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Original Article

Comparison of past and current dental school curricula for dental students of National Taiwan University

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Abstract *Background/purpose:* The complete curriculum schedule of the School of Dentistry, National Taiwan University (NTU) appeared in 1960. This study aimed to understand the development of dental education in Taiwan by comparing the past and current dental school curricula of NTU.

Materials and methods: This study collected the 1960, 1990 and 2020 dental school curriculum schedules for dental students of NTU from the related websites and used the documentary and secondary data analyses to further compare the obtained data.

Results: The number of credits for all the curricula offered by NTU to undergraduate dental students decreased from 264 in 1960 to 243 in 1990 and further to 242 in 2020 with a total

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decrease of 22 credits by 8.3%. The number (proportion) of credits of medicine courses decreased from 102 (38.6%) in 1960 to 52 (21.4%) in 1990, and then increased to 60 (24.8%) in 2020, with a total decrease of 42 credits by 41.2%, while those of dentistry courses increased from 70 (26.5%) in 1960 to 122 (50.2%) in 1990 and further to 132 (54.5%) in 2020, with a total increase of 62 credits by 88.6%. Among them, clinical practice of dentistry had the greatest growth with a total increase of 42 credits by 233.3%.

Conclusion: The increase of dentistry courses and the decrease of medicine courses are the general trends for modern dental education. The dental school of NTU has the ability to provide more refined dentistry courses to catch the world trend of dental education.

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Introduction

Different from the development path of western medicine, which experienced a long process of accumulation and growth of professional knowledge, Taiwan's medical civilization developed rapidly during the Japanese colonial period. The colonial government directly transplanted the western medical system to Taiwan. The medical services, education, and research of western medicine are deeply rooted in this land, and medical professionals with the roles of modern physicians and dentists have also begun to appear in Taiwan.^{1,2} Due to the particularity of colonial rule, although modernized dental services were first implemented in Taipei Hospital in 1906, the first specialized dental teacher began to teach dentistry at the Taiwan Government Medical School in 1914, and the independent dental subject began to be taught in the medical school in 1918. Throughout the Japanese colonial period, only one medical school was established for cultivating physicians in 1899, but no dental school was established for cultivating dentists.³⁻⁵ Even so, Taiwan's dental technology progressed its modern form a hundred years ago.⁶ Although medical students who studied dental courses and physicians who received dental training could also become dental practitioners, the main source of real dental talents were Japanese dentists and Taiwanese dentists who studied dentistry in Japan.¹

The post-war Taiwan's dental profession experienced a difficult period and continued to wait for the government to set up a dental school, but it was not smooth.^{1,7} The 1951 Project for Establishment of Department of Dentistry and Department of Pharmacy of National Taiwan University (NTU) recorded that "The present dentists and pharmacists, except a part from the mainland, were all graduated from colleges or universities in Japan. For six years since the restoration, our youths have not been able to study dentistry and pharmacy, either inside or outside the island." The Department of Dentistry of NTU was finally established in 1953. Due to the unsatisfactory enrollment in the first two years, the Department of Dentistry of NTU did not have complete dental students from grades 1 to 6 until 1960. There was the first class of dental graduates in 1961, showing that the fault in the replacement of Taiwan's dentist manpower has continued for at least 15 years since the post-war period.

The complete curricula of the Department of Dentistry of NTU appeared in 1960, and it has been more than 60 years till now. Through the analysis of the content of the curricula of the Department of Dentistry of NTU, we could understand the basic required learning subjects for dental students in the dental school of NTU. Moreover, the dental curricula could also reflect the contemporary level of dental technology or the focus of dental development. The purpose of this study was to understand the development of dental education in Taiwan from more than 60 years ago to the modern era by comparing the past and current dental school curricula of NTU. The results of the study can be used as the basis for the research on the history of dental education in Taiwan and as a reference for future dental education planning.

Materials and methods

This study used the documentary analysis and the secondary data analysis to collect the information of the curriculum schedules for the Department of Dentistry of NTU. This information was open to access and could be collected from the related websites. Moreover, we chose the 1960, 1990 and 2020 curriculum subject schedules as the research objects for comparison in this study.

In addition, the past content of dentistry curricula for dental students, such as the 1960 and 1990 curriculum schedules, were obtained from the website of NTU curriculum digital archive, and the current one, such as the 2020 schedule, was obtained from the website of NTU curriculum inquiry. Moreover, university publications, such as the introduction to NTU, were used to check the correctness of curriculum schedules. Furthermore, according to the subject category, all the curricula were divided into: common compulsory courses (language and humanities), basic science, basic medicine, basic dentistry, clinical medicine, clinical dentistry, and clinical practice. According to the clinical attributes, dentistry-related subjects were divided into: Oral and maxillofacial surgery, Oral pathology, Orthodontics, Periodontology, Pediatric dentistry, Endodontics, Prosthodontics, Operative dentistry, and others. All data obtained from the related websites were classified and stored in excel files and used for descriptive statistics.

