

Application of Remote Online Learning in Oral Histopathology Teaching: An Acute Response to the COVID-19 Pandemic

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Abstract

Background: The aim of this study was to investigate the experience of the combination of remote learning and virtual microscopy in oral histopathology teaching, a unique experience in China in response to the Covid-19 pandemic.

Methods: 192 third-year dental students were recruited to participate in the course independently on the E-learning platform and Virtual Simulation Experiment Teaching Center of Stomatology of Nanjing Medical University. A questionnaire survey explored students' satisfaction with the education. Differences of assessment results among different groups were compared using Mann-Whitney U and independent-sample T tests.

Results: The mean Theory test scores of the Online group (80.93 ± 12.15) were significantly higher than those of the Traditional group (73.65 ± 8.46) ($P < 0.01$). The mean total scores of the Online group (82.94 ± 10.76) were significantly higher than those of the Traditional group (77.25 ± 7.55) ($P < 0.01$). The percentage of high total test score (test score > 85) of the Online group (54%) was also significantly higher than that of the Traditional group (15%) ($P < 0.01$). Furthermore, both remote learning and virtual microscopy courses were well accepted by students according to the questionnaire.

Conclusions: The application of remote learning and virtual microscopy have enhanced oral histopathology teaching in China in response to the Covid-19 pandemic.

Background

In 2020, the Covid-19 pandemic has driven great changes to higher education all over the world, owing to social distancing limitations[1-5]. This has led to an immediate change to remote learning by a variety of universities. The oral histopathology teaching of Nanjing Medical University in China also faced unique challenges. This study aimed to identify the approaches taken in Nanjing Medical University to deliver oral histopathology education through both online teaching and face-to-face laboratory teaching.

It is true that Covid-19 pandemic limited the teaching in the first quarter of 2020 in China. Oral histopathology is an interdisciplinary discipline providing understanding of the nature and cause of diseases. It is one of the most important dental disciplines, connecting morphological changes to clinical work. Therefore the study of oral histopathology is important in dental study [6].

Due to the covid-19 pandemic, the transition to remote learning tools is urgent[3,4]. To make the transition to remote learning easier, we've applied the browser-based e-learning and the virtual educational system for dental students accessible from off-campus that will help educators and students as they navigate remote learning. Students could choose to determine what access to the remote learning, such as computer, tablet or mobile device. Indeed, the good online E-learning platform of Nanjing Medical University has allowed students to finish after-class assignments, quiz and case analysis. Additionally, undergraduate dental students used the Virtual Simulation Experiment Teaching Center for Dentistry

(VSETCD) of Nanjing Medical University for online learning at home. VSETCD is a good carrier of information and the open sharing of teaching resources undoubtedly. With the development of virtual reality technology, conventional stained slides are scanned and transferred into virtual records. Virtual microscopic slides have opened a new digital model of oral histopathology remote learning[7,8]. The fast move to remote learning could keep students engaged in study solving the problem of teaching delay caused by social distancing limitation. Moreover, students always contacted instructor for each class directly and promptly when studying from home. There were office hours for teachers through wechat and e-learning platforms during this distance learning period. Remote online learning represented an applicable educational methodology in oral pathology teaching in response to the Covid-19 Pandemic.

To overcome immediate impact by Covid-19 Pandemic, we needed to make online courses. Online courses were convenient for universities to deliver. In our study, all the theoretical lessons were video recorded and given through the Internet from February 17th to April 18th for the new semester. Faced with the current situation with COVID-19, we have really kept students engaged in oral histopathology learning via different platforms and methods. Then in April, the situation surrounding COVID-19 changed for better in China. From April 18th to May 30th, students had laboratory lessons in the classrooms with masks and used optical microscope to observe stained slides to obtain the images. Laboratory teaching methods and the application of microscopy skills can really enhance students' learning and motivation. This paper discusses the application of remote learning and virtual microscopy in the special period of oral histopathology teaching, an acute response to the Covid-19 pandemic.

