer of knowledge and the development of problem-solving ability.

5. Conclusion

Promoting the development of students' thinking quality is an important goal of Senior English teaching, the key to achieving this goal lies in the design of an efficient question chains. Therefore, in reading teaching, teachers should recognize problems of senior English reading teaching in questioning and promote the implementation of deep learning by arousing interest, facilitating prediction, analyzing

structure, exploring theme, developing critical thinking, promoting transferring. In addition, teachers should follow the principle of question chains and employ the question chains mode properly. Through the effective design of the question chains, students are encouraged to better interpret the text, effectively improve their comprehensive language skills, and then realize the cultivation of the quality of thinking.

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