ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202202_5(2).0052

Research on the Teaching of Construction Engineering Data Management Courses

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Abstract

Based on the background of vocational and technical school education, this paper expounds the present situation and problems in the field of construction engineering data management and its professional practitioners -- data personnel. The content first discusses the practice and research on teachers' teaching methods of construction engineering materials courses from the aspects of school education, classroom teaching, social needs, industry standards and professional requirements, and subsequently puts forward an innovatively composite teaching method with the core of retelling strategy and processing strategy based on information processing psychology, taking the leading concept of stratified teaching, and applying multi-channel situational teaching mode combined with information software technology teaching strategy, complemented by stimulating students' individual initiative. It aims to train each student to become a qualified engineering project documenter with excellent professional quality, skills, and the ability to quickly adapt to professional work.

Keywords

Documenter; Construction project data; Vocational college; Teaching research; Teaching method; Teaching pattern; Cognitive psychology; Situational teaching; Stratified teaching; Information software technology; BIM model; Information collaboration.

1. Introduction

In a construction project, the project data and documents are an important technical basis for project process management, final completion and acceptance, project information recording, project quality evaluation, safety level determination, project final settlement and audit. Therefore, construction project data management is an important work to effectively ensure project quality and safety, project information recording and tracing. Due to its characteristics of complexity, randomness, timeliness, authenticity and comprehensiveness, the documenter engaged in this work must have professional competence. Therefore, the problem on how to train and improve the skills of professional documenters becomes highlighted.

This paper introduces an overview of current construction project data management, points out problems existing in current practice of construction project data management, analyzes the reasons, and from three aspects explores how to cultivate full-time college students more effectively and improve their professional knowledge and vocational skills during their study, and how to make this learning and working process change from boring to comfortable and interesting.

Based on vocational and technical school education, this paper will discuss the practice and research on teachers' teaching methods for construction project data management courses, and try to explore and summarize curriculum teaching methods that can better enhance students' professional knowledge and understanding of project data management, and can cultivate documenter talents to achieve excellent professional quality and skills.

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2. Construction Project Data Management

Construction project data management is mainly responsible for the managing work related to project data, including preparation of data management plan, establishment of ledger, process management, handover, and acceptance, etc. Personnel who specialize in this type of work are called "Documenter". As one of the eight members of the construction industry, they have clear job responsibilities described in the National Occupational Standards. They can pass the national professional qualification examinations through specialized vocational training and obtain a professional qualification "Documenter" certificate. The work contents and requirements that must be implemented in construction project data management are stipulated in national standards such as "Code for Putting Construction Project Documents into Records" [1], "Unified Standard for Constructional Quality Acceptance of Building Engineering" [2], and "Occupational Standards for Construction Site Technician of Building and Municipal Engineering" [3].

3. Current situation of Enterprise Data Management

3.1. Professional Standards for Documenter

In China, the position of documenter requires the professional qualification certificate of "Documenter". To obtain such a certificate, one must pass the qualification examination which covers two parts: professional knowledge and professional skills. Among them, professional knowledge includes: general knowledge, basic knowledge and post knowledge; Professional skills include: plan management, collection and sorting, use and storage, filing and handover, and information system management [4]. The occupational requirements of a documenter are summarized in Figure 1.