Methods

Participants and setting (Fig. 1)

In China, the 5-year dental undergraduate education programme is comprised of 4 years of preclinical training (year 1-4, including theoretical courses and practical courses) and 1 years of clinical training (year 4-5). This study was conducted at the School of Stomatology of Nanjing Medical University, China. Oral histopathology was taught in the third academic year and included 18 hours of lectures and 18 hours of practical laboratory sessions. 192 students in the third year of dental study with the basic knowledge of histology and embryology were invited to participate in oral histopathology course 98 third-year dental students of Grade 2016 took oral histopathology course face-to-face in 2019 (Traditional group). The rest 94 participants of Grade 2017 took online oral histopathology course using digital methods (E-Learning platform and Virtual Simulation Experiment Teaching Center for Dentistry) plus face-to-face laboratory learning in 2020. During the practical laboratory sessions, the students in both Traditional group and Online group observed the same glass slides for morphological learning. In addition, participants in Online group had the access to log on the online dental learning platform freely for remote learning. Established online learning platform with virtual microscopic slides was supported by Virtual Simulation Experiment Teaching Center for Dentistry of Nanjing Medical University. There were no differences in previous academic records between Traditional group and Online group. All the undergraduate dental students completed the oral histopathology learning and filled out the

questionnaires in the study at the end of the semester. The participants provided informed written consent, and the study followed the Declaration of Helsinki and the guidelines of the Ethics Review Committee of Affiliated Stomatological Hospital of Nanjing Medical University with regard to medical protocols and ethics.

Utilization of Online Learning Platform (Fig. 2&Fig. 3)

For theoretical courses, Dental undergraduate students could download theoretical courses through the E-Learning platform of Nanjing Medical University and applied Virtual Simulation Experiment Teaching Center for Dentistry for morphological learning at home. A member of the teaching team was online to welcome students to the online-learning room and make sure everyone can join smoothly. She always run test sessions to confirm stable internet access and using the software before the classes. Also, we've designed an onboarding process to fully support remote-learning experience for students since technical issues can get in the way of the best for the attendees. In our study, dental undergraduate students all attended the face-to-face experiment study in April and May.

Assessment Quizzes (Fig. 1)

Test questions were designed by a non-investigator from a third party based on the teaching syllabus of Oral Histopathology published by People's Medical Publishing House in 7th edition. Post-tests composed of a set of Lab test and Theory test. The Lab test included the evaluation of students' drawing of histopathological structures and structure identification. The Theory test included single-choice questions (30 items, 1 points each), identification sections (5 items, 4 points each) and essay questions (5 items, 5 points each), which mainly covered basic knowledge of oral histopathology. During the period of marking, identity information of any participant was sealed to avoid bias, and each score point was double-checked by two examiners. Examiners were instructed and calibrated on the evaluation process prior to initiation. Files containing private information were deleted immediately after data collection.

Questionnaire (Table 2)

The study data were collected in June 2020. A questionnaire was conducted with the students after completion of the study, which were used to demonstrate their responses and feedbacks towards the remote learning experience. The sum of the questionnaire points per subject was obtained. The questionnaire included the enjoyment and learning efficiency about remote online learning. Responses from digital group were sorted and analyzed by two independent researchers (1 = strongly disagree, 2 = somewhat disagree, 3 = neither agree nor disagree, 4 = somewhat agree, and 5 = strongly agree).

Statistical Analysis

Data was analyzed using the statistical software program SPSS 22.0 for Windows software (SPSS, Inc., Chicago, IL, USA). Differences of the test scores among the different groups were evaluated by two-way ANOVA (if the data was normally distributed and had variance homogeneity) and Kruskal-Wallis tests (if the data was not normally distributed or had no variance homogeneity). Statistical significance was

defined as $P < 0.05$. The procedure was approved by the Ethical Committee Board of School and Hospital of Stomatology, Nanjing Medical University.

Results

Combination of Remote Learning and Virtual Microscopy Enhances Oral Histopathology

A total of 192 dental students were included in the study, and none of the students were missing at different stages of the study. The sample was composed by 192 dental students attending the third academic year of the undergraduate dental programme in 2020(Online group , n = 94) and 2019 (Traditional group, n = 98). The survey revealed students were aged from 20 to 23 years (average age of 22) in the study. The total score was 100 for each student. The score for daily performance was 10 for each student, which included the evaluation of students' drawing performance and on-line course, making up 10 per cent of the total score. The total score for Lab test was 10 for each student, which evaluated students' grasping of structures, making up 10 per cent of the total score. In the laboratory course of oral histopathology, students need to draw the microscopic manifestations of typical section and deepen their understandings of typical structures through drawing. The paper score for Theory test was 100, which mainly covered basic knowledge of oral histopathology, making up 80 per cent of the total score.