Results

All the curricula offered by NTU to undergraduate dental students in the academic years of 1960, 1990 and 2020

In 1960, the dental school of NTU had complete students in grades 1–6 for the first time. Based on one academic year, the course name, number of credits and number of subjects provided by NTU to undergraduate dental students in the academic years of 1960, 1990 and 2020 are shown in [Tables 1–3](#). All the curricula were divided into: common compulsory courses (language and humanities), basic science, basic medicine, basic dentistry, clinical medicine, clinical dentistry, and clinical practice (so-called internship). There were very few courses in the medical humanities classified as basic medicine or basic dentistry. Almost all courses were compulsory with very few elective courses. One-credit subject required 1-h lecture per week, while one-credit experiment/hands-on required 2-3-h laboratory teaching and learning per week. Physical education, military training, or a few 0-credit courses were not covered in this study.

In the tradition of NTU, the courses of first and second years of medical school and dental school are called pre-medical courses, and the common compulsory courses and basic science courses are mainly provided by College of Liberal Arts and College of Science. In the third year and beyond, the medical courses and dental courses are mainly provided by medical school and dental school, respectively. The clinical practice in the fifth and sixth years performed in National Taiwan University Hospital, also known as clerkship and internship, respectively. Dental students in the clerkship could do the scaling for the patients and those in the internship could treat the patients with relatively simple procedure under supervision of visiting staff in Department of Dentistry, National Taiwan University Hospital. The number of credits (one academic year basis) for all the curricula offered by NTU to undergraduate dental students decreased from 264 in 1960 to 243 in 1990 and further to 242 in 2020 ([Table 4](#)), while the number of subjects increased from 94 in 1960 to 101 in 1990 and further to 112 in 2020 ([Tables 1–3](#)). It indicates that the overall curriculum development tends to decrease the credits of subjects and increase the number of subjects. From 1960 to 2020, the number of credits and subjects for common compulsory courses, basic science and clinical medicine decreased, while the number of credits and subjects for basic dentistry, clinical dentistry and clinical practice increased. In addition, the number of credits in basic medicine decreased, but the number of subjects increased ([Tables 1–4](#)).

The number of credits for various types of courses offered by NTU to undergraduate dental students in the academic years of 1960, 1990 and 2020

Based on one academic year, the number of credits for all the curricula offered by NTU to undergraduate dental students had a total decrease of 22 credits by 8.3% from 1960 to 2020 ([Table 4](#)). The number (proportion) of credits for

common compulsory courses decreased from 38 (14.4%) in 1960 to 33 (13.6%) in 1990 and further to 24 (9.9%) in 2020, with a total decrease of 14 credits by 36.8%. Among them, language courses had the greatest reduction with a total decrease of 16 credits by 57.1% ([Table 4](#)). For basic science, the number (proportion) of credits also decreased from 54 (20.5%) in 1960 to 36 (14.8%) in 1990 and further to 26 (10.7%) in 2020, with a total decrease of 28 credits by 51.9% ([Table 4](#)). For medicine, the number (proportion) of credits decreased from 102 (38.6%) in 1960 to 52 (21.4%) in 1990, and then increased to 60 (24.8%) in 2020, with a total decrease of 42 credits by 41.2%. Among them, clinical medicine had the greatest reduction with a total decrease of 25 credits by 73.5%. However, clinical practice of medicine was completely canceled ([Table 4](#)). For dentistry, the number (proportion) of credits increased from 70 (26.5%) in 1960 to 122 (50.2%) in 1990 and further to 132 (54.5%) in 2020, with a total increase of 62 credits by 88.6%. Among them, clinical practice of dentistry had the greatest growth with a total increase of 42 credits by 233.3% ([Table 4](#)).

The number of credits for medicine and dentistry courses offered by NTU to undergraduate dental students among different grades in the academic years of 1960, 1990 and 2020

Based on one academic year, the number of credits for medicine and dentistry courses offered by NTU to undergraduate dental students decreased from 148 in 1960 to 114 in 1990, and then increased to 132 in 2020, with a total decrease of 16 credits by 10.8% ([Table 5](#)). For the 1st and 2nd grades, the number (proportion) of credits increased from 0 in 1960 to 9 (7.9%) in 1990 and further to 25 (18.9%) in 2020, with a total increase of 25 credits. Among them, basic medicine had the greatest growth with a total increase of 16 credits ([Table 5](#)). For 3rd and 4th grades, the number of credits decreased from 83 in 1960 to 74 in 1990, and then increased to 77 in 2020, with a total decrease of 6 credits by 7.2%. Among them, basic medicine had the greatest reduction with a total decrease of 26 credits by 43.3%. However, clinical dentistry had the greatest growth with a total increase of 18 credits by 450% ([Table 5](#)). For 5th and 6th grades, the number (proportion) of credits also decreased from 65 (43.9%) in 1960 to 31 (27.2%) in 1990 and further to 30 (22.7%) in 2020, with a total decrease of 35 credits by 53.8%. Among them, clinical medicine had the greatest reduction with a total decrease of 23 credits by 88.5%, followed by clinical dentistry with a total decrease of 14 credits by 38.9% ([Table 5](#)).

The number of credits for dentistry courses and clinical practice of different dental specialties offered by NTU to undergraduate dental students in the academic years of 1960, 1990 and 2020

Based on one academic year, the number of credits for all dentistry courses and clinical practice offered by NTU to undergraduate dental students increased from 70 in 1960 to 122 in 1990 and further to 132 in 2020, with a total increase of 62 credits by 88.6% ([Table 6](#)). With the increase of dentistry courses, only the oral pathology-related dentistry

Table 1 All the curricula offered by National Taiwan University to undergraduate dental students in the academic year of 1960.

