

Application of the Plan-Do-Check-Act Cycle to Quality Management of Online Teaching for Nursing Students in China During the COVID-19 Pandemic: A Self-Controlled Trial

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Research Article

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Abstract

Background: During the COVID-19 pandemic, online education has become popular. However, it was worth probing into how to ensure the quality of online teaching due to the change of learning environment and the barrier of space distance. Zimmerman's self-regulated learning theory argued that the students' self-regulated learning was the interaction between and among ego, behavior and environment, and self-regulated learners could not only a learning process for the inner active control and adjustment, but also through external feedback to the external form of learning and learning environment to take the initiative to monitor and adjust. This study aimed to explore the effectiveness of online teaching management for nursing students based on plan–do–check–act (PDCA) cycle management during the COVID-19 pandemic, and provide reference for further improving online teaching management.

Methods: 151 nursing students from a school were used to select through a cluster sampling method as the participants, and the PDCA cycle was applied to manage online teaching. The effectiveness of teaching was investigated and analyzed using the Nursing Students' Independent Learning Ability Scale, General Self-Efficacy Scale, and a self-administered online teaching satisfaction questionnaire before and 3 months after PDCA application.

Results: The overall satisfaction rate of nursing students with online teaching was 100%, and 99.11%–100% of the students expressed satisfaction with all aspects of the PDCA. Differences in nursing students' independent learning ability (77.475 ± 12.521 vs. 81.168 ± 17.287) and self-efficacy (23.532 ± 4.751 vs. 25.015 ± 5.395) before and after PDCA application were significant ($p < 0.05$).

Conclusions: The PDCA cycle is conducive to improving the independent learning ability and self-efficacy of nursing students, effectively improving the quality of online teaching, and providing a reference for blended teaching quality management in the post-epidemic era.

Background

The coronavirus disease (COVID-19) pandemic has changed every aspect of the world as we know it, including teaching and learning in various countries. At the beginning of the new semester in 2020, countries such as China, the United States, and Germany implemented online teaching and learning at all educational levels and disciplines [1–6]. Online teaching has become a common trend and a normalized teaching method worldwide [7–8]. However, online teaching in the context of the pandemic presents both opportunities and challenges. For example, online teaching and learning has also been shown to provide students with “easier and more effective access to a greater variety and range of information” [9] and improve the knowledge and skills of medical undergraduates [10]. Meanwhile, when face-to-face teaching is switched to online teaching at home, it also brings many problems. Many problems are encountered because of the change of learning environment and the barrier of spatial distance, such as inadequacy or lack of management, learner motivation, time, technology, infrastructure, and institutional safeguards [9]. Therefore, some scholars suggest that sustainable and effective online teaching and learning should be

improved in terms of teaching and learning management, educational design, learning resources, and teaching and learning interactions [11–12].

The plan–do–check–act (PDCA) cycle, also known as the Deming circle, was introduced into China in the late 1970s. The four stages are in a continuous cycle. It was originally used for total quality management and has since been extended to work in a wide range of industries, including teaching.

This study aimed to further explore and analyze the management of online teaching quality of nursing students during the epidemic through the application of PDCA cycle, which has important practical significance for the continuous improvement and improvement of online teaching quality during the epidemic, and provides reference for blended teaching quality management in the post-epidemic era.

Methods

Research participants

A cluster sampling method was used to select 151 nursing students from a school as research participants. The inclusion criteria were (1) provision of informed consent and voluntary participation, (2) enrolment in nursing professional courses in the probation period, and (3) the presence of conditions for online learning and answering online questionnaires. The inclusion criteria were (1) non-nursing students, (2) not fully involved in the probation course, and (3) lack of conditions of online learning.

Research Methods

Online teaching plans and instructional quality control plans were developed using the PDCA cycle (Fig. 1).

