Alignment between Classroom Education and Clinical Practice of Root Canal Treatment among Dental Practitioners in China :A Cross-Sectional Study

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Abstract

Background: Root canal treatment (RCT) being one of the most common interventions provided by general dentists in clinical practice and the preferred treatment method for treating endodontic diseases.However, China exhibits certain differences from other countries, both in the content and discipline orientation of endodontic education.Past research on endodontic teaching primarily focused on undergraduate and postgraduate students, leading to the limitations of research not addressing specialized students and lacking feedback from clinical practitioners.This study aims to identify issues related to the differences between clinical practices and classroom education, the effectiveness of teaching content, difficulties in practical components, and the bias in educational training.

Objective: This study aimed to investigate the subjective appraisals of Chinese dental practitioners concerning the congruence between classroom education and clinical practice of root canal treatment.

Methods: A total of 90 questionnaires were distributed via the Internet to dental practitioners in the eastern coastal areas of China using random sampling. The questionnaire segmented the root canal treatment process into 9 distinct phases (including preoperative preparation, intraoperative procedures, postoperative cleaning, and relevant doctor-patient communication), and gauged the respondents' sensitivity to the posed queries by using 7-point Likert scales.

Results: A total of 83 valid responses were collated. Notable disparities were perceived by junior practitioners between classroom teachings and clinical requisites in both root canal treatment procedures and doctor-patient communication ($p<0.05$). In the phase of root canal disinfection and temporary sealing, respondents under the age of 29 perceived there were significant differences between classroom education and clinical requirements ($p<0.05$). Dental professionals in Shanghai indicated relatively minor discrepancies between academic instruction and clinical demands across multiple procedural steps ($p<0.05$). The collective assessment of the clinical complexity of root canal treatment exhibited a convergent trend, albeit with an overall difficulty rating surpassing those of individual procedural stages. More than half of the respondents believed that there is a need to improve and increase the proportion of teaching on indications for root canal treatment and doctor-patient communication.Over half of the participants advocated for enhancements and augmentation in the curricular emphasis on endodontic indications and doctor-patient communication skills. Only 3.7% of the respondents had encountered VR/AR applications during their school studies. In addition, in the free comments received, respondents mentioned the importance of lecturers in the instructional process.

Conclusions: Prevalent structural variances exist in the preclinical root canal treatment pedagogy within China, attributable to factors such as experiential deficiencies, abbreviated academic durations, and regional developmental disparities. Teaching content related to periodontal disease is relatively minimal, leading to increased difficulty in judging the indications for root canal treatment. This investigation, focusing on the experiential insights of dental practitioners, offers a novel vantage point for the ongoing refinement of dental educational paradigms. Clinical Trial: This study was approved by the Ethics Committee of Shanghai University of Engineering Science (Approval No. EST-2024-027).

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KEYWORDS

Root Canal Treatment, Endodontic Education, Dental Education, Clinical Practice, Dental Professional Students

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AUTHOR CONTRIBUTIONS

Ma XinYue: Conception and design of the study, work and data collection, analysis and interpretation of the results, draft manuscript, review and edition of the manuscript. Huang JingShi: Conception and design of the study, draft manuscript, review and edition of the manuscript.

DATA AVAILABILITY STATEMENT

The datasheets of the study are available after communication with the corresponding author.

FUNDING INFORMATION

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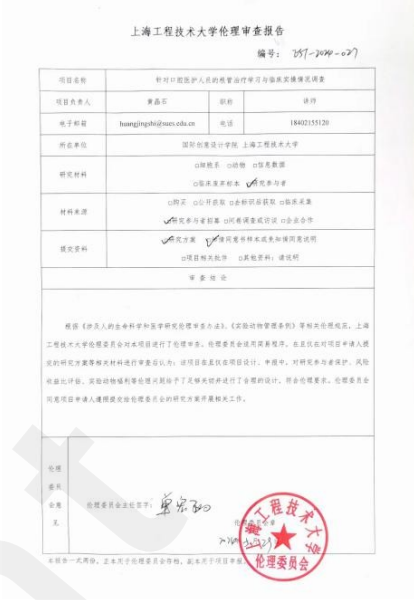
CONFLICT OF INTEREST STATEMENT

All authors declare that they have no conflicts of interest.

ETHICS APPROVAL STATEMENT

This study was approved by the Ethics Committee of Shanghai University of Engineering Science (Approval No. EST-2024-027). All data were handled and evaluated according to the above-mentioned principles.



上海工程技术大学伦理审查报告

编号：EST-2024-027

项目名称	针对口腔医护人员的感管治疗学习与临床实操情况调查		
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所在单位	国际创意设计学院 上海工程技术大学		
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根据《涉及人的生命科学和医学研究伦理审查办法》、《实验动物管理条例》等相关伦理规范，上海工程技术大学伦理委员会对本项目进行了伦理审查。伦理委员会认同简易程序。在且仅在对项目申请人提交的研究方案等相关材料进行审查后认为：该项目总体设计合理，申报中，对研究参与者保护、风险收益比评估、实验动物福利等伦理问题给予了足够关切并进行了合理的设计，符合伦理要求。伦理委员会同意项目申请人遵照提交给伦理委员会的研究方案开展相关工作。

伦理委员会主任签字：

上海工程技术大学 伦理委员会

REPORTING GUIDELINES

This study does not involve clinical trials and has not undergone clinical trial registration.

PATIENT CONSENT STATEMENT

The written informed consent of the participants was obtained prior to enrolment in the study.

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ABSTRACT

Purpose: This study aimed to investigate the subjective appraisals of Chinese dental practitioners concerning the congruence between classroom education and clinical practice of root canal treatment.

Materials and Methods: A total of 90 questionnaires were distributed via the Internet to dental practitioners in the eastern coastal areas of China using random sampling. The questionnaire segmented the root canal treatment process into 9 distinct phases (including preoperative preparation, intraoperative procedures, postoperative cleaning, and relevant doctor-patient communication), and gauged the respondents' sensitivity to the posed queries by using 7-point Likert scales.

Results: A total of 83 valid responses were collated. Notable disparities were perceived by junior practitioners between classroom teachings and clinical requisites in both root canal treatment procedures and doctor-patient communication ($p<0.05$). In the phase of root canal disinfection and temporary sealing, respondents under the age of 29 perceived there were significant differences between classroom education and clinical requirements ($p<0.05$). Dental professionals in Shanghai indicated relatively minor discrepancies between academic instruction and clinical demands across multiple procedural steps ($p<0.05$). The collective assessment of the clinical complexity of root canal treatment exhibited a convergent trend, albeit with an overall difficulty

rating surpassing those of individual procedural stages. More than half of the respondents believed that there is a need to improve and increase the proportion of teaching on indications for root canal treatment and doctor-patient communication.Over half of the participants advocated for enhancements and augmentation in the curricular emphasis on endodontic indications and doctor-patient communication skills. Only 3.7% of the respondents had encountered VR/AR applications during their school studies. In addition, in the free comments received, respondents mentioned the importance of lecturers in the instructional process.

Conclusion: Prevalent structural variances exist in the preclinical root canal treatment pedagogy within China, attributable to factors such as experiential deficiencies, abbreviated academic durations, and regional developmental disparities. Teaching content related to periodontal disease is relatively minimal, leading to increased difficulty in judging the indications for root canal treatment. This investigation, focusing on the experiential insights of dental practitioners, offers a novel vantage point for the ongoing refinement of dental educational paradigms.

BACKGROUND

Periapical lesions and endodontic diseases are highly prevalent among the global adult population[1], with root canal treatment (RCT) being one of the most common interventions provided by general dentists in clinical practice and the preferred treatment method for treating endodontic diseases.

Studies have shown that RCT is a challenging clinical intervention in dentistry, leading to varying degrees of practical difficulty for dental practitioners. Over 70% of dental practitioners express a desire for more clinical training[2]. Unlike most surgical dental procedures, RCT involves multiple steps, and any errors can result in unsatisfactory outcomes. RCT is performed in a concealed space, with limited space for operation and without visual control. It involves a variety of equipment, requires fine competence of the dentist, and involves complex operational procedures. According to dental practitioners, they often perform RCT procedures feeling a lack of control. In an emotional survey report related to RCT, nearly all dentists expressed feelings such as anxiety, frustration, stress or exhaustion[3].

Compared to other dental disciplines, endodontic therapy demands higher levels of manual dexterity and independent operational skills. Educational institutions play a crucial role in nurturing individuals to meet societal needs[4]. Optimal dental education should produce competent general practitioners in dentistry to ensure patient safety[5].[6]. However, the different education among

dental schools are considered a major obstacle to standardizing and ensuring the quality of dental education[5]. Early research on endodontic education focused on improving teaching methods, while later studies began to focus on different learning periods and the introduction of new technologies.[7] Authoritative organizations such as the European Society of Endodontology (ESE) have established guidelines to ensure educational standards. Furthermore, most dental schools in China offer a 5-year dental training program leading to a Bachelor of Dental Surgery degree, with the emphasis on clinical practice training in the final year of the dental education plan (following the "Clinical Practice for Chinese Undergraduate Students Majoring in Stomatology" standards established by Chinese Stomatological Association).[8] Due to differences in economic and cultural backgrounds between Western countries and China, disparities exist in dental education programs, licenses, curricula, and facilities.[9]

Regarding the allocation of teaching time in endodontic education, significant differences exist among countries. previous studies show substantial variations in preclinical endodontic education at dental schools. In Germany, the average time spent on theoretical courses is 13.3 hours, practical courses require an average of 45.4 hours, and the total time for the endodontics course averages 56 hours[10].[11]. In Spain, 95% of schools allocate over 20 hours for preclinical training, with 60% of schools dedicating over 50 hours[12]. However, in a study in China, 71.99% of Chinese schools spend less

than 4 hours per week on endodontics education, totaling no more than 80 hours per semester, with the lowest training time allocated to periodontics and significant shortages in facilities for dental surgery courses[13]. This indicates that education emphasis and methods vary greatly across regions.

In terms of educational systems, comparing China and the United States illustrates two distinct teaching models: In the US, after completing 4 years of general education, students are required to independently prepare some practice equipment, have relatively ample time to focus on coursework and preclinical training at schools, and enhance their skills through dental practice[9]. In China, dental schools are divided into three categories: 8-year program, 5-year program, and 3-year program. The 8-year program is only held in a few renowned dental schools in China, while the majority of dental students pursue the 5-year Bachelor program[14]. Although the order and proportion of courses may differ across schools in China, the undergraduate curriculum generally includes basic courses and dental courses. The undergraduates take public courses and basic courses of medicine in the first 2 years, focusing on clinical medical courses in the junior and senior years, with the opportunity to do a rotation in several departments such as Otolaryngology and Endocrinology. In the final year, there is no theoretical research, and all the time belongs to clinical practice. In America, clinical practice typically takes 2 years. Additionally, China has 93 dental institutions offering a shorter 3-year training program for dental assistants[15]. Upon

completion of the 3-year program and assessments, students are awarded the junior college in China, comparable to Bachelor of Science in Dental Hygiene in US (70% superposable curriculum). Differences in the dental degree concepts between China and the US might lead to inequity situations[16]. Dental education in China is mainly government-supported, with schools providing equipment for students, some dental schools cannot afford to provide advanced materials for all students.[9].