In the laboratory course of oral histopathology, students in the Online group really raised more questions compared to the students in the Traditional group. Indeed they valued the opportunity to solve the problems through face-to-face communication. As shown in Table 1, the test paper score, the score for on-line courses and for Lab test shall be added to the total score. The mean test paper scores of the Online group (80.93 ± 12.15) were significantly higher than those of the Traditional group (73.65 ± 8.46) ($P < 0.01$). The mean total scores of the Online group (82.94 ± 10.76) were significantly higher than those of the Traditional group (77.25 ± 7.55) ($P < 0.01$). The percentage of high total test score (test score > 85) of the Online group (54%) was also significantly higher than that of the Traditional group (15%) ($P < 0.01$). There were no differences of the Lab test scores between the Online group (8.13 ± 1.75) and the Traditional group (8.28 ± 6.48) ($P > 0.05$). There were no differences of the total scores between the male students (80.54 ± 9.90) and the female students (83.71 ± 10.87) in the Online group ($P > 0.05$).

Students' Attitudes towards the Remote Online Learning

Participants were asked to rate their perceptions of the learning experience with remote learning and virtual microscopy at the end of their study. The surveys were tailored for the 94 third-year dental students in Online group. As shown in Table 2, responses were sorted and analyzed. A comprehensive breakdown of all questions and the constitutional ratios of responses are shown in Table 2. Nearly 85.1% (n=80) of the students strongly agreed that they could gain knowledge well via remote learning and the Virtual Educational System for Dentistry. Only one (1.06%) partially disagreed with this statement. 87(92.26%) out of 94 students strongly agreed that watching the video lessons makes it easier for me to understand

the essentials of the lessons compared with the conventional method. Furthermore, both remote learning and virtual microscopy courses were well accepted by students according to the questionnaire.

Discussion

In recent years, with the development of science and technology, the integration of various resources in the teaching has become the development trend[2]. With the interruption of Covid-19 pandemic, dental institutions are confronted with great challenges in teaching. As the Covid-19 pandemic limited the face-to-face teaching in the classroom in February 2020, we recently restructured our pathology curriculum in Nanjing Medical University. Rather than holding face-to-face sessions with students in the classroom, we delivered the theoretic lessons remotely using the latest technology. Online-based oral histopathology education seems to be gaining gradual acceptance among undergraduate dental students.

Augmented and virtual reality technology will represent a promising tool for of dental education in the future[9]. Over the years, some pathology teaching departments in medical universities have been integrating modern teaching methods including problem-based learning and computer-based methods (such as virtual microscopy and online cases) into their curricula[8,10,11]. Also, oral histopathology has developed from an autopsy and macroscopy based discipline to a technically histological discipline applied in the teaching field[12]. E-learning platform and virtual simulation experiment teaching are the products of information technology and crucial parts of educational informatization. The Virtual Simulation Experiment Teaching Center for Dentistry of Nanjing Medical University has been focusing on the construction of dental information-based experimental teaching resources and projects. The virtual simulation experiment system for oral histopathology has also been developed and constructed as a convenient solution for delivering learning. The microscopic digital interactive system, which integrates microscopic image, text, animation and flexible interaction, has been applied to oral histopathology virtual learning these years[13-15]. The application of virtual learning showed that dental students were capable of repeated viewing of virtual slides, which could help students consolidate key knowledge points and reinforce their learning after classes. In general, dental undergraduate students have benefited from this online teaching mode of teacher-student interaction and image sharing[13].

Meanwhile, dental students could download theoretical lessons through the e-learning platform of Nanjing Medical University at home. E-learning in dental education has been increasing along with blended educational techniques before the COVID-19 pandemic. E-learning had become an important method in dental education. It could provide education with lower costs at any time and anywhere [16–18]. It has also been found to satisfy different teaching and learning styles. Most higher education institutions are moving to implement online education in their programs[17,18]. The E-learning platform can provide a stage for sharing and discussion. Students must log in to the e-learning platform to further finish a learning task list for each class. We have incorporated case analysis exercises to help students gain a clinico-pathological point of view.