PDCA cycle implementation process

For implementation, *gynecology and obstetrics nursing* was taken as an example:

(1) Plan (P) – teaching planning

1) Teaching and learning analysis and determining deficiencies and challenges

To ensure the quality and effectiveness of online teaching, first, the teaching and research department relies on the school platform to facilitate teacher participation in various online teaching skill training programs before the commencement of classes and conduct trials to ensure that each teacher is proficient in at least two to three online teaching tools. Second, through trials of various online teaching tools and learning and exchange of typical experiences in online teaching, excluding various uncontrollable factors, such as network speed, the advantages and disadvantages of various online teaching tools are analyzed and summarized. Third, before the commencement of the course, the Wenjuanxing, a professional online questionnaire survey platform provided by Hunan Changsha Ranxing

Information Technology Co., LTD, is used to conduct an “online teaching survey during the epidemic prevention and control period” and investigate the online learning tools mastered by nursing students, challenges of online learning, and expected teaching methods and suggestions.

Using the three above-mentioned methods, the following potential problems arising during the online teaching and learning of this course are addressed: (1) The online teaching tools selected by teachers are inconsistent, and they are frequently switched within the same class. (2) Live online teaching is more popular, but the focus is not adequately high, and the challenges are not clearly elucidated. (3) There is limited interaction between teachers and students online. (4) The interest in online teaching should be improved, as the interest among nursing students is not high. (5) There is a lack of objective and effective teaching and learning feedback. (6) The use of electronic teaching materials is inconvenient.

2) Discuss and determine the response plan with nursing students as the center

The suggested activities are as follows: unify online teaching tools, build a teaching model, and develop a teaching program; design teaching resources effectively for easy use and instant sharing, designed carefully to enrich the classroom and enhance the interest of nursing students in learning; carry out curriculum ideology and politics and aid the development of a scientific and objective teaching evaluation method.

(2) Do (D) – Teaching and learning implementation

1) Before the class, build an online teaching model, formulate an online teaching plan, and build an online learning flow chart.

Based on the premise of facilitating teaching in nursing students and taking into account the advantages and disadvantages, teachers of this course uniformly chose Tencent Classroom as the online live teaching tool; developed the online teaching mode of the “university massive open online courses (MOOC) platform/QQ group (publishing learning materials) independent learning + Tencent Classroom live broadcast + QQ group after-class assistance”; formulated the online teaching program of the course, specified the weekly learning tasks, key learning points, and difficulties; and used available teaching resources and methods. Moreover, an “online learning flow chart” was prepared to guide nursing students in familiarizing them with the online teaching process and ensure the smooth launch of the course.

2) During the class, elaborate the design, create “authentic, interesting, interactive, organized, expansive, nurturing” classroom, and practice the “three entire” nurtures the human pattern, that is, the whole staff nurtures the human, the entire process nurtures the human, omni-directional nurtures the human.

First, restore the “authenticity” of the classroom. Tencent Classroom was used to broadcast live and share teaching aids, videos, and pictures to visualize the teaching content. The whole teaching process was in the form of a “picture-in-picture” so that nursing students could hear clearly and clearly view the teacher’s face, thus realizing online face-to-face teacher– student interaction.

Second, make the classroom more interesting. The course introduction is linked to Internet phrases to bring teachers and students closer, such as “teasing from boyfriend” and “period.” The teaching modules are richly designed and named in a way that is popular with nursing students, such as “small sensations,” “questions and answers,” “talking,” “parent–child” interaction, and “small trials.” The teaching tools are flexible and varied, and hands-on teaching adds to the interest. Moreover, on the basis of the traditional teaching models, pictures, videos, and 3D animation is incorporated promptly to turn abstraction into intuition, which facilitates learning and mastery.

Third, increase the interactivity of the classroom. In the classroom, interactive activities are initiated through small videos or keywords, and nursing students leave comments or “raise their hands” in the “discussion forum.” For example, with “period,” nursing students left comments on the discussion forum to show that they had gained knowledge about premenstrual syndrome, common discomforts during menstruation, and how to take good care of themselves. The CCTV documentary “The Firsts in Life – The World at First Sight” was useful to promote emotional involvement in students. An increase in interactivity made the online classroom “vibrant” and allowed nursing students to easily manage their professional knowledge.

