Summer 6-19-2015

An IT Professional Talents Training Model in Colleges Based on Animal Cell Structure

Ruijun Zhang
School of Management, Wuhan University of Science and Technology, Wuhan, 430081, China

Ting Hu
School of Management, Wuhan University of Science and Technology, Wuhan, 430081, China, ZH12130517@163.com

Wen Cai
School of Management, Wuhan University of Science and Technology, Wuhan, 430081, China

An IT Professional Talents Training Model in Colleges Based on Animal Cell Structure

RuijunZhang[1], TingHu[2], WenCai[3]*

[1]School of Management, Wuhan University of Science and Technology, Wuhan, 430081, China

[2]School of Management, Wuhan University of Science and Technology, Wuhan, 430081, China

[3]School of Management, Wuhan University of Science and Technology, Wuhan, 430081, China

Abstract: Under the current period background of big data and cloud computing, there is a huge demand for professionals in related fields such as information technology (IT). To solve this problem, this paper puts forward an IT professional talents training model based on animal cell structure by comparing the structures of animal cells and its efficient operation principle with IT professional training model system. According to the efficient-working principle of 'Nucleus-Cytoplasm-Environment', this model is built as a 'Class (The Core)-College (Internal Environment)-Enterprise (External Environment)' training model for IT-majored students. The motivation is to cultivate students' abilities in these four aspects: structure, application, analysis and innovation, namely, regarding theory teaching as the core, college practice training as the pulling force and enterprise project resources as the pushing force. The reliability and validation of this model have been demonstrated by simulation results in Wuhan University of Science and Technology.

Keywords: animal cell structure, Information Technology (IT) talents, cultivation model

1. INTRODUCTION

Recently, the application of big data has been widespread no matter at home and abroad. Data type and amount in human society is growing in amazing speed which is caused by emerging new services [1], so big data has gradually become an indispensable part of management, business [2], finance and other fields. However, with the repaid development of information technology, IT students are suffering from the 'facture' phenomenon, which exists in the practice of theory and technology. Graduates cannot meet the demand of interdisciplinary IT talents for enterprises because of lack of experience. In addition, examination oriented education for many years deprive graduates of their innovation abilities on the level of technology.

How to cultivate IT elites who have solid theoretical foundation, strong practical abilities, and innovation thoughts comprehensively is a big problem that the frontline teachers in teaching and program practice to explore. Courses reform, practical-training system establishment [3] and a three-dimensional structure model, including hardware, process, and software [4], are proposed, aiming to cultivating composite-type talents in IT fields. Many teachers begin to underline project practice for IT students, and update the teaching method, such as the IT talent cultivation mode driven by actual projects [5], school-enterprise corporation model [6]-[8] and so on. The '3+1' mode, namely, 3-year principle theoretic teaching and one-year enterprise engineering practice [9] and the '2+1+1' training mode based on CDIO concept [10], both combine theory and practice closely. In addition, innovation ability is also very important for IT talents when they are implementing an engineering project. Demand-oriented mode based on practice training project [11]-[13], and problem-oriented mode [14][15] are put forward to train students' abilities of independent thinking and problem-analysing, and to enhance their innovation ability.

However, in above studies, most of them just explore one or two aspects and few put theoretical teaching, technology practice and innovation ability together. Aiming to this problem, through analysis of

* Corresponding author. E-mail: ZH12130517@163.com.

animal cell structure, we find that the perfect and efficient operation for every part in a cell is similar to IT professional training system operation. As a result, combining with the animal cell structure, the article simulates a 'Class-College-Enterprise' IT talents cultivation model. It is important for us to take the animal cell structure as an example to cultivate IT elites in the combination of classroom, college and enterprise. Only in this way can we make all the parts as a whole to cultivate IT elites who have abilities of theory, skill and innovation, namely the innovation ability of structure, application, analysis and solving problems in a program.

2. PROBLEMS EXISTED IN IT RELATED STUDENTS

There are nearly 2000 universities setting up the majors about computer science and technology, software engineering and information management in China. But many IT graduates' comprehensive abilities majored in computers are not strong enough. As a result, the enterprises are not satisfied with graduates' work. Above all, there exist the following problems for the students majored in computer when they are looking for a job.

