



Competency-based construction of a comprehensive curriculum system for undergraduate nursing majors in China: an in-depth interview and modified Delphi study

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Background: The traditional nursing undergraduate curriculum is deeply influenced by the medical curriculum, and there are problems such as uneven distribution of theoretical and practical class hours, and a high proportion of subject-related knowledge points. The lack of nursing characteristics is not conducive to improving the competency of nursing students. After two rounds of Delphi consultation, the opinions of the expert group tended to be concentrated, and finally a comprehensive curriculum system for undergraduate nursing was constructed according to the future development trend of nursing in China.

Methods: The research is carried out in three stages: (I) the literature on comprehensive nursing undergraduate comprehensive curriculum construction at home and abroad in the past 5 years is reviewed to understand the current situation of domestic and foreign nursing undergraduate comprehensive curriculum construction; (II) conduct semi-structured interviews with nursing education experts and nursing professional teachers to preliminarily determine the indicators of the comprehensive curriculum system for nursing undergraduate majors based on competency; (III) experts who are proficient in nursing undergraduate education knowledge are invited to conduct two rounds of modified Delphi surveys, and finally complete the construction of the curriculum system of this research.

Results: On the basis of interviews with experts and teachers, 5 course groups (first-level indicators) and 16 professional comprehensive courses (second-level indicators) were finally constructed after two rounds of expert consultation. The coefficient of variation of index was 0.000–0.112. The effective recovery rate of the two rounds of expert consultation questionnaires was 100%, the expert authority coefficients was 0.940 and 0.961, the expert opinion coordination coefficient was 0.263 and 0.275, $P < 0.001$. The highest weight of the first-level indicators in this study is the professional core course group (0.333). Among the secondary indicators, nursing humanistic cultivation and professionalism (0.750) and nursing education theory and practice (0.528) accounted for a relatively high proportion.

Conclusions: Correspondence experts in this study are highly motivated, coordinated, and authoritative, and the indicators constructed are scientific and reliable. This study is expected to provide a curriculum framework for the construction of a comprehensive curriculum system for undergraduate nursing in China.

Keywords: Nursing; baccalaureate; competency-based theory; curriculum; education

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Introduction

With the development of nursing teams and the impact of COVID-19 on the nursing industry, international training of high-quality and high-level nursing undergraduates faces new challenges (1,2). Professional courses play a vital role in the cultivation of nursing undergraduate students, while the traditional nursing undergraduate professional curriculum is deeply affected by the medical curriculum, which is usually characterized by an uneven distribution of theoretical and practical class hours, repeated discipline-related knowledge points, and a lack of nursing-specific teaching points (3). These traditional courses usually miss the health needs of each stage of the life cycle, and are not conducive to improving the competency of nursing students. A study has shown that the development of nursing students' competencies is unbalanced in various dimensions, and the clinical nursing ability needs to be improved (4). Compared with the relatively comprehensive professional curriculum system of nursing competency abroad, the nursing undergraduate curriculum system in China requires nursing students to accept more complicated and time-consuming courses in actual teaching, and the existing courses lack targeted professional training for nursing undergraduate students. On the basis of competence, western countries have made relatively mature reforms to the nursing undergraduate curriculum system, and formed a relatively complete nursing undergraduate comprehensive curriculum system. With the rapid development of modern nursing technology, some adjustments and changes have been made in the traditional nursing undergraduate curriculum in order to meet the needs of modern nursing undergraduate personnel training, but the scope of reform is still limited to the existing framework. In order to enable nursing education to meet the needs of the development of modern health care services, better serve the major strategy of building a healthy China, and more scientifically improve the competence of nursing undergraduates. Therefore, the nursing undergraduate curriculum system urgently needs to be reformed to meet the needs of the development of modern nursing. It is necessary to construct a comprehensive curriculum system for nursing undergraduate majors based on competency based on the experience and suggestions of experts through the Delphi method.

A comprehensive curriculum establishes a series of coherent courses through the cross-integration of the contents of adjacent fields, which can connect the contents

of the courses of various disciplines, thereby overcoming the drawbacks of the subdivision of the courses (5). In recent years, comprehensive courses have been widely used in basic medicine, pharmacy, clinical medicine, and other professional disciplines, combining practical and theoretical knowledge, which can effectively integrate educational resources (6-8). Professional courses play a vital role in the cultivation of nursing undergraduate talent, and the nursing undergraduate professional curriculum model in China is influenced by the traditional "discipline-centered" curriculum model. It can reflect the professional nature and characteristics of nursing, but it cannot meet the needs of the development of modern society (9). The concept of competency was originally proposed by Professor McClelland in the United States, which refers to the knowledge, skills, and personal characteristics required by the staff who exceed the performance standards in the performance appraisal to be competent for the job (10), which is the premise of safe and effective nursing provided by newly graduated nurses. We present the following article in accordance with the CREDES reporting checklist (available at <https://apm.amegroups.com/article/view/10.21037/apm-22-471/rc>) and the survey was performed according to the Delphi studies criteria (11).

