Influence on the Training Mode of Talents in Fire Engineering Colleges Based on OBE

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***Abstract*—The reform of the domestic fire control system has brought about strong social demand for innovation in terms of updating the fire control engineering education system. There are many existing problems in terms of the training of engineering talents at local fire engineering colleges, including unclear training objectives, an unreasonable curricular system, an overly standardized teaching method, the neglect of students' personal development, the limited practical capability of engineering teachers, overly standardized evaluation methods, and too great of an emphasis on learning results, etc.; all of which relate to the concept of so-called "outcome-based education" (OBE). We propose the following modifications in terms of the OBE training model employed by local fire engineering colleges: the strengthening professional construction, the definition of training objectives, the alteration of the curriculum system, the adjustment of curriculum content, the reform of teaching methods, increased attention to students' needs, the assembly of a contingent of teachers, the improvement of evaluation systems, and the cultivation of applied fire engineering talents for the society.**

***Index Terms*—fire engineering, personnel training, OBE educational philosophy, application type**

I. Introduction

As a new discipline, fire engineering has a very limited number of colleges and universities in China, and the personnel training system and educational model are not mature enough to meet the social demand for fire personnel. Modern engineering education advocates have advanced concepts such as "student-centered learning," "outcome-oriented teaching," and "constant improvement," all of which highlight the meticulous and scientific nature of professional education focused on the reflection of the basic requirements of undergraduate education. These approaches effectively play to their strengths in terms of teaching and learning, and they pursue efficiency and effectiveness in educational practice. Today, fire engineering is becoming increasingly important. The OBE concept is a key technique in terms of the comprehensive reform of fire engineering education and models of personnel training. The OBE model seeks to comprehensively improve students' applied ability and enable them to become skilled personnel in order to meet the emerging needs of their society.

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II. The OBE Perspective on the Status Analysis of Personnel Training at Local Engineering Colleges and Universities

Outcome-oriented education has developed into a complete system since it was first proposed by Spady (1981), focusing on four core problems [1], [2]: What should students strive to learn and master? What are the goals in achieving these learning results? How can students be assisted in achieving these learning outcomes? How can one effectively evaluate whether students have achieved these learning outcomes? First of all, it is necessary to clarify the differences between the OBE educational concept and more traditional educational methods in terms of personnel training [3]-[5]. This paper compares these two approaches to education in terms of six aspects of their utilization: teaching philosophy, role orientation, curriculum, teaching methods, learning methods, and evaluation methods (see Table I).

In this paper, after investigating the current situation in terms of personnel training practices at local fire engineering colleges, we discuss some outstanding problems inherent to common educational approaches.

A. Unclarity of Personnel Training Objectives

At present, despite the fact that local fire engineering colleges have realized that their engineering personnel training should meet local economic and social needs, the positioning of personnel training objectives is still not sufficiently precise. Key training objectives cannot be refined further based solely on market demand and should have to do with the training of applied engineering personnel. This problem has led to a mismatch between local personnel training objectives and personnel demand. Next, some local fire engineering colleges have failed to clearly differentiate between their own training objectives and those of high-level engineering universities, and they

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have hesitated in choosing between the training of high-level applied practitioners and researchers. As a result, the position of students majoring in fire engineering often tends to unclear after graduation.

TABLE I. COMPARISON BETWEEN OBE AND TRADITIONAL EDUCATIONAL PHILOSOPHY

personnel training	traditional concept	OBE philosophy
Teaching idea	Teaching objectives, curriculum arrangement and teaching progress are all plan-oriented, emphasizing the implementation of the plan	Training objectives, curriculum, teaching process, evaluation criteria are outcome-oriented, emphasizing open teaching
Role definition	Passive acceptance, teacher's request first	Active learning, outcome-oriented learning
Curriculum	Subject structure is centered and subject experts are oriented	Demand-centered, student and employer (stakeholders) Orientation
Teaching method	Teachers are the center, advocating the teaching of different subjects and competitive learning among students.	Student-centered, advocating collaborative teaching and building a learning community
Learning style	Accept learning, mechanical memory	Critical study, pay attention to thinking
Evaluation method	Knowledge-oriented, summary evaluation, results-oriented	Ability-oriented, how much to evaluate, and with attention to process

B. A Disconnect between Theory and Practice

The problem of *emphasizing theory over the practice* in the curriculum of the fire engineering specialty is particularly salient. The curriculum structure focuses on basic knowledge and multi-disciplinary perspectives, with numerous and varied courses. The proportion of courses offered for the cultivation of students' abilities does not meet the requirements of the market industry. Relevant coursework focusing on the cultivation of students' learning abilities, engineering practice and application, etc., are very inadequate, which results in certain difficulties in terms of students' future employment.