Category	Subject name (number of credits)	Subjects (number of credits)
Common compulsory courses	1st grade: 8 subjects (24) Chinese (4 + 4), Freshman English (4 + 4), Three principles of the people (2 + 2), Modern history of China (2 + 2) 2nd grade: 4 subjects (10) International organizations and international situations (2), German (3 + 3), Latin (2) 3rd grade: 2 subjects (4) German (2 + 2) ^a	14 subjects (38)
Basic science	1st grade: 14 subject (26) Calculus (3 + 3), General chemistry (3 + 3), General chemistry laboratory (1 + 1), General zoology (2 + 2), General zoology laboratory (1 + 1), General botany (2 + 2), General botany laboratory (1 + 1) 2nd grade: 15 subjects (28) General physics (3 + 3), General physics laboratory (1 + 1), Organic chemistry (3 + 3), Organic chemistry laboratory (1 + 1), Analytical chemistry (2 + 2), Analytical chemistry laboratory (1 + 1), Comparative anatomy (2), Comparative anatomy laboratory (1), Psychology (3) 3rd grade: 5 subjects (35) Gross anatomy (12), Histology (4), Embryology (2), Biochemistry (8), Physiology (9) 4th grade: 5 subjects (25) Pathology (8), Bacteriology (8), Medical psychology (1), Pharmacology (6), Public health (2) 5th grade: 1 subject (2) Public health (2)	29 subjects (54)
Basic medicine	3rd grade: 5 subjects (35) Gross anatomy (12), Histology (4), Embryology (2), Biochemistry (8), Physiology (9) 4th grade: 5 subjects (25) Pathology (8), Bacteriology (8), Medical psychology (1), Pharmacology (6), Public health (2) 5th grade: 1 subject (2) Public health (2)	11 subjects (62)
Basic dentistry	3rd grade: 2 subjects (5) Dental histology (2), Dental morphology (3) 4th grade: 3 subjects (6) Dental pathology (4), Dental materials (1), Dental pharmacology (1) 5th grade: 1 subject (1) Prevention for oral diseases (1)	6 subjects (12)
Clinical medicine	4th grade: 1 subject (8) Clinical diagnostics (8) 5th grade: 6 subjects (10) Internal medicine (2 + 2), Surgery (2 + 2), Radiology (1 + 1) 6th grade: 12 subjects (16) Internal medicine (2 + 2), Surgery (2 + 2), Ophthalmology (1 + 1), Otorhinolaryngology (1 + 1), Pediatrics (1), Forensic medicine (1), Clinico-pathological conference (1 + 1)	19 subjects (34)
Clinical dentistry	4th grade: 1 subject (4) Operative dentistry (4) 5th grade: 10 subjects (34) Fixed prosthodontics (6), Prosthodontics (9), Oral surgery (5), Root canal therapy (2), Oral diagnosis (3), Oral medicine (2), Periodontology (2), Pediatric dentistry (1), Dental roentgenology (1), Orthodontics (3) 6th grade: 2 subjects (2) Dental clinical conference (1 + 1)	13 subjects (40)
Clinical practice	6th grade: 2 subjects (24) Clinical practice (12 + 12) (One and a half months each for Internal medicine and Surgery; three months each for Oral surgery, Oral medicine, and Prosthodontics)	2 subjects (24)
Overall		94 subjects (264)

^a German in 3rd grade is an elective course.

Table 2 All the curricula offered by National Taiwan University to undergraduate dental students in the academic year of 1990.