Due to the aforementioned reasons, China exhibits certain differences from other countries, both in the content and discipline orientation of endodontic education. Past research on endodontic teaching primarily focused on undergraduate and postgraduate students, leading to the limitations of research not addressing specialized students and lacking feedback from clinical practitioners. This study is designed as a random sampling survey targeting clinical healthcare professionals to gather evaluation data on clinical RCT and corresponding teaching practices. This aims to identify issues related to the differences between clinical practices and classroom education, the effectiveness of teaching content, difficulties in practical components, and the bias in educational training.

MATERIALS AND METHODS

The questionnaire was distributed and collected in May 2024, over a period

of 30 days. A total of 90 questionnaires were distributed, yielding 83 valid responses. Seven incomplete or unsuccessfully retrieved questionnaires were excluded from the data analysis, resulting in a response rate of 92.22%. The questionnaire was filled out anonymously, with no personal names or specific hospital names disclosed. This study was conducted in the form of a questionnaire and was approved by the Ethics Committee of Shanghai University of Engineering Science (Approval No. EST-2024-027).

The design of the questionnaire content involved referencing the Delphi method and forming an expert panel through three rounds of voting and discussion, resulting in the final valid questionnaire. The expert panel comprised experienced dental professionals, university professors, and dental care nurses. The discussion focused on the professionalism, representativeness, and relevance of the questions, as well as an overall assessment of the clarity and fluency of the question statements. The questionnaire consisted of 30 questions categorized into four sections. Basic questions were graded using seven-point Likert scales for sensitivity of responses, with some questions allowing for multiple choice and free-form responses. The main content addressed issues related to the disparities between learning during school and clinical work, the practical challenges of clinical RCT, and the educational methods for RCT. The questionnaire referenced a standardized endodontic textbook used in China, segmenting the entire process of clinical RCT into 9 stages, including indications for RCT, X-

ray imaging and observation, equipment adjustment, local anesthesia, root canal preparation, disinfection and temporary sealing, filling, post-treatment supplies arrangement, and communication between medical staff and patients during clinical practice.

To prevent respondent misunderstandings, non-consensual operational terms were annotated in the questionnaire [Appendix]. Participants were required to read the survey instructions prior to participating in the survey, which outlined the basic process and main content of the questionnaire, as well as clarified the voluntary nature of participation and the non-commercial research purposes of the data.

Data collection was managed using online survey software. Descriptive statistics were applied to each question to obtain basic distribution characteristics, and data were cross-compared for different grouping situations. The statistical analysis in the study was carried out using SPSS 26 (IBM), with one-way analysis of variance used for certain differential issues and the K-W independent sample test and non-parametric test methods used for questions related to the difficulty of RCT operations. The level of statistical significance was set at $p < 0.05$.

RESULT

The participants in the study were exclusively practicing dental

professionals, with 45.78% hailing from the Shanghai region, as depicted in the density distribution map(Figure.1). These survey participants all have undergone university-level education in the field of dentistry, possess a minimum of 1 year of clinical dental work experience, and have engaged in the performance of root canal treatment (RCT) during their professional tenure. The age demographic of participants ranged from 21 to 60 years, comprising 36.1% males and 63.9% females. In terms of their educational attainment, 26.5% held junior college degrees, 44.6% possessed bachelor's degrees, and 28.9% had obtained master's degrees. The spectrum of clinical dental work experience extended from a minimum of 1 year to a maximum of 36 years.

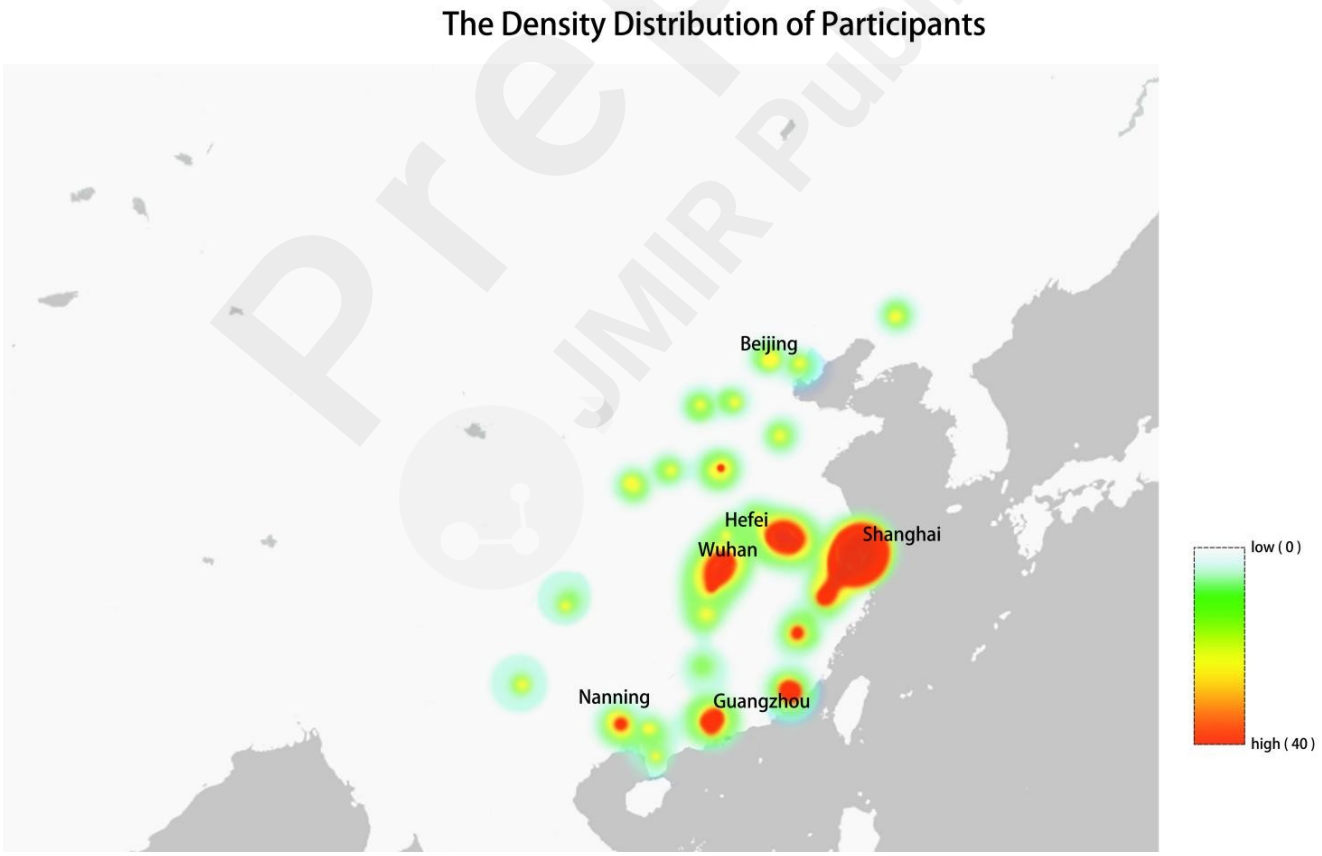

Figure.1

Density visualization of the regional distribution of clinics: *color indicates the number of participants from less (green) to more (red).*

Regarding the congruence between specific aspects of school instruction and clinical practices, respondents' answers exhibited notable disparities. This investigation revealed that in the X-ray imaging and observation stage, the congruence between bachelor's and master's degree holders was notably superior to that of junior college graduates ($p < 0.05$). Participants with junior college degrees account for 50% (11/22) of the total who expressed negative evaluations of school teaching (selecting "completely unsatisfied," "most cannot satisfy," and "slightly unsatisfied" options). In contrast, those with bachelor’s and master's degrees reported negative evaluations at rates of 22.9% (8/35) and 33.3% (8/24) of their respective totals. Bachelor’s and master's degree holders significantly surpass junior college degree holders in their positive assessments of school teaching and clinical practices; the proportion of junior college degree holders who gave positive evaluations (choosing "completely satisfied," "a little to satisfy," and "slightly satisfied" options) is 36.4% (8/22) of their total, while bachelor’s and master's degree holders selected positive evaluation options at rates of 77.1% (27/35) and 66.7% (16/24), respectively. Thus, bachelor’s and master’s degree holders evidently hold more favorable views of school teaching and clinical operations compared to those with junior college degrees. For further details refer to

Error: Reference source not found(A). Similarly, discrepancies based on educational backgrounds were also apparent in other phases, such as root canal disinfection and temporary sealing, root canal filling, post-operative supplies organization, doctor-patient and nursing coordination, as depicted in Error: Reference source not found.

