







## Design a Network Architectural Teaching System by Auto CAD

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**Abstract.** As the scale, shape and function of engineering construction projects become more and more complex, the design of building systems has become more and more complex. In order to help students better acquire course resource information, effectively demonstrate the teaching process, and help students understand the curriculum and learn effectively, this paper designs an Auto CAD network architecture design teaching system. We analyze and compare the teaching model based on the network architecture design teaching system, and introduce the cluster analysis to the course resource management. An Auto CAD model was constructed through collaborative design among professionals based on Auto CAD technology. We analyze and compare the characteristics of traditional 2D design and inter-professional collaborative design based on Auto CAD technology, and select appropriate 3D simulation software for inter-professional collaborative design. The teaching of Auto CAD architectural design course proposed in this paper has certain innovation and practicability, and puts forward some constructive suggestions on the solution of the problem.

**Keywords:** Auto CAD; architectural design; teaching; collaborative design.

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### 1 INTRODUCTION

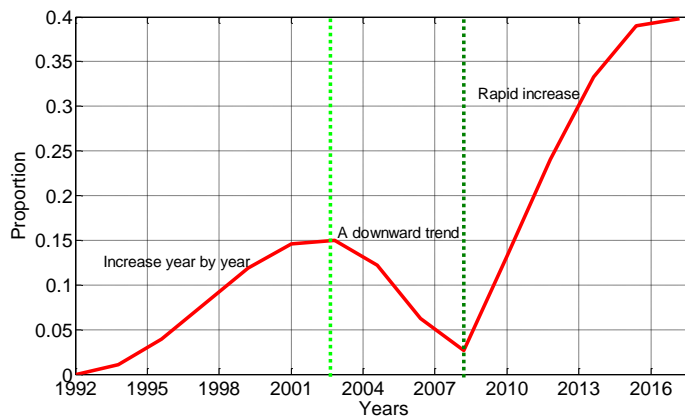
Architectural education in China started relatively late. From its inception to development, architecture majors have been run in several long-established traditional colleges for quite some time. However, as the specialty deepens into different industry fields, various institutions of different backgrounds have created their own architecture majors according to their own directions, and they are no longer limited to engineering colleges. This integrates the architecture profession with other disciplines and better serves the society, driving the healthy development of the entire industry, relevant opinions were proposed by Musa et al. [1,2].

A good CAD software must have a solid function graphics support system. Jane introduced that the Auto CAD series software developed by Autodesk has always been the top product in the CAD market, and has strong performance, user-friendly user interface, and rich secondary development

tools [3]. It has become the most commonly used CAD software and secondary research and development platform. Nima et al. introduced that Auto CAD software and its graphics format have become a CAD standard and a basic carrier for popularizing next-generation design work [4-6]. It is currently the most widely used CAD software in the world, accounting for about 40% of the global CAD / CAE / CAM software market. The trend of the proportion of Auto CAD in the CAD / CAE / CAM software market is shown in Figure 1.

Ding et al. introduced that Education must be targeted and taught according to its aptitude, especially the professional education of architecture [7-9]. The disciplines have strong practicality. For applied universities, the combination of theory and practical engineering is more important, and its applicability is emphasized. And because the specialty of architecture has a short period of discipline construction in general application-oriented colleges, it has not come out of its own characteristics, and has always been based on the teaching models and experience of well-known architectural universities. However, with the development of society and the use of specific practices, the models and experience it brings to the public have shown more and more problems in specific teaching, and even some gaps still exist in some specific teaching, Mark Garcia et al [10,11]. Because the teaching mode of architecture is related to the specific resources and culture of the area where the college is located, it is strongly related to the employment direction of students and the talent market demand of the local construction-related industries. The school's professional positioning, teaching resources, student resources, and teaching methods need to be reformed in accordance with its own characteristics.