Category	Subject name (number of credits)	Subjects (number of credits)
Common compulsory courses	1st grade: 10 subjects (29) Chinese (4 + 4), Freshman English (4 + 4), Three principles of the people (2 + 2), History of China (2 + 2), Introduction to philosophy (2), Introductory sociology (3) 2nd grade: 2 subjects (4) Contemporary history of China (2 + 2)	12 subjects (33)
Basic science	1st grade: 8 subjects (18) Calculus (3 + 3), General chemistry (2 + 2), General chemistry laboratory (1 + 1), General biology (4), General biology laboratory (2) 2nd grade: 11 subjects (18) General physics (2 + 2), General physics laboratory (1 + 1), Analytical chemistry (2), Analytical chemistry laboratory (1), Organic chemistry (2 + 2), Organic chemistry laboratory (1 + 1), General psychology (3) 2nd grade: 3 subjects (5) Biochemistry (2), Medical psychology (1), Biostatistics (2) 3rd grade: 8 subjects (25) Gross anatomy (6), Histology (4), Physiology (4), Physiology laboratory (2), Microbiology and immunology (4), Microbiology and immunology laboratory (2), Environmental medicine (2), Medical ethics (1) 4th grade: 4 subjects (13) Pathology (3), Pathology laboratory (4), Pharmacology (4), Pharmacology laboratory (2)	19 subjects (36)
Basic medicine	2nd grade: 3 subjects (5) Biochemistry (2), Medical psychology (1), Biostatistics (2) 3rd grade: 8 subjects (25) Gross anatomy (6), Histology (4), Physiology (4), Physiology laboratory (2), Microbiology and immunology (4), Microbiology and immunology laboratory (2), Environmental medicine (2), Medical ethics (1) 4th grade: 4 subjects (13) Pathology (3), Pathology laboratory (4), Pharmacology (4), Pharmacology laboratory (2)	15 subjects (43)
Basic dentistry	1st grade: 1 subject (1) Introduction to oral sciences (1) 2nd grade: 2 subjects (3) Dental morphology (1), Dental morphology laboratory (2) 3rd grade: 4 subjects (8) Oral embryology & histology (1), Oral embryology & histology laboratory (1), Oral anatomy (4), Dental materials (2) 4th grade: 5 subjects (8) Oral pathology (2), Oral pathology laboratory (2), Dental pharmacology (1), Public health dentistry (1), Occlusion (2) 4th grade: 6 subjects (7) Introduction to internal medicine (1 + 1), Introduction to surgery (2), Clinical diagnostics (1 + 1), Clinical diagnostics laboratory (1) 5th grade: 1 subject (2) Otorhinolaryngology (2)	12 subjects (20)
Clinical medicine	4th grade: 6 subjects (7) Introduction to internal medicine (1 + 1), Introduction to surgery (2), Clinical diagnostics (1 + 1), Clinical diagnostics laboratory (1) 5th grade: 1 subject (2) Otorhinolaryngology (2)	7 subjects (9)
Clinical dentistry	4th grade: 7 subjects (13) Oral diagnosis (2), Dental roentgenology (2), Operative dentistry (2), Operative dentistry laboratory (3), Endodontics (1), Endodontics laboratory (1), Periodontology (2) 5th grade: 15 subjects (29) Pediatric dentistry (2), Fixed prosthodontics (2), Fixed prosthodontics laboratory (4), Orthodontics (2), Orthodontics laboratory (1), Removable partial denture prosthodontics (2), Removable partial denture prosthodontics laboratory (3), Complete denture prosthodontics (2), Complete denture prosthodontics laboratory (2), Oral and maxillofacial surgery (2 + 3), Dental anesthesiology (1), Forensic dentistry (1), Dental clinical conference (1 + 1) 5th grade: 2 subjects (12) Clinical practice (6 + 6) 6th grade: 12 subjects (48) Oral diagnosis clinical practice (2 + 2), Dental roentgenology clinical	22 subjects (42)
Clinical practice	5th grade: 2 subjects (12) Clinical practice (6 + 6) 6th grade: 12 subjects (48) Oral diagnosis clinical practice (2 + 2), Dental roentgenology clinical	14 subjects (60)

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Table 2 (continued)

Category	Subject name (number of credits)	Subjects (number of credits)
	practice (2), Operative dentistry clinical practice (6), Endodontics clinical practice (4), Periodontics clinical practice (4), Fixed prosthodontics clinical practice (6), Removable partial denture prosthodontics clinical practice (6), Complete denture prosthodontics clinical practice (4), Oral and maxillofacial surgery clinical practice (8), Orthodontics clinical practice (2), Pediatric dentistry clinical practice (2)	
Overall		101 subjects (243)

courses showed a decrease, and the dentistry courses related to all other dental specialties showed an increase. For oral pathology-related courses, the number (proportion) of credits decreased from 17 (24.3%) in 1960 to 12 (9.8%) in 1990 and further to 10 (7.6%) in 2020, with a total decrease of 7 credits by 41.2% (Table 6). For oral and maxillofacial surgery, the number of credits increased from 11 in 1960 to 19 in 1990, and then decreased to 18 in 2020, with a total increase of 7 credits by 63.6%. However, its proportion of credits decreased from 15.7% in 1960 to 15.6% in 1990 and further to 13.6% in 2020 (Table 6). For orthodontics, the number of credits increased from 3 in 1960 to 5 in both 1990 and 2020, with a total increase of 2 credits by 66.7%. However, its proportion of credits decreased from 4.3% in 1960 to 4.1% in 1990 and further to 3.8% in 2020 (Table 6). For periodontology, the number (proportion) of credits increased from 2 (2.9%) in 1960 to 8 (6.6%) in 1990 and further to 13 (9.8%) in 2020, with a total increase of 11 credits by 550% (Table 6). For pediatric dentistry, the number of credits increased from one in 1960 to 4 in both 1990 and 2020, with a total increase of 3 credits by 300%. However, its proportion of credits increased from 1.4% in 1960 to 3.3% in 1990, and then decreased to 3.0% in 2020 (Table 6). For endodontics, the number (proportion) of credits increased from 2 (2.9%) in 1960 to 8 (6.6%) in 1990 and further to 13 (9.8%) in 2020, with a total increase of 11 credits by 550% (Table 6). For prosthodontics, the number of credits increased from 21 in 1960 to 35 in 1990, and then decreased to 30 in 2020, with a total increase of 9 credits by 42.9%. However, its proportion of credits decreased from 30% in 1960 to 28.7% in 1990 and further to 22.7% in 2020 (Table 6). For operative dentistry, the number (proportion) of credits increased from 8 (11.4%) in 1960 to 18 (14.8%) in 1990, and then decreased to 17 (12.9%) in 2020, with a total increase of 9 credits by 112.5% (Table 6). For others, the number (proportion) of credits increased from 5 (7.1%) in 1960 to 13 (10.7%) in 1990 and further to 22 (16.7%) in 2020, with a total increase of 17 credits by 340% (Table 6). Thus, except for the dentistry courses which could not be classified into a specific dental specialty, periodontology and endodontics courses had the greatest growth regardless of the number and proportion of credits (Table 6).