Fourth, knowledge is “organized” logically. Mind maps are used to link knowledge points, lay out the knowledge surface, increase the layering and logic of knowledge understanding, and help nursing students unlock effective thinking patterns. Moreover, to highlight the key points, the difficulties should be discussed to attract the attention of students. During the lecture, include more pictures and fewer words, e.g., when explaining “ovulatory disorders and abnormal uterine bleeding,” a diagram will clearly explain its causes and consequences.

Fifth, the “expandability” of knowledge was highlighted. For example, “get to know loop electrosurgical excision procedure (LEEP)” expands the clinical frontiers and introduces the common clinical treatment methods for cervicitis. The “no better how beautiful the spring is, you are a million times better-Doula delivery” extends learning in the form of group work and mutual evaluation of homework, which expands the scope of the online teaching content.

Sixth, include the “nurturing” aspect of the profession. In light of the COVID-19 pandemic, the course takes maternal and child health in the context of life as a guide, guiding nursing students to think about life, cherish life, inspire innovation, and promote an enterprising attitude.

3) Post-class, Tencent QQ helps students teach and learn to grow with each other.

Through the Tencent QQ group, we actively answer questions for nursing students and continue to build a bridge for knowledge internalization, so that “teaching” and “learning” are inseparable and mutually promotional.

(3) Check (C) – Teaching evaluation

The assessment model is a combination of learning assessment and teaching assessment, real-time process feedback and summative feedback, and quantitative and qualitative evaluations.

(4) Act (A)

According to the evaluation results, the experience gained will be used in the next cycle of teaching activities. The problems identified in this cycle and rectification measures will be focused on in the next cycle of teaching quality monitoring so that problems can be identified and solved and feedback provided promptly to ensure that they do not recur, which will promote the smooth development of teaching activities and provide a guarantee for the continuous improvement and enhancement of teaching quality.

Evaluation indicators

(1) Self-regulated learning ability

The Self-regulated Learning Ability Scale for Nursing Students [13] was used to evaluate learning; the scale comprises 28 items in three dimensions: self-management ability, information ability, and learning cooperation ability. The Cronbach alpha coefficient of the total scale was 0.86, and the split-half reliability was 0.77, which indicated good reliability and validity. The 5-point Likert scale was used, and the higher the total score, the stronger their self-regulated learning ability.

(2) Self-efficacy

The general self-efficacy scale [14] was used for evaluation, with an internal consistency coefficient of 0.87, test-retest reliability of 0.83, split-half reliability of 0.9, and correlation coefficients of 0.60–0.77 for the ten items and total scale score, with good reliability and validity. The higher the total score, the stronger the self-efficacy.

(3) Online teaching satisfaction survey

A self-made questionnaire was used, which included (i) general information (sex, age, and grade, among other items.), (ii) an online teaching survey (satisfaction with each aspect of the PDCA implementation process and its reasons), (iii) a survey on the use of each online teaching tool, among others.

Data collection method

The self-regulated learning ability and self-efficacy of nursing students were assessed respectively before and 3 months after PDCA application to the online teaching of *gynecology and obstetrics nursing*. A survey was also conducted on the online performance of nursing students and the satisfaction rate of online teaching of this course after PDCA application. The teaching team relied on Wenjuanxing to conduct an anonymous online survey.

Data analysis

The collected data were verified, numbered, and entered into the EXCEL database, and IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, NY, USA) was used for data processing and analysis. Categorical data were described by frequency and percentage for χ^2 test. Quantitative data were described by mean \pm standard deviation for the t -test, and $\alpha = 0.05$ was taken as the significance level.