Based on the analysis of the characteristics of the Auto CAD course, this paper conducts research on the teacher-student interaction mode suitable for the course, helping teachers and students to interact effectively and helping students to learn effectively. Based on the analysis of the characteristics of the Auto CAD course, the classification / clustering study of the characteristics of the course resources is carried out, so that resources between courses and network resources can be aggregated together. The emergence of Auto CAD technology provides complete technical support for collaborative design and builds a good technical platform. Various professional designers can realize the accurate and timely transmission of information through the design platform based on Auto CAD, which greatly improves the efficiency and technical content of collaborative design.



**Figure 1:** The proportion of Auto CAD in the CAD / CAE / CAM software market.

## 2 RESEARCH ON AUTO CAD COURSE NETWORK ARCHITECTURE TEACHING SYSTEM

### 2.1 Analysis of the Characteristics of Auto CAD Integrated Development Environment And its Resource Characteristics

The basic integrated development environment of Auto CAD has the following characteristics:

(1) It integrates the development programs of various standard parts libraries, symbol libraries, and mold design into the Auto CAD design environment to improve worker efficiency and reduce repetitive error pressure.

(2) The normal and efficient operation of the function modules called under the Auto CAD platform depends on a dedicated and consistent internal data conversion interface between them.

(3) Industrial manufacturers in the design and manufacturing industry have increasingly higher functional requirements for the rapidly developing and changing manufacturing technology. The seamless integration of the industry's excellent foundation and general software into the manufacturer's Auto CAD software system has become an inevitable choice.

(4) The open architecture enables users and third-party software developers to modify the original system to meet their respective needs, thereby expanding system functions.

Auto CAD, an automated computer-aided design software developed by Autodesk, has become a popular drawing tool. The Auto CAD course is a highly practical course. It is employment-oriented. Students need to use the reading and drawing skills learned in this course to practice and solve related problems in real life.

Auto CAD course resources in the teaching system generally have the following characteristics:

(1) There are various resources in the AutoCAD course, which are manifested in the resources can be WORD documents, PDFs, and other types of files; they can also be pictures or even videos. These resources can be uploaded by teachers, or they can refer to resources on the network.

(2) The resources in the AutoCAD course are time-based, and the knowledge of AutoCAD and its tools will be updated quickly.

(3) The resources on the AutoCAD course do not exist alone, and they have more or less correlation with other resources, such as courseware by other teachers, learning resources on the Internet, etc.