Discussion

It has always been the constant educational goals of dental schools to cultivate professionally competent dentists and

to promote dental student attributes to become a full-contributing member of the profession.⁸ With the advocacy of new thinking and the advancement of dental technology, new elements have been added to the educational goals of dental schools, such as cultivating outstanding stomatology talents with humanistic literacy and social responsibility, training stomatology professionals with international outlook and morality, and nurturing professionally qualified dentists who know how to be proactive and lifelong learning, so as to achieve the goal of taking care of the oral health of the whole people. The above are the new educational goals set by today's dental schools of Taiwan. In fact, no matter how the educational goals are set in words, we can also understand the learning content and focus from the specific learning subjects which are taught to dental students, and the names, categories, clinical attributes, weights, and proportions of these subjects. Moreover, we can further understand the educational goals of contemporary dental schools through knowing what kind of professional abilities are needed for dentists and should be taught to the dental students. In addition, from the teaching content offered by the dental schools, we can also discover the level of contemporary dental technology development.

The complete curriculum schedule of the dental school of NTU first appeared in 1960, and it has been developed for more than 60 years. Based on one academic year, this study calculated all the courses offered by NTU to undergraduate dental students and compared the curriculum subject schedules of dental school of NTU among the academic years of 1960, 1990 and 2020. We initially found the changes of the curriculum subject schedules over the past 60 years. The results of this study showed that the weights and proportions of dental students' learning subjects belonged to different categories and clinical attributes, and they actually changed considerably over the past 60 years.

The total number of learning credits for undergraduate dental students decreased, mainly due to the reduction of common compulsory courses (language and humanities) and basic science and medicine courses. This change subsequently provided spaces for a substantial increase in dentistry courses. In the earlier years, there was a medical internship (internal medicine and surgery), but this course was finally cancelled. This change allowed a marked increase in the dental internship from 18 credits to 60 credits. However, medicine courses and dentistry courses were still the most important learning content for dental

Table 3 All the curricula offered by National Taiwan University to undergraduate dental students in the academic year of 2020.

Category	Subject name (number of credits)	Subjects (number of credits)
Common compulsory courses	1st grade: 8 subjects (24) Chinese (3 + 3), Freshman English (3 + 3), Introduction to philosophy (3), General education courses (3 + 3+3)	8 subjects (24)
Basic science	1st grade: 8 subjects (19) Calculus (3 + 3) ^a , General chemistry (3), General chemistry laboratory (1), Organic chemistry (3), Organic chemistry laboratory (1), General biology (4), General biology laboratory (1) 2nd grade: 3 subjects (7) General physics (3), General physics laboratory (1), General psychology (3)	11 subjects (26)
Basic medicine	2nd grade: 7 subjects (16) Environment and health (2), Biochemistry (4), Biochemistry laboratory (2), Medical psychology (1), Microbiology and immunology (2), Microbiology laboratory (1), Biostatistics and epidemiology (4) 3rd grade: 9 subjects (21) Physiology (4), Histology & laboratory (3 + 1), Embryology (1 + 1), Neuroanatomy (2), Group discussion for anatomy & physiology (2), Gross anatomy and laboratory (4 + 3) 4th grade: 5 subjects (13) Pathology and laboratory (4 + 3), Pharmacology (2 + 2), Pharmacology laboratory (2) 5th grade: 1 subject (1) Medical ethics (1)	22 subjects (51)
Basic dentistry	1st grade: 1 subject (1) Introduction to oral sciences (1) 2nd grade: 5 subjects (6) Introduction of dental research (1), Dental morphology (2), Dental morphology laboratory (1), Dental materials (1), Public health dentistry (1) 3rd grade: 6 subjects (8) Oral anatomy (1 + 1), Oral embryology & histology (2), Dental materials (1), Occlusion (2), Physician and humanities (1) 4th grade: 3 subjects (7) Dental pharmacology (1), Oral pathology & diagnosis lecture and laboratory (2 + 4) 5th grade: 3 subjects (4) Seminar for dental research (1), Masticatory disorders & orofacial pain (1), Oral health care management (2) ^a	18 subjects (26)
Clinical medicine	4th grade: 3 subjects (6) Clinical diagnostics & laboratory (2), Introduction to internal medicine (2), Introduction to surgery (2) 5th grade: 2 subjects (3) Otorhinolaryngology (2), Emergency medicine (1)	5 subjects (9)
Clinical dentistry	2nd grade: 2 subjects (2) Operative dentistry (1), Operative dentistry laboratory (1) 3rd grade: 5 subjects (8) Operative dentistry (1), Operative dentistry laboratory (1), Fundamental periodontology (2), Fixed prosthodontics and laboratory (2), Dental roentgenology (2) 4th grade: 6 subjects (14) Endodontics (3), Endodontics laboratory (2), Clinical periodontology (3), Complete denture prosthodontics (2), Complete denture prosthodontics laboratory (2), Fixed prosthodontics and laboratory (2) 5th grade: 13 subjects (20) Oral and maxillofacial Surgery (2 + 4), Dental anesthesiology (1),	28 subjects (46)