Our aim is to establish a oral histopathology curriculum and help students grasp the basic knowledge of oral histopathology. Our lectures and practices aim to provide an opportunity that will enable our students to develop a way of clinical thinking, to gain evidence based judgements and improve diagnostic skills for future study. As this is a new and emerging field of our oral histopathology curriculum, a member of the teaching team was online to welcome students to the online-learning room and make sure everyone can join smoothly, conducting successful online education programmes. She always run test sessions to confirm stable internet access before the classes. Also, we've designed an onboarding process to fully support remote-learning experience for students since technical issues can get in the way of the participant. We know that online learning is different from learning in person. And we've carefully designed our concrete sessions with these differences in mind, to ensure each student still get the same level of interactivity as in our face-to-face teaching. Compared with the traditional offline teaching, online teaching has its unique focus and concerns in the oral histopathology teaching. The prompt convenience of the online teaching and the high quality of the virtual microscopic slides offered an opportunity to identify microscopic structures for better learning. The remote teaching model could meet the needs of students at home during this challenging time. Our students were able to take advantage of the unique opportunity to learn online theoretical lessons and review various typical virtual microscopic images in their own spare time, which is essential to the grasp of knowledge.

In the past, theoretical teaching is the main part of the traditional teaching model. Nowadays, observing glass slides should be given priority to maintain efficiency in laboratory course. With oral histopathology teaching hours having decreased over the years, students can always get the full value the new reform these years. This is the reason that we have been introducing a new laboratory course, namely theoretical teaching for one-half time and laboratory learning for the other half. Hence, in April when COVID-19 pandemic was under control in China, all undergraduate dental students in Nanjing Medical University all went back to the classrooms for traditional laboratory study, a shift back to traditional optical microscope methods. The face-to-face laboratory class has its disadvantages in favour of online learning. Once the traditional experimental teaching method of oral histopathology has always been students' using microscope to observe characteristics and drawing pictures by themselves. It is noteworthy that with the digital creative interaction system, the whole class could share typical and interesting images synchronously in the class. We ensured a very collaborative network environment for learning, upgrading teaching quality. As with every student, we consulted and discussed the histological findings of the slides carefully with him face-to-face. We would learn what the current challenges were and help him diagnose the problems one-to-one. This partially explained why the face-to-face laboratory study can always greatly promote the learning efficiency. Finally, students finished a questionnaire after study.

In the present study, 94 dental undergraduate students took part in our newly designed oral histopathology curriculum, which incorporated remote learning and virtual microscopy courses. Indeed, an improvement in the classes was observed by the teacher; also, a higher interaction with the students was described. All the teachers and students all cherished the precious chance for face-to-face study. Consequently, the assessment outcome of the Online group were significantly better than the Traditional group. On one hand, the results showed a statistically significant increase in test scores. On the other

hand, a questionnaire to evaluate the students' overall satisfaction with integrated teaching in oral histopathology was applied. A high level of interest and acceptance was documented among dental undergraduate students in the study. The questionnaire results from the students of the experimental group indicated 85.1% of the students strongly agreed that using remote online learning with better reviews of the images could enhance study than traditional method. Overall, the responses of remote learning and virtual microscopy in the Online group were positive. These findings are in disagreement with many other studies that have reported a positive impact of e-learning on dental education[19].

To sum up, COVID-19 crisis has been affecting the whole world. To maintain high quality of oral histopathology education, a strategy should be developed as an acute response to the pandemic. The response of the current oral histopathology education in Nanjing Medical University to the crisis has been extraordinary. Teaching and assessments have been provided online and face-to-face for the dental curricula in design. Improved student performance was observed when online learning and virtual microscopy courses were introduced in oral histopathology education. There is still great potential for its further development and improvement. We could imagine that, social distance limitation will no doubt be in place in the near future until a COVID-19 vaccine is developed. This in turn has posed an impact on all the activities carried out in dental education. Currently, it is our hope that this continuous crisis will lead to the beginning of many new collaborations. Remote learning, the new method, has been vital to help cope with the social distance limitation caused by this current crisis. The results in the present study demonstrated that the application of remote learning and virtual microscopy have enhanced oral histopathology teaching.

Conclusion

This study found that remote learning and virtual technology have a positive impact on oral histopathology. Remote learning and virtual technology will represent a promising tool for of dental education in the future. The findings highlight the application of remote learning and virtual microscopy have enhanced oral histopathology teaching in China in response to the Covid-19 pandemic.

Abbreviations

VSETCD:Virtual Simulation Experiment Teaching Center for Dentistry

Declarations

Ethics and Consent to Participate

No personal information was collected. Ethical approval was obtained from the Academic Board of Nanjing Medical University. All participants completed written informed consent. Study methods were performed in accordance with approved guidelines.

Consent for Publication

Not applicable.