Methods

Design

The research is carried out in three stages: (I) the literature on comprehensive nursing undergraduate comprehensive curriculum construction at home and abroad in the past 5 years is reviewed to understand the current situation of domestic and foreign nursing undergraduate comprehensive curriculum construction; (II) conduct semi-structured interviews with nursing education experts and nursing professional teachers to preliminarily determine the indicators of the comprehensive curriculum system for nursing undergraduate majors based on competency; (III) experts who are proficient in nursing undergraduate education knowledge are invited to conduct two rounds of modified Delphi surveys, and finally construct a comprehensive curriculum system for nursing undergraduate majors based on competency. The Delphi technique plays an indispensable role in the field of medical and health research. Based on competency and related research on undergraduate nursing programs, we conducted this improved Delphi survey (*Figure 1*).

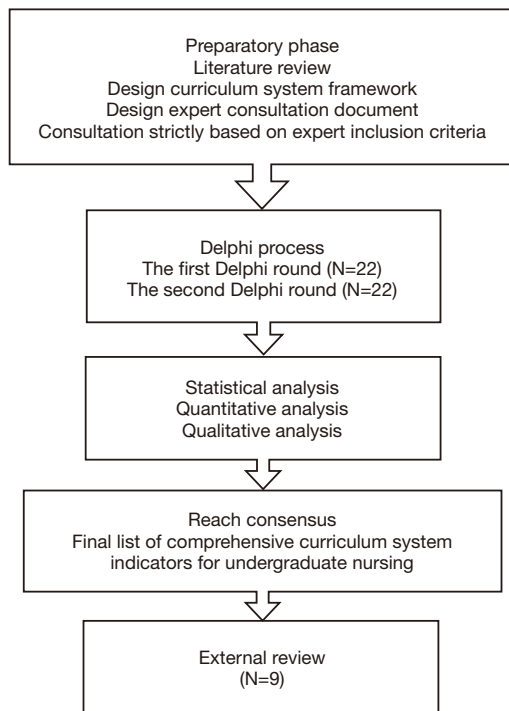


Figure 1 The flow chart of the Delphi process.

Preparation of the draft of the comprehensive curriculum system

Literature review

Using “nursing, undergraduate/baccalaureate, curriculum/curricula, competition” as search terms, we searched Wanfang, China National Knowledge Infrastructure (CNKI), PubMed, Cochrane Library, Web of Science, Medline, and Joanna Briggs Institute databases. The literature was collected from August 2020 to November 2021, and relevant information on the undergraduate curriculum of nursing majors was collected on the official websites of 11 medical schools in the United States, the United Kingdom, Canada, Australia, and other countries. By consulting the relevant information of undergraduate nursing courses in foreign universities, understanding the current situation of foreign nursing undergraduate courses, so as to conduct in-depth interviews with nursing education experts and nursing undergraduate teachers.

The publication of the Flexner Report in 1910 formed a classic academic system combining “undergraduate medical pre-education + post-undergraduate medical education”, marking a turning point in American medical education and guiding the standardization of American

professional education. It subsequently had an impact on the accreditation of professional education worldwide (12). The integration and reform of medical education courses has also been gradually carried out. In 1993, at the Edinburgh World Medical Education Summit, experts proposed the “organ-systems-based curriculum” (OSBC) system model, that is, basic courses (public basic courses). It is a subject-centered curriculum system consisting of 3 stages: foundation courses, clinical professional courses and clinical practice (13). With the continuous development of medical education, new curriculum systems such as the life cycle curriculum system have emerged and have been gradually applied in the field of nursing.

In 1998, the American Association of Colleges of Nursing (AACN) proposed 5 competencies that undergraduate nursing students (hereinafter referred to as “nursing students”) should have, including general education knowledge, professional values, core competencies, core knowledge, and role development (14). The framework of the nursing education curriculum system in the United States has been reformed, and the curriculum system framework originally composed of a single theory has been abandoned. Each nursing school has formed a different curriculum system framework according to its own situation. Most of the curriculum frameworks for undergraduate nursing in the United States consist of multiple parts (15). Taking examples from the American nursing curriculum (16), the nursing curriculum at George Mason University follows the standards set by the Commission on Collegiate Nursing Education (CCNE), a branch of the AACN for undergraduate nursing education, and follows the philosophical principle of “people-centered”, in accordance with the “whole person” society. It divides nursing courses into general education courses, nursing preparatory courses, and nursing professional courses, which run through the concept of “holistic nursing”. Among them, nursing professional courses are divided into maternal-neonatal pathophysiology and nursing, pediatric pathophysiology and nursing, and adult pathophysiology and nursing courses according to the life cycle curriculum model. Duke University School of Nursing offers an Accelerated Bachelor of Science in Nursing (ABSN) degree education program. ABSN students must have obtained a Bachelor’s degree in other majors and completed the required basic medical courses before applying. The program includes a total of 16 months, 58 credit hours of intensive courses, and nearly 800 credit hours of clinical practice. Its nursing professional courses include nursing