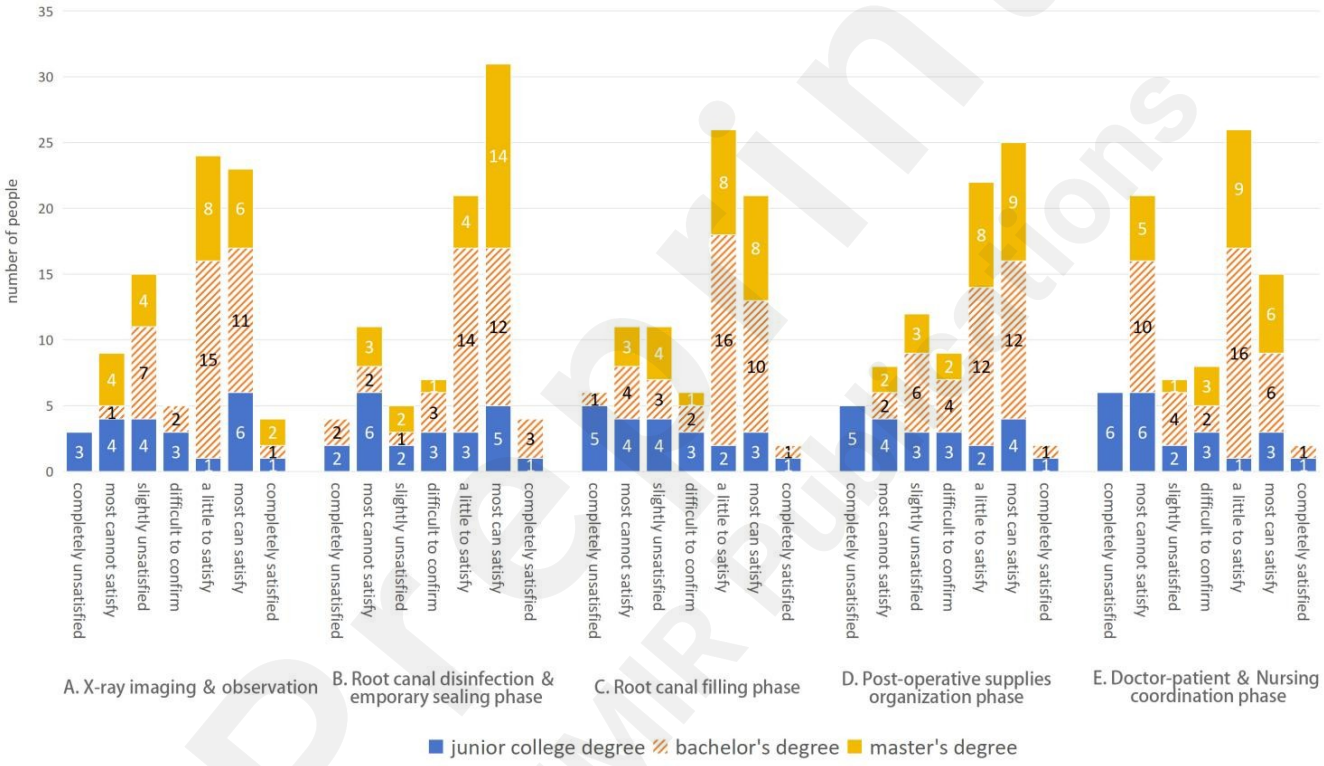

Figure.2

The Congruence Between School Instruction and Clinical Practices

The perceptions of respondents with different educational backgrounds regarding the integration of school teaching and clinical practices across five stages of RCT: Junior college degree holders who selected negative evaluation options such as "completely unsatisfied," "most cannot satisfy," and "slightly unsatisfied" constituted 50% (11/22), 45.5% (10/22), 59.1% (13/22),

54.6% (12/22), and 63.6% (14/22) of their demographic, respectively. In contrast, those who opted for positive evaluations like "completely satisfied," "a little to satisfy," and "slightly satisfied" represented 36.4% (8/22), 40.9% (9/22), 27.3% (6/22), 31.8% (7/22), and 22.7% (5/22) of the same group. On the other hand, bachelor's and master's degree students who chose negative evaluation options made up 26.2% (16/61), 16.4% (10/61), 24.6% (15/61), 21.3% (13/61), and 32.8% (20/61) of their respective totals, while those who selected positive evaluation options accounted for 70.5% (43/61), 77.0% (47/61), 70.5% (43/61), 68.9% (42/61), and 62.3% (38/61) of their groups.

In the phases of root canal disinfection and temporary sealing operations, it is apparent that the "40~" age group perceives a significantly higher alignment between school teaching and clinical practices compared to the "21~29" age group ($p < 0.05$). Among participants aged 40 and above, 50% (5/10) selected "slightly satisfied," followed by 30% (3/10) who chose "a little to satisfy" and 20% (2/10) who opted for "completely satisfied." Conversely, within the 21~29 age group, 23.5% (12/51) of participants indicated "slightly unsatisfied", which trailed only behind the 25.4% (13/51) who chose the "a little to satisfied" option. For further details, refer to Error: Reference source not found.

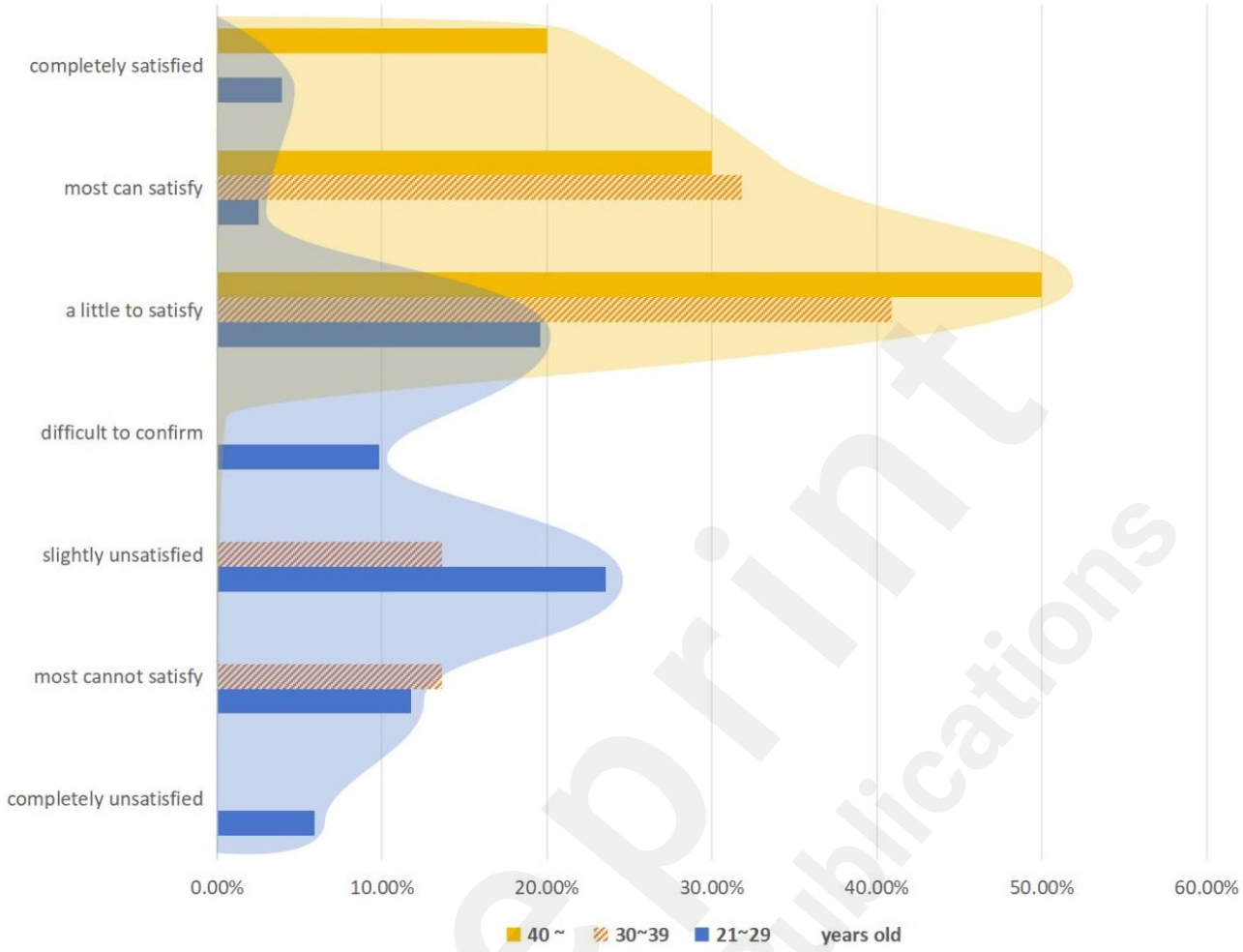

Figure.3

The Choices of Respondents in Root Canal Disinfection and Temporary Sealing Phase:

In the context of root canal disinfection and temporary sealing phase, respondents of different age groups expressed their views on the integration of school teaching and clinical operations: The 40+ age group (yellow) exclusively opted for positive attitudes (choosing "completely satisfied," "a little to satisfy," and "slightly satisfied" options), whereas 41.2% (21/51) of the 21-29 age group (blue) selected negative attitudes (selecting "completely

unsatisfied," "most cannot satisfy," and "slightly unsatisfied" options).

On the issue of the practical difficulty of clinical treatment, respondents' evaluations were homogeneous, revealing no significant categorical disparities. With respect to the overall difficulty of clinical treatment, 82% of respondents (68/83) selected the options of "slightly difficult" and "normal", exhibiting a skewness value of 0.701. In the assessment of the difficulty of each phase of RCT, respondents generally perceived the difficulty of each stage to lie between "normal" and "slightly easy", with skewness values lower than the overall difficulty skewness value. Detailed findings are illustrated in Error: Reference source not found.

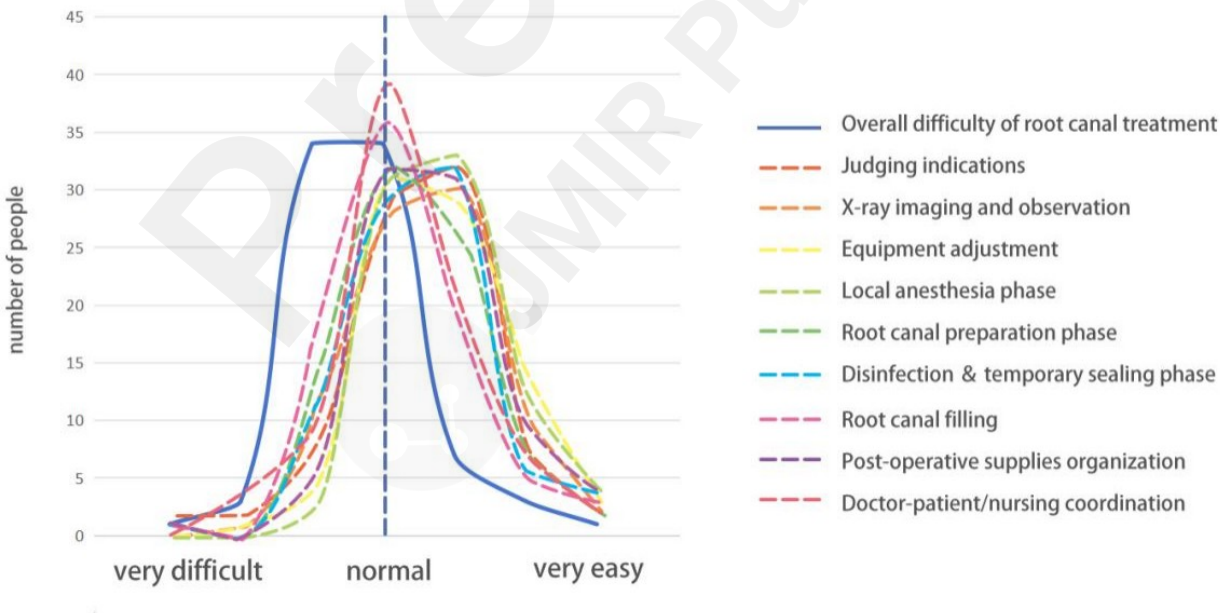

Figure.4

The Response Trend's Difficulty of the Overall and Each Phase:

The trend in respondents' answers to the overall difficulty of RCT and the difficulty of each stage is depicted as follows: The solid line (representing the overall difficulty of RCT) has a skewness value of 0.701, which is larger than the skewness values of the dashed lines (representing the difficulty of each individual stage).