A. Backward knowledge reservation

In our country, the common teaching mode is centring on theories. At present, the student training scheme is drafted according to four years planning. And it is rarely adjusted and modified, so it lags behind the speed of development in IT technology. For example, 'Cloud computing' technology has been widely used, but a lot of students in school do not really understand its concept, and only a few students know about it from their teachers mentioned in or out of class. The curriculum lags behind the fast update in IT industrial technology, so students' knowledge reserve is backward, and cannot timely get access to the latest IT technology.

B. Weak engineering practice ability

In school, the college students spend most of their time on theoretical learning, together with the constraints of training conditions and school funding, which makes it more difficult for students to train their learning long and proficiently. For example, programming curriculum is essential for IT majored students. But when the class is finished, only chance to practice is a short-term curriculum design which cannot make students skilful. Of course, competitions and projects are good chances, but there are few, and cannot take every student into account. Because of lack of long-term training, what they learn will be forget quickly. As a result, although the students have learned many programming languages, they cannot program, let alone system design and implementation ability about project.

C. Lack of innovation ability

College education is mainly under the mode of student passive accepted type, single type and optional type. Due to long time of examination-oriented education, students get used to be indoctrinated, rather than acquire knowledge on their own. Under the mode of 'teacher teaching, student listening', students rarely raise questions about teacher's lecture. For example, one programming language can be used to solve a problem, and many students do not want to change another program language that may achieve the same effect, even simpler and more practical. Being lack of thinking, students cannot analyse the problem effectively during project implementation, not to mention apply it in a more satisfactory manner.

Generally, all these problems restrict the IT related professional students' abilities in adapting to social work. They cannot transfer their learning into productive forces, which lead to the waste of theories and technologies learned in the university.

3. BIOMIMETIC ANALYSES BETTWEEN ANIMAL CELL STRUCTURE AND IT TALENT TRAIING

A cell is the most perfect unmanned factory. Though the cell is individual that is invisible, but each part in it can farm out and cooperate with others precisely, so that the cell can become an integral part of each creature. Compared with plant cells, animal cells have better fluidity. All parts in a cell constitute the whole, combine

well, and connect perfectly. It is similar with the relationship among the aspects of IT talents training in undergraduate colleges and universities. Therefore, it is feasible to analyse the model of IT talents cultivation based on animal cell structure.

3.1 Structural similarities

The corresponding relationship between animal cell structure and IT talents training system is shown in Figure 1. According to the sequence from inside to outside, it is described as follows:

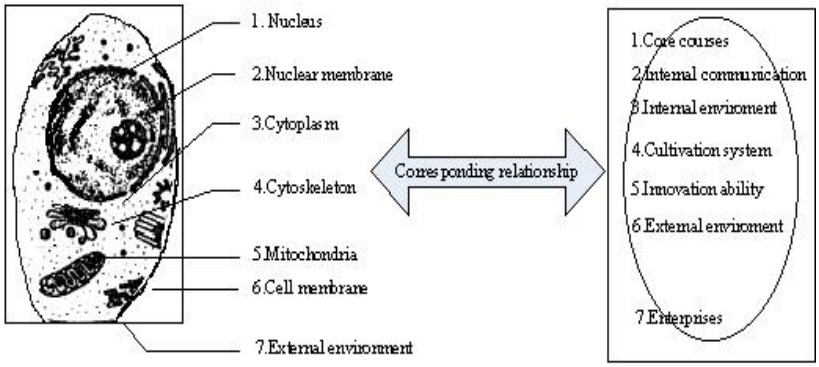

Figure 1. The corresponding relationship between animal cell structure and IT talents cultivation system

A. Nucleus and professional core courses

The nucleus is the most important organelle in a cell, and it is the control centre to realise heredity and metabolism. It also directs all activities in the cell orderly. Core curriculum in general consists of many courses, and it plays a decisive role in forming professional knowledge structure and core competitiveness for IT talents.

B. Nuclear membrane and internal communication

There are many small holes in the cell nuclear surface, so that the nucleus can exchange substance with cytoplasmic environment effectively to complete the function that the cells need. Under the school education, because of particularity of IT technology training, communication between teachers and students plays a considerable role in IT students training. A perfect mode of teaching and communication can develop students' thinking ability rather than instil them knowledge.

C. Cytoplasm and college environment

The cytoplasm composes the environment that the life activities of intracellular organelles can be carried on. It is also a place to achieve various chemical reactions. As the college is learning place for IT professional students, it applies students with necessary equipment and learning atmosphere, and set a good foundation for students' learning majored in computer.