Results

Of 151 students who participated in the survey, 139 (92.1%) effectively responded before the PDCA cycle application and 137 (90.7%) effectively responded after the PDCA cycle application. The detailed description of the participants is shown in Table 1. There were statistically significant differences in participants' self-regulated learning ability and self-efficacy before and after the application of PDCA cycle ($P < 0.05$) (see Table 2 and Table 3, respectively). More than half of the students said that they liked the class because the classroom atmosphere was relaxed and active, the methods used increased attentiveness, the learning content was interesting, learning was useful, and the learning experience was enjoyable, so the overall satisfaction rate of nursing students to online teaching was 100% (Fig. 2). The completion of course resources on the MOOC platform is 100%, with a score of 98.010 ± 3.651 on the online unit test and 94.286 ± 8.421 on the online end-of-course exam.

Table 1
General information of nursing students before and after PDCA application

Item	Before application (n = 139)	After application (n = 137)	χ^2/t value	<i>P</i> -value
Age ($\bar{x} \pm s$, age)	22.05 \pm 0.75	22.11 \pm 0.69	-0.628	0.530
Sex [cases (%)]	9 (6.5)	6 (4.4)	0.589	0.443
Male	130 (93.5)	131 (95.6)		
Female				

Table 2
Comparison of the self-regulated learning ability of nursing students before and after PDCA application ($\bar{x} \pm s$, scores)

Item	Before application	After application	<i>t</i> value	<i>P</i> -value
Overall score	77.475 \pm 12.521	81.168 \pm 17.287	-2.035	0.043
Self-management skills	25.755 \pm 4.528	27.051 \pm 5.737	-2.084	0.038
Information skills	32.576 \pm 5.880	34.343 \pm 8.657	1.987	0.048
Ability to learn and cooperate	19.144 \pm 3.981	19.781 \pm 4.449	1.254	0.211

Table 3
Comparison of the self-efficacy of nursing students before and after PDCA application
($\bar{x} \pm s$, scores)

Item	Number of people (cases)	Total score	T value	P-value
Before application	139	23.532 ± 4.751	-2.421	0.016
After application	137	25.015 ± 5.395		

Discussion

The PDCA cycle can effectively improve the independent learning ability of nursing students

Independent learning ability is a necessary asset for present-day nursing workers to gain lifelong learning; therefore, nursing educators at home and abroad have paid attention to the cultivation of the independent learning ability of students [15–16]. However, some studies have shown that the overall independent learning ability of nursing students in China is not high [13]. Therefore, some scholars have suggested enriching learning resources and providing students the scope to improve their independent learning ability [17]; e.g., online learning can increase feedback, question and answer, technical support, and other interactions to improve student participation in online learning [12]; teaching method reformation, and teaching assessment system improvement [15, 18]. In this study, independent online teaching was conducted during the epidemic, making full use of modern information technology, monitoring the quality of teaching through the PDCA cycle, continuously implementing the “student-centered” and “competency-based” educational philosophy, and adopting flexible and variable teaching methods. In the teaching process, the quality of teaching is monitored through the PDCA cycle, the “student-centered” and “competency-based” educational concept is always implemented, and flexible teaching methods and evaluation methods are used to mobilize the learning enthusiasm and initiative of nursing students, particularly their ability to acquire information and manage learning. Although group work, discussion, and debriefing were used, they did not exert significant effects on the ability of nursing students to learn cooperatively.

The PDCA cycle helps nursing students develop a sense of self-efficacy

Jiao Yanhui [19] showed that the independent learning ability of nursing students is positively related to their self-efficacy and is suggested for optimizing the educational environment and enhancing the self-efficacy of students to improve the independent learning ability of nursing students. Studies conducted in other countries have also shown that students with a high sense of self-efficacy have higher demands on