Regarding perception issues in certain phases, the responses of the participants have exhibited significant variances. For instance, in the equipment adjustment phase, the congruence of the participants from the Shanghai area is generally higher than that of the participants from other regions, and they also perceive the clinical practice difficulty of this phase to be relatively low ($p < 0.05$). For the composition of the difference in the equipment adjustment phase, refer to Error: Reference source not foundA: the graph of the sample of the Shanghai area shows a positively skewed distribution, with a skewness value of 0.385; the graph of the sample from other areas exhibits a negatively skewed distribution, with a skewness value of -1.013. In other phases such as indications judgment, equipment adjustment, root canal preparation, root canal disinfection and temporary sealing, root canal filling, post-operative supplies organization, and the phase of doctor-patient/nursing coordination in the clinic, the graphical representation of the sample from the Shanghai area also reveals a significantly positive bias compared to those from other areas, as detailed in Error: Reference source

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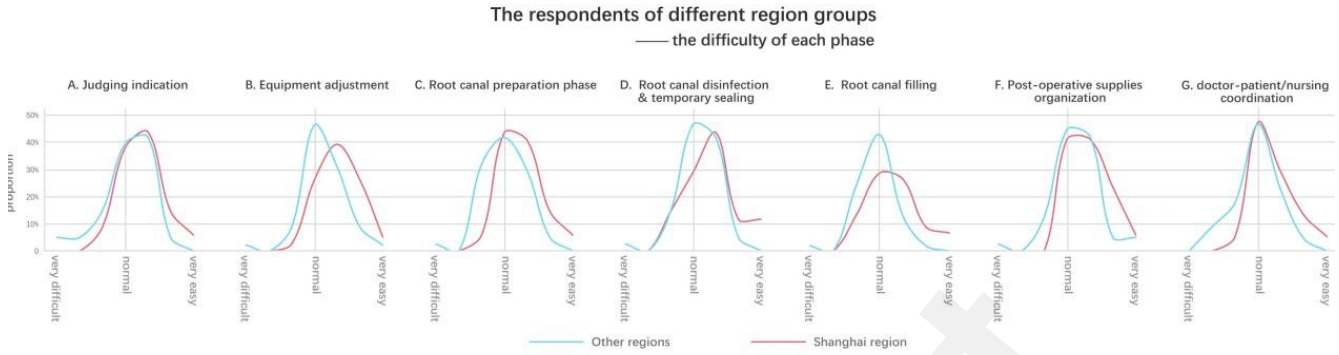

Figure.5

The respondents of different region groups__the difficulty of each phase:

The trend in responses to questions about the variability in certain phases of RCT shows that the skewness values for the Shanghai population samples, from left to right across the seven graphs, are 0.385, 0.105, 0.567, 0.323, 0.499, 0.578, and 0.758, respectively. In contrast, the corresponding skewness values for the population samples from other regions are -1.013, -0.339, -0.306, -0.942, -0.383, -0.211, and -0.215.

In the survey assessing the disparities between clinical work and on-campus learning, 69.9%(58/83) of the respondents opined that the scenario of judging the indications for RCT in the clinic is more intricate, 68.7% (57/83) of the respondents held the view that there is a marked divergence in the modes and methods of doctor-patient communication in the clinic vis-à-vis the related instruction in the academic setting, and with regard to the configuration and

application of equipment, 51.8% (43/83) of the respondents contended that there is a significant variance between the clinical RCT work and the on-campus pedagogy. See Error: Reference source not found for details.

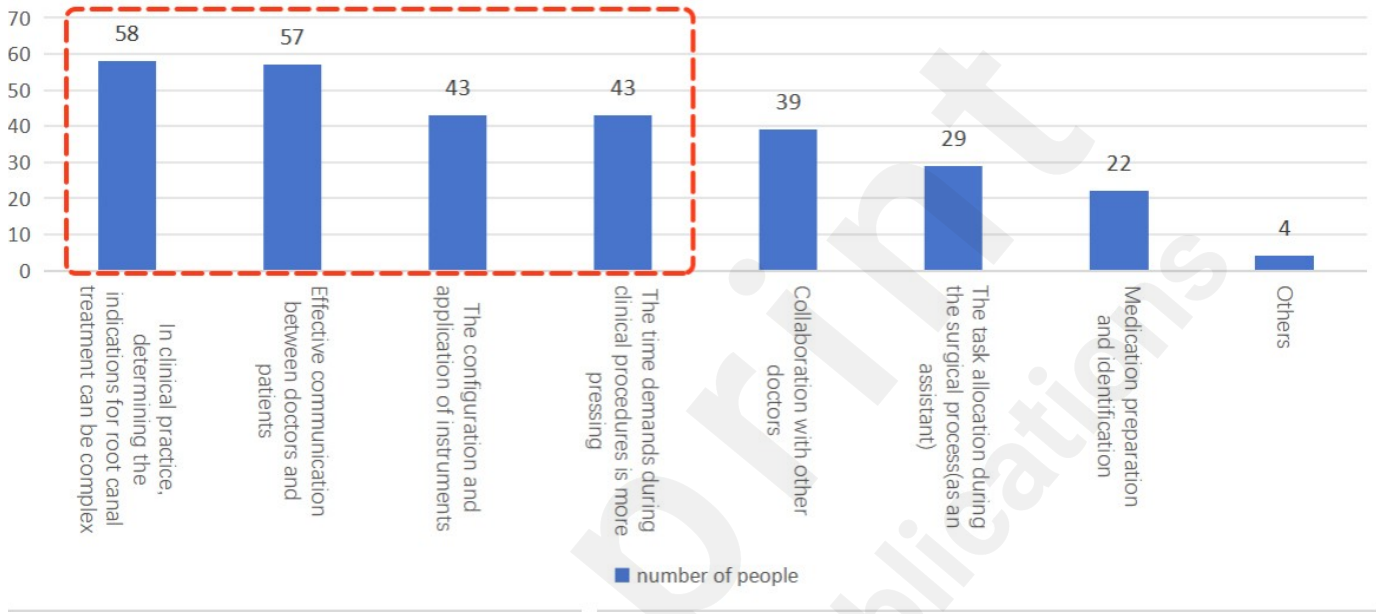

Figure 6

The major difference between clinical work and school study:

the red box highlights the option endorsed by over half of the participants.

When asked about the teaching methods encountered in the school, 78% (64/83) of the respondents received cavity preparation and filling training in the school, 75.6% (62/83) of the respondents reported that video demonstration was a prevalent teaching method, and 61% (50/83) of the respondents were exposed to the practice of taking X-ray imaging in the school. However, 25.6% (21/83) of the respondents were exposed to dental modeling software practice and digital assessment and review, and only 3.7% (3/83) of the respondents

were exposed to VR/AR in the school learning process. See Error: Reference source not found for details.

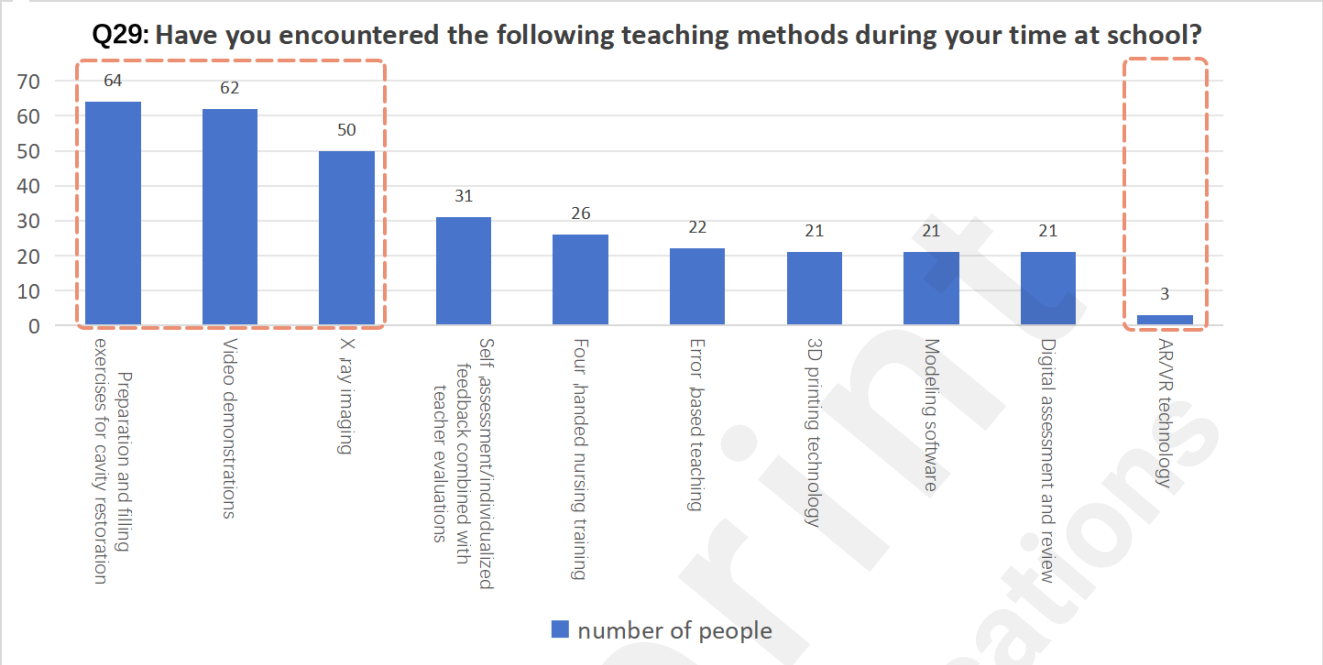

Figure.7

The answer situation of how the respondents learned in school:

The red box highlights the teaching methods that over half of the participants have been exposed to: preparation and filling exercises for cavity restoration, video demonstration and X-ray imaging, along with a method that few participants have encountered: AR/VR technology.

56.6% (47/83) of the respondents believed that there is too much didactic teaching in the school teaching process, while the proportion of practical practice is insufficient. 48.2% (40/83) of the respondents advocated for an enhancement in the identification and treatment teaching of different pulp conditions. 45.8% (38/83) of the respondents expressed the desire for an

augmentation in the identification and treatment instruction of various periodontal conditions. In addition, respondents who believed that the school should focus on the content of patient psychological care/doctor-patient communication and appointment schedules in the clinic also reached 43.4% (36/83). See Error: Reference source not found for details.

