Discussion and Practice on the Teaching Mode of Guiding Knowledge System Building and Application
—A Case Study of Food Chemistry Courses

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Abstract—This paper analyzes the inherent relationship between teachers' teaching and effective learning of students, and explores the teaching method of effectively improving students' thinking ability during the classroom teaching. By focusing on the course of Food Chemistry offered at the specialty of Food Science and Engineering by the institutes of higher learning of China, this paper guides students to establish and expand their unique knowledge systems by means of painting, and facilitate students in to rebuild and expand their knowledge systems by adopting inquiry-based questions that combine domestic and international research hotspots as orientation. The analysis of students' performance before and after teaching reform, the percentages of the students who achieved 90~100 points increased from 4.42% to 22.40% and 18.30% respectively; those of the students who achieved 80~89 points increased year by year; those of the students who achieved 70~79 points decreased year by year; those of the students who achieved 60 to 69 points decreased from 22.12% to 9.80% and 5.10% respectively; and those of the students who were below 60 points decreased from 3.54% to 2.20% and 0.70% respectively.

Keywords—Knowledge System, Thinking Ability, Creative Talent

I. INTRODUCTION
Institutes of higher learning mainly perform the tasks of training talents and delivering high-level talents that can promote the progress of the society to the community. Currently, we are undergoing the booming development of the fourth industrial revolution that originated from the Internet of Things (IoT). Different from previous industrial revolutions, the current revolution is developing at an exponential non-linear speed. And the intertwining and convergence of economic globalization and information technology will produce impacts on various fields.

We have now entered the stage of conquering difficulties during the reform and opening up. We are facing deep-level conflicts against the current development mode. To deepen scientific and technological system reform and implement the strategy of innovation-driven development can contribute to the mutual synergy between technological innovation and industrial revolution and to sustainable development. Under the background of the current times, there is an increasingly urgent demand for creative talents and higher requirements for undergraduate teaching and education. The most important link is to make the teachers’ teaching and students’ learning more effective. And “whether teaching is effective is mainly determined by whether the development needs of teachers and students as participants are satisfied through teaching. [1]”

II. REFLECTIONS ON TEACHING AND LEARNING
The main purpose of higher education is not to impart specific knowledge but to improve students’ high-level thinking ability and disciplinary thinking [2]. Although teaching and learning are somewhat compatible with each other, knowledge imparting and memorization are different from the so-said “teaching” and “learning” [3]. In addition, learning and improvement of students’ thinking ability can contribute to the improvement of students' learning ability, thus facilitating students’ lifelong learning [4].

Currently, the teaching method that highlights knowledge imparting cannot clearly present the internal links of knowledge to students. Also, it is not conducive to the expression of the characters and inner profound meanings of the knowledge imparted under both social and discipline backgrounds. As a result, the duration in which students understand the depth of the knowledge learned is extended. For students, knowledge acquisition is not simple memorization but individuals’ integration of knowledge based on their deep understanding [5], as well as rebuilding and application of new and previous knowledge on the above basis.

Despite a series of reforms carried out in classroom teaching at institutes of higher learning, the dull teaching exists in higher education of China. During the teaching process, specific content of discipline textbooks is emphasized; and result evaluation is highlighted. As a consequence, teachers focus more on the teaching of superficial knowledge and skills and students are mainly interested in the content of tests;
students focus more on knowledge memorization during the learning process rather than interaction and combination of various theories, information and experience and analysis of complex matters by applying the theories learned. Students’ learning only remains at the level of memorization and simple application of knowledge. Then, most college students lack deep and thorough understanding of the knowledge after classroom learning [6].

In the present society, different disciplines treat the same field differently as the division of disciplines is refined and both depth and breadth of interdisciplinary crossing and integration are expanded. In addition to different focuses of discipline content, different perspectives are also derived from different perspectives, depths and breadths of discipline analysis objects, thus causing different solutions to the same problem. In order to become the talents who are able to solve problems from different perspectives and depths and in a creative manner, students are required to integrate and flexibly apply the intra- and inter-disciplinary knowledge systems that involve multiple disciplines in brains.