Table 1 Semi-structured interview outline

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- (I) In your work, have you known/read the literature on competency theory and life cycle curriculum model, as well as relevant materials on the curriculum system of nursing undergraduates at home and abroad? what content impressed you the most?
- (II) What do you think is the necessity of constructing a comprehensive nursing course for undergraduate nursing?
- (III) According to the content of the literature such as competency theory and life cycle curriculum model, what kind of courses do you think should be included in the comprehensive nursing curriculum system for undergraduate nursing in China?
- (IV) Based on your understanding of competency theory and life cycle curriculum model, which comprehensive nursing courses do you think undergraduate nursing students should study? what is the reason?
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of families of childbearing age, nursing of infants, children, and adolescents, nursing of the elderly, and nursing of complex health problems. The nursing curriculum of the University of Washington is based on the educational philosophy of diversity, openness, inclusiveness, dynamics, and inter-nationality, and adopts a progressive curriculum setting model for the setting of undergraduate courses in nursing. The basic medical courses include microbial immunology, anatomy, and physiology, among others, focusing on curriculum integration and reducing curriculum repetition.

Medical schools in other countries have also reformed their nursing curriculum. Undergraduate education in the nursing higher education system in the United Kingdom is specialized in training adult nursing, child nursing, mental health nursing, and learning disability nursing (17). According to the unified British nursing education system and curriculum in the “Pre-registration Nursing Education Standards (2010)”, King’s College London has set up the department into 5 parts for training: adult nursing, child and family nursing, mental health nursing, midwifery department, and the Palliative Care Institute. Among them, the Department of Adult Nursing aims to cultivate curious and compassionate nurses. The course setting is based on the “people-centered” philosophy and is set up for each specialty training direction. For example, the adult nursing training direction includes adult nursing and adult nursing courses in biological sciences. The framework of the undergraduate curriculum for nursing majors in the School of Nursing, University of Saskatchewan, Canada is based on “primary health care”. The curriculum focuses on multicultural background and emphasizes professional identity. The health model theory is used to divide professional courses into patient and family-centered care, exploring chronic disease and aging care, and maternal and adolescent family-centered care, among others (18).

In-depth interview

In this study, the purposeful sampling method was used to select 9 nursing teachers and nursing education experts for interviews. Inclusion criteria for teachers: (I) have more than 5 years of teaching experience in nursing at the undergraduate level; (II) bachelor degree or above; (III) voluntarily participate in this research, and can continue to participate in interviews during the research period. Inclusion criteria for experts: (I) have more than 10 years of experience in nursing education, nursing management or clinical nursing, be proficient in nursing professional knowledge and skills, and be able to provide professional advice and guidance for the research; (II) bachelor degree or above; (III) associate degree Senior or senior professional title; (IV) voluntary to participate in this research, can continue to participate in interviews during the research period.

This study used semi-structured interviews to collect information. Based on the literature review to set up interview outline questions for undergraduate nursing teachers and nursing education experts (see *Table 1* for details). The researcher learns interview skills, develops an interview plan, and outlines an interview outline. Conduct interviews at the agreed time and place, and try to choose an independent and confidential space for interviews. The duration of each interview is 30–60 minutes. During the interview, the conversation will be recorded and recorded, and the interview materials will be transcribed within 24 hours. Express gratitude to the interviewee for follow-up verification of the interview results. Using Nvivo version 11.0 software for coding, coding according to the expert’s description of the comprehensive curriculum definition of the undergraduate nursing specialty to determine the comprehensive curriculum elements of the undergraduate nursing specialty. These codes are refined to form a preliminary competency-based comprehensive curriculum system entry pool for undergraduate nursing.