D. Cytoskeleton and cultivation system

The cytoskeleton is liable to be overlooked in the cell research, but it plays an important role in ensuring life activities inside the cell orderly. It can maintain a certain shape and stability of internal environment. Establishing an IT professional training system is a supporting framework for cultivating IT students. In the college environment, it is represented as culture planning establishment, curriculum system scheme and so on.

E. Mitochondria and innovation ability

Mitochondria are specific organelles in the animal cell, and the main energies (Adenosine-triphosphate, referred to as ATP) of life activities for cells are produced by mitochondria's process metabolism. It is the power of continuing a cell life. As far as training IT talents is concerned, besides the theoretical knowledge and technical abilities, solving the problems flexibly and using technology innovatively are 'ATP' for IT talents, which are the necessities for a successful IT man.

F. Cell membrane and external communication

When cell membrane isolates materials inside a cell from outside to maintain relative independence of the cell, fusion and fluidity of cell membrane fluidity are very important to friendly exchange the material between inside and outside of a cell. This is similar to the effective barrier that is formed by colleges and businesses when IT students are being trained. Namely, the colleges and enterprises are both interrelated and mutually independent.

G. Extracellular environment and enterprise

Although cells can ensure relative independence for internal environment, yet the substance exchange between inside and outside of cells is indispensable. The nutrients cells needed are mainly derived from the extracellular environment. In the training of IT talents, schools and enterprises cooperate effectively, so IT projects in enterprise provide plenty of nutrition for students. Therefore, students can also enhance their abilities of engineering practice through the projects during learning theoretical knowledge.

3.2 Functional similarities

Through analysis of the similarities between animal cell structure and IT personnel training system, the relationship of them can be described as follows from the inside to outside:

A. Heredity and knowledge delivering

Heredity is the main way to ensure excellent genes. It guarantees a generation of gene continue to the next generation, and let the next generation has both good genes of the parents and different genes form them. Similarly, at the undergraduate stage, knowledge delivering lays a foundation in cultivating IT talents. The study of theories provides students with certain abilities of structuring in the project implementation. Teaching is like cell inheriting. Teachers transfer useful knowledge and skills to students continually and senior students share their practical experience with junior students. Therefore, each student can accumulate basic IT knowledge and skills in IT training, and constitute a unique knowledge structure combining different project environment.

B. Independent and cooperation

Although each cell is the smallest place for life activities, organelles in a single cell are relatively independent. Every organelle can complete its functional response independently. For example, the cell nuclear is responsible for heredity, and mitochondria produces energies required by the cell. But, if the whole cell needs to complete the chemical reaction, the organelles in the cell must be in a mutual cooperation. As for cultivating IT talents, although school, teachers and enterprise are different individuals, the three have to be in close contacts. An individual plays a single role in the IT personnel training, only combing with other factors can train IT students in an all-round way. For example, teachers’ lectures can cultivate students' ability of structuring projects, and the practice in enterprises can develop students’ ability of application and analysis, which are indispensable and essential for an IT student.

C. Energy and innovation

A lot of chemical reactions in the animal cell require energies (ATP) supporting. Energy is the driving forces of material metabolism. In the training of IT talents, innovation is one of easily ignored and essential abilities. Being indulged in examination-oriented education for many years, students have formed a habitual pattern of solving problems and are lack of innovation ability. While implementing an IT project, technical problems and unsatisfied practical needs will continue to occur. This inherent thinking mode cannot solve all nonprocedural problems and the innovation ability is very important. There are many solutions to a technical difficulty. Only through constant thinking, can a most effective and reasonable method be found, thus to reduce the cost of projects implementation. Therefore, innovation ability is the energy for IT projects implementation.

D. Interchange of material

The cell membrane has the characteristics of fluidity, which makes the cells not stationary but can effectively carry on interchange of material with external environment. The appropriate interchange of material

can satisfy the normal life activities of cells. In the training of IT talents, the school environment and the enterprise environment also need 'interchange of material'. The theoretical knowledge and model skills of students are required to practice, students, who are the new force, meanwhile, are also demanded to inject new impetus for the resolution of key technology in a project as well as reducing the development costs.