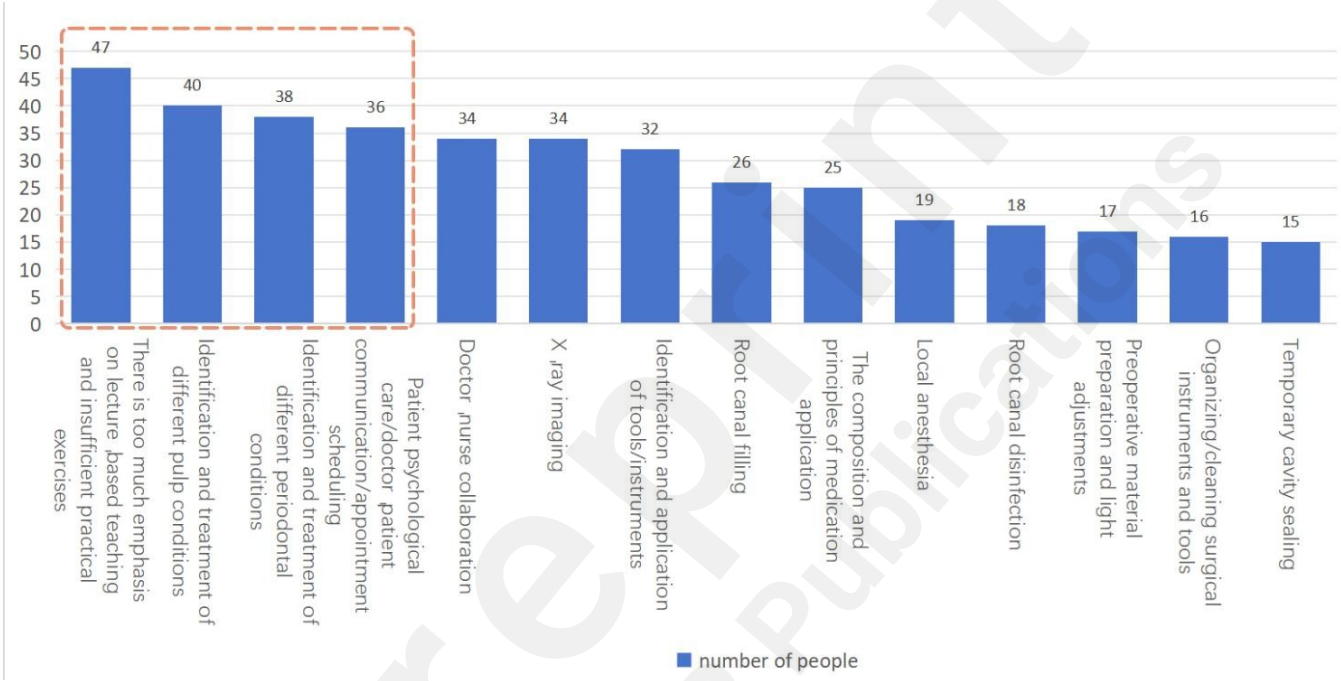

Figure.8

Respondents considered an improved aspect of the school:

the red box denotes the four aspects of RCT teaching that a significant number of participants suggest should be improved.

Finally, this study collated and categorized the self-statements of the participants in the "other" option, in the clinical practice of RCT, there is a noted difficulty in identifying or utilizing/disbursing tools or medications: 20% (3/15) of the respondents think it is difficult to use the Gutta Percha Obturation

Guns in the root canal filling phase. 33.33% (5/15) of the dental practitioners believed residual pulpitiis is a common complication of RCT. In addition, 20% (3/15) of the respondents emphasized that in the on-campus instruction, the importance of the practice instructors cannot be understated, of which 66.67% (2/3) are college degree holders.

DISCUSSION

The findings of this research indicate that the extent of RCT instruction received by dental professionals in Southeast China is influenced by a variety of factors, including educational background, geographical location, age, instruction in periodontal diseases, and perceived difficulty. These disparities not only reflect the subjective perceptions of dental practitioners regarding the efficacy of RCT education but also highlight the discrepancies between academic instruction and clinical demands.

In terms of educational background, the outcomes of this study reveal that different educational environments will lead to differences in the clinical adaptability of dental practitioners in the RCT. Compared to those holding bachelor's or master's degrees, dental practitioners with junior college degrees perceive a lower congruence between on-campus instruction and clinical application. Moreover, in responses to open-ended questions, participants underscored the significance of the teaching proficiency of academic staff,

especially in the field of junior college education, where there is a pronounced scarcity of systematic RCT instructional resources. This phenomenon may stem from the fact that in dental pedagogy, RCT content is predominantly geared towards undergraduates and above students, with scant research focused on junior college dental education. We used "endodontics", "root canal therapy", "teaching", and "students" as the core keywords to search in Google Scholar. In the nearly 6 years (2017-2024) of relevant Chinese literature, only Zhang Hua (2017)[16]. and Haofeng Jiang, Lu Shen and others (2022)[17]. mentioned the issue of dental education for people with junior college degrees, while studies concerning undergraduate and higher qualifications constituted 92.3% (24/26) of the total. The dearth of dedicated teaching and corresponding research inevitably leads to a deficiency in theoretical grounding and practical experience for junior college students when confronted with specialized treatments. Notably, the proportion of dental practitioners with junior college degrees actively practicing in China is substantial. For instance, in Shanghai, 38.6% of dentists employed by dental units possess junior college degrees[18]. A survey on dental resource allocation in community health centers in Shanghai's Pudong New Area reported that 27.0% of dentists and 70.5% of dental nurses hold junior college degrees[19]., underscoring the indisputable influence of the professional competency of these practitioners on the overall medical standards of the dental sector. Furthermore, previous research results have shown that students from A and

A+ level schools showed higher satisfaction with their preclinical courses[13], suggesting that disparities exist not only between non-equivalent but also equivalent qualification-awarding schools. The allocation of educational resources emerges as a crucial factor affecting teaching satisfaction, necessitating attention to the issue of educational resource tilt.

In the multifaceted issue concerning the influence of regional disparities on the perception of RCT instruction, this study discerned that dentists in Shanghai exhibit a greater acknowledgment of the efficacy of institutional teaching compared to their counterparts in other locales. Concurrently, Shanghai-based practitioners perceive a relatively lower degree of difficulty in clinical applications. This suggests that the caliber of dental pedagogy may be intrinsically linked to regional variations. Regional differences can cause inequality in dental services and education. One of the main reasons is the inequality of economic income, necessitating governmental intervention and regulation[20].[21]. A national survey on dental health resources corroborates the existence of inequality in the distribution of the national professional institutions and stomatological workforce[22]. The highest concentration of dentists is observed in Beijing, whereas Tibet records the lowest[15]. Apart from inter-provincial and inter-city economic disparities, intra-city variances are also evident. For example, the total number of dental health care personnel in Shanghai is relatively sufficient, but its distribution is unfair, and fewer dental health care personnel are employed in the suburbs[18]. In the study of Sophie

F. Reda, Seif M. Reda, and others[20], further highlights the significant difference in dental services accessed by urban versus rural residents, substantiating the findings of this investigation. In conclusion, the research underscores the impact of regional disparities on the allocation of dental medical resources, aligning with the outcomes of this article and indirectly affirming the strong correlation between dental instruction and factors such as regional economic development and urban scale.

This investigation also unveiled significant disparities in the perception of certain skills attributable to age factors. For instance, in the issue of differences in the operation phase of root canal disinfection and temporary sealing, the fit of the "40 ~" group is significantly higher than that of the "21~29" group. As shown in Figure 2, age factors have diversity in the perception evaluation of the difficulty of clinical RCT. The "40~" group generally focuses on more satisfied choices for school teaching, while nearly half of the "21~29" group are not very satisfied with school teaching. The underlying reasons for this variance may be twofold: firstly, the evolution of teaching content and methodologies related to clinical RCT in Chinese dental education over the past two decades; secondly, the potential memory bias among older respondents due to their extended years in practice, coupled with a reduced sensitivity to the intricacies of RCT. Additionally, the disconnect between contemporary teaching content and clinical practice cannot be overlooked. Some pedagogical approaches fail to keep pace with clinical

advancements, or certain procedural aspects are not adequately emphasized during institutional instruction, leading to student difficulties in adapting to the clinical environment. Further examination is warranted to elucidate these specific circumstances.

In this study, nearly half of the dental practitioners hope that the school will increase the identification and treatment teaching of different periodontal diseases and endodontic diseases. A comprehensive grasp of periodontal diseases is deemed essential for the achievement of successful therapeutic outcomes. The study of Jurič, Vidmar, and others pointed out that periodontal disease is also one of the main reasons for the failure of RCT[23], thereby underscoring the inadequacies in current curriculum design. The issue of periodontal disease education is not confined to China but is also pronounced in other countries, with the US and Europe grappling with inconsistencies in teaching methodologies[25].[26]. These conclusions of previous surveys coincide with the conclusions in this study, which shows that periodontal disease teaching is a difficult point in dental teaching and practice. The degree of on-campus training and practice is not enough, and most dental schools in China cannot provide sufficient equipment and materials for all students. In addition to this, the periodontal disease course allocation time in Chinese schools is the lowest[13]. The scarcity of class hours and courses hinders students from acquiring an in-depth understanding and mastery of relevant knowledge. Consequently, students emerge from their academic programs without

sufficient training and quality assurance in periodontal disease management, resulting in clinical practitioners who are ill-equipped in this domain. The outcomes of the fourth national dental health survey reveal a scarcity of dentists and periodontists, coupled with a generally poor periodontal health status among the Chinese populace and inadequate periodontal treatment[15]. This paucity of clinical periodontists, in turn, limits the availability of specialized educators in the field of periodontology, incapacitating academic institutions from offering robust guidance and support, thereby compromising the quality of instruction. There is a vicious cycle in periodontal disease teaching (lack of teaching teachers, less allocation of teaching hours, and weak clinical demand). The lack of teaching resources leads to the lag of teaching concepts, further resulting in the inability of school teaching content to meet actual needs, which is an issue that needs to be urgently addressed.