According to the literature review, in-depth interview,

Table 2 Coding and nodes of semi-structured interview results

Coding hierarchy	Encoding result
Primary coding	1. Professional knowledge courses
	2. Operation skills course
	3. Career development planning courses
	4. Interpersonal communication course
	5. Humanities training course
	6. Laws and regulations course
	7. Clinical practice courses
	8. Nursing courses for different groups of people
	9. Medical basics course
	10. Nursing foundation and development
	11. Public health care course
	12. Rehabilitation nursing course
	13. Introductory course in scientific research
	14. Introductory nursing education course
	15. Introductory nursing management course
Secondary code	1. Basic knowledge courses
	2. Professional knowledge courses
	3. Core skills course
	4. Humanities training course
	5. Character development course
	6. Introductory course of professional related knowledge
Three-level coding	1. Basic knowledge course group
	2. Core knowledge course group
	3. Core skills course group
	4. Values course group
	5. Character development course group

the previous work of the research group, and qualitative interviews of nursing experts with rich experience in education, management, and clinical practice, the research group initially constructed the comprehensive nursing curriculum system index for undergraduate nursing majors based on competency, including 20 items in 5 fields.

Delphi process

The expert panels

The expert selection criteria were as follows: (I) those with

more than 10 years of experience in nursing education, nursing management, or clinical nursing, those proficient in nursing professional knowledge and skills, and those able to provide professional advice and guidance for this research; (II) educational background of a bachelor's degree or above; (III) deputy senior title or above; (IV) voluntarily participated in this research, and could continue to participate in the completion of the questionnaire during the research period. This study invited experts from 19 colleges, universities, and tertiary hospitals in 12 provinces and cities across China from May to August 2021 through the convenience sampling method. Based on the suggestion of the number of invited experts by the Delphi method (19), we finally included 22 experts to participate in this study.

Data collection

In the first round of expert correspondence, emails were sent to 22 experts. The expert letter inquiry questionnaire included the following 3 parts: (I) letter to experts, which clarifies the main purpose, content, and precautions of this letter inquiry; (II) nursing undergraduate professional comprehensive curriculum system consultation questionnaire containing a total of three tables. *Table 1* is the first-level indicator letter inquiry form and *Table 2* is the second-level indicator letter inquiry table. Both *Table 1* and *Table 2* use the Likert 5-level scoring method and assign 5, 4, 3, 2, and 1 point from “very important”, “important”, “general”, “unimportant”, and “very unimportant”, respectively. We also set up a column of “items that you think need to be revised” so that experts can judge each indicator; (III) expert basic information questionnaire, including the expert's personal data and research overview, the expert's familiarity with the indicators, and the basis for judgment.

After the first-round collection of the opinions by expert letter inquiries, we documented and analyzed the results and feedback of the experts' letter inquiries, and adjusted the content of the consultation form. We then conducted the second round of consultation with the above experts participating in the study until the experts reached a preliminary consensus. The research team completed the final selection of indicators. All experts completed the questionnaire within 15 days. Finally, we invited 9 domestic experts in nursing education, nursing management, clinical practice, statistics, and other fields to conduct a final review of the indicators.

Statistical analysis

The interview data were coded using Nvivo version

11.0 software to extract keywords. We used IBM SPSS 21.0 statistical software and Yaahp version 2.3 software for statistical analysis of the collected data from expert consultation. The basic data of experts were expressed as mean \pm standard deviation (SD), percentage (%), and frequency. The positive coefficient of experts was expressed by the recovery rate (%) of the questionnaire of the expert letter. The degree of expert authority was expressed by the expert authority coefficient (Cr). Cr was determined by the expert judgment coefficient (Cs) and the expert familiarity (Ca). The arithmetic mean of Cs and Ca was the Cr value (20). The degree of harmonization of expert opinion was expressed by the coefficient of variation (CV) and Kendall's coefficient of harmony (W) assigned to the importance degree (21). The degree of concentration of expert opinion was expressed as the mean \pm SD. The combined weights of the indicators at all levels were calculated using the analytic hierarchy process. The qualitative interview research data were processed and summarized by 2 independent researchers. In this study, the indicators were screened based on the mean value of importance assignment >3.50 and $CV <0.25$, and the full score rate of the indicators was used as a reference. For indicators that did not meet the standards and indicators suggested to be adjusted by experts, we discussed with the members of the research team and experts then decided whether to keep, modify, or increase the indicator.

Ethical considerations

The study conformed to the provisions of the Declaration of Helsinki (as revised in 2013). This study does not involve human experiments and does not need to provide proof of ethical review, but all relevant personnel involved in this study have given informed consent to ensure the smooth conduct of this study. The privacy of the participants is clearly stated in the research consent document we've provided before this study was conducted, and the participant's signature on the document indicates their voluntary participation in this study.

Results

Semi-structured interview results

The cumulative interview time is approximately 440 minutes. After the interview, the recording was transcribed into text in a timely manner. The transcribed

text was about 5,000 words. The Nvivo version 11.0 software was used for material analysis. After repeated comparison and induction, the basic knowledge course group, core knowledge course group, core skill course group, there are 5 themes in the value course group and the role development course group (see *Table 2* for details).