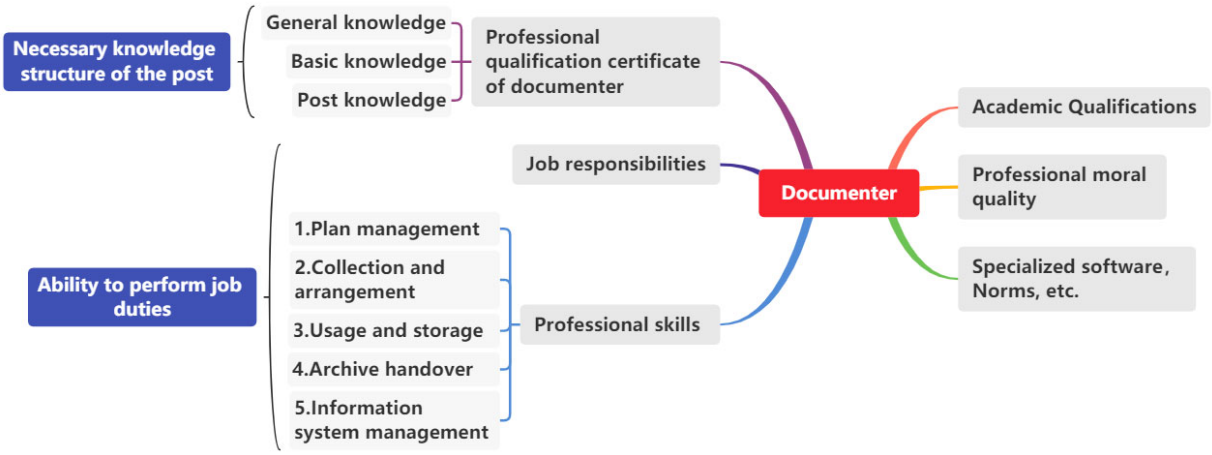

Figure 1. Occupational requirements for a documenter

3.2. Problems Existing in Construction Project Data Management Positions

With the replacement by new data management methods brought by the prevalence of professional informatization and software technology, the problems existing in construction project data management positions are becoming more and more prominent. In the process of implementing project-based teaching, six points have been summarized from social research and practice, as shown in Table 1 below.

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Table 1. Problems existing in construction engineering data management positions

No.	Problem	Description
1	Unproficient in new technology	It is difficult for old employees to adapt to the new technology. In the face of the large-scale and complex data management requirements of modernization, the forced use of data management software has the problems of reduced quality and lagging speed.
2	Unskilled new employees	New employees have little work experience, shallow cognition and deep understanding, and it is difficult to independently undertake new and difficult work with long construction period, large scale, many management procedures, complex technology and strong project comprehensiveness in a short time, resulting in problems such as loss, omission, lack, difference and error in document management, which affects the integrity, authenticity and systematicness of construction project data.
3	Low technical level	Archives and data management is a kind of meticulous and systematic work that is more complex, monotonous, boring and cross checking. There are few on-site research topics, few opportunities for positive contact with high-tech jobs, and the corresponding remuneration is moderate, so it is difficult to introduce senior talents, making it difficult to improve the overall data management level.
4	Inconsistency between archived data and the actual situation on site	In social practice, there have been cases where staff only manage data in the office, are not familiar with construction technology, and prepare data based on subjective assumptions, resulting in data inconsistent with the actual situation on site.
5	Defect in control of the construction companies	Enterprises have low requirements for data management and lack of professionals in system management. In addition, they have little demand for data utilization and statistical analysis, and the data management business is outsourced. In this case, the data management completely depends on the Labor Party and only relies on the contract to submit results. The strict process control system is often ignored, resulting in the decline or even lack of construction project data quality.
6	Lack of training mechanism	In practice, staff training and knowledge upgrading mostly rely on the training of software developers and lack of professional guidance from schools and research institutions. As a result, documenters only use the software after training and do not know much about the professional knowledge behind it, which deviates from the positioning of focusing on training technical talents in teaching and scientific research in Colleges and universities.

In order to change these situations, on the one hand, potential construction project data management practitioners learning at school need to comprehensively and systematically master the professional knowledge and skills as much as possible, learn to use the modern information management technical approaches, and cultivate a diligent, pragmatic, meticulous and professional working attitude; On the other hand, it needs to raise project leaders' awareness of the importance of construction project data management, establish and improve

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the management mechanism, especially optimizing the workflow and data management technology; Under any circumstances, it should be better to stimulate the initiative and enthusiasm of full-time staff, and fundamentally improve the quality, standardization, and integrity of construction project data. At the same time, through learning from the excellent management experience at home and abroad, management methods can be continuously improved to meet the growing needs of data management and social development in the construction industry, and the professional level can also be enhanced.