(continued on next page)

Table 3 (continued)

Category	Subject name (number of credits)	Subjects (number of credits)
Clinical practice	Orthodontics (2), Orthodontics laboratory (1), Removable partial denture prosthodontics (1 + 1), Removable partial denture prosthodontics laboratory (1 + 1), Special care in dentistry (1), Pedodontics (2), Forensic dentistry (1), Oral implantology (2) 6th grade: 2 subjects (2) Dental clinical case conference (1 + 1) 5th grade: 11 subjects (16) Preclinical training course (1 + 1), Oral diagnosis clinical practice (1 + 1), Dental roentgenology clinical practice (1 + 1), Preliminary clinical practice in operative dentistry (2), Preliminary clinical practice in prosthodontics (2), Preliminary clinical practice in periodontics (2), Preliminary clinical practice in oral and maxillofacial surgery (2), Preliminary clinical practice in endodontics (2) 6th grade: 9 subjects (44) Operative dentistry clinical practice (6), Endodontics clinical practice (6), Periodontics clinical practice (6), Fixed prosthodontics clinical practice (6), Removable partial denture prosthodontics clinical practice (6), Complete denture prosthodontics clinical practice (2), Oral and maxillofacial surgery clinical practice (8), Orthodontics clinical practice (2), Pediatric dentistry clinical practice (2)	20 subjects (60)
	Overall	112 subjects (242)

^a Calculus in the second semester of 1st grade and oral health care management in 5th grade are elective courses.

students. The number (proportion) of credits of these two types of courses increased from 172 (65.2%) in 1960 to 174 (71.6%) in 1990 and further to 192 (79.3%) in 2020, with a total increase of 20 credits by 11.6%. Furthermore, these courses were almost all compulsory courses. In addition to common compulsory courses and basic science courses, although NTU offered a variety of elective courses to the dental students, there was very limited space for dental students to take these elective courses.

The number of dentistry subjects increased regardless of basic dentistry, clinical dentistry, and dental practice. The

overall alterations of dental courses reflect the fast development of modern dentistry. Due to the development of modern dentistry and the accumulation of dental knowledge and technology, there were many dentistry courses that needed to be subdivided into several parts. This also reflects that some basic medicine and basic dentistry courses are adjusted to two parts and taught in 1st and 2nd grades, and some clinical dentistry courses are also adjusted to two parts and taught in 3rd and 4th grades. In addition, although the sum of the credits and subjects of the basic, clinical courses and clinical practice of each

Table 4 Number of credits (one academic year basis) for various types of courses offered by NTU to undergraduate dental students in the academic years of 1960, 1990 and 2020.

	Number (proportion) of credits			Number (rate) of changes		
	1960	1990	2020	1960–1990	1990–2020	1960–2020
Overall	264 (100%)	243 (100%)	242 (100%)	–21	–1	–22 (–8.3%)
Common compulsory courses	38 (14.4%)	33 (13.6%)	24 (9.9%)	–5	–9	–14 (–36.8%)
Language	28 (10.6%)	16 (6.9%)	12 (5.0%)	–12	–4	–16 (–57.1%)
Humanities	10 (3.8%)	17 (7.0%)	12 (5.0%)	7	–5	2 (20%)
Basic science	54 (20.5%)	36 (14.8%)	26 (10.7%)	–18	–10	–28 (–51.9%)
Medicine	102 (38.6%)	52 (21.4%)	60 (24.8%)	–50	8	–42 (–41.2%)
Basic medicine	62 (23.5%)	43 (17.7%)	51 (21.1%)	–19	8	–11 (–42.3%)
Clinical medicine	34 (12.9%)	9 (3.7%)	9 (3.7%)	–25	0	–25 (–73.5%)
Clinical practice	6 (2.3%)	0	0	–6	0	–6 (–100%)
Dentistry	70 (26.5%)	122 (50.2%)	132 (54.5%)	52	10	62 (88.6%)
Basic dentistry	12 (4.5%)	20 (8.2%)	26 (10.7%)	8	6	14 (116.7%)
Clinical dentistry	40 (15.2%)	42 (17.3%)	46 (19.0%)	2	4	6 (15%)
Clinical practice	18 (6.8%)	60 (24.7%)	60 (24.8%)	42	0	42 (233.3%)

Table 5 Number of credits (one academic year basis) for medicine and dentistry courses offered by NTU to undergraduate dental students among different grades in the academic years of 1960, 1990 and 2020.