General and specialized courses are generally offered at Chinese universities. Based on these courses, the teaching that focuses on knowledge system building and the knowledge system of courses that can be understood by students during the teaching can help students establish their unique knowledge systems based on their existing knowledge structure and experience; contribute to the self-building and expansion of their knowledge systems in and among disciplines; facilitate them to find and solve problems from different discipline perspectives and levels by combing their own experience (see Fig.1), promote the improvement of their in-depth learning experience and thinking ability and the all-round development of their minds.

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**III. REFLECTIONS ON THE INTERNAL LINKS BETWEEN TEACHERS’ TEACHING AND IMPROVEMENT OF STUDENTS’ THINKING ABILITY**

Training the creative talents with creative thinking and potential represents the mission to promote China’s independent innovation. As training creative talents is the main task of higher education, teachers are required to focus on the cultivation of students’ high-level thinking ability and promote the forming of students’ disciplinary thinking when they teach them.

Disciplines involve unique thinking and the perspectives, depths and breadths of problem analysis are also different, thus affecting and limiting problem solving. And specific content of learning and the thinking ability of individuals complement to and affect each other. As classroom teaching directly affects students’ learning effect, the organic combination of course teaching and thinking ability improvement can promote students’ deep understanding towards knowledge system [7] and help them to build meaningful knowledge systems, which constitute the preconditions for students’ high-level thinking. The improvement of high-level thinking ability contributes to the improvement of learners’ critical, analytical and creative thinking.

Students’ effective learning represents the reprocessing of knowledge system with knowledge memorization as bridge. That means knowledge memorization complements to and is closely correlated with critical thinking improvement [8]. During the teaching process, the shifting of memorization to critical thinking improvement requires effective guidance by teachers (see Fig.2). Teachers should clearly impart knowledge points of courses and the knowledge system composed of knowledge points by combining disciplinary thinking. Also, they should relate to prior experience of students, stimulate their experience and feelings, and trigger their complex cognition process [9] [10].

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Fig. 1. The core objective of teaching is to promote the improvement of students’ thinking ability.
During the process of classroom teaching, teachers guide students to memorize knowledge points and establish the knowledge system of courses at different levels and depths, guide and motivate students to establish and expand their own intra- and inter-disciplinary knowledge systems, which can promote students to effectively understand disciplinary thinking. On such basis, with the problems in the complex context, teachers promote and motivate students to flexibly and proficiently apply their unique knowledge systems, thus effectively training students’ thinking ability and disciplinary thinking (see Fig.2). By applying the above strategies in classroom teaching, teachers can help students gradually improve their abilities to find and solve discipline problems in the complex context during the classroom teaching.

Students may obtain a sense of fulfillment when experiencing the self-building, expansion and application of the knowledge systems during their learning process. As a result, students would obtain more sense of enjoyment during the learning process; more drive for learning and more desire for self-knowledge system rebuilding and re-expansion when learning new knowledge (see Fig.3). Then, students can establish their unique complex cognition process during the learning process and gradually improve their thinking ability during the continuous learning and practice. The unique intra- and inter-disciplinary systems built by students themselves can confer them unique perspectives and levels to find and solve problems and the abilities to find and solve problems in a creative way.

![Diagram](image-url)

Fig. 2. The shifting of memorization to critical thinking improvement requires effective guidance by teachers and students’ reprocessing of knowledge systems in brains.

![Diagram](image-url)

Fig. 3. Teachers’ effective guidance and promoting students to build and expand their self-knowledge systems is conducive to the gradual improvement of students’ self-knowledge systems.
IV. ANALYSIS OF TEACHING CASES AND EFFECTS

Despite plenty of factors of affecting classroom teaching for students, the focus of the classroom teaching aimed at improving students’ high-level thinking is to improve their thinking ability through classroom teaching. That relates to whether the effectiveness of teaching measures can be implemented.