4. Teaching Method Study Based on Cognitive Psychology

4.1. Clarification of the Job Requirements Corresponding to the Course

Firstly, the object of vocational education services is society. Therefore, the premise of teaching is to do detailed social demand research and vocational position research as much as possible. By conducting discussions on professional development with various groups in the industry, listening to and collecting the demand for data management talents in the industry, analyzing and clarifying the talent training direction, a general framework of related knowledge and skill training objectives is set up. With the goal of quality education as the core to cultivate noble professional quality and craftsman spirit, a reasonable knowledge structure and gradient range are established. Further, by deconstructing the job requirements, the knowledge and skill points are determined and training programs are selected in the form of modules or theme series.

Secondly, it demands to develop a habit of understanding and abiding by rules, establish professional thought and attitude, and skillfully operate technical work. Data-related courses have obvious characteristics of information classification management, which have clear framework system but is challenging with many provisions. The content covers multiple cooperative organizations and specialized fields, which is highly professional. It also involves many kinds of technologies, complex and practical.

At present, five key words commonly used in teaching: mastering, familiarizing, understanding, capable, and willing still have important guiding significance for teaching evaluation, which concentrate the key elements needed for high-quality combination of vocational education and future employment. Effectively realizing these five aspects and mastering as a seamless integration are the core of successful teaching.

4.2. Teaching Design Combined with Cognitive Psychology

4.2.1. Overall Teaching Design Based on Industry Development

In the teaching process, by formulating teaching strategies based on information processing viewpoints and in accordance with the law of cognitive psychology, concepts are deconstructed into unit modules that conform to mind maps, and then scientific methods such as retelling strategies and processing strategies are used to achieve the teaching goals. Subsequently the curriculum structure, knowledge system, and the position of each teaching unit in the structural framework are determined and arranged. At the same time, considering the actual requirements of social production for this occupation, the content of professional qualification examinations is incorporated into the teaching process as an important part. The entire teaching design scheme is developed according to the documenter examination syllabus, and is presented with an overall perspective, systematization, and hierarchy. In such a way that the two aspects of subjective initiative and objective needs can complement each other, and knowledge instruction to college students can be effectively accomplished.

In the necessary process of talent developing, the early stage is called initial awareness period. During this period, technical hobbies and interests are cultivated through topic-promoting teaching. Basic qualities and professional habits required by data management occupation are

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experienced. The professional knowledge acquired can be consolidated through element-oriented teaching, to achieve solid and sufficient professional level. The landmark achievement of the initial period of data-management oriented courses is that students go through systematic training and pass the examination on general rules of data management. After passing the examination, they can start to work.

The middle stage is the training period. Through element-led or task-driven project-based teaching, the training minimizes the knowledge and ability weakness in document preparation, provides rich practical experience cases, excites learning interest, urges students to practice to improve the ability of document preparation, and encourages students to practice hard to improve their document preparation ability. At the same time, the ideological education of cultivating a pragmatic and rigorous work style is implemented in the entire teaching process to achieve dual-track parallelism. The landmark achievement of the middle stage is changing unfamiliar learning content into familiar operation experience, not good at data collection and categorization into skilled in document preparation, gradually adapting to the professional characteristics in project management practice, and maturing gradually in ideological understanding.

The later stage is the mature stage, in which students become professionals through cognition, learning, internship and practice. Then, their work skills are also improved from learning business to mastering business.

Figure 2 is the mind map of overall teaching design based on industry development.