	Number (proportion) of credits			Number (rate) of changes		
	1960	1990	2020	1960–1990	1990–2020	1960–2020
Overall	148 (100%)	114 (100%)	132 (100%)	–34	18	–16 (–10.8%)
1st and 2nd grades	0	9 (7.9%)	25 (18.9%)	9	16	25
Basic medicine	0	5	16	5	11	16
Basic dentistry	0	4	7	4	3	7
Clinical medicine	0	0	0	0	0	0
Clinical dentistry	0	0	2	0	2	2
3rd and 4th grades	83 (56.1%)	74 (64.9%)	77 (58.3%)	–9	3	–6 (–7.2%)
Basic medicine	60	38	34	–22	–4	–26 (–43.3%)
Basic dentistry	11	16	15	5	–1	4 (36.4%)
Clinical medicine	8	7	6	–1	–1	–2 (–25%)
Clinical dentistry	4	13	22	9	9	18 (450%)
5th and 6th grades	65 (43.9%)	31 (27.2%)	30 (22.7%)	–34	–1	–35 (–53.8%)
Basic medicine	2	0	1	–2	1	–1 (–50%)
Basic dentistry	1	0	4	–1	4	3 (300%)
Clinical medicine	26	2	3	–24	1	–23 (–88.5%)
Clinical dentistry	36	29	22	–7	–7	–14 (–38.9%)

dental specialty have increased, only the credits and subjects related to oral pathology have decreased. This alteration could be attributed to the cancellation of oral medicine and the merger of oral pathology and oral diagnosis subjects. The change may reflect the development direction of the disciplines in the dental school, but it needs further studies to understand whether the reduction of oral pathology-related credits in the dental schools is beneficial or detrimental to the dental students.

The results of this study found that the earliest courses provided by dental school of NTU had included the learning of nearly all the dental specialties related to clinical professions. Compared with today's dental courses, there were only the differences in the number of credits and the number of subjects. This result was similar to our previous finding that in the Japanese colonial period a hundred years ago, Taiwan's dental technology has already had the appearance with nearly all modern dental specialties.⁶ However, the weight of medicine courses in the earliest courses exceeds that of dentistry courses, indicating the shortage of dental teachers in the early years of dental school development and the difference in the dental education philosophy that needs to arrange a large number of medicine courses to enrich the learning content and to increase the medical knowledge of dental students.

The appearance of new subjects, such as oral implantology and oral health care management, shows that our dentistry curriculum is evolving with the world trend. Although the dental professional curriculum has increased significantly, including the number of credits and the number of subjects, the structure of basic dentistry and various dental specialties has not changed much, and the overall curriculum structure still focuses on the enhancement of dental treatment technology. The field of social dentistry has so far received little attention. For example, there was only a one-credit compulsory course, physician

and humanities, which was related to medical humanities. In fact, it was not a new subject, but was an adjustment of a 0-credit old course into a one-credit new course. In contrast, the field of social dentistry began to appear in the United States in the 1960s,⁹ and there was also a Japanese dental school that published a textbook of dental history and had a course of dental history in the 1910s. Dental history is the description about not only the technological advancement in the field of dentistry, but also the personalities of dental professionals. In addition, dental professionals' interests and passions can have an impact on dental history as a manifestation of the dental work itself.¹⁰ Unfortunately, the majority of dental courses in different countries do not include dental history.^{11,12} Furthermore, our dental school advertises the educational goal of improving students' humanistic literacy, but in the current curriculum structure, except language courses, humanities courses are very rare. In fact, there is currently no course in dental humanities and no plan to increase the medical humanities or the courses related to enhancement for students' sense of social responsibility. This may be detrimental to the development of professional dentists with humanistic literacy and social responsibility.

In addition, the opportunities for our dental students to learn basic knowledge of oral pathology and develop their ability to diagnose oral diseases are dwindling. In the past 60 years, the number of credits of all dentistry courses of our dental school increased from 70 in 1960 to 132 in 2020, with a total increase of 62 credits by 88.6% (Table 6). However, among all dentistry courses for dental students, the number (proportion) of credits of oral pathology-related dentistry courses decreased from 17 (24.3%) to 10 (7.6%), with a total decrease of 7 credits by 41.2%. Obviously, our dental education seems to go in a clinical technology-oriented direction and pay little attention to the course of oral pathology.

Table 6 Number of credits (one academic year basis) for dentistry courses and clinical practice of different dental specialties offered by NTU to undergraduate dental students in the academic years of 1960, 1990 and 2020.