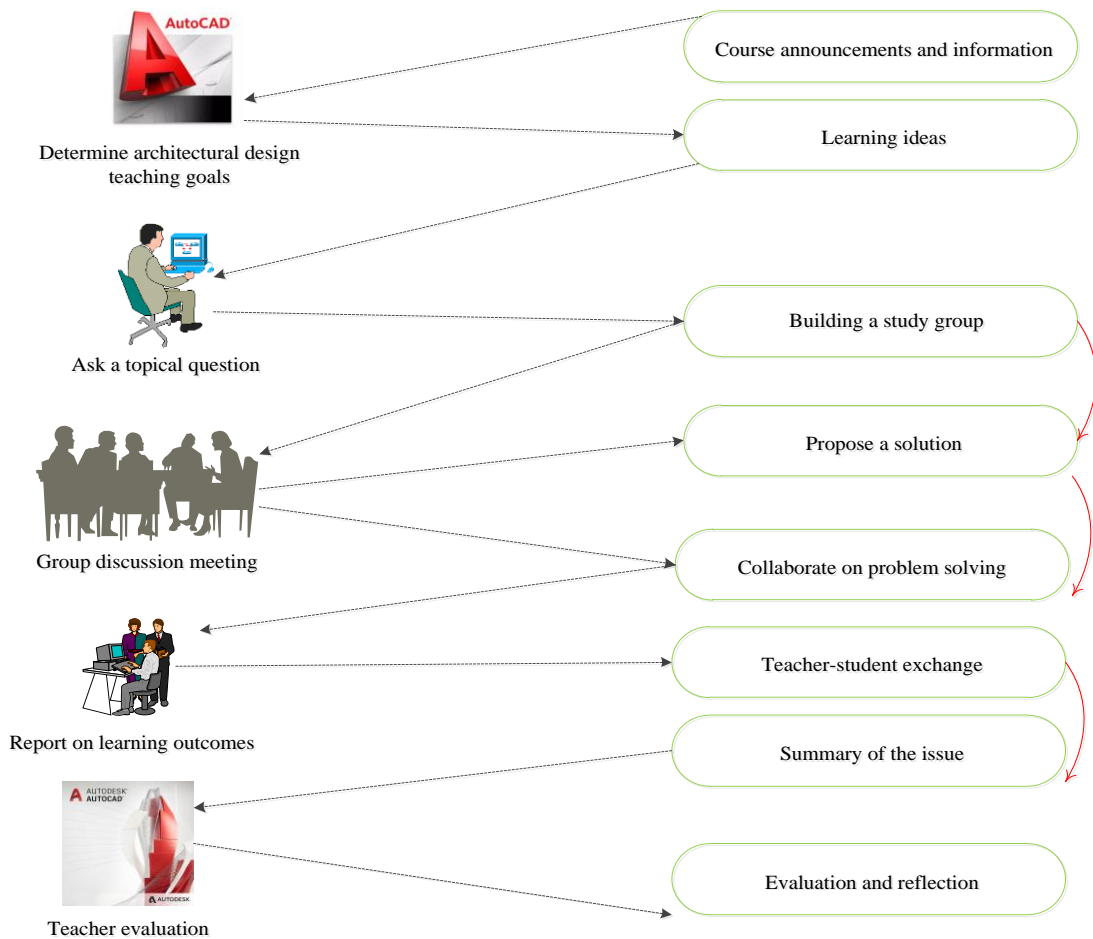
Parametric drawing is an emerging thinking technology developed by the AutoCAD market, and is a representative idea to realize intelligence. In the ranks of products being put into mass production, its automation design efficiency has become a big problem. Using the parametric drawing idea can effectively solve the problems of poor drawing quality, high repetitive drawing rate and large waste of resources in real time. At the same time, according to the designer's requirements for different models of products, humanized drawing, that is, for products with the same overall frame, by adjusting its size ratio, the product map can be scaled without modifying the overall frame ratio. Each figure is constructed by several lines, and the program is used to complete the interactive drawing function after a specific value is given. The parameter letters are used in the program instead of the size information. When the program is called, the letters are valued. The Auto CAD drawing function is also divided into a drawing module. The letters in this module will be assigned new values and then the drawing function will help improve the efficiency of drawing.

## **2.2 Analysis of Blended Learning Mode of Auto CAD Course**

Auto CAD becomes more and more important to explore a learning model that is effective and suitable for the characteristics of the course. The more popular is the mixed teaching mode, which is based on the traditional classroom teaching mode, adding the network teaching system part, so that the two organically combine. While maintaining the advantages of traditional teaching and learning, it can also provide students with communication and guidance without leaving the classroom.

Problem-based learning is an activity that achieves continuous learning through the promotion of a series of questions. For learning, an important assumption is that students master knowledge and gain wisdom through a series of problem solving.

Focusing on the problem, learners work together to solve problems in the context by grouping, as shown in Figure 2. In this process, learners provide solutions to the problems raised in the situation through self-study, mutual communication, discussion, and communication with teachers. At the same time, learners' self-learning ability, cooperation and communication ability between learners will be improved.



**Figure 2:** Problem-centered teaching model.

Modern teaching increasingly regards the teaching process as a system. Through careful and comprehensive analysis of various interwoven factors that affect successful learning, such as students, teachers, teaching materials, learning environments, etc., they choose coping strategies and integrate effective methods to stimulate and promote student learning. The attention and thinking on the problem system can avoid the simple question-and-answer processing and design of problems in teaching, so that the problem really becomes the internal driving force to promote student learning.