Availability of data and material

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Y Zhong, W Zhang, LK Liu and Y Xu made substantial contributions to conception and design of the article as well as the drafting the initial manuscript and later revision thereof. Y Zhong, W Zhang, Yangyu Zheng and Y Jiang participated in the design and drafting of the manuscript. Y Zhong and Wen Sun conducted the interviews. All authors contributed to the revision of the manuscript, have given approval of the final version and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Not applicable.

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Tables

Table 1: The assessment outcome of students in our study

Grade	Number of Students	Male /Female	Lab Score	Theory Score	Total Score
2016 Grade	98	32/66	8.28±6.48	80.9±12.15	77.25±7.55
2017 Grade	94	30/64	8.13±1.75	73.65±8.46	82.94±10.76
<i>P</i> value	–	–	> 0.05	< 0.01	< 0.01

Table 2 The questionnaire items for the students concerning their attitudes towards using the remote online learning

Items	Contents	Strongly agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Item 1	I enjoyed learning via the line and online virtual microscope system.	80(85.11%)	13(13.83%)	1(1.06%)	0(0)	0(0)
Item 2	Watching the video lessons made it easier for me to understand the essentials of the lessons.	87(92.55%)	7(7.45%)	0(0)	0(0)	0(0)
Item 3	The video lessons were well made.	83(88.30%)	10(9.64%)	1((1.06%)	0(0)	0(0)
Item 4	The teaching content was updated and interesting.	77(81.92%)	11(11.70%)	6(6.38%)	0(0)	0(0)
Item 5	The digital method can improve my self-learning.	76(80.85%)	17(18.09%)	1((1.06%)	0(0)	0(0)

Figures

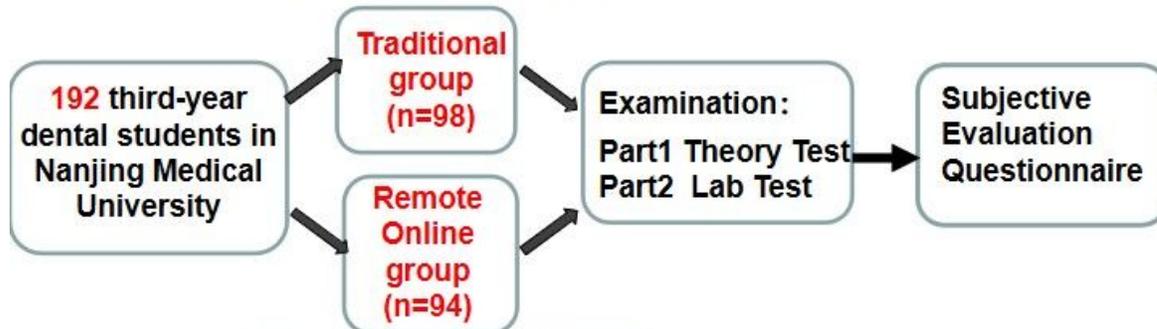
Phase 1

Teaching in Classroom



Phase 2

2 Parts of Tests **Phase 3**

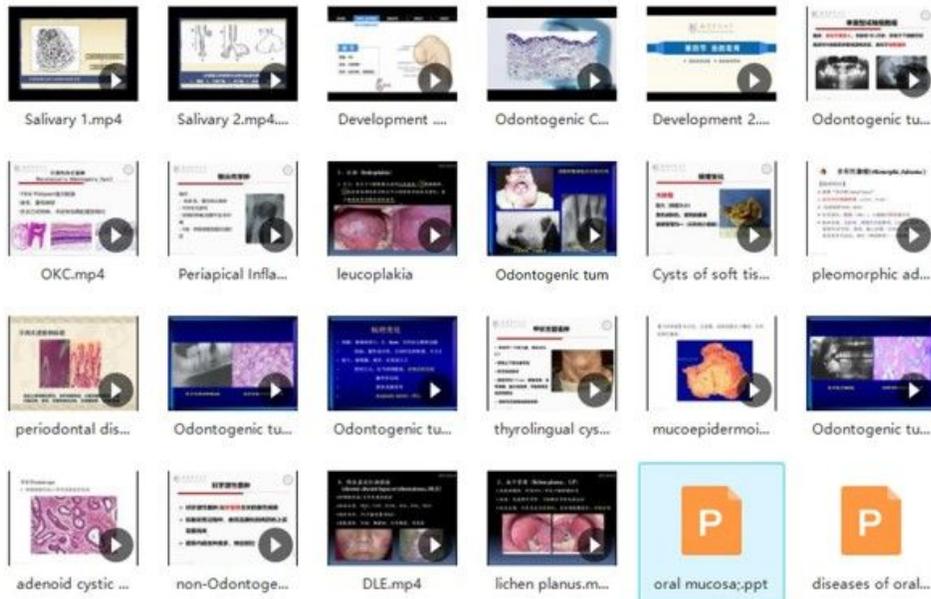


**Remote Online Learning
+Laboratory Class**

Figure 1

Flow chart of the practical process using remote learning for Dentistry in this study