C. The Neglect of Students' Personalities by Common Teaching Methods

The development of diversified teaching methods is a feature of instruction at local engineering colleges in recent years. Common teaching methods in the cultivation of abilities include case teaching, group discussion, cognitive practice, lecture reports, etc. [6], [7], and the fire engineering specialty also draws on this model. However, in the practice of teaching, the instructor is the main figure of the classroom, and the instillation of basic theory is still the most common form of teaching. This approach cannot be very effective in motivating students' subjective initiative. Many seemingly different teaching methods are merely superficial formalities, such as the use of group discussion, cognitive practice, and/or school-enterprise cooperation [8], [9]. Without giving every student an equal opportunity to learn, it is difficult for individual students to fully exert their active role.

D. Lack of Teachers' Own Engineering Background Ability

As a new major, fire engineering is deficient in terms of the professional backgrounds of teachers. Many teachers lack basic professional knowledge, and even fewer possess practical engineering teaching ability and the ability to solve everyday problems. Teachers generally lack real-world experience in terms of engineering practices and they do not possess a sufficient in-depth understanding of developing industry trends and production practices. This results in difficulties having to do with teachers' practical teaching abilities and their capability of meeting the demands of personnel training. Fire engineering teachers also need to be innovative and capable of scientific research, especially in terms of the potential applications of big data. They must also constantly update their system of knowledge system and teaching methods in order to meet the needs of professional development. Obviously, the current skill level of teachers in local fire engineering colleges is generally insufficient in meeting the requirements for the training of applied engineering students in this new era.

E. Unitary Evaluation Methods

At present, both the demand for skilled professionals and training objectives have diversified. The existing evaluation system, however, has stagnated. Instructors continue to rely on unified examination questions and this arrangement of examinations and tests is still the main approach used for evaluation by local fire engineering colleges. This approach ignores the assessment of the students' practical operation ability and, at the same time, it reduces the students' initiative to learn and advance. The use of "surprise studies" and "key points" before examinations has become a common problem for students. There have been too much emphasis on examination results, which ignores the learning process of students. This cannot truly reflect the level of students' ability and it is not conducive to cultivating students' interest in learning, which harms students' sense of personal effectiveness. In addition, the evaluation system of fire engineering colleges lacks an effective mechanism for the ongoing improvement of engineering education, which fails to ensure the improvement of the quality of engineering education. The existing evaluation system cannot comprehensively and consistently evaluate students' learning achievement in the completion of their degree. In addition, teachers' professional levels tend to be inadequate to the actual needs of the engineering industry.

III. Recommendations for Fire Engineering Colleges in Terms of the OBE Personnel Training Model

We investigated some existing problems in terms of personnel training in modern local fire colleges. Based on an analysis of the characteristics of typical OBE engineering personnel training mode cases, local fire engineering colleges must take into account the anticipated learning results and training objectives and must drive the modes of OBE personnel training reform for the whole fire engineering educational system. Aspects of these reforms including training objectives, the curriculum system, teaching methods, teaching staff, and the evaluation system. This overall concept is shown in Fig. 1.