	Number (proportion) of credits			Number (rate) of changes		
	1960	1990	2020	1960–1990	1990–2020	1960–2020
Overall	70 (100%)	122 (100%)	132 (100%)	52	10	62 (88.6%)
Oral pathology	17 (24.3%)	12 (9.8%)	10 (7.6%)	–5	–2	–7 (–41.2%)
Basic dentistry	6	6	8	0	2	2 (33.3%)
Clinical dentistry	5	2	0	–3	–2	–5 (–100%)
Clinical practice	6	4	2	–2	–2	–4 (–66.7%)
Oral and maxillofacial surgery	11 (15.7%)	19 (15.6%)	18 (13.6%)	8	–1	7 (63.6%)
Basic dentistry	0	4	2	4	–2	2
Clinical dentistry	5	5	6	0	1	1 (20%)
Clinical practice	6	10	10	4	0	4 (66.7%)
Orthodontics	3 (4.3%)	5 (4.1%)	5 (3.8%)	2	0	2 (66.7%)
Basic dentistry	0	0	0	0	0	0
Clinical dentistry	3	3	3	0	0	0
Clinical practice	0	2	2	2	0	2
Periodontology	2 (2.9%)	8 (6.6%)	13 (9.8%)	6	5	11 (550%)
Basic dentistry	0	0	0	0	0	0
Clinical dentistry	2	2	5	0	3	3 (150%)
Clinical practice	0	6	8	6	2	8
Pediatric dentistry	1 (1.4%)	4 (3.3%)	4 (3.0%)	3	0	3 (300%)
Basic dentistry	0	0	0	0	0	0
Clinical dentistry	1	2	2	1	0	1 (100%)
Clinical practice	0	2	2	2	0	2
Endodontics	2 (2.9%)	8 (6.6%)	13 (9.8%)	6	5	11 (550%)
Basic dentistry	0	0	0	0	0	0
Clinical dentistry	2	2	5	0	3	3 (150%)
Clinical practice	0	6	8	6	2	8
Prosthodontics	21 (30%)	35 (28.7%)	30 (22.7%)	14	–5	9 (42.9%)
Basic dentistry	0	2	2	2	0	2
Clinical dentistry	15	15	12	0	–3	–3 (–20%)
Clinical practice	6	18	16	12	–2	10 (166.7%)
Operative dentistry	8 (11.4%)	18 (14.8%)	17 (12.9%)	10	–1	9 (112.5%)
Basic dentistry	4	5	5	1	0	1 (25%)
Clinical dentistry	4	5	4	1	–1	0
Clinical practice	0	8	8	8	0	8
Others	5 (7.1%)	13 (10.7%)	22 (16.7%)	8	9	17 (340%)
Basic dentistry	2	3	9	1	6	7 (350%)
Clinical dentistry	3	6	9	3	3	6 (200%)
Clinical practice	0	4	4	4	0	4

Indeed, knowledge of oral pathology, oral medicine, and oral diagnosis is the cornerstone of oral health care delivery. In today's dentistry with highly divided specialties, a professional dentist does not need to learn all dental treatment techniques, but basic knowledge of oral pathology, oral medicine, and oral diagnosis for making a correct clinical diagnosis of oral and maxillofacial diseases especially the oral precancerous lesions, oral cancers, and odontogenic diseases is absolute indispensable. It is also the responsibility of any oral care provider to be professionally equipped with such capabilities. We believe that undergraduate dental students should try to learn enough knowledge of oral pathology, because they have the responsibility for diagnosing the oral and maxillofacial diseases for their patients in the future dental practice career, especially to diagnose the life-

threatening oral diseases such as oral cancers for their patients before they are aware of it.^{13–16} In fact, after the dental students graduate from their dental schools to become dentists, there are still many opportunities and channels to learn various dental treatment techniques, but there is almost no motivation and opportunity to learn the knowledge about oral pathology.¹⁷ Therefore, when the dental school plans to adjust dental professional courses, it should give priority to the adequacy of oral pathology-related dentistry courses. As for the strengthening of other dental professional knowledge and technology, dental students have more opportunities to enrich these professional knowledge and technology in their postgraduate years, especially after the implementation of postgraduate year training program for dentists (PGYD).¹⁸

Furthermore, the internship course of sixth grade year in domestic dental schools has an accreditation with constitutional level. In 2017, Taiwan had a constitutional interpretation by the grand justices stating that the language, medical culture, and disease types of clinical practice training (or clinical internship course) in foreign dental schools are different from those in Taiwan and cannot replace the internship course of sixth grade year in domestic dental schools. Therefore, it is reasonable that graduates of foreign dental schools still need to complete a one-year internship course in a teaching hospital in Taiwan before they can take the national dentist license examination.^{18,19} In Taiwan, with the implementation of the postgraduate year training program for physicians and dentists, medical schools systematically cancel the clinical internship course of seventh grade year and a two-year postgraduate year training program has been implemented. In contrast, dental schools in Taiwan still maintain this one-year clinical internship course in their 6-year dental school education. Thus, the development time for a physician increases by one year, but the development time for a dentist increases by two years.¹⁸ Therefore, among dental schools in Taiwan, there has also been a discussion about the cancellation of the internship course of sixth grade year in the dental school education system. Based on the accreditation of the importance of a one-year clinical internship course in dentistry with constitutional level, in addition to ensuring the training quality of dental students, it has also become a threshold for the foreign dental graduates to obtain a dentist license in Taiwan. Therefore, we conclude that the clinical internship courses in the current dental school education system in Taiwan should be maintained.

From the development of dental history, the number of undergraduate dental students in school of dentistry of NTU has grown from less than 10 for the first time to now more than 200 every year. The number of dental graduates has grown from only 5 in the first graduated class to now nearly 40 every year. The number of full-time and part-time dental teachers (including attending dentists) has increased from only one in 1953 to 88 in 2020,²⁰ and the dentistry courses provided for dental students have evolved from the medicine-based courses to the dentistry-based courses. We believe that the dental school of NTU has the ability to provide more refined dentistry courses to catch the world trend of dental education, but there is still space for improvement of dentistry courses. For example, the lack of humanities courses (such as social dentistry or dental history) and the reduction of oral pathology-related dentistry courses are issues that should be addressed. Furthermore, it is also time to think about designing dentistry courses related to social services, such as dental services for people of disadvantaged groups and those in the rural areas of Taiwan.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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