4. THE IT TALENTS TRAINING SYSTEM MODEL BASED ON ANIMAL CELL STRUTURE

4.1 The Establishment of the model

The IT talents training system model ('Class-College-Enterprise' mode) is proposed based on the bionic analysis of animal cell structure (as shown in Figure 2). This mode is similar to the functional mode of cells, that is, 'Nucleus-Cytoplasm-External environment', in which the nucleus is the core of a cell, controlling the genetic of cell and the corresponding life activities. Cytoplasm forms the internal environment for organelles activities, and also carries out interchange of material between external environment and cell, to assist the cell in completing life activities. Here, the model of 'Class-College-Enterprise', regarded as the core of classroom teaching, is the theoretical basis for students' learning and practice. Curriculum design and various competitions can provide technical training opportunities, enhance communication between teachers and students and then create a good environment within the college. Enterprise projects practice supports the running of university's internal environment, and injects innovation motivation to study and carry on the engineering practice.

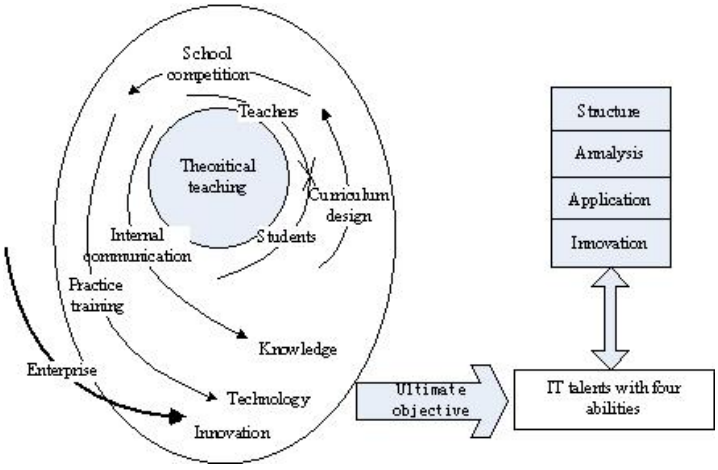

Figure2. The operation mechanism of IT talents training system model

4.2 The staged training program for IT related undergraduate talents

In view of the above mentioned model and analysis of college teaching as well as enterprise external environment, all aspects of IT talents training will be integrated effectively like a cell. According to this model, a training program of 'four stages' is put forward to cultivate IT students' abilities of project architecture, analysis, application and innovation.

A. The first stage: theoretical knowledge = professional basic courses + frontier discipline courses

The traditional training model lays stress on imparting the basic theoretical knowledge to IT talents, which takes teachers' teaching as the core. But with the repaid development of IT industry, the laggard professional training system cannot satisfy students' grasp and understanding of technology. The first stage, therefore, should focus on not only the professional basis courses, but also the frontier discipline courses, which means the unfamiliar defects of latest trends in IT industry. Take big data and cloud computing for example, which both two are leading the IT industry into a new era. Then besides the basis courses, some frontier discipline courses related to big data, Internet of things, data mining techniques should be studied in order to broaden students'

horizons through the optional courses, seminars, forums and other forms.

B. The second stage: practical training = curriculum design + professional competition + case scenario design

The main way that students put the theoretical knowledge into practice is curriculum design as well as a few discipline competitions. However, it cannot solve the underlying problems. Take the students majoring in information management for example. Firstly, curriculum designs cannot satisfy the actual needs other than simulating a simple system design, which differ greatly from the real system implementation. Secondly, discipline competitions are not common, and they are mostly in the proposition of 'problem and solving' mode. The students can train themselves in recent time but cannot realize the goal of studying in a long term. The second stage adds case scenario design when discussing the training links. It mainly points at partial technological curriculum besides curriculum design and some discipline competitions. Its main manifestations is that teachers regard some certain case (such as campus smart card overall system scheme design) as teaching situation and let students design the solution scheme independently. The content is not restricted and students are encouraged to form a team to investigate, and then simulate the case.

C. The third stage: college-enterprise cooperation = project-driven + engineering practice

The engineering practice is the key to improving the application ability of students majored in IT. The college-enterprise cooperation is an effective way for colleges to train students' skills, which mainly reside in the project-driven and certification practice. Teachers are encouraged to undertake enterprise projects in order to provide students with the opportunities to practice, bringing schools and enterprises the 'win-win' situation. On one hand, students are encouraged to go to the front-line of enterprise in the name of the individual or the college to practice themselves and improve hands-on skills, such as business portal development; on the other hand, from the point of teachers, they are encouraged to go into enterprises, leading students to undertake large IT projects in designing, developing and implementing (such as optimization decision problems in blending ore process of iron and steel enterprises), so as to enrich the teaching contents.