online courses, suggesting that online teaching should be focused on evaluating teaching design, developing learning resources, and setting learning objectives [10, 20]. In this study, reforms were made in the teaching management and various aspects of the teaching process. By announcing the teaching plan in advance and adopting a task-driven approach, students were motivated to set learning goals and choose effective learning strategies. By relying on the advantages of online information availability, students were guided to identify and solve problems through the provision of rich online learning resources. By reforming teaching methods and means to create successful experiences for nursing students, the performance of nursing students was positively evaluated from multiple perspectives. The PDCA cycle is used to monitor and evaluate all aspects of teaching and learning, guide nursing students to summarize their failures and correctly attribute them, eliminate or reform undesirable behaviors and negative emotions that affect learning, stimulate interest in learning, build self-confidence in learning, and continuously enhance their sense of self-efficacy, thus enabling nursing students to actively participate in learning and continuously develop and improve their independent learning ability. This will enable nursing students to alternately improve their self-regulated learning ability and self-efficacy.

The PDCA cycle has improved the quality of online teaching and learning, providing a reference for teaching in the post-epidemic era

The quality of talent cultivation is an important indicator to measure the level of higher education, and the quality of teaching determines the quality of talent cultivation. Therefore, teaching quality forms the core of education. Teaching management, as a means of monitoring teaching quality and achieving it, plays a vital role in improving the quality of talent cultivation. Teaching activities form a continuous process; similarly, teaching quality monitoring is also a continuous cycle of improvement, which is in line with the PDCA cycle. By applying PDCA to online teaching, the teaching team has effectively solved the problems that exist in independent online teaching, such as inadequate teaching management and the lack of independent learning ability, and improved the quality of independent online teaching, making it substantially similar to offline teaching.

The study has some limitations. First, this study has a small sample size and concentrated on one major, the findings of which may not apply to students of other majors. Second, this study only assessed online and offline performance and did not compare the academic performance of students. In the future, comparative studies could be conducted in groups to evaluate differences in knowledge acquisition among students under different modes of teaching management.

Conclusions

There is a law in teaching, but there is no fixed law in teaching, and the most important thing is to obtain the law. Therefore, with the application of the PDCA cycle in independent online teaching quality monitoring during an epidemic, in future, the following concepts should be incorporated in teaching: the teaching design should have a soul and be student centric, and teachers should provide guidance and feedback to summarize PDCA control quality. The epidemic will eventually be controlled, and future

research can combine face-to-face teaching, with full consideration to the advantages of online teaching under the PDCA cycle, and explore the strategies to improve the quality of hybrid teaching.

Abbreviations

PDCA, plan–do–check–act; COVID-19, coronavirus disease; MOOC, university massive open online courses

Declarations

Ethics approval and consent to participate

All methods used in this study were in accordance with relevant guidelines and regulations. After a rigorous review, the Ethics Committee of Binzhou Medical College waived the need for consent and ethical approval for teaching research.

Availability of data and materials

The dataset collected and analyzed in this study is not publicly available because it includes personal information of students, and there are restrictions on ethical approval and anonymity. However, data are available upon reasonable request to the corresponding author.

Competing interest

Not applicable

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Authors' contribution

HW designed and developed the study and wrote the main manuscript text; PZZ contributed to collecting and analyzing the data. Additional, figures 1-2 and table 1-3 were prepared by PZZ; XLZ helped secure the grant, instructed the teaching program and implemented part of the plan; HW carried out all the plans;

XLZ, YYF and PZZ instructed and revised the manuscript. The authors reviewed and approved the manuscript.