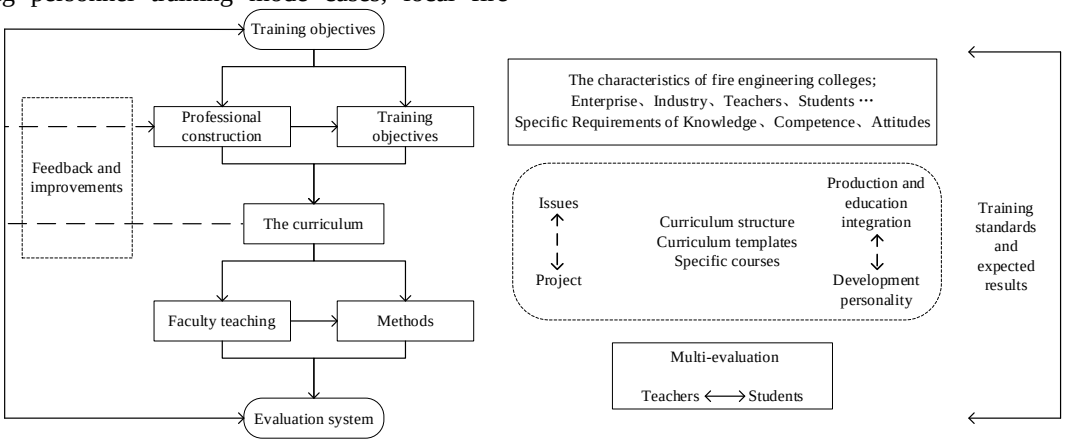

Figure 1. Approaches to the reform of the OBE personnel training model.

A. Clear Training Objectives

Engineering education has different characteristics at different levels of schools in terms of teaching resources, school levels, school operation characteristics, service orientations, etc. Training objectives must have distinct contrasts [10]. Fire engineering colleges and universities must clearly define their own engineering education orientations, which differ from those of both high-level engineering universities and technical colleges. The goal of personnel training must be shifted from knowledge-oriented external demands to outcome-oriented internal demands. It is important to prioritize serving the development of the regional economy and to make the overall goal the training of high-quality applied fire engineering professionals in order to meet the needs of the society. At the same time, in order to deal with the complexity of industry problems and the diversity of engineering professional demand, local engineering colleges and universities must further clarify, refine, and regularly revise their training objectives. In addition, they must formulate training standards that are consistent with the expected learning outcomes in order to reflect the training characteristics and operational orientations of different colleges and universities. Training standards should cover the foundations of natural sciences, humanities, social sciences, modern information technology, engineering professional knowledge, lifelong learning, engineering practice, complex problem-solving, language, comprehensive applied knowledge, team cooperation, innovation and critical thinking, professional ethics, national feelings, international vision, ecological awareness, physical and mental well-being, etc. (Fig. 2)

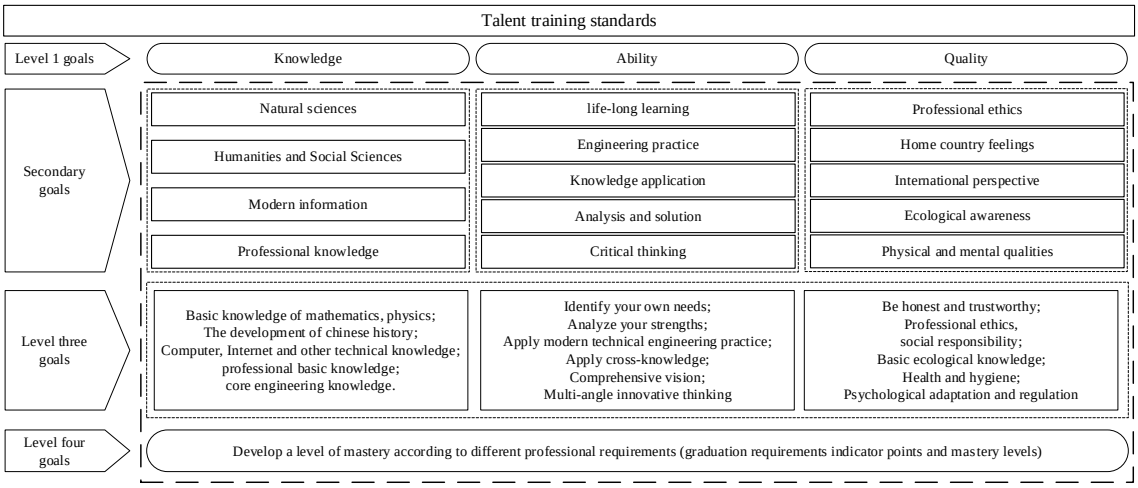

Figure 2. Professional training standards

B. Rebuilding the Curriculum System

As the main conveyor of personnel training, the curriculum system is an organic whole constructed according to the school's personnel training objectives. Courses from each part of the curriculum should be independent but related to one another and they should act on the expected learning outcomes from the three aspects of knowledge, ability, and quality. The current curriculum structure of local fire engineering colleges attaches too much importance to the theoretical coursework and it deviates significantly from the goal of training high-quality applied engineering professionals in this new era. Therefore, schools must pay attention to the proportion of practical courses and form a complete curriculum system composed of modules including courses on general knowledge, professional theory, professional practice, and skill development. The curriculum system can meet both of these training objectives and standards at the same time, while reflecting the development and heritage of the discipline and its professional field. They also reflect the main values of students and highlight the advantages and professional characteristics of the school.