D. The fourth stage: innovation = question-demand orientation + opening teaching

Innovation is the power of a project implementation. Students should be guided gradually to learn how to grasp the ability of creative thinking. The concept of problem-oriented can be traced back to the problem theory proposed by the famous philosopher Popper in the earliest twentieth Century. Popper thought that scientific development is a process to find problems, to solve problems continuously, and then discover new problems again [16]. The problem-oriented teaching originates from solving the problems in the real world. Once the problem is established, in a 'hypothesis-reasoning-checking' way, students try to solve the problem from the personal point and multiple dimensions. Regarding the question-demand orientation as the basis, with various ways of lectures, seminars, projects discussion and other forms, and carrying on opening teaching, it encourages students to express different ideas. At the same time, it changes teachers' teaching model, then guides students to form the habit of self-thinking, to innovate boldly and to solve problems from different aspects. Only that can enhance the solving problems ability of IT students. For example, in the campus intelligent vehicle management project, brainstorming is used by the project team when faced with the low recognition rate problem in car license. To solve the problem, team members respectively proposed many methods, such as video identification, ETC (Electronic Toll Collection), IC (Integrated Circuit) card, manual duty and so on. Finally, the effective integration of various kinds of identification fields is successfully completed with multithreading technology.

5. CULTIVATION EFFECTS

In accordance with the above animal cell model, Wuhan University of Science and Technology makes a bold attempt at IT related professional talents training in stages. In terms of the theory curriculum reform, the college not only establishes basic professional courses, such as programming language, data structure, database,

software engineering, system analysis and design, but also increases additional frontier professional curriculum, such as data collecting technology, data mining technology, Internet of things, big data, from which students can not only strengthen their basis professional knowledge, but also grasp the latest IT technology. In addition to the curriculum design, the college adds web design competition, program design contest, mathematical modelling contest, robot contest, human intelligence contest and so on, to provide chances for students to preferably participate in technology practice.

In addition, college-enterprise cooperation increases the engineering practice opportunities for students. Students participated in research projects guided by teachers with the Ministry of Water Resources, Wuhan Urban Management Bureau, Ziling cement plant of GeZhou Dam, Wuhan Genie Scale Manufacturing Corporation, Idea Technology Group Corporation, and other enterprises and public institutions, completed dozens of information systems development, and made great achievements. For example, the Yangtze River flood control project information service system, national flood disasters prevention planning information system and the landfill unattended measurement system in Wuhan Urban Management Bureau. Take the project of intelligent weighing system as example. It was developed and implementing with Wuhan Genie Scale Manufacturing Corporation. In this project, teachers worked as a leader while students worked as a team and they went into the enterprise to practice. Combining the frontier knowledge, they successfully designed an intelligent weighing system with flexible interface and elastic pound lists designing. The system has obvious advantages and practical uniqueness among the same industry. The students' abilities in theoretical framework, problem analysis and application are fully enhanced, and engineering practice ability is exercised perfectly. Due to the great achievements made by students in these projects, they have been employed by Alibaba, Tengxun, Changjiang Water Resources Commission and other well-known enterprises and public institutions. Some have got highly appraisal and become technology backbone in the enterprises and public institutions.

6. CONCLUSION

Due to limited resources and fixed teaching model in the undergraduate colleges and universities, it is very difficult to cultivate IT talents with abilities of architecture, analysis, application and innovation in project implementation. This paper points out that IT related professional personnel training system is very similar to the animal cell structure through the analysis of animal cell structure. The principle of life activities of 'Nucleus-Cytoplasm-External environment' model forms an organic whole, with which the cells can run efficiently. This paper, therefore, combining with this model, puts forward the 'Class-College-Enterprise' training model for IT talents. The model focuses on training IT talents from three aspects of 'theory + technology + innovation', then proposes the 'four stages' talents cultivation suggestion, namely, cultivating IT talents from architecture, application, analysis, and innovation, by way of reforming flexible curriculum, increasing case teaching situation, enhancing college-enterprise corporation, and using question-demand orientation. By ways of 'learning and using straight' and 'consolidating use', IT related professional students are able to make what they have learnt become skills, and can adjust the environment immediately once they enter the enterprise.