Expert consultation results

Basic information of the expert panel

In this study, 22 questionnaires were distributed in the 2 rounds of expert correspondence, and the effective recovery rate was 100%. The average age of the 22 experts in the fields of nursing education, nursing management, and clinical nursing practice involved in this study was 44.36 ± 7.11 years old, and the average working years in their professional field was more than 10 years (see *Table 3* for details).

Reliability of the expert panel

The authority coefficients of the first round and the second round in this study were 0.940 and 0.961, respectively. The overall Kendall's W values of the first and second round of letter polling were 0.263 and 0.275, respectively, and both were of statistical significance ($P < 0.01$).

Delphi round 1

In the first round, experts judged the first draft of the proposed comprehensive curriculum, and a total of 36 expert revision suggestions and comments were received. The members of the research group fully reviewed and discussed the expert advice and evaluation, and made the following adjustments based on the research purpose and the collected literature:

- (I) The "basic knowledge course" and "core knowledge course" of the first-level indicators should be distinguished in terms of majors, and the concept of curriculum groups should be clearly defined.
- (II) Among the secondary indicators, experts believed that "nursing foundation and development" should belong to the "professional basic course group", and "global health care" can be adjusted to "public health care and rehabilitation nursing". For "nursing humanistic cultivation in multicultural background" and "nursing research fundamentals" the full score rates were, respectively, 76.19% and 45.45%, with average values of 4.682 and 4.409. Compared with other dimensions, the experts

Table 3 Basic information of the expert panel

Characteristics	Number	Composition ratio (%)
Age (years)		
<40	6	27.27
40–50	9	40.91
>50	7	31.82
Professional titles		
Senior (professor/senior nurse)	14	63.64
Associate senior (associate professor/associate senior nurse)	8	36.36
Professional experience (years)		
10–19	13	59.09
20–30	5	22.73
>30	4	18.18
Educational background		
Bachelor's degree	4	18.18
Master's degree	9	40.91
Doctorate	9	40.91
Professional fields		
Nursing education	18	81.82
Nursing management	2	9.09
Nursing practice	2	9.09

suggested that “nursing humanistic cultivation practice in a multicultural context” and “nursing research practice” should be further integrated with “nursing humanistic cultivation in a multicultural context” and “nursing research fundamentals”, and adjusted to “nursing humanities cultivation and professionalism” and “nursing research design”. The knowledge of “introduction to nursing clinical practice” and “nursing career planning and employment guidance” overlapped, and the full score rates were, respectively, 36.36% and 72.73%, with average values of 4.682 and 4.364, which were lower than other dimensions. Experts recommend merging into “nursing management and clinical decision making”. The “professional skills course group” can be adjusted to “basic nursing technology application”, “intermediate nursing technology application”, and “advanced nursing

technology application” according to the process of students’ admission to clinical practice and the difficulty of the course (see *Table 4* for details).

Delphi round 2

The experts thought that the definitions of each course should be clearly defined, and a brief description of the course should be provided. Finally, a comprehensive curriculum system index for undergraduate nursing majors based on competency was formed, including 5 first-level indicators and 16 second-level indicators (see *Table 5* and *Table 6* for details).

External validation

We invited professional reviewers who were not involved in the project to conduct an online meeting to fully discuss the universality and importance of each indicator. The index system was unanimously agreed on by experts at the meeting, and they all held a positive attitude, believing that the index system can reflect the various abilities that nursing undergraduates should acquire from course study.

Discussion

This study adopted the commonly used methods of index system construction, which include the in-depth semi-structured interview method, Delphi method, analytic hierarchy process, and literature analysis method. On this theoretical basis, combined with literature analysis, the reliability and objectivity of the results are guaranteed. Through the Delphi method and the interview method to formulate the letter inquiry questionnaire, collect the experience and wisdom of nursing experts in multiple fields and regions, and summarize, analyze, modify and improve the results of the letter inquiry, and finally complete the construction of the comprehensive nursing curriculum system for undergraduate nursing. The authority coefficients of experts in this study in the first and second round were 0.940 and 0.961, respectively, indicating that experts have a high degree of authority (22). The effective recovery rate of the 2 rounds of questionnaires was 100%, indicating that the experts had a high degree of active participation in this research. The CV of each index ranged from 0.000 to 0.112. The overall Kendall harmony coefficient of the second round of expert letter inquiries was higher than that of the first round, and the chi-square test result was $P < 0.01$, indicating that the expert opinions showed a basically consistent trend. Overall, the indicators