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References

1. Zhou L, Wu S, Zhou M, Li F. 'school's out, but class' on', the largest online education in the world today: taking china's practical exploration during the covid-19 epidemic prevention and control as an example. *Best Evid Chin Edu* 2020; 4(2):501–519.
2. BBC News. Cambridge University: All Lectures to be Online - Only Until Summer of 2021 BBC. [cited 2020 Jun 19]. Available from: <https://www.bbc.com/news/education-52732814>.
3. Marsicano C, Felten K, Toledo L, Buitendorp M. Tracking Campus Responses to the COVID-19 Pandemic [Epub ahead of print]. 2020. <https://doi.org/10.33774/apsa-2020-3wvrl>
4. Forbes. Esaki-Smith A. Harvard Law School Will Be Online-Only In The Fall, Harvard's Entering MBA Class Is Down Nearly 25%. [cited 2020 Jun 19] Available from: <https://www.forbes.com/sites/annaesakismith/2020/06/04/harvard-law-school-will-be-online-only-in-the-fall-harvards-entering-mba-class-is-down-nearly-25/#387d44da4dd5>.
5. Basilaia G; Kvavadze D. Transition to Online Education in Schools during a SARS-CoV-2 Coronavirus (COVID-19) Pandemic in Georgia. *Pedagogical Research*. 2020, 5(4):em0060.
6. Kerres M. Against All Odds: Education in Germany Coping with Covid-19. *Postdigital Science and Education*. 2020, 2(3):690–694..
7. Murphy MPA. COVID-19 and emergency eLearning: Consequences of the securitization of higher education for post-pandemic pedagogy. *Contemporary Security Policy*. 2020, 41(3):1–14.
8. Ferraro FV, Ambra FI, Aruta L, Iavarone ML. Distance learning in the COVID-19 era: perceptions in southern Italy. *Education Sciences*. 2020;10,355.
9. O'Doherty D, Dromey M, Loughheed J, Hannigan A, Last J, McGrath D. Barriers and solutions to online learning in medical education - an integrative review. *BMC Med Educ*. 2018;18(1):130.
10. Pei L, Wu H. Does online learning work better than offline learning in undergraduate medical education? A systematic review and meta-analysis. *Med Educ Online*. 2019;24(1):1666538.
11. Wang C, Xie A, Wang W, Wu H. Association between medical students' prior experiences and perceptions of formal online education developed in response to COVID-19: a cross-sectional study

- in China. *BMJ Open*. 2020;10(10):e041886.
12. Delnoij LEC, Dirkx KJH, Janssen JPW, Martens RL. Predicting and resolving non-completion in higher (online) education – A literature review. *Educational Research Review*. 2020;29:100313.
 13. Hong YM. Establishing Norms for the Instrument of Competencies of Autonomous Learning of Nursing Students. Shanghai: Naval Medical University; 2016.
 14. Schwarzer R, Born A. Optimistic self-beliefs: Assessment of general perceived self-efficacy in thirteen cultures. *Word Psychology*,1997,3(1–2):177–190.
 15. Zhou HY, Sun YR, Chi YH, Hu XF, Wang J, Zhang YL. Difference Analysis of Military Undergraduate Nursing Students Autonomous Learning Ability. *Nursing Journal of Chinese People’s Liberation Army*. 2017,34(2):63–68.
 16. Ghiyasvandian S, Malekian M, Cheraghi M A. Iranian Clinical Nurses' Activities for Self-Directed Learning: A Qualitative Study. *Global Journal of Health Science*. 2016; 8(5):48–58.
 17. Chen CY, Shen Q, Chen YY. Correlation between Web-based Self-learning Ability and Time Management Tendency of Nursing Undergraduates and Its Influencing Factors. *Nursing Journal of Chinese People’s Liberation Army*. 2019,36(11):1–5.
 18. Han HH, Ye GY, Zhou SP, Shen KZ, Zhao CY. Application of Participatory Teaching Methods in Surgical Nursing for “3 + 2” Higher Vocational Nursing students. *Nursing Journal of Chinese People’s Liberation Army*. 2017,34(15):53–55.
 19. Jiao YH, Song M. Independent study ability and its influencing factors of undergraduate nursing students. *Nursing Research*. 2018,32(13):2110–2114.
 20. Regmi K, Jones L. A systematic review of the factors - enablers and barriers - affecting e-learning in health sciences education. *BMC Med Educ*. 2020;20(1):91.