Step 1 Log in to E-learning of NJMU for Theoretical Lessons Videos& PPTs



Step 2 Log in to E-learning of NJMU for After-class Assignments, Quiz and Case Analysis

Student ID	Grade	Hand-in Time	Status	Score for Test	Evaluation
17380111	Grade 17	2020/3/31 19:10:00	Issued	95.00	Good
17380109	Grade 18	2020/3/30 21:45:00	Issued	100.00	Good
17380123	Grade 19	2020/3/30 19:52:00	Issued	95.00	Good
17380128	Grade 20	2020/3/29 9:12:00	Issued	100.00	Good
17380113	Grade 21	2020/3/28 23:26:00	Issued	95.00	Good
17380124	Grade 22	2020/3/28 20:48:00	Issued	95.00	Good
17380103	Grade 23	2020/3/28 19:30:00	Issued	100.00	Good
17380126	Grade 24	2020/3/28 16:34:00	Issued	100.00	Good
17380125	Grade 25	2020/3/28 11:49:00	Issued	100.00	Good
17380101	Grade 26	2020/3/27 18:17:00	Issued	100.00	Good
17380118	Grade 27	2020/3/26 22:06:00	Issued	100.00	Good
17380116	Grade 28	2020/3/25 20:23:00	Issued	95.00	Good
17380130	Grade 29	2020/3/24 20:50:00	Issued	95.00	Good
17380114	Grade 30	2020/3/21 20:55:00	Issued	100.00	Good
17380122	Grade 31	2020/3/21 17:07:00	Issued	90.00	Good
17380117	Grade 32	2020/3/21 13:14:00	Issued	95.00	Good
17380121	Grade 33	2020/3/21 11:40:00	Issued	85.00	Good
17380129	Grade 34	2020/3/20 22:14:00	Issued	95.00	Good
17380127	Grade 35	2020/3/18 12:50:00	Issued	85.00	Good
17380120	Grade 36	2020/3/18 11:11:00	Issued	100.00	Good
17380102	Grade 37	2020/3/17 15:56:00	Issued	100.00	Good
17380115	Grade 38	2020/3/14 9:28:00	Issued	95.00	Good
17380119	Grade 39	2020/3/13 18:16:00	Issued	100.00	Good
17380108	Grade 40	2020/3/12 19:24:00	Issued	95.00	Good
17380112	Grade 41	2020/3/12 14:49:00	Issued	100.00	Good
17380110	Grade 42	2020/3/12 11:25:00	Issued	100.00	Good
17380106	Grade 43	2020/3/11 9:45:00	Issued	100.00	Good
17380104	Grade 44	2020/3/11 9:41:00	Issued	100.00	Good

Online
Assignments
Score

Figure 2

Students log in to E-learning of NJMU for theoretical lessons videos& ppts. Students log in to E-learning of NJMU for after-class assignments, quiz and case analysis.

Step 1
Log in to VSETC of NJMU



南京医科大学口腔医学院 | 附属口腔医院
口腔医学虚拟仿真实验教学中心
Virtual simulation experimental teaching center of stomatology

**Virtual Simulation Experiment
Teaching Center of Stomatology of
Nanjing Medical University**

首页 中心概况 师资队伍 教学平台 特色创新 资源共享 校企合作 规章制度 开放实验室 申报专区

↓ 虚拟实验在线课程云资源库



**Dental
Anatomy**



**Oral
Histopathology**



**Functional
Science**



**Virtual Oral
Laboratory**

Step 2
Virtual Microscopic Slides Learning

115.28.176.223:9000/ndp/serve/view?objectid=EE2E6062-3293-422D-80C7



11-11 Mucoepidermoid Carcinoma



11-12 Adenoid Cystic Carcinoma



11-13 Eosinophilic Lymphogranuloma



11-14 Fibrous Epulis



11-15 Epulis Hemangiomatosa



11-16 Squamous Cell Papilloma

Figure 3

Students log in to Virtual periment Teaching Center of Stomatology of Nanjing Medical University for Virtual Microscopic Slides Learning.