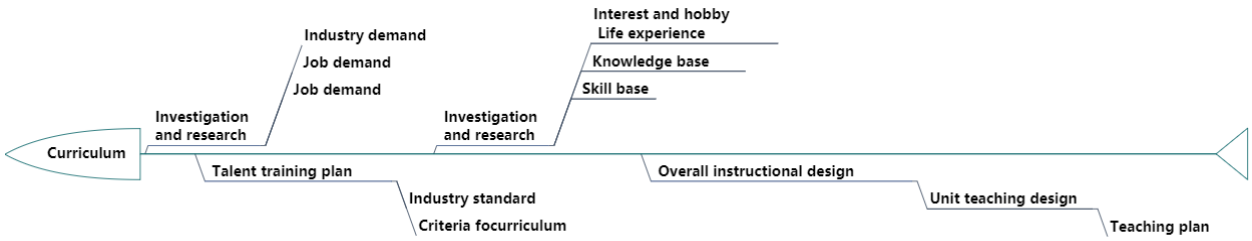

Figure 2. Mind map of overall teaching design based on industry development.

4.2.2. Eight Elements of Unit Teaching Design

The eight elements of unit teaching design are origin, target, content, key and difficult points, teaching methods, exploration and practice, process assessment, and multidimensional evaluation. These key elements are the focus of unit teaching, and their full realization is the key to successful teaching.

The idea of teaching design should originate from teachers' idea and the attitude of changing passive working into active teaching. In the book "If You Give Me Three Days of Light" written by the contemporary American writer Helen Keller, teacher Sullivan inspired Helen's hope and passion for life through her efforts. Helen graduated with excellent grades and became a well-known writer and educator, who mastered five languages: English, French, German, Latin, and Greek. Therefore, the main task of the first element "origin" is to actively investigate students' status, cognition, knowledge reserve, interest points, learning styles and habits, and to enquire of their preparation for class and difficult problems.

Based on this, after the whole teaching strategy is designed, the unit teaching strategy is designed, and teaching organizing form and teaching methods are conceived. Educators explore how to stimulate students' interest, but teachers need to reflect at any time, whether the teaching design only stays in the subjective view that students may or should be interested in this, whether in fact students are still just simply meet the teacher' s requirements to complete the task. If so, that is still another form of passive learning. When a teacher introspection has

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done the following points, the sunshine of love will eventually move and stimulate the heart of the students.

These include: whether they have communicated and discussed with each teaching individual with the enthusiasm of loving the education profession and caring for the growth of students, whether they have truly studied the state of students' absorption and application of knowledge, whether they have really stimulated their learning initiative, and whether they are committed to not only improving their academic performance, but also focusing on the improvement of students' comprehensive ability, whether they commit to becoming good teachers and friends of students and helping them grow? Compared with the teaching objectives and quality objectives of each teaching unit, are there any specific measures or methods that really stimulate students' subjective initiative? What are the shining points? How do the students perform in the first, middle and later stages? These aspects are complex and difficult to measure with specific data indicators, and they all belong to the category of cognitive psychology. They are based on grasping students' cognitive psychology, and then stimulate students' autonomous learning and active thinking from the aspect of subjective initiative, so as to achieve the purpose of changing passive acceptance into active behavior. This teaching method based on cognitive psychology has been proved as an effective method of educating students by teaching practice.

Another point to be mentioned here is that in the process of teaching combined with cognitive psychology, the necessary records and the analysis report summarized from them are important auxiliary tools for continuous review and adjustment of education methods, but also an important reference basis for evaluation.

4.3. Unit Teaching Strategy

Adhering to the concept of cultivating high-quality and highly skilled technical talents, it is of great significance for teachers to develop their ability to design teaching contents and carry out teaching activities. At present, the classroom is still the main place for teachers to teach. Based on the characteristics of complex contents and detailed requirements of construction engineering data management, the application of educational psychology based on cognitive cultivation in the whole teaching process of construction engineering data curriculum design is helpful to better achieve the goal of classroom education. In the teaching design, it is suggested to apply different teaching methods at different levels, referring to the three-level model of teaching methods proposed by Professor Fuquan Huang[5] and the textbook structure of contemporary curriculum and teaching theory.