Figures

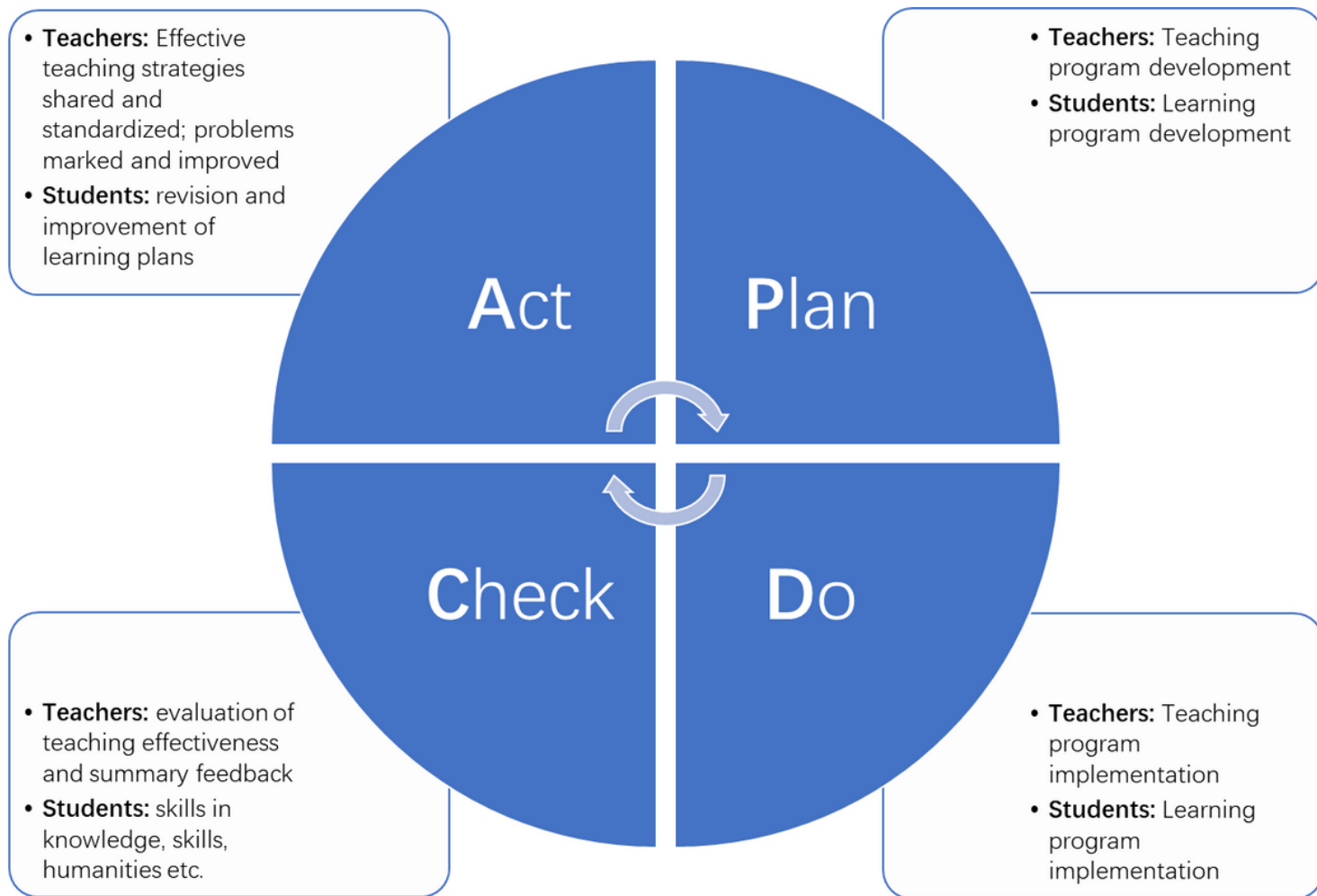


Figure 1

The PDCA cycle is used to guide online teaching plan development and teaching quality improvement