Food Science, as an interdisciplinary discipline, and other disciplines interact with the development of other disciplines. New theories and achievements continue to emerge. The teaching of Food Science, as its core course, requires the gradual optimization of teaching content and increase in the latest research results both at home and abroad. While the contradiction between the increase in teaching content and decrease in teaching hours occur in classroom teaching. Students are burdened with heavy workload and faced with the contradiction between effectiveness of learning and insufficient time and efforts spent. In order to improve students’ thinking ability by teaching, we should first solve the problem of improving students’ thinking ability within a short period of time.

In response to the situation, we should first guide the establishment of the knowledge system and then combine the inquiry-based learning with problems as orientation during the process of classroom teaching. In classroom learning, we should guide students to establish the knowledge system. For inquiry-based learning, group learning after class is focused on. And inquiry-based problems are mainly the current hotspots of food and related disciplines both at home and abroad. We should promote students to gain a deep understanding in class and guide and trigger them to solve problems in multiple ways and from different perspectives so as to contribute to the effective combination and mutual promotion of classroom and extracurricular learning.

When guiding students to establish knowledge system, we should guide students to establish links between the knowledge previously learned by students and the food chemistry knowledge system taught, trigger their interest and reduce their sense of being unfamiliar with food chemistry learning while respecting students’ previous learning and the self-thinking mode established so as to make students rapidly get integrated into in-depth course learning. In this respect, we introduced painting into the courses of Food Chemistry and requested students to draw the content of classroom teaching within 3 to 5 minutes.

Painting creation is the process during which the painter, intentionally or unintentionally, chooses his/her knowledge system and its components [11]. The image thinking, abstract thinking and inspirational thinking applied in the divergent thinking derived painting conception and creation can help students to get rid of the constraint of inertia thinking and expand students’ perspectives and depths of pondering over problems. The essence of painting is to freely express an individual’s thought by combining various symbols, representing the external presentation of the individual’s unique thinking [12]. Meanwhile, the pleasant experience obtained in the free painting creation makes the boring specialized knowledge agile and students easily accept and master specialized knowledge. Fig.4 shows three pairs of knowledge system diagrams drawn by students within 5 minutes when learning the chapter of Lipids. In Fig. a, a student combines the content learned in the chapter of Lipids in the form of the Chinese words “Zhi Jing (literally “best regards” in English”). In Fig. b, a student builds the knowledge system in a garden and a house in the sun by focusing on the garden and the house. It can be seen from the figures that, for the same content taught by teachers, students usually have different learning methods due to their different focuses on life. The internalized knowledge system is closely correlated to students’ interest in life and learning. Each student has his/her unique way of internalizing the knowledge system and obtains some inspirations. Respecting students’ living and learning experience constitutes the basis for students’ efficient learning. The unique learning style that closely combines emotional experience can rapidly increase students’ memorization and deep understanding of specialized knowledge.

The evaluation of the teaching effects before and after teaching reform is shown in Fig.5. The traditional closed book test remained to be adopted in evaluation. Students’ performance in the tests for three years was analyzed and compared (see Fig.5). While the number of inquiry-based tests increased in the tests, the percentages of the students who achieved 90–100 points increased from 4.42% to 22.40% and 18.30% respectively; those of the students who achieved 80–89 points increased year by year; those of the students who achieved 70–79 points decreased year by year; those of the students who achieved 60 to 69 points decreased from 22.12% to 9.80% and 5.10% respectively; and those of the students who were below 60 points decreased from 3.54% to 2.20% and 0.70% respectively. It can be seen that the teaching method of guiding knowledge system building, expansion and application is effective in helping students to gain a deep understanding of teaching content, as well as to analyze and solve problems.
I. SUMMARY AND PROSPECTS

Classroom teaching is an important link of students’ learning. It effectively improves students’ learning effect and proposes even higher requirements for teachers. Teachers need not only to master the knowledge system for the courses taught and its linkage with the knowledge systems of relevant disciplines but also timely update the knowledge system, understand the trend of disciplines as well as the latest theories and research results in the fields of natural science and social science both at home and abroad. To promote and trigger the building, expansion and application of students’ high-level knowledge system requires teachers’ lifelong learning. There is a long way to go for a teacher in this respect.

REFERENCES