4.3.1. Create A Multi-channel Teaching Situation

Classroom atmosphere construction is one of the important tasks in teaching, which is the premise and guarantee of teaching. When setting the case situation, teachers throw out questions, which is usually the overall goal. Experienced teachers can imagine the understanding and response of students at different levels, and accurately grasp the state everyone's reaction, so as to timely guide and integrate it with the learning experience, and in a timely manner to lead the state of stimulating potential and active learning. In other words, in early stage students may still approach the subject or project passively, but through skilled teaching design, students can quickly take the initiative to participate in activities. Through conscious understanding, familiarity, and practice, they can quickly master new knowledge and develop self-confidence. Enter the stage of self-reinforcement learning, to achieve deep memory, mastery and even draw inferences from one instance.

Knowledge points are complicated to trigger clues for learners at different levels, so teaching design should also be multiple perspectives, so as to provide participants with a wider field of thinking and participation space. The teaching methods used should also be as diverse and flexible as possible. For example, don’t rush to give standard answers, but throw out guiding

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inspirations to stimulate students' initiative thinking and imagination. The interesting experience and exploration process can give students more gains beyond textbook knowledge, and thus further become part of the classroom quality evaluation standard. There are usually three channels to achieve the above goals:

Channel 1: goal-oriented, unique result, heroes based on right and wrong. The evaluation is simple, and the criterion is whether the result is consistent with the answer. The workload of teachers is small and the traditional model is adopted, so there is less dispute about the evaluation result.

Channel 2: goal-oriented, the results are not unique, and the participation status is included in the evaluation scope. The workload of process assessment is large, and there is no right or wrong. It takes a lot of energy to evaluate different schemes and develop evaluation standards.

Channel 3: Goal-oriented, fragmented value assessment. There may not be complete results, but there will be some valuable fragments and shining points, and it is suggested to adopt "evaluation method" to incorporate these factors into the comprehensive evaluation scope. The evaluation method refers to the method by which teachers combine similar evaluation experience and standards in the industry to formulate personalized evaluation indicators to determine whether the students' results have special value or experience significance.

4.3.2. Exploratory Teaching Stage in Hierarchy

In order to make all kinds of differentiated students can obtain effective education and improve vocational skills to the maximum extent during the limited period of study at school, it is of practical significance to explore stratified teaching. Stratified teaching is to provide differentiated teaching methods for different students/groups, so that students can fully obtain the maximum harvest within the range of their abilities during school study, meeting the learning needs of most students while taking into account the characteristics of a small number of students, and striving to teach and clarify their doubts to each student. According to the characteristics of class students, teachers use the principle of cognitive psychology to fully analyze the characteristics of students[6], and apply the right medicine to the case, integrate stratified teaching into pre-class, in-class, after-class and assessment systems, and design a complete teaching plan in advance. Matching the above-mentioned stratified teaching idea in the follow-up design and teaching service can avoid simple and rough ways such as low-level unsuitable learning and blindly reducing difficulty of knowledge points, so as to achieve the ideal teaching effect.

Studies have proved that learners can learn logically step by step with the development of time. If they can solve learners' key problems in key links, the learning effect will be better. The so-called creation of situations in learning is to establish a variety of learning situations, as far as possible to avoid a single situation. Different situations meet the learning ability needs of different student groups, so that students have the freedom to draw inferences or innovative thinking upward, and have the possibility to master basic professional skills downward.

In teaching practice, combined with cognitive psychology, the author has summarized the following methods for creating learning situations:

(1) Knowledge point series method: design and construct primary, secondary and advanced questions, promote the thinking process step by step, guide the process of teacher-student interaction, explore the process, correct deviation process, and finally achieve the ideal results.

(2) Using digital technology multimedia interactive platform, design and arrange images, audio and video, story, and other forms to show the scene, and assisted by real cases. Teachers strive to create rich and vivid classroom content, attract students' attention, and enhance the teaching effect.