Table 4 The results the first round of the expert consultation

Items	Mean ± SD	CV	CW
A. Basic knowledge course	4.818±0.386	0.080	0.140
A1. Medical foundation in nursing major I—infant and toddler period	4.864±0.343	0.071	0.250
A2. Medical foundation in nursing specialty II—adolescence and adulthood	4.909±0.287	0.059	0.500
A3. Medical foundation in nursing specialty III—old age	4.909±0.287	0.059	0.250
B. Core knowledge courses	4.909±0.287	0.059	0.290
B1. Nursing foundation and development	4.864±0.343	0.071	0.170
B2. Crowd-centered nursing I—infant and toddler nursing	4.909±0.287	0.059	0.260
B3. Crowd-centered nursing II—adolescent and adult nursing	4.909±0.287	0.059	0.170
B4. Crowd-centered nursing III—geriatric nursing	4.955±0.208	0.042	0.340
B5. Global health care	4.455±0.656	0.147	0.070
C. Core skills course	4.955±0.208	0.042	0.290
C1. Nursing practice I—infant nursing practice	4.909±0.287	0.059	0.260
C2. Nursing practice II—adolescent and adult nursing practice	4.909±0.287	0.059	0.260
C3. Nursing practice operation III—geriatric nursing practice	4.955±0.208	0.042	0.260
C4. Nursing humanities cultivation practice in multicultural context	4.682±0.466	0.099	0.140
C5. Nursing research practice	4.364±0.481	0.110	0.060
D. Values course	4.773±0.419	0.088	0.140
D1. Nursing humanities cultivation in multicultural context	4.636±0.481	0.104	0.330
D2. Nursing ethics and laws and regulations	4.909±0.287	0.059	0.670
E. Character development course	4.773±0.419	0.088	0.140
E1. Nursing research fundamentals	4.409±0.577	0.131	0.180
E2. Nursing role development I—educator	4.455±0.498	0.112	0.180
E3. Nursing role development II—manager	4.364±0.481	0.110	0.110
E4. Nursing career planning and employment guidance	4.364±0.481	0.110	0.110
E5. Introduction to nursing clinical practice	4.682±0.555	0.119	0.420

SD, standard deviation; CV, coefficient of variation; CW, combined weights.

of the comprehensive curriculum system for nursing undergraduate majors based on competency in this study were highly reliable.

According to the research results, the consistency test ratio (CR) and the consistency index (CI) of the indicators at all levels were both <0.100, indicating that the judgments of the 2 rounds of experts on the indicators were basically the same (23). The professional skills course group (0.333) has the highest weight among the first-level indicators of this study. The professional skills course group is a necessary skill operation course for nursing undergraduates

to meet the training standards, which is in line with the current national training requirements for high-quality nursing undergraduates. It can build a bridge for improving the basic abilities and personal qualities of nursing students. In the secondary indicators of this study, nursing humanistic cultivation and professionalism (0.750), nursing education theory and practice (0.528), basic nursing technology application (0.429), intermediate nursing technology application (0.429), and adult and elderly health promotion and nursing (0.415) accounted for a relatively high proportion. In order to realize the sustainable development

Table 5 The results the second round of the expert consultation

Items	Mean ± SD	CV	CW
A. Professional basic course group	4.955±0.208	0.042	0.167
A1. Nursing foundation and development	4.864±0.343	0.071	0.167
A2. Medical basics of maternal and infant care	4.909±0.287	0.059	0.333
A3. Fundamentals of medicine in child and adolescent nursing	4.909±0.287	0.059	0.333
A4. Fundamentals of medicine in adult and elderly care	4.864±0.343	0.071	0.167
B. Professional core course group	4.955±0.208	0.042	0.167
B1. Maternal and infant health promotion and nursing	4.909±0.287	0.059	0.244
B2. Child and adolescent health promotion and nursing	4.909±0.287	0.059	0.244
B3. Adult and elderly health promotion and nursing	4.955±0.208	0.042	0.415
B4. Public health care and rehabilitation nursing	4.545±0.498	0.110	0.098
C. Professional skills course group	5.000±0.000	0.000	0.333
C1. Basic nursing technology application	4.909±0.287	0.059	0.429
C2. Intermediate nursing technology application	4.909±0.287	0.059	0.429
C3. Advanced nursing technology application	4.545±0.498	0.112	0.143
D. Professional values course group	4.955±0.208	0.042	0.167
D1. Nursing humanistic cultivation and professionalism	4.682±0.466	0.099	0.750
D2. Nursing ethics and laws and regulations	4.364±0.481	0.110	0.250
E. Professional role development course group	4.955±0.208	0.042	0.167
E1. Nursing research design	4.636±0.481	0.104	0.140
E2. Nursing management and clinical decision making	4.909±0.287	0.059	0.333
E3. Nursing education theory and practice	4.955±0.208	0.042	0.528