With regard to the integration of new media technologies in classroom instruction, this study indicates that traditional pedagogies predominantly prevail in RCT education within the Chinese context, with video presentations being one of the most frequently employed methods. and the application of other new media is lacking. The utilization of other novel media is notably scarce. Given the technically intricate nature of root canal therapy, there exists a greater imperative for practical instruction and direct, personalized guidance. The underutilization of new media in teaching can be attributed to two primary factors. Firstly, some educators may lack the requisite training and experience

in employing new media for instructional purposes, thereby hindering the effective integration of these technologies. This limitation underscores the current constraints in utilizing new media to impart practical skills. Secondly, the absence of adequate technical infrastructure and resources in certain educational institutions poses a significant barrier. The lack of necessary equipment for new media applications and the dependency on network connectivity for online teaching further exacerbate these challenges. Previous research has demonstrated the potential of new media technologies, such as AR (Augmented Reality) and VR (Virtual Reality), to offer innovative learning opportunities for dental practitioners. These technologies facilitate the establishment of a safe, effective, and sustainable feedback-driven learning mechanism, thereby enhancing the educational experience for students.[26]. However, such teaching methods have not been popularized, necessitating further exploration and implementation to bridge the gap between contemporary technological capabilities and dental educational practices.

In terms of the perceived difficulty of RCT, the findings of this study reveal an intriguing trend: participants report a higher level of difficulty when considering RCT as a whole, as opposed to assessing the difficulty of each individual phase separately. As illustrated in Figure 3, the perceived difficulty peaks on the simpler end when phases are evaluated independently, whereas in the overall assessment, a majority of respondents deem the operational aspects of RCT to be more challenging. This subjective impression bias may

stem from the necessity for dental practitioners to coordinate each phase within the broader context of the procedure, necessitating a comprehensive consideration of multiple factors, thereby amplifying the perceived complexity of the overall operation. Alternatively, it could indicate a potential disconnect between the instructional phases of RCT and their clinical application, suggesting a possible gap in the integration of theoretical knowledge with practical skills. Endodontic therapy, when compared to other dental specialties, demands a higher degree of manual dexterity and autonomous operational capability. Previous studies have shown that dental students have difficulties to varying degrees in judging the indications of RCT, taking X-rays, and root canal filling[27].[28].[29]. These observations align with the outcomes of the present study, underscoring the relative challenge associated with these phases and pointing to existing educational deficiencies. However, the specific reasons underlying these challenges are not fully elucidated by this questionnaire and warrant further investigation.

This study adopts the perspective of practicing dental practitioners to retroactively scrutinize issues pertaining to RCT instruction, aiming to ascertain the efficacy of academic teaching in clinical applications. The random sampling methodology employed, devoid of restrictions based on academic qualifications, effectively mirrors the circumstances and requirements of clinicians in the field. Furthermore, this investigation utilizes the Likert seven-point scale, which, in contrast to the widely employed five-

point scale, is more adept at reflecting the genuine subjective assessments of respondents regarding the subject matter[30].

The primary limitation of this study pertains to the geographic scope of data collection, which is predominantly centered around Shanghai and its adjacent cities in southeastern China. The variability in responses may be attributed to regional disparities in teaching methodologies and the broad age range of participants, leading to an imbalanced sample distribution and consequently impacting the level of confidence in the findings. Moreover, due to the constraints of the sample size, the generalizability of the survey results requires enhancement, necessitating further investigation to meticulously evaluate the nuances of academic teaching efficacy, clinical application, and the intricacies of RCT.

CONCLUSION

This study conducted a cross-sectional survey to assess the perceived discrepancies between classroom instruction in RCT and clinical practice among practicing dental clinicians. The findings reveal structural disparities in factors such as clinical experience, educational qualifications, and hospital location. These disparities influence clinical treatment plan decisions, potentially leading to overtreatment or inappropriate management, thus exacerbating patient discomfort, extending treatment duration, and increasing

treatment burden. Optimizing classroom content can expedite students' transition to clinical practice and bolster their confidence in the diagnostic and therapeutic process. By focusing on clinicians' satisfaction with RCT education in conjunction with their work experience, this study offers a novel perspective and a crucial reference for refining dental education.

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Abbreviations

RCT : root canal treatment

APPENDIX

Survey on Root Canal Treatment Learning and Clinical Practice

——for Dental Professionals

Please read the Clinical Research Informed Consent Form [Attached] carefully before filling out the questionnaire.
Thank you for your participation!

Basic Information

1. Please tick your gender

✓ Male
✓ Female

2. Please tick your highest level of education □

✓ Secondary Vocational
✓ Junior college Degree
✓ Bachelor's Degree
✓ Master's Degree
✓ Doctoral Degree

3. Please fill in the name of your major studied in school _____
4. Year of graduation _____
5. Years of working in your current job _____ years

(If work experience < 1 year, the questionnaire ends)

6. Have you been clinically involved in root canal treatment related work? (Select "Yes" to continue the questionnaire, select "No" to end the questionnaire)

✓ Yes
✓ No

7. Please briefly describe your usual work content:
You can tick

✓ Doctor
✓ Nurse
✓ Technician
✓ Guide
✓ Other, please specify below(You can specify the work content below, e.g., surgical assistance, oral scanning, etc.)

8. How do you perceive the difficulty of performing/assisting in root canal treatment clinically?
[Please tick the degree you think from the following seven numbers:

Difficulty Level	Very difficult	Quite difficult	Slightly difficult	Normal	Slightly easy	Quite easy	Very easy

Number	1	2	3	4	5	6	7

Questions about the discrepancy between in-school learning content and clinical work

Do you think that the learning during your time at school meets the content needs of clinical work ?

	Very difficult	Quite difficult	Slightly difficult	Normal	Slightly easy	Quite easy	Very easy
Judging indications	1	2	3	4	5	6	7
X-ray imaging observation	1	2	3	4	5	6	7
Equipment adjustment	1	2	3	4	5	6	7
Local anesthesia phase	1	2	3	4	5	6	7
Root canal preparation phase	1	2	3	4	5	6	7
Disinfection Temporary sealing	1	2	3	4	5	6	7
Root canal filing	1	2	3	4	5	6	7
Post-operative supplies organization	1	2	3	4	5	6	7
Doctor-patient/nurs-ing coordination	1	2	3	4	5	6	7

Questions about the practical operation of clinical root canal treatment procedures

How do you perceive the difficulty of judging the indications for root canal treatment in clinical practice ?

	Completely Unsatisfied	Most Cannot Satisfy	Slightly Unsatisfied	Difficult to Confirm	Slightly Satisfied	A Little to Satisfy	Completely Satisfied
Judging indications	1	2	3	4	5	6	7
X-ray imaging observation	1	2	3	4	5	6	7
Equipment adjustment	1	2	3	4	5	6	7
Local anesthesia phase	1	2	3	4	5	6	7

Root canal preparation phase	1	2	3	4	5	6	7
Disinfection Temporary sealing	1	2	3	4	5	6	7
Root canal filing	1	2	3	4	5	6	7
Post-operative supplies organization	1	2	3	4	5	6	7
Doctor-patient/ nursing coordination	1	2	3	4	5	6	7

Questions about the methods and approaches of school education in root canal treatment

28. What do you think is the biggest difference between clinical work and in-school learning in terms of root canal treatment? [Multiple choices]
A. Drug preparation and identification
B. Configuration and application of instruments
C. More complex clinical judgment of root canal treatment indications
D. Need for coordination with other doctors during the treatment process
E. More urgent time requirements for clinical operations
F. Task division in various stages of the surgical process (as an assistant)
G. Methods of doctor-patient communication

29. Have you been exposed to the following teaching methods in school? If so, please tick. [Multiple choices]

A. Video demonstration
B. 3D printing technology
C. AR/VR technology
D. Modeling software
E. Digital assessment and review
F. Self-assessment/Individualized feedback combined with teacher evaluation
G. Four-handed nursing training
H. Cavity preparation and filling exercises
I. X-ray film shooting
J. Error-based teaching method

30. Which aspects of root canal treatment-related teaching content do you think can be improved in school learning? [Multiple choices]

A. Too much lecture-based teaching, insufficient practical exercises
B. Composition and principles of applied drugs

C. Differentiation and treatment of various periodontal diseases
D. Differentiation and treatment of various pulp diseases
E. Preoperative material preparation and lighting adjustment
F. X-ray film shooting
G. Local anesthesia
H. Identification and application of tools/instruments
I. Root canal disinfection
J. Temporary sealing of the cavity
K. Root canal filling
L. Medical and nursing cooperation
M. Postoperative organization/cleanup of surgical instruments and tools
N. Psychological care for patients/doctor-patient communication/scheduling appointments, etc.