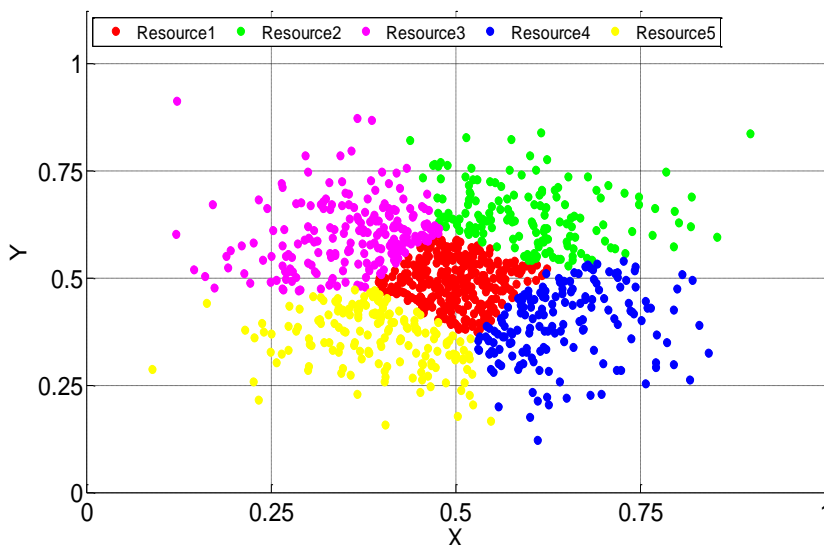
### 2.3 Clustering of Teaching Resources

Teaching resource clustering is to group teaching resources into multiple clusters according to certain rules or methods, so that the content of teaching resources in the same cluster maintains a relatively high degree of similarity, and at the same time, there is a big gap in resource content. Aiming at the type of data, the purpose of clustering teaching resources, and the processing method, more commonly used are partition-based clustering algorithms, hierarchical clustering, density-based clustering, and model-based clustering algorithms. Several different clustering methods of teaching resources are shown in Table 1.

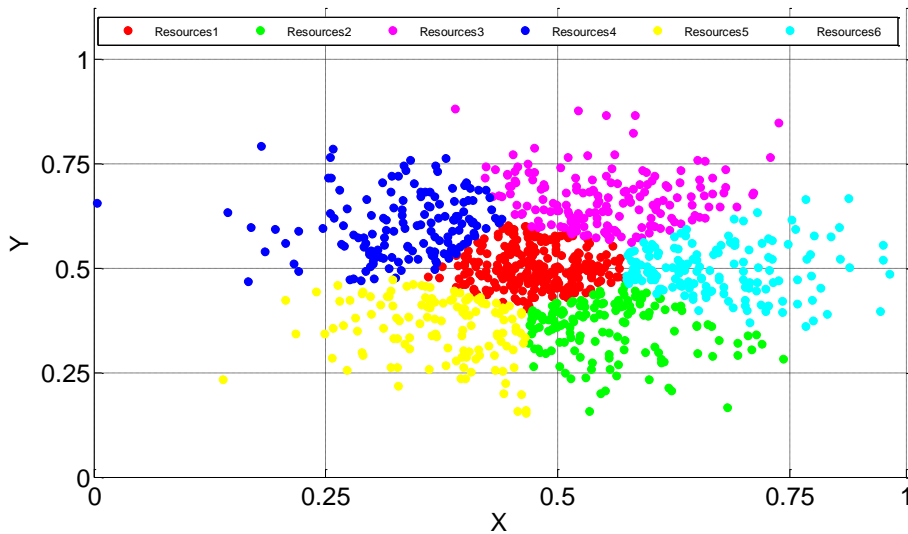
Clustering method	Description
Partition-based approach	Among the clustering algorithms based on partition, the K-mean algorithm is more representative.
Layer-based approach	Hierarchical clustering creates a hierarchy to divide a given data set. This method can be operated from top to bottom and bottom to top.
Density-based approach	Connecting adjacent areas with sufficient density can effectively handle abnormal data and is mainly used for clustering spatial data.
Model-based approach	After unsupervised processing, the generated clusters can be labeled with subject words or in other ways, reflecting the spatial relationship between the clustered text clusters.

