The Optimal Design of the Course Content and Teaching Method of Materials Forming and Processing Technology Based on Knowledge Network

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Keywords: Materials forming and processing technology; Knowledge network; Knowledge unit; Teaching method.

Abstract. Materials forming and processing technology is an important professional course in the undergraduate curriculum system of packaging engineering major. Based on the teaching requirements of the training program for undergraduate students of packaging engineering major in Beijing Institute of Graphic Communication, this paper constructs the knowledge network of the course with selected knowledge units and knowledge points and optimizes the teaching content. In the course teaching practice, multimedia teaching, inductive teaching, case study teaching, and other teaching methods are adopted to help students construct knowledge and develop skills. The course teaching can better meet the needs of discipline and specialty construction.

Introduction

Nowadays commodity packaging has become an indispensable part of the commodity circulation process. In the life cycle of packaging products, the forming and processing of materials is the most important life-cycle phase. Therefore, materials forming and processing technology is considered as an important professional course in the curriculum system of packaging engineering major. Its content involves an important knowledge domain of the knowledge system of packaging engineering. The purpose of this course is to make students master the fundamental principles, characteristics, and applications of different manufacturing processes used for packaging materials and containers, understand the basic structure and operating principle of various types of processing equipment and cultivate the students' ability to analyze and solve problems in practice.

As described in the principle of knowledge network construction, the set of knowledge units constitutes the knowledge system. In the course construction of materials forming and processing technology, the curriculum knowledge was firstly decomposed into a series of knowledge units and then subdivided into a number of knowledge points. Finally, the knowledge points and knowledge units were connected with relationships to build an orderly knowledge network. The optimized course content can be more suitable for the teaching requirements.

Optimized Design of Theoretical Teaching Content

Division of Knowledge Units

In the curriculum system of packaging engineering major in BIGC, the prerequisite of materials forming and processing technology course is packaging material science, and the follow-up courses including relevant knowledge are packaging structural design, packaging technology. The division of core knowledge units was based on the classification of the main packaging materials and containers, namely paper materials and containers, plastic materials and containers, metal materials and containers, glass materials and containers, and flexible packaging laminates. The division method of knowledge units will help students activate the knowledge points related to the fundamentals of packaging materials and actively construct the knowledge network when learning the relevant knowledge units of this course.
Decomposition of Knowledge Points

In the teaching activities, knowledge point is regarded as the basic unit of transferring information. The knowledge units of the course should be further decomposed into a number of knowledge points [1]. Some knowledge units, such as plastic material processing technology, were decomposed into knowledge points according to the difference in forming and processing principles. For the other knowledge units, such as glass material forming and processing technology, the decomposition of knowledge points was mainly based on the process flow of glass container manufacturing. The teaching contents of the course are shown in Table 1.

Table 1. Teaching Contents of Materials Forming and Processing Technology.

<table>
<thead>
<tr>
<th>Core Knowledge Units</th>
<th>Knowledge Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Packaging Material Forming and Processing Technology</td>
<td>Introduction; Pulping; Papermaking; Finishing; Pulp molding.</td>
</tr>
<tr>
<td>Plastic Packaging Material Forming and Processing Technology</td>
<td>Extrusion; Injection molding; Blow molding; Thermoforming; Compression molding; Calendering.</td>
</tr>
<tr>
<td>Glass Packaging Material Forming and Processing Technology</td>
<td>Batch preparation; Forming and molding; Annealing; Inspection; Packaging, transportation, and recycling.</td>
</tr>
<tr>
<td>Metal packaging Material Forming and Processing Technology</td>
<td>Two-piece can manufacture; Three-piece can manufacture.</td>
</tr>
<tr>
<td>Flexible Packaging Laminates Forming and Processing Technology</td>
<td>Dry laminating; Wet laminating; Solvent-free laminating; Extrusion coating and laminating; Co-extrusion laminating.</td>
</tr>
</tbody>
</table>

Principles of Course Content Design

For the purpose of forming a systematic and orderly theoretical knowledge system, three principles were mainly followed:

(1) Embedding the basic theories as important knowledge nodes. The content of different knowledge units should involve relevant basic theoretical knowledge, which will serve as the theoretical basis of formulation design and processing condition control. For example, as an important knowledge node, the rheological theory should be embedded in the knowledge unit of plastic packaging material forming and processing technology.