Supplementary Files

Untitled.
URL: http://asset.jmir.pub/assets/e1945d63b71066036170f808407ea17b.pdf

Untitled.
URL: http://asset.jmir.pub/assets/3ae12dd3b37f5bf60096b251982d20f3.pdf

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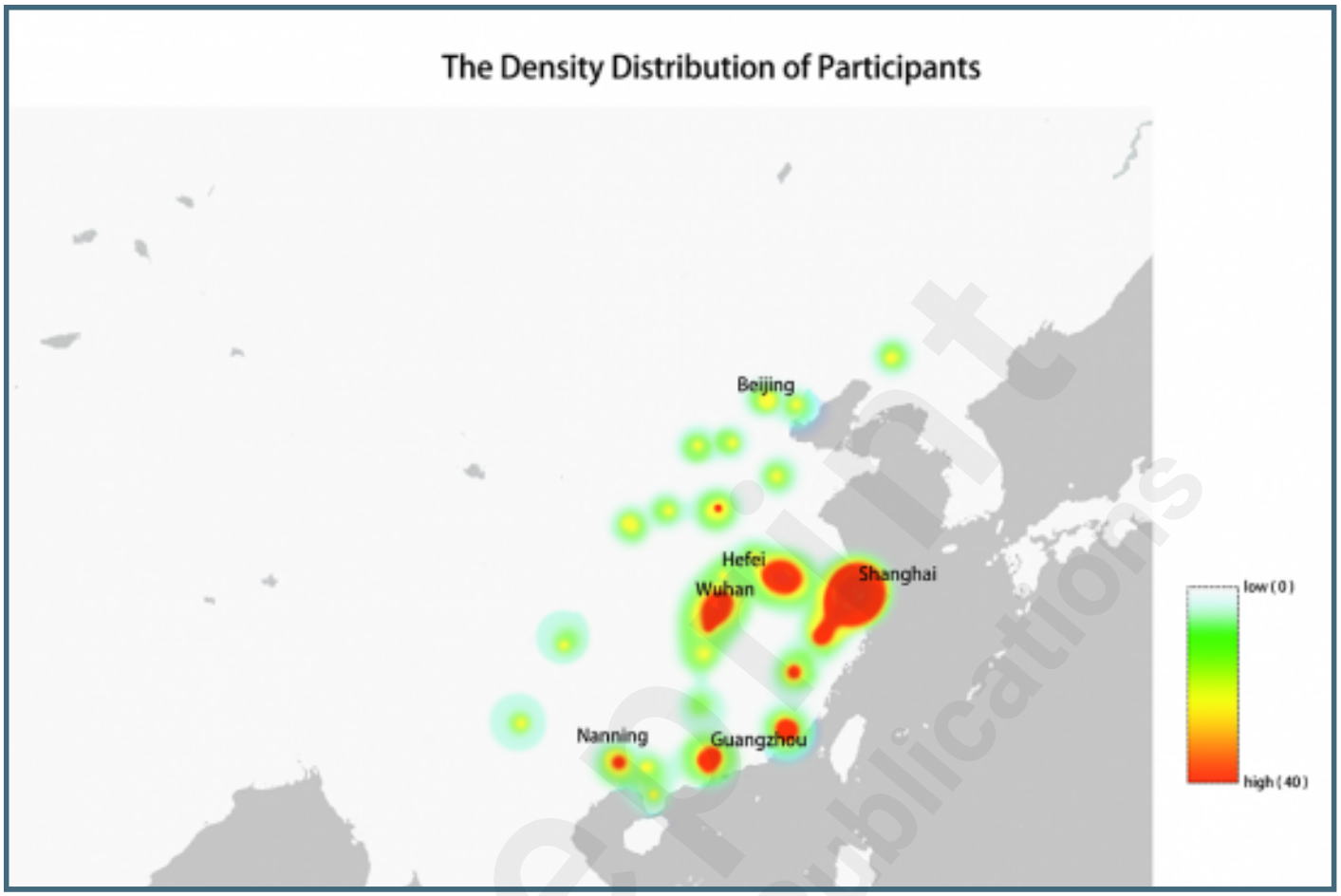
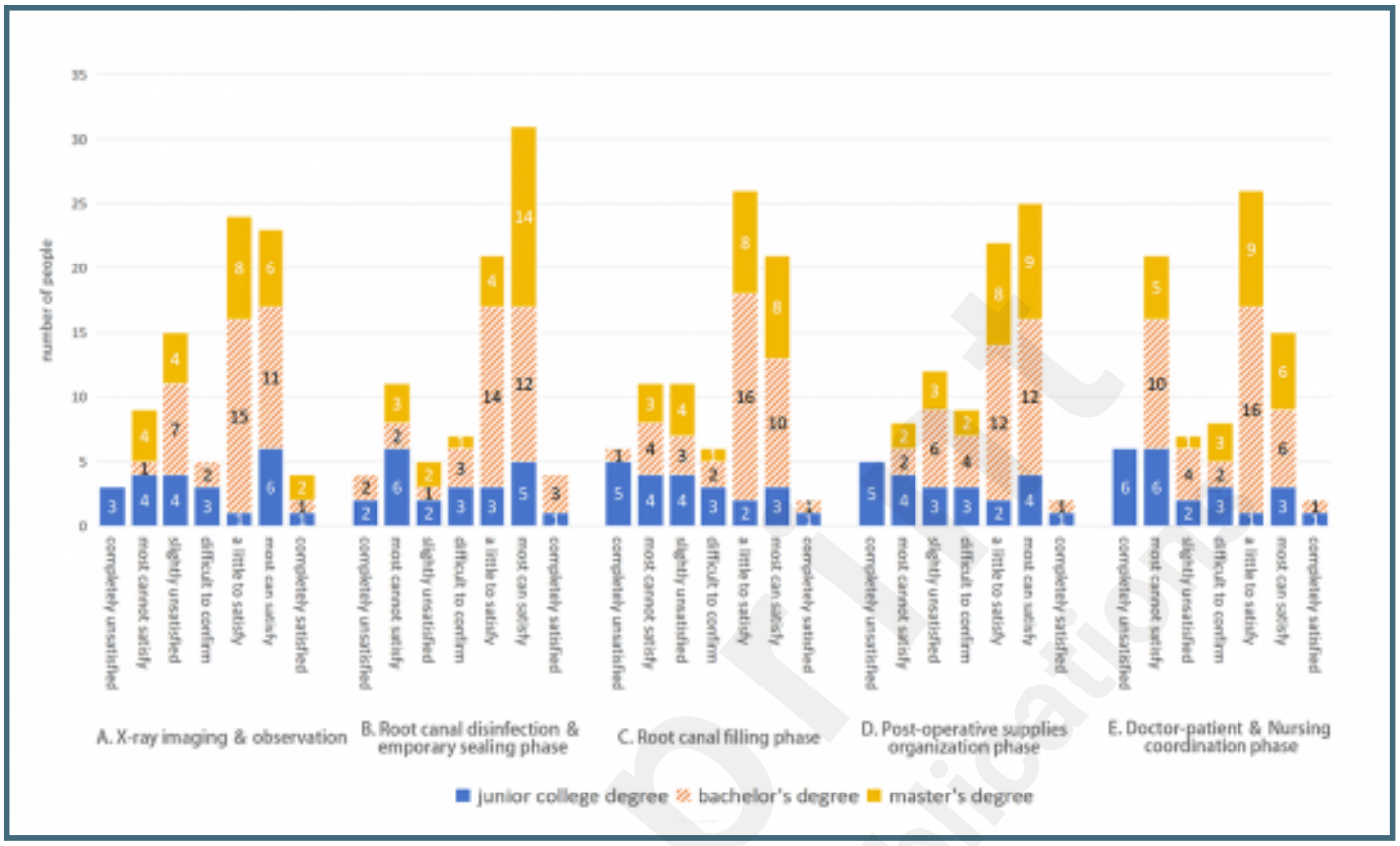
URL: http://asset.jmir.pub/assets/7928344ccc5090774fdd60afc5568051.pdf

Figures

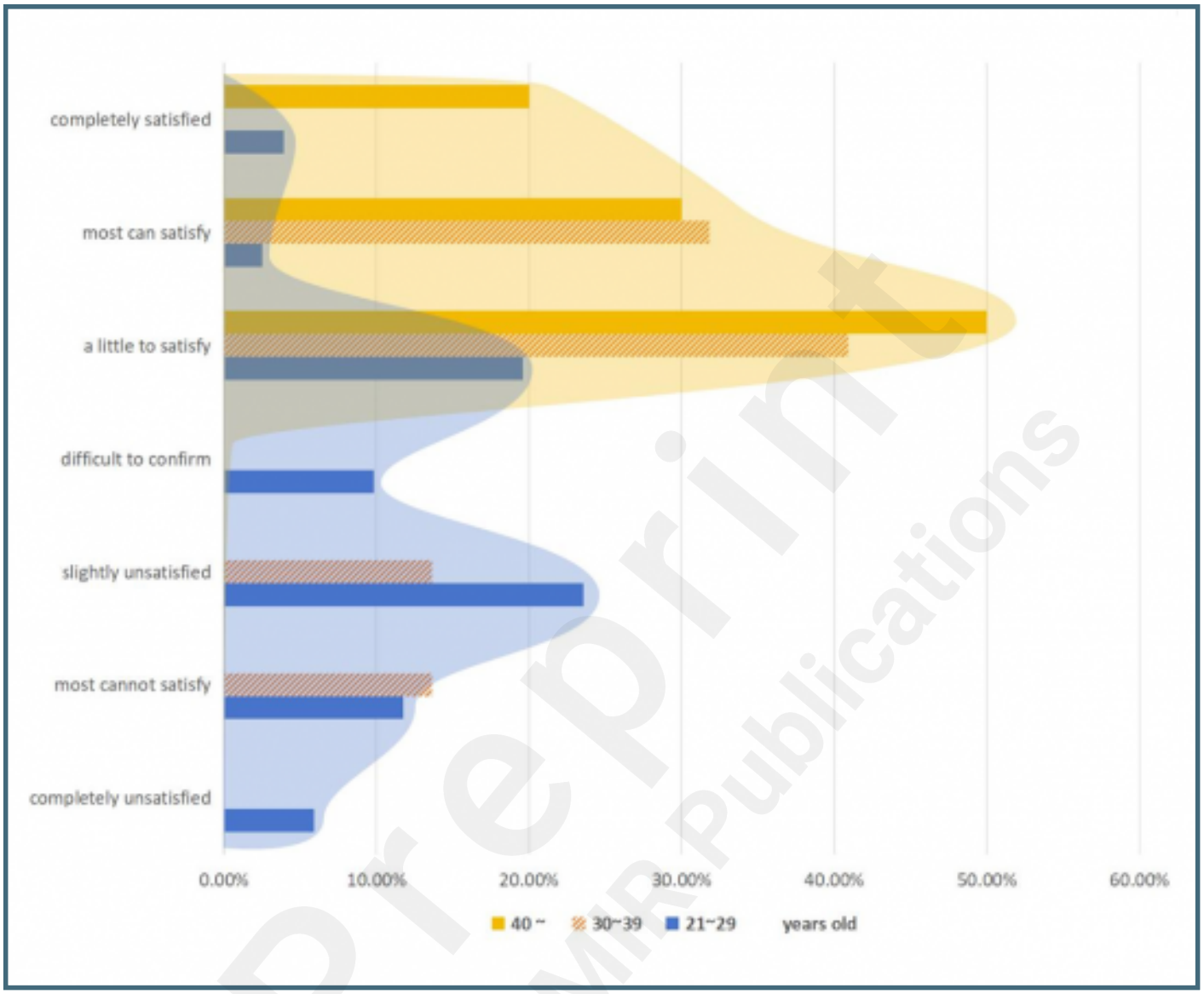
Density visualization of the regional distribution of clinics.