SD, standard deviation; CV, coefficient of variation; CW, combined weights.

of higher nursing education, three-dimensional and all-round professional ethics and humanistic spirit education should be constructed in modern higher nursing education. This complex requirement for knowledge structure, ability structure and quality structure of higher nursing talents shows that it is necessary to strengthen humanistic quality education in modern higher nursing teaching. The nursing education theory and practice course will explain the basic theory, teaching methods, and skills of pedagogy and nursing education. Education is an indispensable role of nursing practitioners, regardless of the clinical or medical school. The nursing education theory and practice course aims to guide nursing students to learn how to use relevant resources of institutions or clinics to complete educational work, so as to help nursing students achieve a successful transition to the role of educator. In

addition, practical teaching is not only the continuation, supplementation, expansion and deepening of theoretical teaching, but also a key link in improving the practical skills and quality of nursing students and cultivating the innovative consciousness and ability of nursing students. Therefore, the professional practice teaching for nursing undergraduates is also an important part of the comprehensive nursing curriculum system in this study. The results of the seventh census in China showed that the population aged 65 and above accounts for 13.50%, which is much higher than the social standard of aging (24). In the context of an aging population, the need for health care for the elderly has become increasingly prominent, so more and more attention has been paid to the health promotion and care of the elderly.

This study takes McClelland's competency theory and

Table 6 Course introduction

Course title	Course introduction
A1. Nursing foundation and development	Explain the core concepts of nursing, the nature of the discipline, the development history, basic theories, and other related knowledge
A2. Medical basics of maternal and infant care	Explain the basic structure and function of mothers and babies and other anatomical knowledge, and introduce the knowledge of pathophysiology, pharmacology, microbiology, and immunology related to their diseases
A3. Fundamentals of medicine in child and adolescent Nursing	Explain anatomical knowledge such as the basic structure and function of children and adolescents, and introduce the knowledge of pathophysiology, pharmacology, microbiology, and immunology related to their diseases
A4. Fundamentals of medicine in adult and elderly Care	Explain the anatomical knowledge of the basic structure and function of adults and the elderly, and introduce the knowledge of pathophysiology, pharmacology, microbiology, and immunology related to their diseases
B1. Maternal and infant health promotion and nursing	Explain the preventive measures and nursing measures for common diseases of mothers and infants, understand the psychological changes of mothers and infants, how to give them social support, and lay the foundation for clinical nursing work
B2. Child and adolescent health promotion and nursing	Explain the prevention and nursing measures of common diseases in children and adolescents, understand the psychological changes of children and adolescents, how to give them social support, and lay the foundation for clinical nursing work
B3. Adult and elderly health promotion and nursing	Explain the prevention and nursing measures of common diseases for adults and the elderly, understand the psychological changes of adults and the elderly, and how to give them social support, and lay the foundation for clinical nursing work
B4. Public health care and rehabilitation nursing	Explain the relevant knowledge and skills that nurses should have to explore the health care system, understand the promotion process of health care related policies, help others stay healthy or promote the recovery of others, so as to cope with the risks and challenges brought by various sudden diseases
C1. Basic nursing technology application	Explain and demonstrate the application of health assessment and basic nursing techniques to patients, and demonstrate how to use communication skills to communicate with patients in different situations
C2. Intermediate nursing technology application	According to the nursing problems involved in the process from admission to discharge, explain nursing treatment and intervention measures, and demonstrate to students techniques such as aseptic manipulation, intravenous treatment techniques, critically ill patient care, and rescue techniques
C3. Advanced nursing technology application	Explain and demonstrate how to provide comprehensive nursing services for people with different cultural backgrounds and vulnerable groups, be familiar with the workflow related to clinical management, and master various operational skills to deal with patient care problems (centralized clinical services are provided at selected institutions)
D1. Nursing humanistic cultivation and professionalism	Explain the relevant knowledge of domestic and foreign cultural traditions, nursing etiquette, interpersonal communication, correctly use domestic and foreign nursing etiquette, interpersonal communication, and other related methods and skills for practical operation, and demonstrate the professional spirit of nursing. Explain the career development path of nursing, and understand the employment of nursing majors. Have knowledge of trends and policies
D2. Nursing ethics and laws and regulations	Explain nursing-related laws and regulations, nursing ethics, and other related knowledge
E1. Nursing research design	Combined with the current situation of nursing development at home and abroad, it will explain the basic steps of nursing scientific research, the basic methods of using scientific research results to guide nursing practice and evaluation, as well as the writing and analysis of nursing papers and scientific reports
E2. Nursing management and clinical decision making	Explain nursing management theory, methods and development history, and other related knowledge, and organize students to carry out nursing simulation management practice activities in different scenarios. Good preparation for entering clinical work
E3. Nursing education theory and practice	Explain the basic theory, teaching methods, and skills of pedagogy and nursing education. Explain the knowledge of applied theory and basic technology in the process of nursing education practice, and organize students to carry out teaching practice activities