**Table 1:** Clustering classification of several different teaching resources.

In view of the diversity and relevance of Auto CAD course resources, the relationship between resources needs to be reflected, and the description of a resource can have many different feature words to describe, and a high-dimensional clustering algorithm is needed. In addition, after the course resources are clustered, they need to have good readability and interpretability. The model-based method can maintain topological continuity, that is, after pointing with similar characteristics in the input are mapped, they are also adjacent in the output space. And it can also reflect the probability distribution of training samples. The data area showing a certain probability distribution in the original data has the same probability distribution in the corresponding area on the map. The results of clustering teaching resources are shown in Figures 3 and 4. Among them, Figure 3 clusters teaching resources into 5 categories, and Figure 4 divides teaching resources into 6 categories. It can be seen from Figures 3 and 4 that the clustering effect is good.



**Figure 3:** Results of teaching resources clustered into 5 categories.



**Figure 4:** Results of teaching resources clustered into 6 categories.

## 2.4 Teaching View of Auto CAD Course

Most of the solutions for online education platforms are designed by information technology companies, and they tend to design technical frameworks and systems. Many schools' websites are created by network management technicians and managers.

Auto CAD is a course that emphasizes practice, communication, and discussion. Its curriculum resources are diverse. This paper combines the characteristics of the course and its resources with the timeliness of course teaching, studies the methods suitable for the teaching of Auto CAD courses and the display of their resource views.

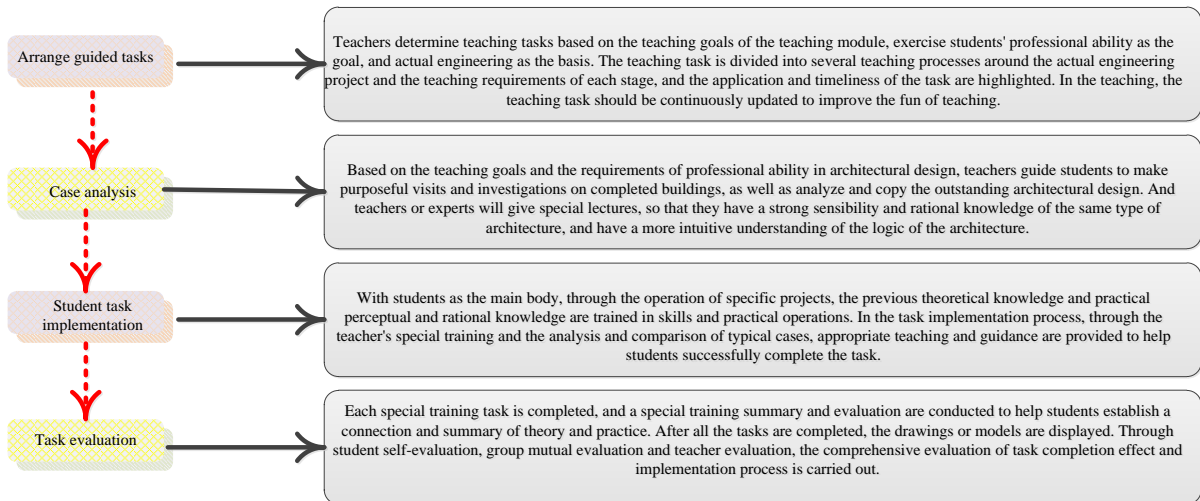
View display requires the following:

- (1) The course syllabus and courseware can be displayed as a whole;
- (2) The panel members' discussions and their respective results can be effectively displayed;
- (3) Course resources and other resources can be clustered;
- (4) The clustered resource information can be displayed in an easy-to-understand manner.

## 3 MULTI-PROFESSIONAL COLLABORATIVE ARCHITECTURAL DESIGN BASED ON AUTO CAD TECHNOLOGY

### 3.1 Design of Teaching Organization Form

The teaching tasks corresponding to each teaching module are carried out in the form of actual engineering design projects. The project design process is complex. Students often do not know how to proceed. This requires teachers to break down complex project design tasks into teaching modules with clear goals. Each teaching module is designed for a certain design training, and each teaching module is advanced step by step in order, and finally the results are comprehensively obtained. Its teaching organization form is "arrange design tasks-case analysis and site visits-student task implementation-task summary and evaluation". The teaching organization form of the architectural design course is shown in Figure 5.