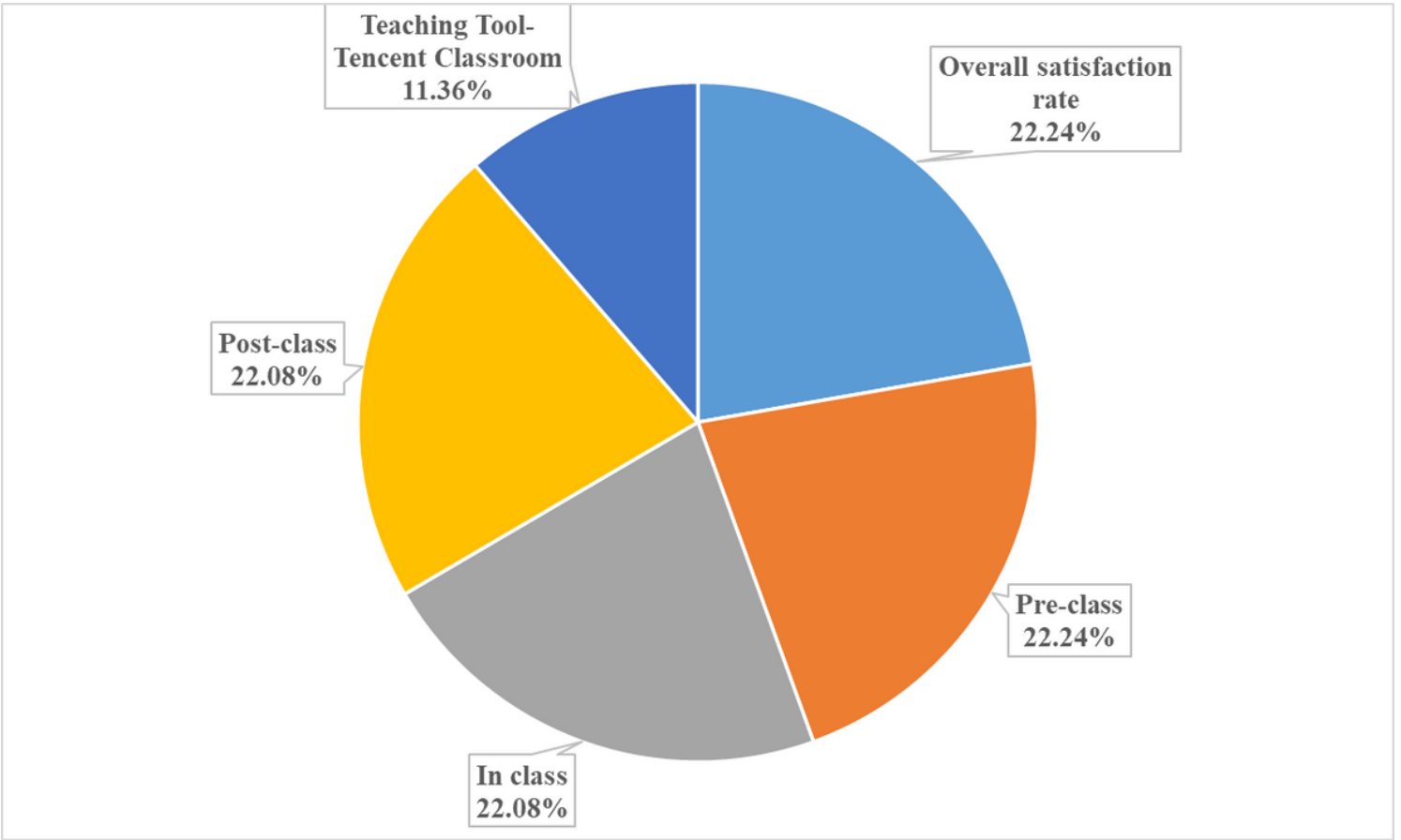


Figure 2

Results of the survey on nursing student satisfaction with online teaching after PDCA application