The organizational form and specific content of courses must also be optimized and altered. A single form of curriculum organization and a purely theoretical curriculum content is not conducive to improving students' practical ability and addressing the actual needs of enterprises, as well as the ability to adapt to the needs of the society. Local engineering colleges of fire-fighting should adopt a more open attitude toward accommodating a diversified curricular organization. As a highly interdisciplinary professional subject, fire-fighting should incorporate a more comprehensive course structure emphasizing the correlation, consistency, and coherence among disciplines in order to cultivate students' overall understanding of practical engineering problems and explore comprehensive solutions. Through the integration courses, broad coursework, and more comprehensive courses reflecting the cultural context of knowledge in combination with the development of regional industry, we can reduce the course content of a variety of subjects. On the other hand, fire engineering colleges and universities should be practical in streamlining non-essential coursework while, at the same time, maintaining sufficiently comprehensive course content and improving the content of practical engineering courses. First, schools should identify the humanities and social science courses needed by applied fire engineering students and they can thereby cultivate well-rounded personalities and other desirable qualities for fire engineering professionals. Second, schools should examine the actual problems having to do with regional engineering issues in order to determine elements of their course content. Curricula should therefore constantly absorb cutting-edge engineering knowledge, including both its theoretical aspects and social reality, while highlighting the practical value of theoretical professional knowledge.

C. Reform of Teaching Methods

1) Problem-based inquiry teaching to develop students' innovative thinking

Engineers should not only have a solid foundation of engineering knowledge but also a keen ability to think about engineering problems comprehensively and make judgments about the possible results. Problem-Based Learning (PbBL) views engineering problems as the breakthrough points for teaching and it stimulates students' inquisitive spirit and creativity by creating problem situations or analyzing typical cases. In addition, aside from classroom teaching, a certain number of classes should be set aside to encourage students to work in small groups to solve engineering problems that are similar to real-life situations and to advance innovative and constructive ideas. In this way, students can improve their independent spirits and critical thinking abilities, as well as promoting the effective transfer of knowledge.

2) Using project-based participatory teaching to strengthen students' dominant position

Project-Based Learning (PjBL) is a concrete, complete, and practical engineering approach that takes teachers as the leading figure and students as the main body in instruction. Teachers and students collaborate in planning and completing projects. This teaching method can tap into and fully integrate the curricular resources of practical experimental projects through various types and levels of interactive cross-practice projects, and do so according to the characteristics of various disciplines and specialties. In addition, the process of implementing projects provides opportunities to help students design projects and plans independently. Students can set up projects individually and form teams to carry out activities within a specified timeframe, however, they must demonstrate clear and specific results. Apart from project results, project-based teaching pays more attention to the process that teachers and students use in completing the project as a whole together, so that everyone can participate creatively in practical activities. In this process, not only can students' dominant position be strengthened, but also students' learning interest and self-confidence can be cultivated. This approach can not only promote cross-disciplinary cultural exchange but it can also improve students' ability to integrate knowledge. Not only can the practical value of teaching be brought into play but students' teamwork and cooperative ability can also be enhanced.

3) Using integrated teaching of production and education to encourage practice and guide employment

Applied engineering professionals trained by local engineering colleges are closely tied to the success of regional enterprises. Promoting the integration of production and education can effectively promote the organic connection between the professional development and industry. The integration teaching of production and education closely connects education and enterprise. By providing opportunities and platforms for practice, the enterprise gives students access to advanced technology,

instruments, equipment, and other resources. The school designs and integrates teaching content together with enterprise engineers with rich practical engineering experience. Local engineering colleges and universities must go to different levels of enterprise practice, rotation practice, and engineer graduation practice during the training of engineering professionals. At present, most of the enterprise practices have no practical significance and they do not make use of the real-world engineering environments. At the same time, students enter the enterprise practice with different identities, different work backgrounds, and gradually come to understand the demands of local enterprises and the regional economy. This not only enables students to become familiar with enterprises but also enables enterprises to understand students, which is beneficial to strengthening school-enterprise cooperation, promoting students' employment, and reducing students' sense of maladjustment caused by the transition between school and society. This enables students to adapt to the work environment more quickly after graduation.