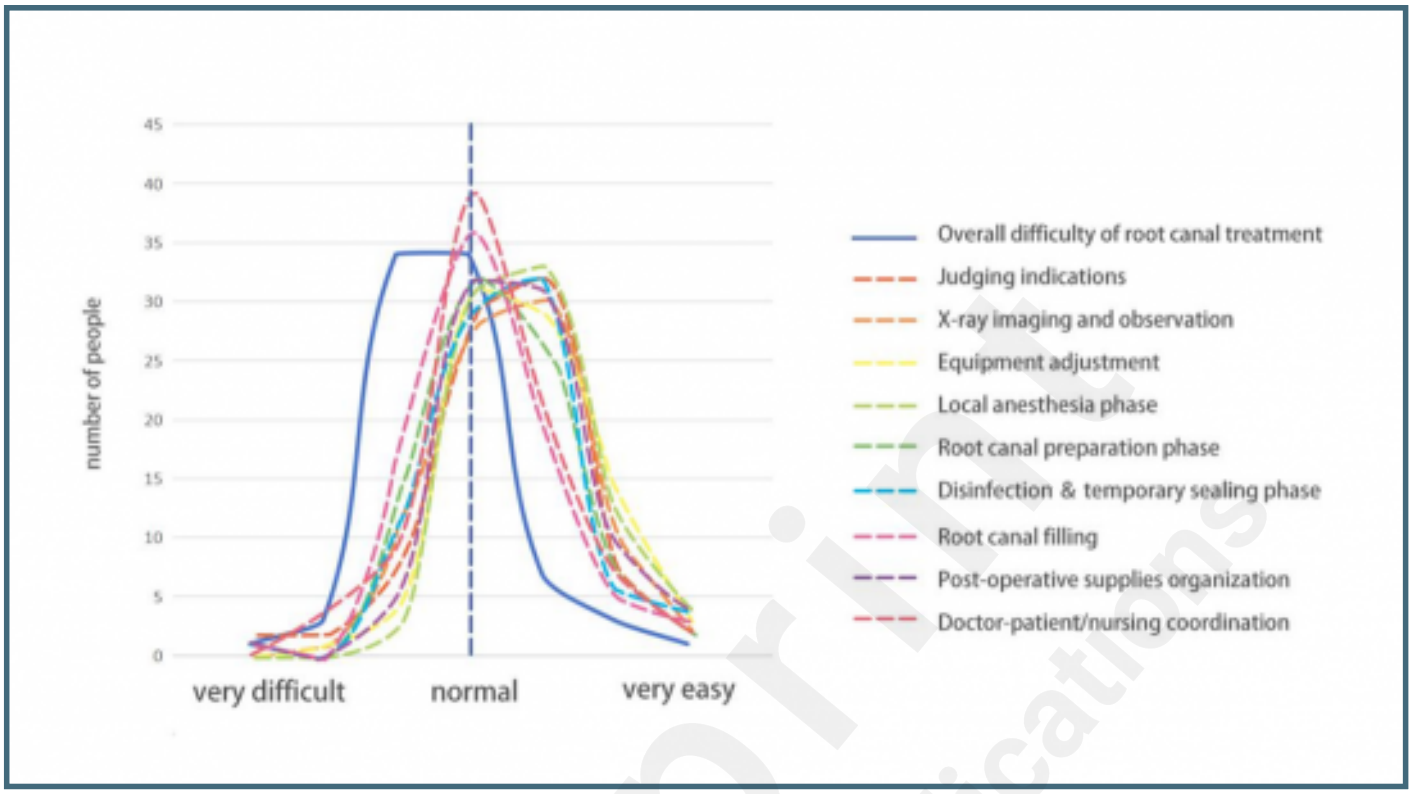
The Congruence Between School Instruction and Clinical Practices.



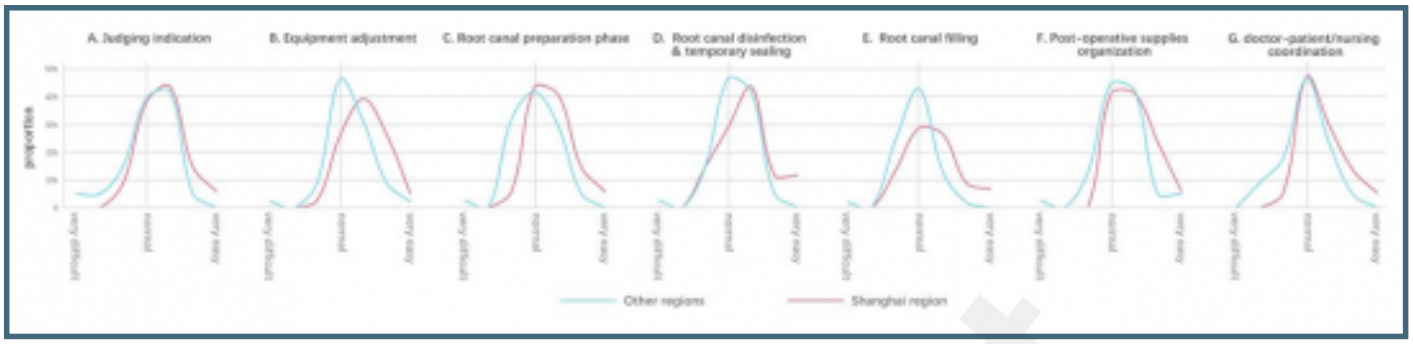
The Choices of Respondents in Root Canal Disinfection and Temporary Sealing Phase.



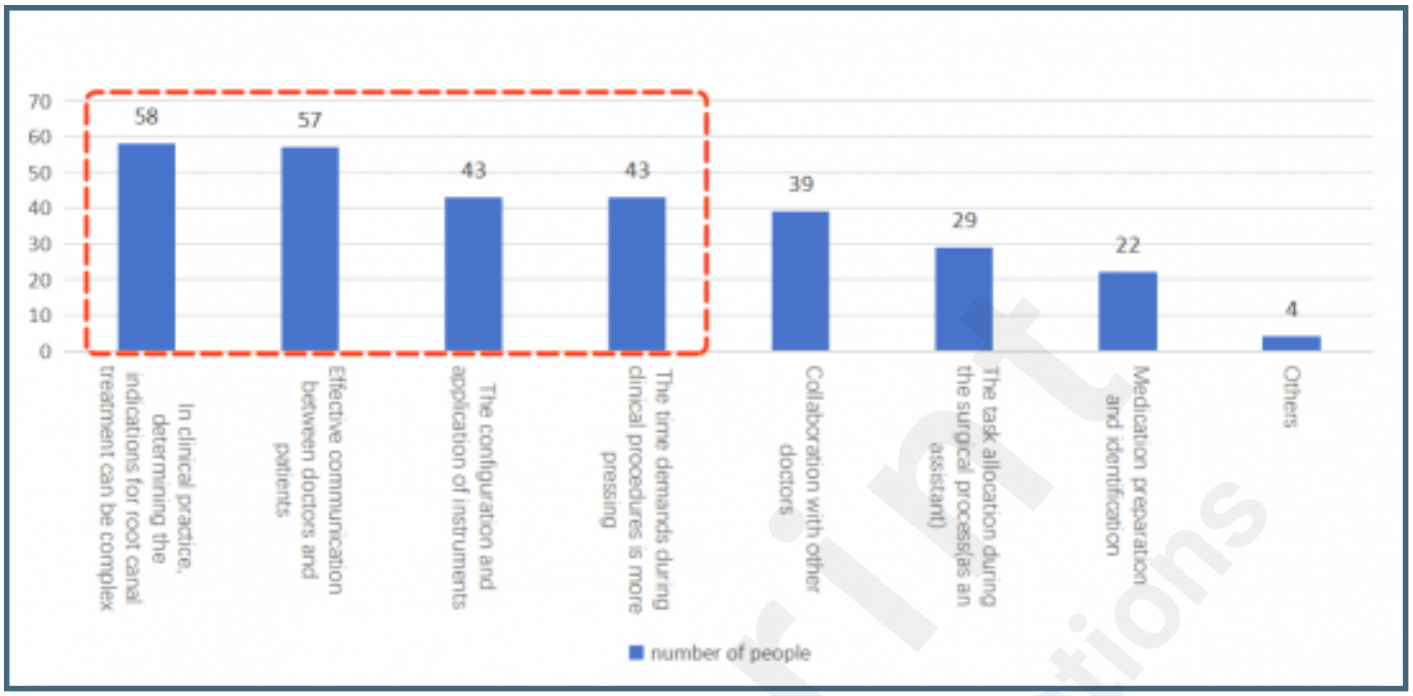
The Response Trend’s Difficulty of the Overall and Each Phase.



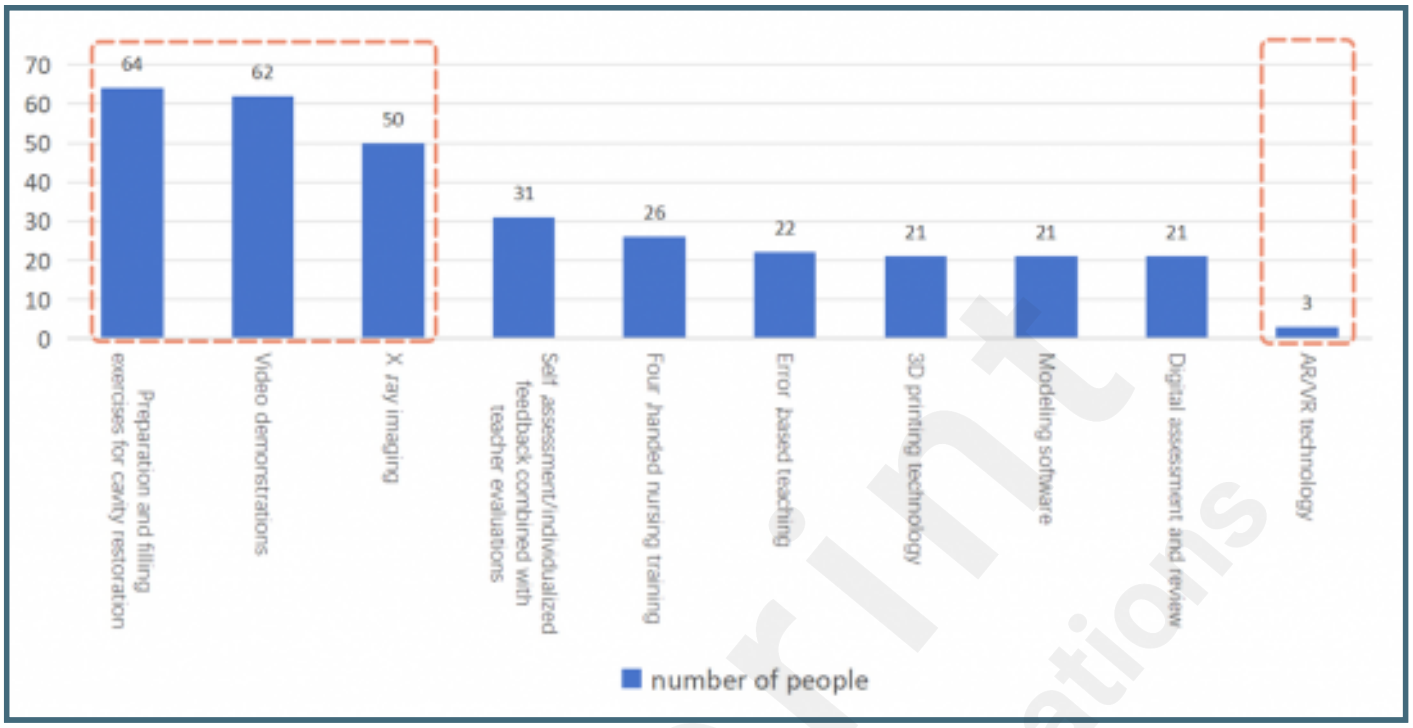
The respondents of different region groups__the difficulty of each phase.



The major difference between clinical work and school study.



The answer situation of how the respondents learned in school.



Respondents considered an improved aspect of the school.