(3) Information cooperation platform based on BIM model provides more real and rich teaching resources and conditions for modern teaching design to play for 3D sand table simulation

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teaching. The key control point of instructional design based on achievement motivation theory is to collect and master students' learning status and progress in time. Teachers can get feedback through classroom interaction, extracurricular communication and homework marking. Master students' learning status, timely give students effective guidance and appropriate evaluation feedback, encourage and stimulate students' learning motivation to form a virtuous cycle.

In conventional teaching methods, when students fail a test or answer certain knowledge points incorrectly, teachers identify these knowledge points as teaching difficulties, and then establish correct and wrong concepts for students through exercises and correct and wrong answers. This traditional teaching method can play a certain role in teaching, but it often causes the problem of disconnection between students' book knowledge and practical work. Therefore, it is necessary for teachers to bring forth new ideas in teaching design and classroom assessment and to organize knowledge teaching and assessment of knowledge points with more advanced methods. Generally, a documenter is basically familiar with the work process in the actual position for about three months, has a little experience in about one year, works smoothly in about three years, and is handy in about five years. Through the teaching reform, students' experience gained in post adaptation period can be completed in the school, or the post adaptation period can be shortened to improve their employability.

5. Teaching Methods

Teaching has methods. Based on the theory of learning motivation, teachers start from raising a question and guide teaching through uncertain angles, namely divergent and definite angle, namely professional progressive methods, so that students can acquire knowledge. The main means of teaching guidance can be summarized as the following four:

(1) Problem-type progressive guidance, as shown in Figure 3 below

(2)

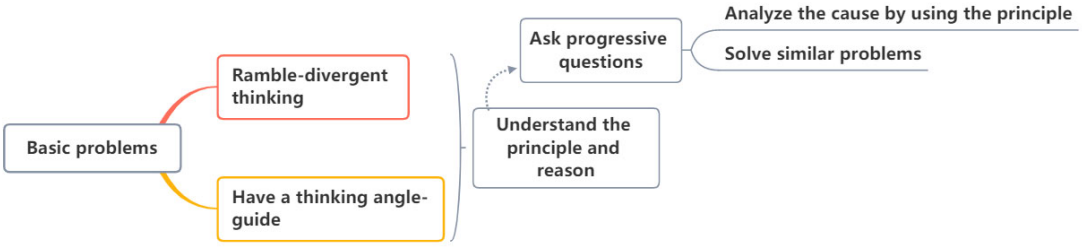

Figure 3. Problem progressive guidance of teaching guidance.

(3) Comparative inquiry guidance, as shown in Figure 4 below:

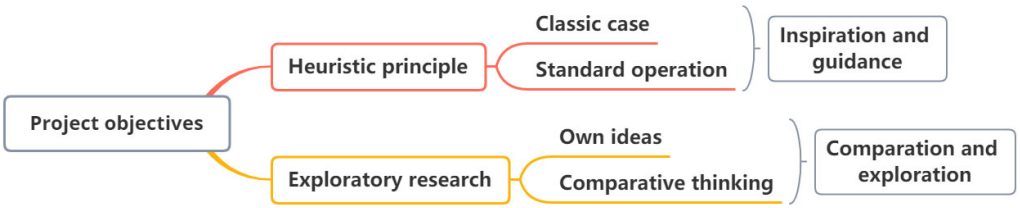

Figure 4. Comparative inquiry guidance of teaching guidance.

(4) Information technology professional software assisted guidance

The characteristics of data management work is easy to get started, difficult to go deep. Due to the numerous provisions, strict standards and boring and complicated contents of related