4) Diversifying teaching methods in order to promote students' personality development

Education at fire engineering colleges must abandon its traditional theoretical indoctrination, broaden its teaching methods, and be more flexible in diversifying its teaching methods. This must be done according to different course content and training needs in order to promote comprehensive and individualized student development. In addition to PbBL, PjBL, production teaching, and integrated teaching, schools can also adopt various teaching methods such as community service, innovation, and expansion. These approaches are student-centered and they encourage students to learn autonomously under the guidance of teachers in order to form personalized learning programs. This allows schools to cultivate and tap into students' research interests and personality potential, and to motivate students to take the initiative to explore and seek out innovation.

D. Improving Instructors' Teaching Abilities

The overall capability of the teaching staff largely determines the quality of personnel training. As the main element in the training applied engineering professionals, local engineering colleges must comprehensively improve the overall quality of engineering instructors, and build a Pablo collection of high-level engineering teachers with the following attributes: firm ideals and beliefs, advanced educational concepts, broad and solid knowledge, rich practical experience, strong educational ability, and professional responsibility with respect to the important task of engineering education. First, we should broaden our vision in terms of recruitment and strengthen ties with well-known universities and research institutes at home and abroad. We should also plan work methods and find specific ways to attract students. We need to actively introduce high-level fire engineering professionals at home and abroad and invite experts and scholars to give lectures in our schools. Second, we must optimize our incentive mechanisms. Based on the guidance of teachers' ethics, abilities, and achievements, we can better promote the classified management of teachers and establish a scientific and reasonable evaluation and incentive mechanism for teachers at fire engineering colleges and universities. Third, we should establish a school training system. We should set up a training center for instructors and invite domestic and foreign experts and scholars to carry out professional training. We should organize teaching drills and exchange teaching experience for teachers. We should comprehensively improve teaching abilities and the teaching levels of teachers majoring in fire protection engineering. Fourth, we must strengthen foreign exchanges. By promoting further educational opportunities and teaching seminars in colleges and universities, excellent teachers may be selected to go out for training and study visits. Through a process of continuing education and professional development, instructors can continuously expand their knowledge and master professional skills in their field, exploring the frontier of engineering development at home and abroad.

E. Enriching the Evaluation System

We need further diversification in terms of evaluation methods and evaluation subjects. Student evaluation, as an important aspect of higher education, is very important in promoting student development and improving the quality of engineering education. However, the traditional evaluation system is too narrow, relying only on written examinations that cannot accurately measure students' learning outcomes in different types of courses. Therefore, fire engineering colleges and universities must establish an evaluation system with multiple methods and subjects. First, evaluation should always be student-centered and should determine the evaluation criteria based on the development needs of students, as well as the needs of regional economic development in terms of applied engineering professionals. It should then build a multi-process evaluation system around these different criteria and be resolute in abandoning methods relying on only a single test paper score. It should adopt a flexible variety of methods, such as classroom question-and-answer, experimental reports, practical skills operation tests, and closed-book examinations in order to comprehensively investigate students' abilities from multiple angles. Second, the points of view and concerns of various evaluation subjects are different. Multi-evaluation subjects such as teachers, students, enterprises, and experts can jointly evaluate students' learning, which can make the evaluation results more objective, fair, and comprehensive. The content of evaluations should comprehensively reflect students' abilities. They should focus on students' practical abilities, innovative spirit, lifelong learning, team cooperation, etc. With the cultivation of students' ability as the core index of student evaluation, we can consistently improve the quality of the cultivation of applied engineering professionals.