(2) Highlighting the mainline of knowledge. The course content covers raw materials, forming processes, and processing equipment of different types of packaging materials. The knowledge points are numerous and scattered. Therefore, in the teaching content design, we should connect the points into lines [2]. For example, the manufacturing process of glass bottles can form a mainline according to its life cycle—glass batch preparation, glass melting, glass bottles forming, annealing, quality inspection, packaging and transportation, and recycling. The teaching content of this knowledge unit was arranged in the same order. Through knowledge linkage, these knowledge points and knowledge units were linked in order to form a systematic and well-organized knowledge network.

(3) Establishing the knowledge correlation among the relevant courses [3]. We collected and sorted out the knowledge points of prior learning, subsequent learning, and analogies in other relevant courses. For example, the knowledge content of "resins and additives" in packaging material science can be used as the prior knowledge of "plastic packaging materials forming and processing technology", which can be given a brief mention in class to arouse the association and memory of the students. The knowledge related to the forming technologies of glass and plastic packaging containers can be used as the basic knowledge in the packaging structural design. Establishing the linkage of the knowledge points among the relevant courses is conducive to the expansion of the knowledge network.
Optimized Design of Teaching Methods and Means

The course content contains a lot of theoretical knowledge related to the forming and processing principles, production process control and various forming equipment. If the teacher elaborated too much abstract theoretical content in class, students would be bored and lose interest in learning. According to connectivism, in the digital age, a teacher is no longer a "knowledge indoctrinator" in the traditional sense, but a "specialized node" embedded in the knowledge network. Being a "mature learner", the teacher should help students to plant themselves in the network [4]. In order to achieve the teaching objectives, it is necessary to adopt flexible and diverse teaching methods and utilize various knowledge carriers (researchers, books, journals, websites, databases, etc.) to help the students construct their knowledge and develop their skills.

(1) Multimedia information presentation. In the network era, knowledge carriers are increasingly diversified. Using appropriate knowledge carriers in teaching can effectively stimulate students' interest in exploration. When making courseware, the expression of theoretical knowledge should be concise. Some typical examples of the manufacturing equipment and the finished products were shown with pictures or material objects. The packaging material and container manufacturing processes were presented with animations or film videos to make students experience the reality of the production site.

(2) Inductive teaching mode. The teaching methods proceed inductively, beginning with observations to be interpreted, questions to be answered, problems to be solved, or case studies to be analyzed [5]. The students were guided to organize, process and group information to have a clear grasp of the course content. For example, in the teaching of "blow molding process for manufacturing plastic packaging container", we firstly played videos of extrusion blow molding, injection blow molding and injection stretch blow molding for the students, and then guided them to analyze the similarities and differences of the three different processing technologies, so as to help them understand further the basic manufacturing principles. Combined with the presentation of packaging products, we directed the students to summarize the characteristics and applicability of the above processes.

(3) Case study teaching mode. In teaching, we took advantage of the close links between the course content and packaging applications and selected some specific packaging products for discussion and analysis. The PET plastic bottle for carbonated beverage packaging was used as an example for case analysis. The students were guided to analyze the packaging requirements of carbonated beverage products firstly, and then discuss the required mechanical properties, barrier properties and chemical stability of the PET plastic bottle, and lastly determine the raw materials, processing methods, equipment, and quality control factors in production. The cases discussed should be familiar to the students so as to arouse their enthusiasm and interest in participating. Through the case analysis teaching method, the students can initially master the methods of analyzing and solving problems.

Conclusion

In the course content design, we applied the theory of knowledge network to properly divided the core knowledge units and knowledge points and constructed an orderly knowledge network through knowledge association to optimize the teaching content. In the teaching practice, we employed multi-media teaching, inductive teaching, case analysis teaching, and other teaching methods to help students to establish their own nodes in the course knowledge network.

Acknowledgement

This research was financially supported by the specialty and course construction projects of Beijing Institute of Graphic Communication in 2019.
References