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courses. it is difficult for students to stimulate their interest in learning, easy to fall asleep and inefficient. Based on these characteristics, it is appropriate to adopt the idea of guided teaching in teaching methods to build a teaching framework and design learning units and practice units. Teachers' work is also changed from boring and independent explanation to guiding and guiding practice. Students are interested in learning with clear objectives and obvious achievements. The application of computer software makes project-based teaching more convenient and feasible. Software technology can quickly realize the modular management of information including a number of work processes, paper group, archiving, consulting and other functions, and also can expand the professional technologies such as safety design, calculation and checking, improve the technical content, and help to quickly cultivate comprehensive talents in management technology. Based on software-assisted project-based teaching, systematic learning ideas can be established with the help of achievement motivation theory, and the results of data management are remarkable on the theoretical basis of normative provisions. Attention should be paid that while emphasizing skill training and comprehensive application, we should focus on general knowledge, basic knowledge, post knowledge and

(5) Collaborative working mode based on BIM

Information technology, especially data management based on BIM collaborative system, has become the development trend of data management in construction engineering industry in the next few years. As the industry attaches more and more importance to construction engineering information, it is an inevitable requirement of this career trend to actively master information management technology, proficient in using BIM software, understanding of national policies and learning local management regulations. Improving the working ability of construction engineering information management staff is an inevitable requirement for this professional trend. The further standardization of data management requires the data staff to perform their duties more strictly, scientifically, completely, and accurately[7]. In this case, vocational colleges give full play to their advantages, actively connect with national policies, carry out regular training, help enterprises solve the knowledge and technical problems of systematic training on information management, and better highlight the special characteristics of practical vocational and technical talents. This is different from universities and colleges that focus on students' scientific research and teaching. Through social training and establishing a good relationship with enterprises, we can expand the popularity of the school, highlight the characteristics of vocational colleges, find industrial education problems, put forward projects, promote the transformation of knowledge into advanced productivity, and cultivate practical and technical talents who can get started when they leave the campus, and make good use of its own advantages to solve social problems and serve the construction industry.

Moreover, a carefully designed flipped classroom is also a good teaching method for designing data management courses. Using PPT, multimedia, micro-lectures, teaching records and other forms, preview in advance, consolidate the review, repeatedly watching, effectively solve theoretical difficulties such as principles.

In addition to above methods, the application of new technology brings new ideas of teaching. The application of virtual reality simulation teaching provides a more intuitive learning scene for data management teaching and solves the problem of inconvenient on-site management practice. Under the overall framework of digital enterprise informatization in the construction industry, it brings great convenience to data collection. However, due to various conditions, it is still in the exploration and development stage. Mature and perfect data collection standards and management are still under further construction.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202202_5(2).0052

6. Conclusion

When teachers sort out, summarize, and use teaching strategies that conform to the laws of cognitive psychology and base on the viewpoints of information processing, to deconstruct concepts into unit module teaching in accordance with mind map. why students sometimes do not understand or accept new methods, or cannot flexibly apply new knowledge? Because students have ideas, communication between teachers and students is also very important! Even if there are scientific teaching and learning methods, teachers should first try to obtain students' psychological identity. For teachers, mastering students' learning psychology is often more difficult and complicated than mastering students' learning difficulties. Before class, teachers need enough work input to collect information and make comparative analysis to design teaching programs. In addition, the comprehensive improvement of students' vocational awareness and skills is inseparable from the cultivation of a positive study attitude, rigorous style and noble morality. While proficient in business skills, the enterprise also needs a good employee who is active, hard-working, practical, willing to study, brave and responsible, with collective mind, solidarity, and happiness.

In conclusion, teachers use the principles of cognitive psychology to thoroughly study the learning status of each student, construct a targeted stratified teaching scheme, adopt a diversified multi-channel situational teaching model, fully and flexibly use a variety of teaching methods executed in combination, and strive to train each student to master comprehensive vocational skills from multi-angle and all-round way, provide the most basic and effective guarantee for their entry into society and future careers, and achieve the fundamental goal of vocational education. After students leave school, they can still have effective learning methods to continuously acquire new knowledge and skills and become outstanding talents needed by society.

Acknowledgments

This work was supported by a grant under the project "Reform Practice and Research of 'Three Education' Based on The Courses of Construction Data Management" (No. WZYGJzd202005) from Wenzhou Polytechnic, China.

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