ACKNOWLEDGEMENTS

This research is supported by the special task project of Humanities and Social Sciences Research-Engineering science and technology talent training research, under Grant 13JDGC009 from the State Education Ministry, by High School Education Research Program, under Grant 2013235 from Hubei Province, China, by Natural Science Foundation Under Grant 2014CFB804 from Hubei Province, and by the National College Students Entrepreneurial Training Program.

REFERENCES

[1] Meng X F, Ci X. (2013). Big data management: Concepts, techniques and challenges. Computer Research and Development, 50(1): 146-169.

[2] Krishnan K. (2013). Big data and business innovation. IBM Data Management Magazine, (5).

[3] Li D S, Wang B, Yuan Da, Xie Q S. (2014). Training of innovative IT talent based on engineer cultivation. World Transactions on Engineering and Technology Education, 12(2): 276-279.

[4] Chen Chaotian, Gong Chunyan. (2010). RETRACTED ARTICLE: The structure models and support mechanism of cultivating system for composite-type talents in IT fields. In: 2nd International Workshop on Education Technology and Computer Science (ETCS 2010), Wuhan, 2010. Piscataway: IEEE Computer Society, 806-809(in English)

[5] Zhang R J, Hu T, Ma K Y, Zhao H L, Wang W B, Mao W X. (2014). An IT talent cultivation mode driven by actual projects-based on research using questionnaires and interviews. World Transactions on Engineering and Technology Education, 12(1): 65-72.

[6] Mao J, Dang Z H, Fang Y Y. (2014). Inter-disciplinary IT service outsourcing talent cultivation mode in China: A school-enterprise integration cooperation perspective. In: 2014 International Conference on Computer, Intelligent Computing and Education Technology (CICET 2014), Hongkong, 2014. Leiden: Taylor & Francis–Balkema, 397-401(in English)

[7] Wang Xueyan, Guo Zhigang, Liu Lina, Chen Xi. (2011). School-enterprise corporation: A new teaching mode of information technology course for students of ethnic minority backbone talents program. In: 2011 International Conference on Consumer Electronics, Communications and Networks (CECNet 2011), Xianning, 2011. Piscataway: IEEE Computer Society, 3506-3508(in Chinese)

[8] Lv Hongyan, Dong Yuhong. (2013). The analysis of college-enterprise cooperation training graduate students management mode. In: 2013 International Conference on Advances in Energy and Environmental Science (ICAEES 2013), Guangzhou, 2013. Zurich-Durnten: Trans Tech Publications Ltd, 2872-2875(in English)

[9] Hu Jun, Guan Chun. (2011). Explorations and practices on Nanchang University "3+1" software talents cultivation mode. In: 2011 International Conference on Computer Science and Education (CSE 2011), Qingdao, 2011. Heidelberg: Springer Verlag, 7-13(in English)

[10] Zhang F, Zhang Y H, Ai X Y, Li X L. (2014). Research on a 2+1+1 IT professional talent training mode based on the CDIO engineering education concept. World Transactions on Engineering and Technology Education, 12(2); 186-190.

[11] Li M D, Mao J L, Lai Q F, He X B, He C L. (2011). Research on creative talents training mode of IT specialty in Normal Colleges. Journal of China West Normal University (Natural Sciences), 4(32): 375-378.

[12] Wu Hanyan. (2011). Training practice talents of information management professional. In: International Conference on Smart Materials and Intelligent Systems 2010 (SMIS 2010), Chongqing, 2010. Clausthal-Zellerfeld: Trans Tech Publications, 571-575(in English)

[13] Lu J Y, Yuan Z S, Wang H B. (2012). Innovation & practice of training mode of applied IT service outsourcing talents. Advances in Information Sciences and Service Sciences, 4(21): 398-404.

[14] Lin P Y, Liu C X, Huang D Q. (2012). Analysis of IT talents cultivation methods in the core of problem-solving ability. Heilongjiang Researches on Higher Education, 8: 126-129.

[15] Wang D Q, Han H, Zhan Z H, Xu J, Liu Q B, Ren G J. (2015). A problem solving oriented intelligent tutoring system to improve students' acquisition of basic computer skills. Computers and Education, 81: 102-112.

[16] Xue J D. (2013). Problem-oriented university classroom teaching. Journal of Shanxi Finance and Economics University, 35(S3):76-78.