IV. Limitations of this Study

Although "learners" are at the center for personnel training, corresponding amendments and improvements have been made in paying attention to expected outcomes, it is still common to stress students' output. Therefore, in the practice of teaching, it is easy to focus too much on results, while ignoring the teaching process and the cultivation of students. In order to achieve stronger results, the intrinsic richness of the teaching process is often ignored. At the same time, learning outcomes often involve practical actions, which is not a process that cannot be concretely manifested. This includes students' values, beliefs, attitudes, and psychological states. However, many advanced psychological features (values, emotions, etc.) are difficult to demonstrate. In the process of student cultivation, only achievements in terms of behavior are emphasized and it is easy to ignore the cultivation of implicit achievements such as emotions, attitudes, and values. In addition, in this professional training model, expected learning outcomes and training objectives are emphasized in order to organize teaching. Students, however, generally refer to past and present situations in setting their ultimate goals. It is easy to organize today's courses by yesterday's decision-making standards when training students corresponding strictly with current results. The training of professionals serves the future to a great extent and this lag in terms of teaching goals can easily become a major limiting factor for professional training.

V. Summary

In order to meet the needs of the new fire protection system, cultivating applied and practical professionals is of great significance for fire protection engineering. Based on the OBE concept, this paper has analyzed the current situation in terms of the talent training model for fire engineering colleges and universities. And to achieve the expected achievements of OBE talent training model, a number of reform suggestions are put forward, including clarifying training goals, reshaping the curriculum system, reforming teaching methods, improving teachers'teaching quality, and enriching evaluation system. As shown in Fig. 3. These methods strive to improve not only the quality of talent and cultivate a sound personality, but also professional knowledge and lifelong learning ability. At the same time training students' critical spirit as well as independent thinking ability, innovative spirit and knowledge integration ability so as to improve practice ability and team work ability. Two major changes promoted by the OBE educational concept are shifting away from strategies focused on student progress and expected outcomes to educator-centered to learner-centered instruction. Taking these demands as guidance, our training goals adapt by having schools take into account localized operation and actual industry demand. We support problem-based inquiry as a teaching strategy in order to develop students' innovative thinking skills and we support the use of project-based participatory teaching to strengthen students' dominant role. From the reverse angle, we underscore the importance of having reasonable curricula and paying attention to practice, and to construct student-centered, diversified teaching methods focusing on the all-around development of students' personalities. We also promote an increased focus on teachers' professional development and the improvement of the depth of the teaching staff in terms of continuing professional development and the diversification of the evaluation system. All of these approaches have provided specific suggestions for improving the personnel training model based on OBE at local fire engineering colleges. These are significant in guiding reforms to engineering education in both theoretical and practical senses at local fire colleges and universities using the concept of OBE education.

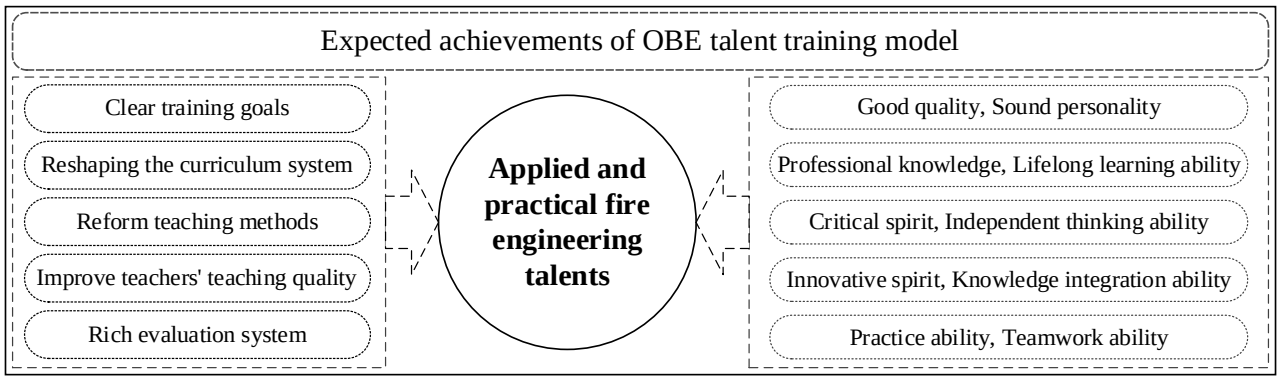

Figure 3. Expected results of OBE training model

Conflict of Interest

The authors declare no conflicts of interest to this work.

Author Contributions

As to contribution, Prof. Yanni Zhang took in charge of the project and evoked the topic; Mr. Xinyu Wen and Mr.

Zhichao Feng doing data analysis; Prof. Kai Wang gave practice support; Prof. Jingyu Zhao wrote the paper; all authors had approved the final version.

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