**Figure 5:** Teaching organization of architectural design course.

In the teaching of the architectural design class, we need students to have a clear understanding of similar buildings and a perceptual understanding of their functions and structures. At the same time, students need to analyze and describe an excellent work that has been completed and thoroughly understand the work. We should focus on organizing teaching courses to guide students to think about what is architecture, from which direction to think about problems, how to proceed with design, what are the ways to deal with problems, etc., so that students really understand the meaning of architectural design, focus on the logic and architecture of the building design methods. The relationship between education and vocational training should be considered in teaching, reducing the use of a large number of assignments to achieve teaching purposes, and giving students more time to think, not just to complete a beautiful assignment.

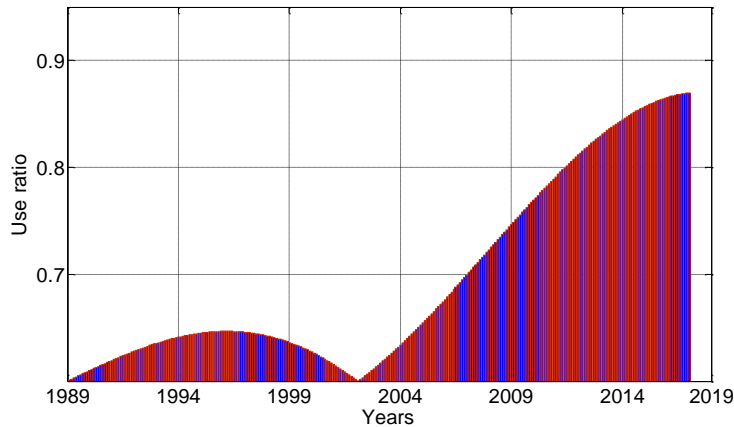
### 3.2 Fusion of Collaborative Design and Auto CAD

Although architects and engineers have generally accepted the concept of collaborative design and applied it to actual projects, they have not yet formed a complete and unified understanding of the meaning of collaborative design. What we mean by collaborative design at this stage means that the project participants communicate the design content and organize the management of the design process in the form of a web conference through the network. However, the information transfer between project participants is still based on CAD files as information carriers, and information is shared across departments, regions, and even national borders through network messages, video conferences and other means. The collaborative operations of the project participants mainly rely on the comprehensive management of information by the network resource library. With the assistance of relevant network management software, the project managers have the corresponding authority levels. The project participants discuss, modify and make targeted design changes through the results exchange to ensure the real-time and uniqueness of the design results.

Since the emergence and application of Auto CAD in the design process of the construction industry, Auto CAD technology has caused a violent impact on traditional design methods, and has brought about revolutionary changes in the design methods of the construction industry. Auto CAD technology shifts the design from a flat 2D design that relies on 2D drawings to a 3D design of the building system using 3D simulation software. However, we must also realize that although multi-professional collaborative design based on AutoCAD has design advantages that traditional design methods cannot match, the application of collaborative design in the actual design process is in its infancy. With the support of related software, collaborative design has relatively complete technical



support, but it will take time to implement it into the entire industry chain and make it truly integrate into the design concept of designers. The proportion of Auto CAD software in architectural design teaching is shown in Figure 6. It can be seen that its proportion has gradually increased in recent years.