Erikson's life cycle theory as the theoretical framework. Experts believe that the construction of the index system is creative, consistent with the international nursing curriculum system, and in line with the whole life cycle health promotion theory. This study adopts the model of "course group + professional comprehensive courses + course introduction" to construct a comprehensive curriculum index system for nursing undergraduate majors based on competency. On the one hand, it can play a guiding role in the establishment of indicators from a macro perspective, and ensure the scientificity and integrity of the establishment of indicators. On the other hand, the basic professional knowledge contained in the curriculum can be understood according to the curriculum introduction, which reflects the connotation of the curriculum. Nursing undergraduate education in China is mostly a "discipline-centered" curriculum setting model. This model has the advantages of facilitating the organization, implementation, and management of teaching, but it also has the disadvantage of not integrating theory and practice, which is not conducive to the competence development of nursing students. The core competence of nursing professionals is particularly important in clinical practice. The core competence of nursing represents the comprehensive performance of nursing professionals in the process of clinical nursing, and is the most important competence that should be cultivated in the process of nursing education. In order to avoid the disconnection between theory and practice, in this study, the professional comprehensive courses included in the professional basic course group, the professional core course group, and the professional skills course group were the supporting courses, and the difficulty level of the course was divided. While teaching theory, nursing students should get in touch with practical courses as soon as possible, not only to learn to use their brains to think, but also to master skills. In this way, the theory is combined with practice, and the clinical nursing ability of nursing students is further improved. In order to cope with risks and challenges brought by various sudden diseases, special public health care and rehabilitation nursing courses are set up. In the course, the connotation of nursing service is closely combined with the health needs of the people, and it promotes nursing students to pay attention to the whole life cycle, health, and well-being. In the process, the ideological change of "people's health as the center" has been realized, and a strong talent guarantee has been provided for promoting the construction of a healthy China. Previous studies showed that the scores of practice

spirit and professionalism in nursing students' professional values were low, and professional values are the soul of nursing work (25,26). Therefore, the cultivation of nursing students' professional values should be strengthened at the undergraduate level. The purpose of this study is to promote the comprehensive improvement of nursing students' professional quality and moral standards from the aspects of nursing humanistic accomplishment, professional spirit, ethics, and laws and regulations, so as to highlight the humanistic care characteristics of nursing and make nursing students feel that nursing is a "warm" discipline, and establish self-confidence in nursing culture. With the continuous development of nursing disciplines, the place where nursing staff study and work is no longer limited to clinical practice, but extends to education, management, and scientific research. Experts suggest that the professional role development course group should involve a full range of knowledge in various fields of nursing, aiming at cultivating undergraduate talents in various fields of nursing.

The competency-based comprehensive nursing undergraduate professional curriculum system constructed in this study provides new ideas for the reform of the nursing undergraduate education curriculum. The curriculum profiles are listed in each curriculum dimension in the system, which can provide a theoretical basis for the cultivation of nursing undergraduate talents. The training of students is more purposeful and pertinent. It also provides a new way for nursing educators to cultivate talents and improve the curriculum structure of nursing undergraduates, highlights the innovation of the curriculum, helps them establish the concept of "public health", and provides nursing students with a new path. It provides direction for the personal development of nursing students and helps to improve the enthusiasm of nursing students in learning. At the same time, the combination of life cycle theory and competency theory ensures that nursing students can improve their abilities while mastering subject knowledge, and promotes nursing students to pay attention to the whole life cycle and the whole process of health. It also provides a reference for the construction of a first-class undergraduate course system in nursing oriented to cultivating competency.

Limited by the funding and timing of the study, only 22 experts were invited for this study. Most of the experts participating in the research came from colleges and universities in various provinces and cities in China or tertiary hospitals. The collected foreign nursing professional curriculum materials are limited to universities

with developed education such as the United States, the United Kingdom, Canada, and Australia, and the scope of correspondence and data collection is relatively limited. In addition, the index content of the initially constructed comprehensive curriculum system is still limited to basic theoretical research, and its applicability and practicability in the application of various colleges and universities in China is yet to be verified. The next step should be to expand the research scope, select pilot units for preliminary application, further evaluate the scientific nature of the index system, and then gradually promote it outwards.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study does not involve human experiments and does not need to provide proof of ethical review, but all relevant personnel involved in this study have given informed consent to ensure the smooth conduct of this study.

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