**Figure 6:** Proportion of Auto CAD software in architectural design teaching.

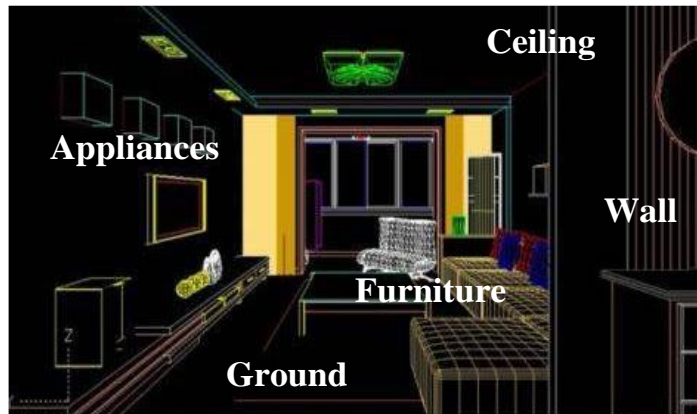
While the development of Auto CAD technology has brought a strong technical impact to the construction industry, it has also promoted the integration of collaborative design technology and Auto CAD technology, making it a whole, interdependent and inseparable from each other. For the same component in the construction process of Auto CAD model, with the transmission and sharing of data between the majors, designers of various majors can simultaneously operate the element of the component from the perspective of each major, and truly realize the core concept of Auto CAD-collaboration.

### 3.3 From 2D Design to 3D Auto CAD Design

In two-dimensional graphic design, designers must have a high spatial imagination ability to truly feel the specific use of the interior space of the building, which has higher requirements for the designer's spatial imagination. Moreover, the designer's perception of the space of the building is a continuous process, and relying solely on two-dimensional spatial representations cannot explain the spatial sequence of the building in detail. Three-dimensional design based on Auto CAD can fully realize virtual reality. Through virtual display of real space, it can provide designers with realistic visual and auditory experience. The building model constructed by the 3D simulation software is a physical mapping of the real building. In the model, the material of each component and the properties of the material can be displayed, and the information of all building components can be viewed at any time, so that designers can compare the real building functions. In addition, compared to two-dimensional plane drawing, the three-dimensional design of Auto CAD can accurately express the geometric characteristics of the building, there are no obstacles to geometric expression, and it can accurately represent any complex architectural shape through the parameter settings of the software. The three-dimensional architectural drawing designed by Auto CAD is shown in Figure 7.

Although 3D attributes are the foundation of Auto CAD design, they are not all. The Auto CAD model not only contains the spatial geometric data given to the building components by the 3D design process, but also integrates non-geometric information such as material characteristics, physical characteristics, mechanical parameters, design attributes, etc. on the basis of the 3D model. The Auto CAD model can automatically obtain 2D drawings such as plan, section, elevation, etc. of the design project through the graphic operation function of the 3D simulation software while meeting the drawing rules of related design professions.





**Figure 7:** 3D architectural drawing of Auto CAD design.

Both the 3D building design based on Auto CAD technology and the traditional 3D building design can complete the construction of the 3D model of the building, but there are still differences between the two, as shown in Table 2.

	Traditional 3D architectural design	Auto CAD 3D architectural design
Design function	Renderings and virtual reality	Renderings, virtual reality, design, analysis, management, etc.
Parametric model	No	Yes
Coordination efficiency	Low	High
Relationship with 2D design drawings	Accessory for 2D design	Logical correspondence

**Table 2:** Differences between Auto CAD 3D building design and traditional 3D building design.

#### 4 CONCLUSION

This paper analyzes the characteristics of the AutoCAD course and its course resources. Combining the characteristics of the course and its resources, a teaching mode suitable for the network teaching of the course is given. Starting from resource organization, the meaning of teaching resource clustering is given, and several different teaching resource clustering classifications are briefly compared, and a clustering algorithm is selected. Based on the characteristics of the Auto CAD course and its course resources, the requirements of view display in the teaching process are given, and the appropriate view is selected as the display of the teaching view. Aiming at the current situation that the traditional two-dimensional and three-dimensional design cannot meet the increasingly complex building system design, this paper proposes a new approach to build an Auto CAD model based on the multi-professional collaborative design method. The building's Auto CAD model is established by software, and the building's Auto CAD model is linked to the building process of the water supply and drainage pipeline system's Auto CAD model, so as to realize the collaborative design between majors. Our architectural education should not pursue a large scale, but should enable students to conduct in-depth research on issues in a small range, and in-depth digestion, which is conducive to the formation of a complete and rational cognitive system for architectural design and to improve students' practical application ability.

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